Aquafarming and Its Impact on Rural Communities of Bangladesh

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The study was conducted to evaluate the impact of aquafarming on rural communities particularly on the fishermen in terms of socio-economic condition in some selected area of Muktagacha upazila in Mymensingh district of Bangladesh. For collection of data through participatory rural appraisal (PRA) tools with a well-structured questionnaire from July to December, 2017 a total of sixty fishermen were selected randomly. Twelve livelihood aspects of fishers were selected and Pearson's product moment correlation coefficient (r) was used to evaluate the changes of socio-economic status. The findings of the study revealed that through aquaculture majority of the respondents about 58.3% moderately changed their livelihood status, while 31.7% reached higher level and only 10% of the respondents were under lower level. Out of twelve selected livelihood aspects seven were positively correlated but four of them had no relationship with their changing livelihood pattern through aquafarming. The survey identified that fishermen faced various problems such as social, economic and technical. Mostly lack of capital, illiteracy on fish farming, unawareness on health, vulnerability and few institutional supports were the main constraints in

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their upliftment. The findings of the research revealed that aquafarming resolutely contributing for the development of socio-economic condition of fishers in the explored area and recommended that GOs, NOGs and stakeholders should take more steps for sustainable development.

1. INTRODUCTION

In the global ecological crisis, exploring the interconnection and correlation between the human (e.g. livelihood) and natural (e.g. ecosystems) systems is vital to accomplish a sustainable and irrepressible future [1,2,3]. Ecosystem services are often recognized as the interface of the complex relationship between human and natural systems. In the developing countries local knowledge, gender, ethnicity, and history of colonialization are considered as crucial determinants for defining human livelihoods [4,5]. Bangladesh is a country of agricultural where majorities of the rural people depend on natural resources (land, aquatic resources, forests, livestock etc.) for their livelihoods. The livelihood capabilities of an individual household can be determined by the assets (natural, physical, human, financial and social capital) along with the activities and the accesses [6]. This is particularly important for poorer households as they have few opportunities of income generation for their livelihoods. Fisheries and aquaculture are one of the most upgrading sub-sector of agriculture throughout the world. A greater percentage of individual has been involved in income generating activities through the development and expansion of aquaculture. Fish farming, marketing and associated activities has become an integral part of human life and livelihood of the rural people of Bangladesh [7,8]. According to the [9], the total fish production was 42.77 lac MT where 6.54 lac was contributed by aquaculture in the fiscal year of 2017-2018. In the gross domestic product (GDP) of Bangladesh fisheries sector contributes 3.57% and about 16.5 million people are directly or indirectly involved in aquaculture related activities [10]. Fisher group is an important community in Bangladesh for economic enrichment and about 16.5 million people are directly or indirectly associated with fish farming activities [9] in spite of this in Bangladesh fishers are the most ungraded group who deprived of many amenities of life. The livelihood condition of the fishermen is not up to the mark and they have to endeavor continuously for survive. When a livelihood can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets for now and future then it can be sustainable [11]. Different approaches had been adopted for sustainable rural development and poverty elimination but in case of poverty focused development activities sustainable livelihood approach has been gradually expanded with its core and principles [12]. The approach basically focused on the fundamental principle analysis of capital assets in the context of the external environment. According to [13] for development and poverty elimination a sustainable livelihood approach is a way of thinking about the objectives, scope and priorities. So, the financial hardship and other complexities can be considered for analyzing the socio-economic conditions of the rural fish farmers. Kumarghata union of Muktagacha upazila under Mymensingh district in Bangladesh is one of the most prominent area where aquaculture is becoming popular day by day due to technological support from Bangladesh Agriculture University, situated in the same region. Most of the people of four villages (Garaikuti, Kumargatha, Pathalia & Kandulia) under this union depends on aquafarming/ fish farming activities for their livelihood.

Advanced knowledge and information are most important for better living. Socio-economic conditions illustrate the present status, standard of living and economic condition of people. In fact, income generating activities determine the socio-economic pattern which may affect the community environment. Overall, for progress and accomplishments of fisheries projects it is necessary to have a sound knowledge on the socio-economic status of the fishers reflects the major limitation of life and also suggests the possible way of developing their livelihood status. Thus, for the first time in Kumarghata union a survey was carried out to evaluate the impact of aquafarming on livelihood pattern of the fishermen and it will largely contribute in the formulation of appropriate management strategy in the study area for socio-economic development of the rural communities.

2. MATERIALS AND METHODS

2.1 Location of the Study Area

Current study was carried on at Kumarghata union of Muktagacha upazila under Mymensingh district, Bangladesh located between *24.76°N* to *90.31°E* (Fig. 1). The area was selected due to favorable hydrological conditions and availability of agricultural land which are low lying and where people mostly depend on fish farming for their livelihood.

Fig. 1. Map showing the location of the study area of Kumarghata union at Muktagacha upazilla in Mymensingh district of Bangladesh. The map is extracted from DIVA-GIS using Geographical Information System (GIS) and visualized by ArcMap version 10.7.

2.2 Methodology

2.2.1 Data collection

From primary and secondary sources data were collected. Fishermen were respondent for primary data and considering the objectives of the study a number of visits were made to the study area for data collection. The data were collected from July to December, 2017 from sixty respondents who were randomly selected. With a different degree of effectiveness Participatory Rural Appraisal (PRA) tools and personal interview were applied for data collection. Data on fish culture techniques, production rate, farming constraints, production costs and benefits, vulnerability concern, gender issues, financial issues, livelihood outcomes, sustainability etc. were conducted through Questionnaire survey. Focus Group Discussion (FGD) and Cross-check interviews with key informants of Participatory Rural Appraisal (PRA) tool was performed. To know about the existing fish farming and marketing systems along with socio economic status of farmers FGD was taken in consideration. Crosscheck interviews were conducted after collecting the data with key informants such as upazila fisheries officer, researchers, DoF and other relevant non-government organization (NGO) workers for confirmation of the collected information. When information was found to be contradictory additional assessment was carried out. A total of 16 key informants were interviewed. Secondary data were collected through literature and publications available from upazila fisheries office, quarterly and annual reports; Books of Bangladesh Bureau of Statistics (BBS) was used to cross- check, complement or illustrate the primary data obtained through the questionnaire survey and group discussion.

2.2.2 Data processing and analysis The collected data were summarized and scrutinized carefully before the final tabulation. The tabulation and graphical representations of the data were performed by Microsoft Excel-2013 and statistical analysis of the recorded data was performed by Statistical Package for Social Science (SPSS 10.5).

3. RESULTS AND DISCUSSION

In current study total 60 fishermen were interviewed and data on various socio-economic conditions like age, education, family and farm size, area of fish farming, knowledge and experience in fish farming, training exposure, annual income, organizational participation, extension media contact etc. were collected. A detailed analysis is made in respect of the aims and objects of the study.

3.1 Age Distribution and Religious Status

The potentiality of human resources can be estimated by the information of age distribution. In this study the interviewee age ranged from 25 to 65 years with an average of 40 years. The investigation showed that majority of the fishers

belongs to the age of 36-50 (50%), while youth having a range of 18-35 years belongs (28.3%) and 51-65 aged class had the lowest involvement (21.7%) (Table 1, Fig. 2). It indicates that number of workable people is high. Results of the current study are related with the result of [14] reported that about half of the respondents were 31-40 years old in the district of Mymensingh and [15] reported that the percentage of old people was highest about 56% and 14% people belonged to the age group of 41-60 years were involved in fisheries of Bangladesh. Religion is important in the socioeconomic life of people that can act as a notable constraint or modifies in social change. In our study area, majority fish farmers about 56.7% were Muslims, while 43.3% were Hindus with the absence of Buddhists or Christians.
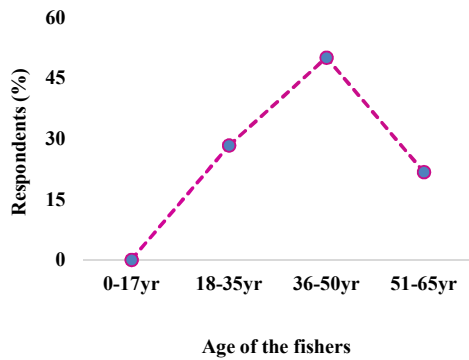

Fig. 2. Age distribution of the respondent fishermen

3.2 Family Size and Type

Family size of the respondents were ranged from 2 to 9 and on the basis of the number of family members the size of the family was divided into three categories such as nuclear family (up to 4), medium family (5-6) and joint family (>6) (Table 1). The data represent that majority (48.3%) of the respondents belongs to nuclear family followed by medium (41.7%) and joint family (10%) (Fig. 3). The above results are corroborated with the findings of [14] stated that the attitude of the fishermen to live in the joint family and nuclear family was about 57.50% and 42% respectively in the district of Mymensingh. Present study result indicates that fishermen of the study area are not consenting to live in the joint family may be due to economic condition as a result in their society the percentage of joint family are lessen gradually but medium to large sized family got extra facilities from the other

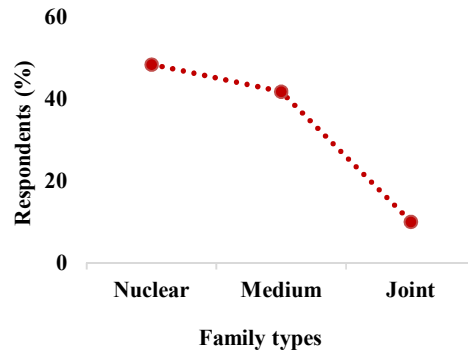members of their family in fish farming activities than that of the nuclear family.

Fig. 3. Family type of the studied respondents

3.3 Housing Condition and Electricity Coverage

During this study efforts were made to find out the status of houses of the fishermen as an indicator of economic status. The majority of the respondents 46.7% had tinshed, while 16.7% had kacha, 26.6% had semi-paka but only 10% had paka or RCC building (Fig. 4) which is more or less agreement with the findings of [16]. The result indicates that socio-economic status of the respondents is upturning as a result they are now able to enjoy electricity. The study revealed that out of 60 interviewed about 80% of the fishermen had electricity access, while minority about 20% had none which represents a better electricity consumption by the fishers in the selected areas.
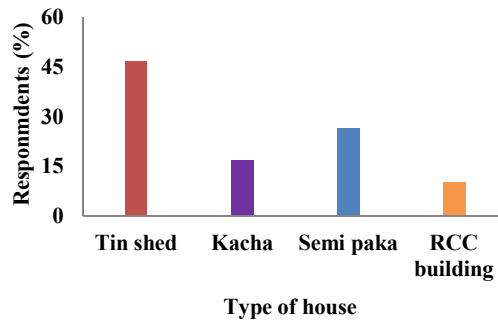

Fig. 4. Types of houses of the fishermen in the study area

3.4 Drinking Water Facilities

The clean and safe drinking water is the most valued elements of a society. The study showed

that 66.70% of the farmers had own tube-well but 33.30% collected drinking water from neighbors tube-well (Fig. 5). But previous study report on drinking water facility of fishermen by [17] showed lower percentage of tube-well ownership. So, the availability of clean and safe drinking water for the fishers in the study area is good enough.
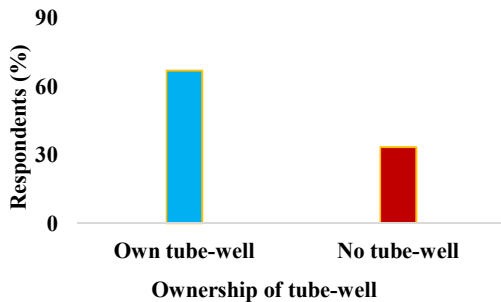

Fig. 5. Ownership of tube-well by the fishermen of the study area

3.5 Health and Sanitary Status

In the study area, it was found that a greater proportion of fishermen depend upon village doctors about 46.7%, while 5% were depended on kobiraj but majority about 48.3% received health service from Govt. upazila hospital (Fig. 6). Besides, during survey it was observed that three types of toilets were used by the fisher men such as i) kacha toilet made of bamboo with leaf shelter with inadequate drainage disposal, ii) Semi-paka toilet made of tin or wood with inadequate drainage disposal and iii) Paka toilet made of brick with good drainage disposal. In the study area, about 3.3% fishers had unhygienic, while 68.3% had semi-hygienic and only 28.2% had hygienic toilet (Fig. 7). The above findings were in agreement with [14,18,19] which indicates a poor sanitary condition of the fishermen due to their financial crisis and reflected their unconsciousness on health.

3.6 Educational Status

In our present study it was noticed that fishermen had diverse level of educational background. Where about 57.7% fishermen had primary education, while 31.7% received secondary education and just 3.3% received higher education and rest of them were illiterate (Fig. 8). In this case [20,21] who had worked with fishers communities give support to the findings of our study. During survey it was heard that at one

time there were rarely educational institutions and extreme poverty pushed most of the fishermen to enter into the fishing profession at their early age of life. Along with schooling of children is an important indicator to assess the livelihood status of farmer. Present survey reported that about 78.3% children were going to school, while 21.7% were not and fishers´ children about 41.15% were found up to primary level, whereas 29.1% not school going and 11.98% children dropped out before completing their primary education reported by [22] which are more or less similar with our present survey. Our findings showed a better educational progress in the study area than the past as the fishers are now able to afford in education.
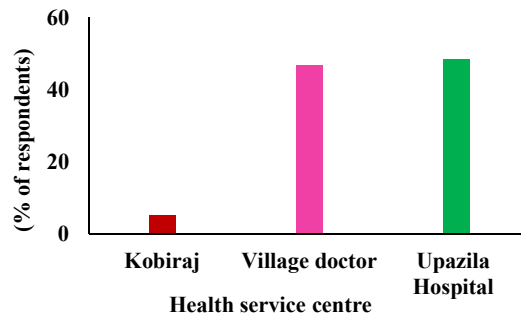
Fig. 6. Health facilities of the fishermen in the study area
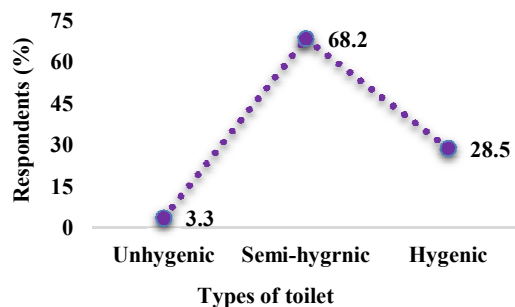
Fig. 7. Sanitary status of the fishermen in the study area

3.7 Area under Fish Farming and Pond Ownership

Area under fish farming of the respondents ranged from 0.36 to 1.66 hectares. Average farm size of the respondents was about 0.67 hectares. During survey based on their farm size three types of farm owner were found where majority of the respondents as 56.7% had marginal sized farm, while 16.7% had medium farm and 26.6%

had small sized farm (Table 1). The information indicates that majority of the respondents had marginal and small farm may be due to financial aspect. On the other hand, based on survey data pond ownership of the respondents classified into four types' viz., single ownership, multiple ownership, single lease and multiple leases. Where, about 50.7% of operators had ponds of single ownership, while about 20.7% had ponds of multiple owner ship, and about 11.7%, 16.9% were involved in single lease and multiple lease ponds respectively (Fig. 9) indicates the less percentage of multiple ownership which may play a vital role for individual success in fish farming.
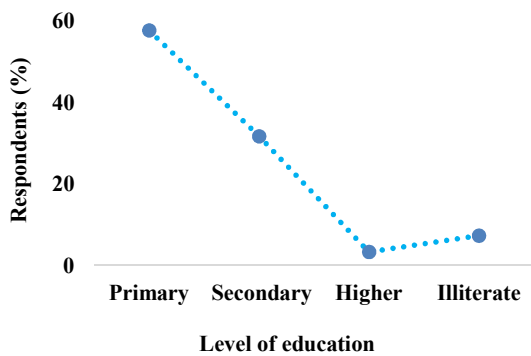

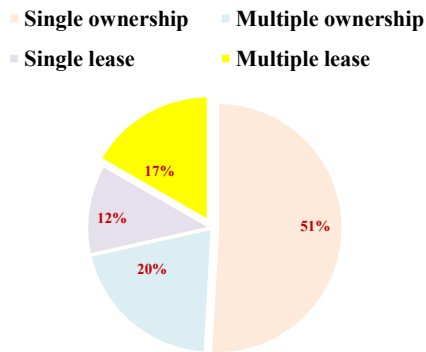**Fig. 8. Educational qualification of the fishermen in the study area**

Fig. 9. Pond ownership of the respondent fishermen in the study area

3.8 Knowledge and Experience on Fish Farming

After analysis of the collected data the scores of knowledge on fish farming of the respondents

ranged from 10-25, with an average of 17.92. On the basis of this scores fish farmers were classified into three categories as low (up to 10), medium (11-20) and high (21-30) (Table 1) which indicated that majority of the fish farmers about (70%) had medium knowledge, while about 30% had high knowledge on fish farming. Moreover, result of the analysis also showed that about 35%, 41.7%, 23.3% of the respondents had low, medium and high experience in fish farming respectively (Table 1) that mostly derived from previous aquaculture practice. Here, majority of the respondents had medium level of experiences may be due to medium aged and collective involvement in fish farming.

3.9 Training Exposure

Training exposure score of the respondents ranged from 0 to 13 days. Data contained in (Table 1) showed that 43.3% of the respondents had no training exposure, while 23.4%, 25%, 5% received short-term, mid-term, long-term training exposure respectively (Table 1) which indicates the lack of long-term training exposure by the respondents may be due to lack of organizational facilities.

3.10 Sources of Credit and Average Annual Income of the Fishers

Sources of credit and average annual income of the fishers: In the study area farmers had to receive loan from bank, NGOs and money lenders for fish farming activities because of their low income. The study revealed that about 43.3% of the farmers had their own money, while about 30% of the farmers received loan from bank for fish farming, about 16.7% received loan from NGOs and rest of the them received loan from arotdar (moneyed man) (Fig. 10). According to the fishers´ opinion present annual income ranged from 87 to 240 (1=1000 TK) with an average of 140.75 (Table 1). The findings showed that about 66.66%, 23.33% and 10% of the respondents had moderate, high and low annual income (Table 1). The annual household income of fishers about (44%) was below 30,000 BDT and just 4% was above 50,000 BDT in southern part of Bangladesh reported by [23] which gives support to our current findings. However, high annual income was in the hand of majority of the respondents due to medium family size along with more earning members and upgrading socioeconomic conditions as well.
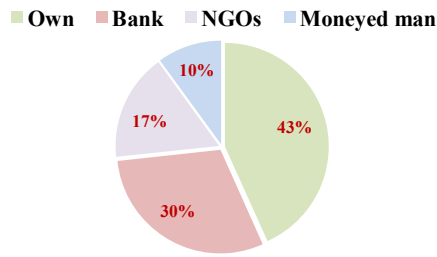
Fig. 10. Source of credit of the respondent fishermen for fish farming in the study area

3.11 Organizational Participation and Extension Media Contact

Our survey revealed that 40% of the respondents had no organizational participation, whereas 25% had medium, 33.3% had low organizational participation, and only 6.7% had high organizational participation may be due to unconsciousness and lower level of education. On the other hand majority of the respondents about 60% had low extension media contact, while 35% had medium but 5% had high media contact (Table 1). In current study area a number of pen farmers had low extension media contact as a consequence of communication gap between the fish farmers and extension agent.

3.12 Savings and Cosmopoliteness

In the present study area only 53.3% fishermen had savings from fish farming, agriculture, business, service and other activities and 46.7% had no savings due to poor resources and household expenses. From the survey, it was also found that about 48.3% of the fish farmers had low compared to 38.4% had medium and only 13.3% had high cosmopoliteness (Table 1).

3.13 Overall Changes of Livelihood Status of the Respondents through Fish Farming

The respondents' changing livelihood scores in all twelve selected characteristics ranged from 0 to 30, with an average of 17, where '0' indicating no change and '30' indicating a very high change. Score of problems of the respondents in fish culture ranged from 7 to 25. Based on the scores, the respondents were classified into three categories as low changes confrontation (up to 10), medium changes confrontation (11-20) and high changes confrontation (21-30) (Table 2). The percentage of changes of livelihood through fish farming of the respondents were about 58.30%, 31.70% and 10.00% considered as medium, high and lower level of changes respectively (Table 2) which indicates that due to various constrains as mentioned earlier nearest to high level of changes was insignificant in the study area.

3.14 Relationship between Capital of Fishermen (Independent Variable) and Changing their Livelihood Pattern (Dependent Variable) through Fish Farming

The changing livelihood pattern of the respondents was carried out through Pearson's product moment correlation of coefficient (r) to test the concerned null hypothesis in the relationship between the dependent and independent variables (Table 3). The correlation co-efficient (r) between age of the fish farmers and their changing of livelihood pattern through fish farming was 0.134 (Table 3). The computed `r' value indicates that age of the fish farmers had no direct relationship with their changing livelihood pattern through fish farming. The value of (r) between education and changing livelihood pattern of the fish farmers was 0.372 (Table 3) which indicates a positive and highly significant relationship. This is due to educated persons of the study area have frequent contact with extension agents, TV programs, which lead them towards better culture method and increase livelihood pattern compared to the individuals with less educational background. But the value of (r) between family size, farm size and changing livelihood pattern of fish farmers were found to be -0.208, 0.584 respectively (Table 3) that indicates respondents' family size was negatively and farm size was positively correlated with their changing pattern of livelihood through fish farming. On the other hand the value of (r) between knowledge in fish farming, training exposure and their changing livelihood pattern were 0.311 and 0.243 respectively (Table 3). As a result, there is a positive and significant correlations between the two above mentioned independent variables with their changing livelihood pattern and the findings are corroborated with [24,25,26]. Moreover, data on (Table 3) also showed that there were some variables as experience in fish farming, extension media contact, cosmopoliteness had no direct effect on changing their livelihood status which is similar with the findings of [27,25]. However, after analysis of survey data it was noticed that annual

family income, organizational participation had a positive correlations with the changing livelihood pattern of the selected respondents through fish farming as the value of (r) were 0.752, 0.69 respectively (Table 3) may be due to the active participation by the fishers with various organization which is very much needed for sustainable development of the fishers.

Table 1. Salient features of the fish farmers

Characteristics	Scoring system	Range Observed (possible)	Categories Percent	Respondents No.		Mean	SD
Age	Years	25-65 (unknown)	Youth (up to 35)	17	28.3	40.83	9.87
			Medium (36-50)	30	50		
			Old (above 50)	13	21.7		
Education	Year(s) of schooling	0-16 (0-18)	Illiterate (0)	5	8.3	4.82	3.73
			Primary level (1-5)	34	56.7		
			Medium (6-12)	19	31.7		
			Higher (above 12)	2	3.3		
Family size	Numbers	2-9 (unknown)	Small (up to 4)	29	48.3	4.57	1.66
			Medium (5-6)	25	41.7		
			Large (above 6)	6	10		
Farm size	Hectare	0.36-1.66 (unknown)	Marginal (0- 0.5 he)	34	56.7	0.67	0.36
			Small (0.51-1 he)	16	26.6		
			Medium (1-3 he)	10	16.7		
Area under fish farming	Hectare	0.32-0.44 (unknown)	Very small (up to 0.35 he)	15	25	0.38	0.04
			Small (0.36-0.4 he)	20	33.3		
			Medium (0.41-0.45 he)	25	41.7		
Knowledge on fish farming	Score	10-25 (0-30)	Low (up to 10)	0	0	17.92	3.83
			Medium (11-20)	42	70		
			High (21-30)	18	30		
Training exposure	Day(s)	0-13 (unknown)	No training (0)	26	43.3	3.80	4.10
			Short-term (1-5)	14	23.4		
			Mid-term (6-10)	15	25		
			Long-term (> 10)	5	8.3		
Annual income	Taka (in"000")	87-240 (unknown)	Low (up to 100)	6	10	140.75	41.48
			Moderate (101-150)	40	66.66		
			High (>150)	14	23.33		
Experience in fish farming	Years	5-30 (unknown)	Low (up to10)	21	35	14.92	8.11
			Medium (11-20)	25	51.7		
			High (21-30)	14	23.3		
Organizational participation	Year(s)	0-26 (unknown)	No participation (0)	24	40	6.55	6.94
			Low (1-10)	20	33.3		
			Medium (11-20)	12	25		
			High (21-30)	4	6.7		
Extension media Contact	Score	6-20 (0-30)	Low (up to10)	36	60	12.12	4.44
			Medium (11-20)	21	35		
			High (20-30)	3	5		
Cosmopoliteness	Score	10-17 (0-18)	Low (up to 12)	29	48.3	12.77	2.09
			Medium (13-15)	23	38.4		
			High (16-18)	8	13.3		

Table 2. Categorization of respondents on the basis of their overall livelihood changes through fish farming (N=60)

Category	Respondents		Mean	Standard Deviation
	Number	Percentage		
Low level (0-10)	6	10.00		
Medium level (11-20)	35	58.30	17	4.655
High level (Above 20)	19	31.70		

Table 3. Correlation matrix

Dependent variable	Independent variables (selected characteristics)	'r'-values (with d.f.=58)
Changing livelihood pattern through fish farming	Age	0.134
	Education	0.372**
	Family size	-0.208
	Farm size	0.584**
	Area under fish farming	0.028
	Knowledge on fish farming	0.311*
	Training exposure	0.243
	Present annual income	0.752**
	Experience in fish farming	0.002
	Organizational participation	0.69
	Extension media contact	0.132
	Cosmopoliteness	0.123

Table 4. Correlation matrix showing the relationships among the variables of survey

		age	education	famiy size	farm size ha	area under fish farming	knowledge farminge on fish farming	training exposure	present income	experience in fish farming	organizational participation	extension media contact	cosmopoliten ess
age	Pearson Correlation	1											
	Sig. (2-tailed)												
	N	60											
education	Pearson Correlation	.111	1										
	Sig. (2-tailed)	.401											
	N	60	60										
famiy size	Pearson Correlation	.165	-.240	1									
	Sig. (2-tailed)	.207	.065										
	N	60	60	60									
farm size ha	Pearson Correlation	.246	.778**	-.165	1								
	Sig. (2-tailed)	.059	.000	.207									
	N	60	60	60	60								
area under fish farming	Pearson Correlation	.013	-.145	.081	-.034	1							
	Sig. (2-tailed)	.923	.270	.540	.799								
	N	60	60	60	60	60							
knowledge farminge on fish farming	Pearson Correlation	.040	.669**	-.024	.529**	.138	1						
	Sig. (2-tailed)	.762	.000	.853	.000	.292							
	N	60	60	60	60	60	60						
training exposure	Pearson Correlation	.054	.469**	-.045	.335**	-.018	.744**	1					
	Sig. (2-tailed)	.684	.000	.731	.009	.891	.000						
	N	60	60	60	60	60	60	60					
present income	Pearson Correlation	.245	.612**	-.216	.850**	-.100	.398**	.266*	1				
	Sig. (2-tailed)	.060	.000	.097	.000	.446	.002	.040					
	N	60	60	60	60	60	60	60	60				
experience in fish farming	Pearson Correlation	.709**	.064	.180	.098	.035	.018	.102	.064	1			
	Sig. (2-tailed)	.000	.628	.169	.458	.792	.893	.436	.627				
	N	60	60	60	60	60	60	60	60	60			
organizational participation	Pearson Correlation	.848**	.103	.231	.213	.111	.043	-.006	.183	.620**	1		
	Sig. (2-tailed)	.000	.432	.076	.102	.399	.746	.966	.161	.000			
	N	60	60	60	60	60	60	60	60	60	60		
extension media contact	Pearson Correlation	.117	.348**	-.181	.221	.027	.136	.118	.259*	.037	.207	1	
	Sig. (2-tailed)	.372	.006	.165	.090	.840	.300	.371	.046	.776	.112		
	N	60	60	60	60	60	60	60	60	60	60	60	
cosmopoliteness	Pearson Correlation	.252	.465**	-.151	.330**	-.068	.313*	.357**	.262*	.148	.246	.544**	1
	Sig. (2-tailed)	.053	.000	.248	.010	.607	.015	.005	.043	.261	.058	.000	
	N	60	60	60	60	60	60	60	60	60	60	60	60

Correlation is significant at the 0.05 level (2-tailed)

4. CONCLUSION AND RECOMMENDA-TIONS

The paper analyses the socio-economic condition of the fishermen in Kumarghata union of Muktagacha upazila under Mymensingh district in Bangladesh and showed that the livelihood status of the fishermen in the study area is not up to the mark as fishers are underprivileged of many basic needs. The level of education of the fishers was inadequate, besides lack of fish farming techniques, media coverage, unawareness about health and poor economic condition hinders their progress. Therefore, the following recommendations can be made to upgrade the socio-economic status of the fishermen

i. Collaboration and active community participation amongst relevant stakeholders including government, NGOs is crucial to ensure their basic needs.
ii. Educational facilities should be increased by the government, NGOs to increase their level of understanding.
iii. Increase of public awareness through training exposure, media coverage, various publications is highly required.
iv. Adequate bank credit under easy terms should be ensured by the Government so that they can use their resources properly.
v. The respondents should be encouraged in good aquaculture practice for maximum production along with marketing and related facilities should be improved.

CONSENT

As per international standard or university standard, Participants' written consent has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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