Turkish Journal of Bioscience and Collections
Volume 8, Number 2, 2024
E-ISSN: 2601-4292

RESEARCH ARTICLE

Present Status, Impact, and Challenges of Fish Farming at Bhaluka Upazila in Bangladesh

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Received: 22.02.2024
Revision Requested: 16.05.2024
Last Revision Received: 02.07.2024
Accepted: 03.07.2024
Published Online: 26.07.2024

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Citation: Mely, S. S., Babu, M. R., Joy, A. S., Islam, M. S., Hossen, M. N., & Islam, M. R. (2024). Present Status, Impact, and Challenges of Fish Farming at Bhaluka Upazila in Bangladesh. *Turkish Journal of Bioscience and Collections*, *8*(2), 85–93. https://doi.org/10.26650/tjbc.1441292

Abstract

Objective: The current investigation was conducted to identify existing fish culture practise, livelihood condition of fish farmers, and the major challenges faced by fish farmers in Bhaluka upazila, Bangladesh.

Materials and Methods: Data were collected through surveys, monitoring, and participatory rural appraisal (PRA) tools like focus group discussions (FGD), using a pre-planned questionnaire survey. A group of 5 fish farmers was interviewed from each of the six villages.

Results: In the study, majority of fish farmers were between the ages of 41 and 60 years. Fish farming was their major occupation; however, they did not receive any formal training in fish culture. Fish ponds were large (> 4000 m^2) and medium in depth (1-2 m), and the most popular fish culture system was polyculture. Commercial feeds were used to supply nutrients, fertilisers (organic and inorganic) were also applied to the pond water to produce natural food. Salt, lime, zeolite, potassium permanganate, and oxygen tablets were used to maintain water quality. Epizootic ulcerative syndrome, argulosis, and tail and fin rot are most prevalent in the winter. Increasing feed costs, lack of financial support, and disease outbreaks were critical challenges in fish farming in the study area. The socioeconomic status of fish farmers was found to improve with fish farming.

Conclusion: Fish farming substantially improved the livelihoods of fish farmers in the study area, despite many constraints. Government support, including microcredit support, the supply of high-quality inputs, including fish fry, feed, vaccinations, and the provision of training facilities could increase fish production in the region.

Keywords: Bhaluka upazila, Constraints, Fish culture, Fish farmer, Livelihood status

Introduction

Bangladesh is considered a favourable region for fish culture worldwide based on its existing resources and climatic conditions (Hasan *et al.*, 2016; Hossain & Ali, 2014). Since ancient times, the socioeconomic development of this region has been significantly influenced by the fish and fisheries industry, which is also part of our cultural legacy (Ali *et al.,* 2008). The fisheries and aquaculture sectors play a dynamic role in ensuring employment generation, foreign exchange earnings, poverty alleviation, and nutritional security of the country (Ali *et al.,* 2014). It is also remarkable that fish alone contributes approximately 60% of animal protein consumption in Bangladesh (DoF, 2019). More than 10 million people directly depend on the fisheries sector for their livelihood (Hoque *et al.,* 2021). This sector contributes 1.24% of total export earnings, 3.57% of gross domestic product (GDP), and 26.50% of agricultural GDP. The total annual fish production in Bangladesh was 4,621,228 metric tonnes (MT) in 2020-2021 and ranked third position in global aquaculture production (DoF, 2022). The aquaculture sector in Bangladesh has been expanded, diversified and technologically advanced day by day.

A significant percentage of rural families participate in part-time fishing (Hughes *et al.,* 1994). About 400,000 ha of freshwater ponds/ditches and more than 900,000 households are directly engaged in aquaculture (ADB, 2010). Fish farming has become a secondary occupation for many aquaculture practitioners in rural areas, and as a result, their socioeconomic situation has improved (Ara, 2005). It has been demonstrated that aquaculture is a more profitable industry than rice farming. Thus, many farmers in rural areas are turning their rice fields into aquaculture ponds (Islam *et al.,* 2017). The production of fish from ponds is rising daily because of rising consumer demand (Ahmed, 2010). Freshwater fish farming is a significant source of income for rural people in Bangladesh (Mazid, 2002). This approach opened up a variety of career options for individuals living below the poverty line (Ahmed & Rahman, 2005). Pond owners have a great opportunity to improve their socioeconomic conditions through fish culture following scientific techniques.

Bhaluka is one of the most important upazila (an administrative region functioning as a sub-unit of a district) for aquaculture and fish culture propagation in the division of Mymensingh, Bangladesh. There are approximately 15,342 ponds (small man-made waterbody) and more than 329 beels (large natural wetlands formed by monsoon flooding) in the Bhaluka upazila (Hasan *et al.,* 2021). Its location makes it one of Bangladesh's best places for fish production. Despite the fact that fish farming involves a significant number of people and has access to abundant fisheries resources, remarkably little research has been done on the present status of fish farming, available fisheries resources and emerging constraints in the study area. Current information about resources, prospects, current status, and constraints is necessary for effective

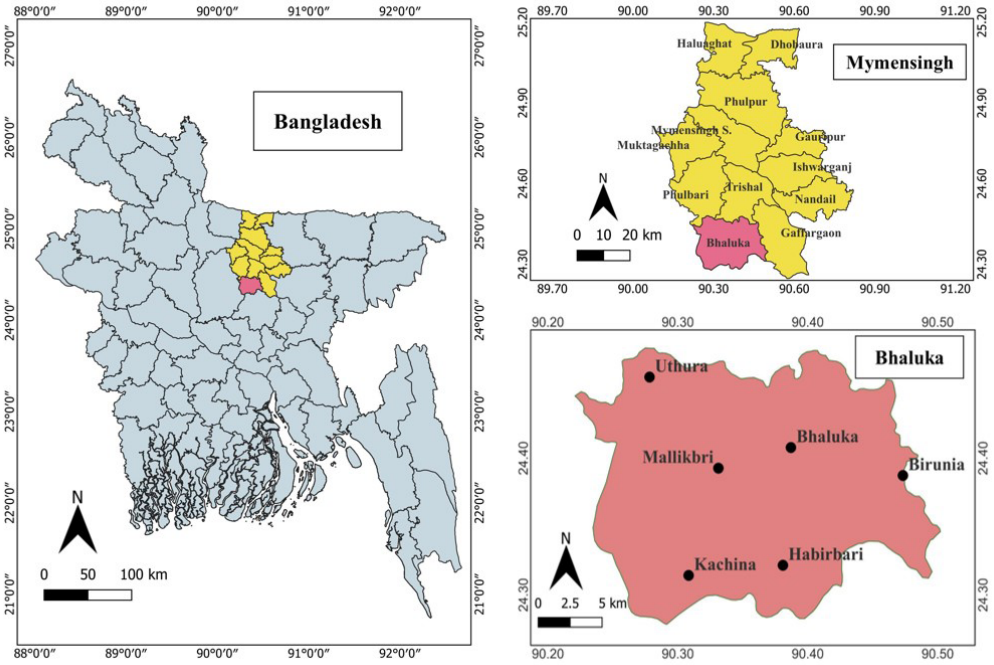

Figure 1. Map of the Bhaluka Upazila study area.

planning and development in any production sector. Lack of appropriate information and socioeconomic data frequently results in the failure of the developmental programme (Das *et al.,* 2018). Therefore, the present study was carried out to assess the present fisheries resources, fish farming conditions, livelihood status of fish farmers, and major constraints faced in the fisheries sector in Bhaluka upazila, Bangladesh.

Materials and Methods

Study area

The current study was conducted in Bhaluka upazila, Mymensingh district (Fig. 1). This upazila is bordered on the north by Fulbaria and Trishal upazila, on the south by Sreepur upazila, on the east by Gafargaon upazila, and on the west by Sakhipur and Ghatail upazila. Five fish farmers from each of the six villages (Uthura, Mallikbari, Bhaluka, Birunia, Kachina, and Habirbari) were chosen at random depending on their cooperation to provide information on fish farming.

Primary data collection

Primary data were gathered through surveys, monitoring, and participatory rural appraisal (PRA) tools like focus group discussions (FGD), and consultations with resource users and stakeholders. A pre-planned questionnaire survey was used to gather primary data on a variety of issues of fish farms, culture practises, production, livelihood status, and constraints related to culture practises. A well-defined and pre-tested questionnaire was used to collect primary data from 30 fish farms. The fish farmers were interviewed at their homes or farms. FGDs were conducted with a group of 5 fish producers from each village.

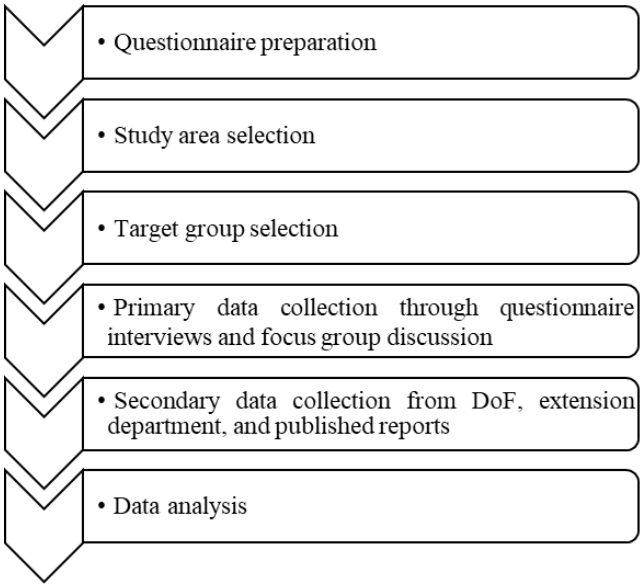

Figure 2. Methodological approach of the study.

Secondary sources

Additionally, secondary information on fish production and fisheries resources was obtained from the Department of Fisheries (DoF). Quarterly and annual reports were also used as secondary sources. Fig. 2 displays a summary of the methodological approach.

Data analysis

Percentage and chi-squared tests were performed using MS Excel and SPSS software (version 25.0). The research area map was generated using QGIS (version 3.22). A Likert scale with values of 4, 3, 2, and 1 was used to rate the constraints faced by farmers in the study area. A variable mean score of 2.5 or above was considered critical, whereas variables with less than 2.5 were not considered critical. The final results are presented in textual, tabular, and graphic representations to illustrate the current state of fish farming practises and the socioeconomic conditions of the farmers in the study area.

Results and Discussion

Demographic characteristics of the fishermen

Demographic characteristics of fish farmers, such as age, education level, occupation, financial support, and source of training, are presented in Table 1. Among all fish farmers, the middle-aged farmers had the highest percentage (53.33%), followed by the young group (36.67%) and old group (10.00%) respectively, in the study area. According to Khatun *et al.* (2013), 46% of fish farmers in the Noakhali district are between the ages of 36 and 50. In another study, Hossen *et al.* (2020) and Ali *et al.* (2009) reported that 52% and 50% of the fish farmers in Barishal Sadar upazila and Tarakanda upazila, respectively, of the Mymensingh district are aged between 31 and 40, respectively, which supports the findings of this study. This information indicates that the majority of the sample farmers were in the active age range and spent more physical energy on fishing.

Education levels among fish farmers aid in the development of conceptual skills and make it easier to acquire technical skills, which can have a direct impact on production generation. In the study area, 53.33% of fish farmers have a secondary education, 23.33% have a primary education, and 10% have a graduate degree or higher. Only 13.33% of farmers are illiterate. According to

Hossen *et al.* (2020), most farmers in Barishal (49%) had a secondary education, whereas only a small percentage (7%) of fish farmers were illiterate. Rahman *et al.* (2016) found that just 15% of pond owners in the study area had a bachelor's degree, 20% of fish farmers had primary-level education, and 32.5% had a high school diploma in Dhumki upazila in the Patuakhali district.

Pond fish farmers were involved in different kinds of activities in addition to raising fish. In the study area, the majority (73.33%) of fish farmers were engaged in fish culture as their primary occupation, while the remaining (26.67%) had it as a secondary occupation. However, in other areas of Bangladesh, fish farmers are engaged in fish culture as a secondary occupation and are involved in business, agriculture, and services as a primary occupation (Ali *et al*., 2009; Hossen *et al*., 2020; Rahman *et al*., 2017). Unlike other areas in the current study area, fish farming is the primary occupation of fish farmers in Bhaluka upazila because it is an important fish farming cluster in the country.

Financial support is crucial for fish culture. In this study, it was observed that roughly 43.33% of farmers used their own funds for fish farming, while 33.33% collected bank loans and 23% collected other sources, such as non-government organisations (NGOs), company loans, moneylenders, and loans from relatives. The findings of this study are similar to those of other studies (Ali *et al*., 2009; Das *et al*., 2018; Hossen *et al*., 2020; Pravakar *et al*., 2013; Quddus *et al*., 2000; Sheheli *et al*., 2013). In the study area, 76.67% of the participants had no prior experience in fish farming. They began fish farming on their own initiative, and 16.67% received training from GOs and 6.67% from other NGOs. Farmers receive training on fish culture from the Bangladesh Fisheries Research Institute (BFRI), the DoF, and various NGOs (Ali et *al.,* 2008; Das *et al.*, 2018; Sheheli *et al*., 2013). Most of the time, farmers used non-scientific methods of fish farming that they learned from their ancestors and neighbours (Ali *et al.,* 2009).

Table 1. Demographic characteristics of fisherman.

Category	Percentage (%)
Age group (age in year)	
Young (20-30)	10.00
Middle (31-40)	36.67
Old (41-60)	53.33
Education level	
Illiterate	13.33
Primary	23.33
Secondary	53.33
Graduate or above	10.00
Occupation	
Fish culture as primary occupation	73.33
Fish culture as secondary occupation	26.67
Source of Financial support for fish farming	
Own	43.33
Bank loan	33.33
Others	23.33
Source of training	
No formal training	76.67
Training from government organizations	16.67
Training from non-government organizations	6.67

Characteristics of the fish pond and culture system

Table 2 lists the characteristics of the fish ponds and fish culture systems in the study area. Pond size is crucial for keeping fish production costs low. According to the study, 26.67% of respondents have pond areas smaller than 2000 m^2, 33% have pond areas between 2000 m^2 and 4000 m^2, and 40% have pond areas larger than 4000 m^2. Although there are variations in pond size throughout the country (Das *et al*., 2018; Pravakar *et al*., 2013; Rahman *et al*., 2022), most of the ponds are larger than 4000 m^2 in the study area. However, farmers believe that smaller to medium sized ponds are suitable for effective management.

Among the studied fish ponds, 60% were within a depth of 1–2 m, followed by shallow (< 1, 23.33%), and deep (> 2, 16.67%). The DoF (2012) stated that the typical pond depth in Bangladesh is between 2 and 5 m, which is consistent with the findings of the current study.

In the research area, 23.33% of the ponds were seasonal and 76.67% were perennial. During the dry season, the water level of the perennial ponds drops but remains suitable for fish farming. In contrast, seasonal ponds are completely unsuitable for fish farming during the dry season. It has been reported that most of the fish ponds in Dinajpur, Chandpur, Rajshahi, and Tangail are perennial ponds (Ali *et al.,* 2008; Fatema *et al*., 2018; Pravakar *et al*., 2013; Saha, 2004). However, Das *et al.* (2018) reported that most (79.09%) fish ponds in Gazipur are seasonal. Moreover, the water-holding capacities of fish ponds are probably dependent on the geographical location.

In this study, it was found that 30% of the fish farmers raised fish in their own ponds, 20% of the fish ponds have multiple ownership, and 50% of the fish ponds are leased. According to Hossain *et al.* (2002), multiple pond ownership is a significant barrier to pond aquaculture. Polyculture of carp, tilapia, and catfish was found to be the major (80%) type of fish culture system, and 20% of the fish farmers were found to carry out pangas monoculture in the survey area. In comparison, polyculture uses available

Table 2. Characteristics of the fish pond and fish culture system.

Category	Percentage (%)
Area (Square meter, m^2)	
Small (< 2000)	26.67
Medium (2000 - 4000)	33.33
Large (> 4000)	40.00
Depth (m)	
Shallow (< 1)	23.33
Medium (1-2)	60.00
Deep (> 2)	16.67
Type	
Seasonal	23.33
Perennial	76.67
Ownership	
Own	30.00
Multiple	20.00
Leased	50.00
Culture system	
Polyculture	80.00
Monoculture	20.00

space and food supplies more efficiently than monoculture (Anil *et al.,* 2010; Hossen *et al.,* 2020). According to other studies, polyculture is also the most popular fish culture system in Bangladesh (Halim *et al.,* 2017; Hossen *et al*., 2020; Pravakar *et al*., 2013; Siddiqua *et al*., 2019).

Major fish species

The popular fish species cultured in the survey area are presented in Fig. 3. The investigation revealed that carp (locally known as Bangla fish) were the most popular species in the study area, including rohu (*Labeo rohita*), catla (*Catla catla*), mrigal (*Cirrhinus cirrhosus*), calibaus *(L. calbasu*), and bata (*L. bata*). The fishermen were also found to raise exotic fish such as silver barb (*Barbonymus gonionotus*), silver carp (*Hypophthalmichthys molitrix*), catfish as pangus (*Pangasius pangasius*), magur (*Clarias batrachus)*, and shing (*Heteropneustes fossilis*), and various other fish, including tilapia (*Oreochromis niloticus*) and koi (*Anabas testudineus)*. Pangus was primarily found growing in monocultures, while other species were mostly grown

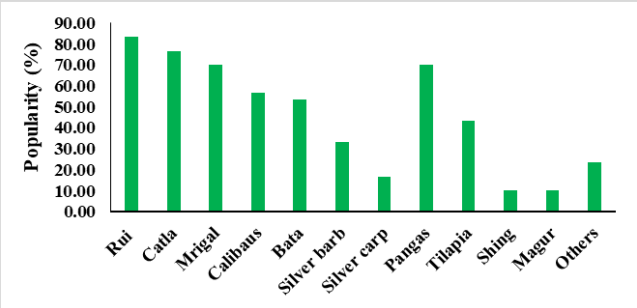

Figure 3. Popular species of fish cultured in monoculture and polyculture systems at Bhaluka upazila.

in polyculture systems. Fatema *et al.* (2018) reported that farmers engaged in carp polyculture, including major carp, exotic carp, and other fish, due to faster growth, high consumer demand, easy production systems, and the availability of fish seeds.

Management of the fish pond

The pond management techniques used in the study area are listed in Table 3. Farmers were found to use both commercial and homemade feed in their ponds. Although commercial diet is expensive, it was found to be the most popular because homemade feed preparation is time-consuming and tedious. Farmers were found to apply both organic (compost, cow dung, and chicken manure) and inorganic (urea, and TSP) fertilisers in the surveyed fish farms. Das *et al.* (2018) reported that fertiliser application is crucial to boost natural food (phytoplankton, zooplankton, and benthic creatures) production and thus increase fish yield. Salt and lime were regularly used chemicals in the fish ponds. In addition, zeolite, $KMnO_4$, oxygen tablets, and other commercial drugs were also found to be used to maintain water quality, prevent, and control fish disease. Kawsar *et al.* (2019) also reported that salt and lime are the most frequently used chemicals in fish culture in Bangladesh. Fish farmers partially harvested (80%) their fish when they grew to marketable size, and 20% of them were found to completely harvest their stock at the end of their culture period. Seine nets (80%) and cast nets (20%) were the most popular fishing gear for harvesting fish.

The management approaches applied in the fish farms of Bhaluka upazila are more or less similar to those applied in other parts of the country (Das *et al*., 2018; Fatema *et al*., 2018; Pravkar *et al*., 2013; Rahman *et al*., 2016; Rahman *et al*., 2022; Siddique *et al*., 2019).

Table 3. Pond management techniques in the study area.

Category	Percentage (%)
Fish culture system	
Extensive	13.33
Semi-intensive	80.00
Intensive	6.67
Feed type	
Homemade feed	20.00
Commercial Feed	60.00
Both	20.00
Harvesting method	
Partial harvest	80.00
Complete harvest	20.00
Fishing gear	
Seine net	80.00
Cast net	20.00

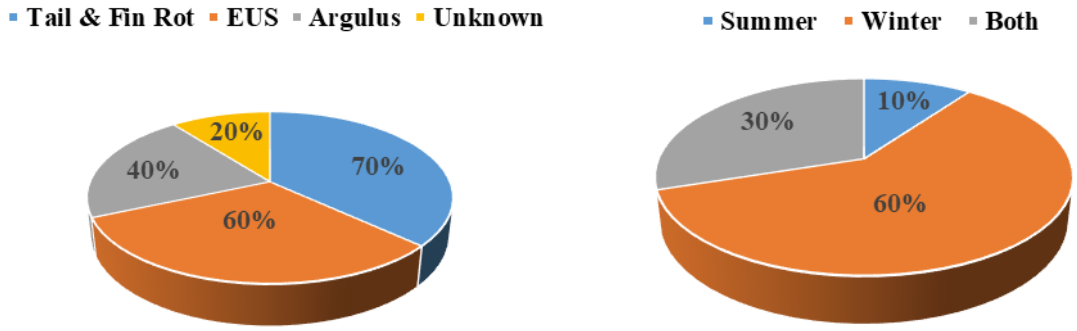

Figure 4. Type and season of occurrence of fish disease.

Chi-squired test to compare demographic factors and fish culture practises

The interrelationships between demographic variables and fish farming practises in the study area are presented in Table 4. In the current study, the age of fish farmers has a statically significant ($P < 0.03$ and $P < 0.01$) association with the source of training on fish culture and pond type, respectively. This indicates that different age groups tend to receive training from different sources and prefer different types of ponds. These findings align with a previous study that reported that older farmers rely more on traditional practises, whereas younger farmers are more inclined to adopt modern techniques and training programmes (Wabbi, 2002). Furthermore, financial support showed a significant association ($P < 0.04$) with pond size. This relationship underscores the importance of financial capital in developing and expanding aquaculture operations. Previous research has similarly noted that financial constraints can limit the scale and productivity of fish farming (Kumar *et al.,* 2018). On the other hand, pond size was significantly associated with feed type ($P < 0.02$). Different management strategies may be required depending on the pond size, which may affect feed type selection. This finding is consistent with studies that emphasise the impact of pond size on aquaculture management strategies (Kumar *et al.,* 2018). Moreover, pond ownership showed a significant ($P < 0.02$) association with the harvesting method. This finding indicates that ownership structures affect operational decisions. Individually owned ponds potentially allow more flexibility for implementing management strategies than jointly owned or leased ponds (Leonard & Mahenge, 2022).

Table 4. Chi-square test (non-parametric data) between demographic variables and fish farming practises.

Variable	Chi-squired value	*P*-value
Age and source of training	14.163	0.03
Age and pond type	11.070	0.01
Financial support and pond size	9.289	0.04
Pond size and feed type	11.222	0.02
Ownership and harvesting method	7.500	0.02

Disease outbreak

Commercial fish farming in Bangladesh faces significant challenges in managing fish disease. Farmers in the study area reported an increase in disease occurrence. In this study area, tail and fin rot was reported in 70% of the farms, epizootic ulcerative syndrome (EUS) in 60%, argulosis in 40%, and an unknown disease in 20% of farms (Fig. 4). Tail and fin rot is a bacterial disease caused by *Flavobacterium columnare*, and EUS is a fungal disease caused by *Aphanomyces invadans* (Arshad & Arockiaraj, 2020; Rahman *et al*., 2010). Diseases were most prevalent during winter. At low temperatures, the physiological activity of fish decreases and they become more susceptible to fish disease (Snieszko, 1974).

Table 5. Impact of fish farming on the living standards of fish farmer (n=30).

Statement	Farmers Opinion (%)		
	Improved	Same as before	Deteriorated
Household income	86.67	13.33	0.00
Position in the family	70.00	26.67	3.33
Housing condition	63.33	36.67	0.00
Health situation	23.33	76.67	0.00
Water facilities	30.00	70.00	0.00
Participation in social activities	86.67	10.00	3.33
Freedom in cash expenditure	60.00	33.33	6.67
Overall livelihood	76.67	23.33	0.00

Table 6. Major constraints in fish farming.

Constraints	Very critical	Critical	Moderately critical	Not critical	Score	Average	Remarks
Increasing feed cost	18	8	4	0	104	3.47	Critical
Lack of financial support	9	12	5	4	86	2.87	Critical
Disease outbreak	9	14	5	2	90	3.00	Critical
Lack of quality seed	3	13	10	4	75	2.50	Critical
Poaching and vandalism	0	2	7	21	41	1.37	Not critical
Transportation cost	3	7	11	9	64	2.13	Not critical
Water supply	6	5	13	6	71	2.37	Not critical
Electricity supply	0	1	8	21	40	1.33	Not critical
Fishing accessories	0	1	6	23	38	1.27	Not critical
Natural calamities	2	5	7	16	53	1.77	Not critical

Impact of fish farming on livelihoods

Table 5 summarises the significant changes in livelihood areas in view of fish farmers. About 76.67% of fish farmers said that fish farming enhanced their quality of life. The family position, housing condition, participation in social activities, and freedom in cash expenditures improved remarkably. However, 23.33% of farmers reported that participation in fish farming has no effect on their overall standard of living, whereas no one reported a deterioration in their livelihood. Rahman *et al.* (2017) and Ali *et al.* (2009) also reported that fish farming has a beneficial impact on income generation and food security. Hossen *et al.* (2020) also found that farmers' socioeconomic circumstances improved after switching from agricultural to fish farming.

Major constraints in fish farming

The major constraints faced by fish farmers are presented in Table 6. Increasing feed costs, lack of financial support, disease outbreaks and lack of quality seeds were identified as critical problems in the study area. Daniel (2018) reported that feed costs represent up to 70% of the total production cost of a fish farm. Due to rising prices for different raw materials, the cost of feed is increasing annually (Prodhan & Khan, 2018). Disease outbreaks and lack of quality fish seeds were also reported as major constraints in fish culture in Chadpur, Gazipur, and Barishal districts, however, farming constraints are more or less similar everywhere (Das *et al*., 2018; Hossen *et al*., 2020; Pravakar *et al*., 2013).

Conclusion

Fish farming substantially improved the livelihoods of fish farmers in the study area, despite many constraints. High feed costs, lack of quality fish seeds, lack of financial support, and disease outbreaks were the critical constraints of fish farming in the study area. The government should provide microcredit support, high-quality inputs, including fry, feed, vaccinations and the provision of training facilities to support fisheries and aquaculture activities in this region.

Ethics Committee Approval: In Bangladesh, ethical approval is generally not required for studies involving invasive procedures, nor have clinical trials or any physical interventions been performed.

Peer-review: Externally peer-reviewed.

Authors Contributions: Conception/Design of Study- S.S.M., M.R.I., M.S.I.; Data Acquisition- S.S.M., M.R.B., A.S.I.; Data Analysis/Interpretation- S.S.M., M.R.I., M.N.H.; Drafting Manuscript- S.S.M., M.R.B., A.S.J.; Critical Revision of Manuscript- M.R.I., M.S.I., M.N.H.; Final Approval and Accountability- S.S.M., M.R.B., A.S.J., M.S.I., M.N.H., M.R.I.

Acknowledgements: The authors are thankful to the fish farmers of the study area for their cooperation.

Conflict of Interest: The authors have no conflict of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

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