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# Evaluation of socio-demographic status of biofloc fish farmers and cost-benefit analysis of biofloc farming in the greater Sylhet region of Bangladesh

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**Abstract**
Technology-based fish farming such as Biofloc fish farming is increasing day by day in Bangladesh. In this study, the socio-economic status of Biofloc fish farmers and the cost-benefit of Biofloc fish farming were assessed in the greater Sylhet Region of Bangladesh. A total of 23 randomly selected farmers were interviewed through a structured questionnaire. The study revealed that educated people (60.9%) are becoming more interested in technology-based fish farming and investing their own money (56.5%) in farm setting. No female Biofloc fish farmers were identified in the study area. It's also observed that all the interviewed farmers (100%) have a secondary option of earning and Biofloc fish culture is considered an easy option to get higher revenue. Most of the farmers (65.2%) belong to the age category of 30-40 and around 61% have an additional monthly income of 30000-50000 BDT/month. The cost-benefit analysis showed that the success of Biofloc depends on the quality of fish seed and feed and also the efficient management of the Biofloc system. The BCR of culturing tilapia and shing are 0.55 and 0.61 respectively while the BCR of Pabda was 1.04. As Biofloc is a new type of fish farming and the farmers are not well adapted to this technological advancement of fish farming technique, they faced multi-factorial problems from getting quality fish seeds to selling the product on the market. Social media such as YouTube and Facebook had a great impact on disseminating Biofloc technology at the field level, especially encouraging young educated people to get involved in Biofloc-based fish farming. However, more research should be taken to find out the best suitable species and profitability of Biofloc technology in aspects of Bangladesh.

**Keywords:** biofloc, tilapia, cost-benefit analysis, Sylhet, socio-economic condition

## Introduction

In the era of modern aquaculture, scientists and collaborators around the world are continuously exploring environmentally friendly and sustainable culture systems to meet the high demand for proteinous food. Among different alternatives such as the Biofloc-system, the recirculatory aquaculture system (RAS), the race-way system, the integrated aquaponics system and the integrated aquaculture system, the Biofloc system has been considered as the most sustainable and cost-effective method. Ray *s.,* (2011) [8] suggested Biofloc Technology (BFT) as the most intensive and advanced technology based on the objective of reducing the use of water, space and feed through an almost zero water exchange culture system. In aquaculture, organic nitrogen waste is a vital problem and some studies revealed that organic nitrogenous waste can be converted into bacterial biomass through the balancing of carbon and nitrogen (C/N) in the environment (Schneider *et al.*,2005) [11]. However, the supplementation of extra carbohydrates (e.g., molasses) can stimulate the growth of a heterotrophic bacterial community which can further convert the nitrogenous substance to microbial protein, which is a great source to alter fish protein substitution in the feed (Avnimelech, 2009) [4]. Additionally, this robust technology-based farming minimizes the use of water and maintains the quality of water within the culture unit through reduction of ammonia and suspended particles (Crab *et al.*, 2010) [6].

Bangladesh is mainly based on pond based (both inland and coastal) aquaculture with a minimum entry to high-tech sustainable aquaculture. A very few farmers are well trained and skilled for high-tech aquaculture as the facilities for new scientific information and materials are highly lacking. Moreover, the recently developed Biofloc technology is completely new in the aquaculture production of Bangladesh and a large portion of culturists are very interested in learning the techniques and production systems. But surprisingly, the available learning materials and the culture systems are highly lacking as the research based on Biofloc technology is in its preliminary stage. Sylhet is the north-eastern district of Bangladesh and is blessed with huge aquatic resources. It is blessed with vast fisheries resources, such as haor, rivers, beels and open water, flood plains, canals and so on. However, the economy of Sylhet is mainly based on foreign remittances and agriculture. Although fish farming is very fast growing in Bangladesh, the pace of fish farming in the Sylhet region is slow. One of the main reasons is lack of proper technical knowledge and the availability of fish seeds (*Rashid et. al.2015).* Nowadays, due to the advancement of technology and also dissemination through different social media, some farmers, both

educated and non-educated, have become interested in high-tech aquaculture such as Biofloc, RAS (Recirculatory Aquaculture System) and the Aquaponics system. Recently there have been quite a few Biofloc fish farms developed in the region and the outcome of these new technologies is not properly assessed. In this study we aimed to assess the present status and future prospects of Biofloc-fish farming in north-eastern Bangladesh and also identify the challenges that are faced by the farmers.

## Materials and Methods

### 1. Location of the study

This study was conducted targeting the north eastern part of Bangladesh, especially four districts of Sylhet Division. As Biofloc is a new farming method, there have been very few farmers in the study area. Among four districts, randomly selected farms (n=23) were taken into consideration for our study.

### 2. Data collection method

Both qualitative and quantitative data were collected through a semi-structured questionnaire from the randomly selected farmers in the study area. All the farmers were male and no female fish farmers were identified. The data collection was done by individual interviews, Focus Group Discussion (FGD) with 7-8 people and also by discussion with NGO personnel, Fisheries officers and community members.

### 2.1. In-Person interview

The in-person interviews were taken at the Biofloc fish farming site in the farmer's house. Some farmers established an indoor Biofloc setting and some established Biofloc on the rooftop, while some other farms are in the outdoor areas. The personal interviews last for 20-30 minutes.

### 2.2. Focus Group Discussion

In total, five Focus Group discussions (FGD) were conducted, consisting of 7-8 people, lasting about 40-45 minutes. FGD was effectively used to collect and validate information on socio-economic changes, production performances, social and economic institutionalization and local knowledge involvement.

### 3. Data Analysis

Based on the objective of the study, the collected data was accumulated, grouped and interpreted. The collected data was then scrutinized and analysed for graphical and tabular presentation. Data from the responses was analysed by MS Excel and statistical software SPSS version 22.

## Results and Discussions

### 1. Socio-economic conditions of Biofloc fish farmers in the study area

The socio-economic condition of the fish farmers was assessed in this area based on the different livelihood capitals such as Physical capital (house structure, sanitation facilities, health care facilities and so on); financial capital (access to credit, income etc.); natural capital, social capital and human capital. Farmers were categorized into three age groups and it was revealed that around 65% of Biofloc fish farmers ranged between the age group 30-40 years, while 21.7% belong to the age group >30 and only 13.1% belong to an age group greater than 50 (Table 1). This depicts the involvement of relatively young, educated people in advanced technology-based fish farming. Among the responses, 100% of farmers are male and 86.9% belong to a Muslim religious group. No female Biofloc fish farmers were observed in the study area as it is based on different technologies and training. Most of the traditional fish farmers, especially women, were not interested in being involved in this type of farming. However, surprisingly, 60.9% of farmers have graduate level education and only 8.7% of Biofloc fish farmers completed primary level education. It was not observed that any illiterate farmers and also farmers in the "can only write the name" group. It is because of the technology and high skills requirement of Biofloc fish farming. Among the Biofloc units visited, 56.5% were in the indoor house structure on farmers' own land and 26.1% of farmers constructed Biofloc units in the outdoor area while only 17.4% on the roof top of the farmers' house. Around 21% of farmers started Biofloc fish farming without prior experience while a majority of the farmers (47.8%) are beginners in fish farming. The involvement of new people in Biofloc farming is because of the social media influence, especially YouTube and Facebook, and also the unavailability of jobs after graduation. It's also revealed that all the interviewed farmers (100%) had a secondary option of earnings and Biofloc fish culture is considered an easy option to get higher revenue by them. Mostly, extensive fish farmers (21.7%) tried to switch their culture method to an advanced technology-based method, hence, Biofloc fish farming. In terms of monthly income of the farmers, around 60% belong to the group 30000 to 50000, while 21.7% belong to the 15000-30000 category and no farmers are found in the category with less than a 15000/month income. This depicts the involvement of a relatively solvent group of people in Biofloc fish farming rather than other fish farming groups. Biofloc farming is considered as the secondary profession besides the primary profession of the farmers in the study area. (Table 1

**Table 1:** Socio-demographic status of Biofloc fish farmers in Sylhet Division (n=23)

| Characteristics | Level | Frequency (n=23) | Percentage (%) |
|---|---|---|---|
| Ages (Years) | >30 | 5 | 21.7 |
| | 30–40 | 15 | 65.2 |
| | 40–50 | 3 | 13.1 |
| | >50 | None | 0 |
| Sex | Male | 23 | 100 |
| | Female | None | 0 |
| Religion | Muslim | 20 | 86.9 |
| | Hindu | 3 | 13.1 |
| Family type | Nuclear | 15 | 65.2 |
| | Joint | 8 | 34.8 |
| Educational status | Illiterate | None | 0 |
| | Can only write the name | None | 0 |
| | Primary level | 2 | 8.7 |
| | Secondary level | 7 | 30.4 |
| | Graduate level | 14 | 60.9 |
| Ownership pattern | Leased | None | 0 |
| | Roof-top of own house | 4 | 17.4 |
| | Indoor structure in own land | 13 | 56.5 |
| | Outdoor structure in own land | 6 | 26.1 |
| | Outdoor structure in others house | None | 0 |
| Aquaculture Experiences | No experiences | 5 | 21.7 |
| | Beginner in fish farming | 11 | 47.8 |
| | Extensive fish farming | 5 | 21.7 |
| | Semi-intensive fish farming | 2 | 8.7 |
| Monthly income (BDT) (1 USD = 101.1 BDT) | >15000 | None | 0 |
| | 15000–30,000 | 5 | 21.7 |
| | 30,000–50,000 | 14 | 60.9 |
| | <50,000 | 4 | 17.4 |
| Alternative occupation | Yes | 23 | 100 |
| | No | None | 0 |
| Home structure | Tin & wood | 3 | 13.1 |
| | Straw roof and bamboo fence | None | 0 |
| | Built-in half bricks (*Semi pacca*) | 13 | 56.5 |
| | Built-in bricks (*Pacca*) | 10 | 43.5 |
| Supply of electricity | Yes | 23 | 100 |
| | No | None | 0 |
| Drinkable water facility | Own tube well | 20 | 86.9 |
| | Neighbor tube well | 3 | 13.1 |
| | River | None | 0 |
| Sanitation facilities | Built in half- bricks (Semi-p*acca*) | 17 | 74.0 |
| | Built-in bricks (*Pacca*) | 6 | 26.0 |
| | Built-in the sand (*Katcha*) | None | 0 |
| Health facilities | Village doctor | None | 0 |
| | Homeopathic | None | 0 |
| | Kabiraj | None | 0 |
| | Hospital | 23 | 100 |
| Financial access | NGO's | 3 | 13.1 |
| | Relatives & Neighbors | 7 | 30.4 |
| | Own fund | 13 | 56.5 |
| | Money lenders (*Mahajan*)/Boat owners | None | 0 |
| | Banks | None | 0 |

The physical assets like housing structure, sanitation facilities, electricity access and health-care facilities are quite better than the other farming groups. As Biofloc farming needed a continuous supply of electricity, it was found that 100% of farmers have access to electricity and almost 87% have a supply of pure drinkable water through their own tube well. No straw roof and bamboo fence house of Biofloc fish farmers were found in the study area. However, the percentage of built-in half bricks (Semi-pacca) and built-in bricks (Semi-pacca) were 74% and 26% respectively. All the interviewed farmers (100%) responded that they went to Upazila hospital or private hospital for any health-related issues and no one cares about homeopathy and Kabiraj (people treat patients with black magic and so on) these days. Most of the farmers (56.5%) used their own fund for the Biofloc farm set-up, while 30.4% loaned interest and free money from relatives and neighbours. As almost all the farmers started Biofloc fish farming as a trial basis, they are expecting loans while continuing it on a bigger scale.

**2. Production related Parameters**

**2.1. Species Cultured in Biofloc Fish Framing in the study area**

**Table 2**

| Name of the Species | No of the respondents | Frequency |
|---|---|---|
| *Tilapia (Oreochromis niloticus)* | 17 | 73.9 |
| *Shing (Heteropneustes fossilis)* | 5 | 21.7 |
| *Pabda (Ompok pabda)* | 1 | 4.3 |

Monosex tilapia (Oreochromis niloticus) is considered one of the best suitable species for Biofloc fish farming. In the study area, the majority (73.9%) of the farmers cultured tilapia in their Biofloc unit. The reason for the culture is due to it's adaptability and availability of fish seeds in the area. However, some farmers cultured shing ((Heteropneustes fossilis) in the Biofloc system as a trial basis and only a single farmer trailed Pabda (Ompok Pabda).

**2.2. Cost Benefit analysis of Biofloc Fish Farming in the study area (10,000L tank)**

Cost benefit-analysis of Biofloc fish farming was assessed and presented in table 3.2.2. As Biofloc is a new technology and the farmers are not yet well known about the culture potentials, the cost of Biofloc a unit is found higher than other culture techniques in the area. No major difference was observed in the total cost of setting up Biofloc units for all the species. In all the species cultured, fish feed comprises the highest cost. As Biofloc needs to be maintained regularly, the regular water quality monitoring kit and also the supply of probiotics and molasses involve higher variable costs. (Table 3.2.2.)

**Table 3**

| Cost Type | Unit Price (Price are in BDT; 106 BDT=1USD) | Total Cost | | |
|---|---|---|---|---|
| | | Tilapia (N=17) | Shing (N=5) | Pabda (N=1) |
| **Fixed Cost** | | | | |
| Tarpaulin tank with drainage outlet | 13*13 Biofloc Fish Tank PVC Tripol 10000L= 8000-10000 BDT | 11187±987 | 12300±786 | 12000 |
| Aerator and Aeration system (Air Bubble Stone: 10-450/-; Air Pump ACO-008, Nano tube) | 4500-5500 | 4106±559 | 3960±364 | 4500 |
| Electricity (Generator and electric supply) | 3500-4500 | 3156±322 | 3200±412 | 3500 |
| Water quality determination kit (pH meter, DO meter, Digital weight Scale, TDS meter, Imhoff cone) | pH Meter (450-5500) | 9300±1407 | 9300±1643 | 9000 |
| | DO Meter (500-5500) | | | |
| | Digital Weight Sclae (800-1000) | | | |
| | TDS Meter (250-5500) | | | |
| | Imhoff Cone (600-1000) | | | |
| Nets, Pipes etc | 1200-1500 | 1200±345 | 1100±230 | 1200 |
| Plastic Items (Mug, Feeding tray, Bucket etc.) | 1500-2000 | 1500±235 | 1600±325 | 1500 |
| Miscellaneous | 2000-3000 | 1835±342 | 2200±450 | 2000 |
| Total Fixed Cost | | 32284±4197 | 33660±4210 | 33700 |
| Variable Cost | | | | |
| Fish seed/fingerling | 5000-6000 no. | 4500±564 | 5200±570 | 7000 |
| Fish feed | 55-60 Kg | 21812±2344 | 25400±3209 | 26500 |
| Probiotics | 1500-2000 | 1350±248 | 1600±223 | 1500 |
| Molasses | 500-600 | 1220±223 | 1326±320 | 1300 |
| Water quality parameters kit (Ammonia, nitrate, nitrite) | 2000-2500 | 1806±233 | 1810±188 | 2000 |
| Equipment Fixing | 1200-2000 | 1150±345 | 1100±250 | 1000 |
| Miscellaneous | 1000-2000 | 1000±450 | 1000±350 | 1000 |
| Total Variable Cost (A) | | 33838±6009 | 37434±6334 | 41300 |
| Total Cost (Fixed Cost + Variable Cost) | | 65122±10206 | 71094±10554 | 75000 |
| Average Production<br>350-560KgTilapia/10000L tank/4-5 months<br>150-280Kg/10000 L tank/ 4-5 months<br>300-450Kg/10000L tank/5-6 months | Market price varies in different season and the size of the fish<br>Tilapia = 90-110 BDT/Kg<br>Shing = 180-220 BDT/Kg<br>Pabda = 250-350 BDT/Kg | 358.37±27.64 | 243.00±29.91 | 312 |
| Total Revenue (B) | Tilapia = 100 BDT/Kg<br>Shing = 180 BDT/Kg<br>Pabda = 250BDT/Kg | 35837 | 43740 | 78000 |
| Net Profit (4 month) | | 1999 | 6306 | 3000 |
| Average Cost/Kg | | 94.5 | 154.04 | 132.37 |
| Revenue-Cost Ratio (B/A) | | 1.05 | 1.16 | 1.88 |
| Benefit-Cost Ratio (BCR) | | 0.55 | 0.61 | 1.04 |

The installation of the Biofloc unit was for a long-term basis and the unit is considered to last for at least 5 years. In the first cycle of production, the benefit and cost ratio (BCR) for tilapia and shing were 0.55 and 0.61 respectively. However, it is revealed that the BCR of Pabda culture is 1.04. The lower average cost/kg was observed in tilapia (94.5 BDT/Kg) while the highest average cost to produce a kg was observed for Shing (154.04 taka/Kg). The selling prices of fishes vary between the species and Pabda generates more profit than the other species.

**2.3. Problems related to Biofloc fish farming in the study area**

The problems associated with Biofloc fish farming were shown in figure 1. As Biofloc is a new type of fish farming and the farmers are not well adapted to this technological advancement of fish farming techniques, techniques face multi-factorial problems from getting quality fish seeds to selling the product in the market. All the interviewed farmers agreed that they didn't get quality fish seeds in the area. They have collected the fish seeds from far distances, especially from Mymensingh, Jessore and Comilla districts. Due to transportation and poor handling, there was a huge mortality that occurred in the initial stage of Biofloc rearing. The other two major problems are electricity interruption and the market price of harvested fish. Around 92% faced the problems of electricity and marketing of their produced fish. Although there is a technological knowledge gap between the farmers (65.2%), they are becoming trained through repeated training from different private and public institutions. Social media have a great impact on people's fascination with Biofloc fish farming. The lack of Biofloc materials and also varying costs for different Biofloc materials increased the cost of production in the Biofloc system.

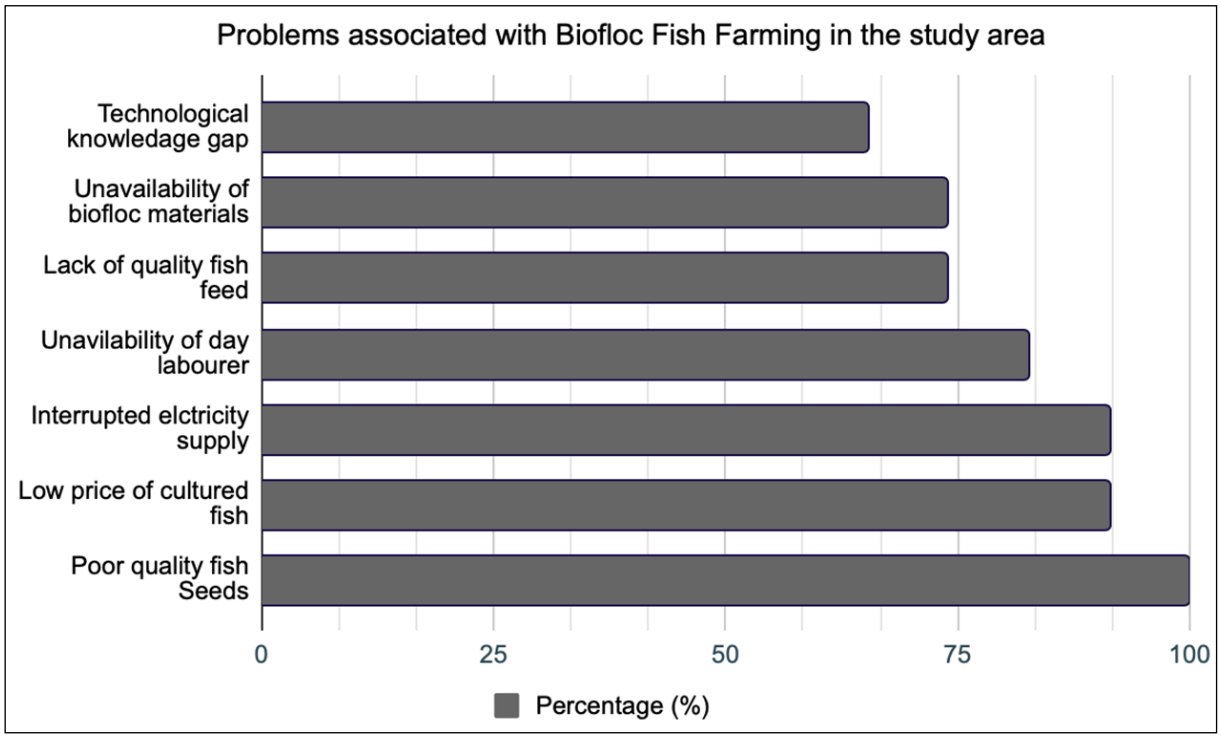


**Fig 1:** Problems associated with Biofloc fish farming in the study area

**Discussions**

Although Biofloc technology has been a promising technology for advanced fish culture around the world, in Bangladesh it didn't get that much success at the commercial level. Social Media influence the positive vibe of Biofloc that is flowing across the country. In our study it was revealed that all of the interviewed (100%) farmers are educated and above 60% of the farmers completed their graduation level. There has been a huge interest in Biofloc technology among the youth and it was found that above 65% of farmers belong to the age category of 30-40. Rashid *et. al*. (2015) also found that the middle age group (31-40) occupied the highest (58.33%) position in fish farming activity in this area. Ali *et. al.* (2022) reported that the Biofloc fish farmers mostly belong to the younger category and (33.33%) farmers completed graduation level studies. No female Biofloc farmers were found in the study area. All the farmers had a second income option. Mostly, enthusiastic, educated youths use Biofloc as a trial basis because of social media influences and also the technological aspects of Biofloc attracted them mostly for indoor rearing of fish. However, Siddiqua *et. al.* 2019 reported only 3% of the fish farmers completed graduate level study, which is the opposite for Biofloc farmers.

The farming communities in Bangladesh are not a financially solvent group. However, in the case of Biofloc fish farmers, the majority (60.9%) belong to the income category of 30000-50000 BDT/month and 56.5% invested their own funds for Biofloc fish farming. Ali *et al*., 2022 reported 93.3% of the Biofloc fish farmers invested their own money in fish culture. No respondents took a loan from the bank, which is similar to the study of Ali *et*

*al*., 2022. It was observed that the housing structure, sanitation facilities, electricity access and health-care facilities are quite better than the other farming groups. This is relevant to the study on fish farmers and fishers by Akter *et al*., 2014; Rashid *et. al*., 2015; Asif *et. al.*, 2017 [2].

The production performances of three species in the studied Biofloc fish farming were assessed to identify the feasibility of Biofloc fish farming in the area. Very few scientific reports were found on the cost-benefit analysis of Biofloc in the studied area. This study revealed that Biofloc is not sustainable on a very small scale and also species selection is a very important part of benefiting through Biofloc fish farming in the study area. It requires fixed term investment for setting up the Biofloc tank and comprises a cost equivalent to one cycle production cost of the cultured species (Table 3.2.2). The setting of Biofloc tank and the water quality parameters test kit consist of the highest cost. Installation of electricity and aeration materials also requires a good amount of money for the Biofloc unit. In terms of variable cost, the feed cost is the major cost and varies slightly in different species. Some other studies (Ahmed, 2007; Boateng *et al*., 2013) [3, 5] also reported that feed cost is the highest cost in the culture of tilapia in different systems, which is similar to the findings of this survey. In Biofloc, it is said to reduce at least 30% of the feed cost by utilizing wasted feed and faces, but it's needed to have good skills for feeding fish and forming Biofloc in the system. The BCR of Tilapia and Shing were 0.55 and 0.61 respectively, while the BCR of Pabda was 1.04. The lowest BCR for this fish culture is because of the calculation of production in a 10000L tank. Ali *et. al*. 2022 reported that the production of fish in Biofloc depends on the tank size, numbers, types and most importantly the efficient management of the venture. A varying level of BCR from 0.833 to 2.88 was observed in different Biofloc farms in his study. It can be noted from table 1, the total fixed cost of all the species cultured is ranging from 32284-33700 BDT. However, the variable cost differs slightly because the feed and fingerling cost costs vary in different species. The average cost of kg/production of three species were 94.5; 154.04; 132.37 respectively and the market price also varies depending on the species. However, farmers believed that they could even get enough profit in this setting, if the quality of fish seeds and feed was ensured and the culture went smoothly till the end of the culture period.

The low production of fish through Biofloc technology in the study area was caused by different reasons. One of the main reasons is farmers themselves. Around 48% of the fish farmers were beginners at fish farming, while above 20% don't have any experience of fish farming. Social media influences, especially YouTube and Facebook, had a great impact on starting fish farming for the majority of the respondents. Studies in different areas (Das *et al*. 2018, Rahman *et al*., 2015, Ali et. al. 2022) [7, 10] also reported at the same time that most cases have started farming without prior training. The other problems depicted in figure 1 have also impacted the production of fishes in the Biofloc system in the study area.

**Conclusion**

Biofloc fish farming has gained the huge attention of the fish farmers in Bangladesh. In particular, the involvement of educated urban farmers is a great sign of improvement in fish production in Bangladesh. As a technology-based farming system, it needs to have prior training of farmers and necessary skills and also the availability of resources involved. The present study suggested that Biofloc fish farming on a very small scale might not be a profitable venture but the proper designing and management of the Biofloc unit should increase the production of fish. The positive role of Biofloc is flowing across Bangladesh. More research should be conducted at government and non-government level to find out the best suitable species and also the profitability of Biofloc in aspects of Bangladesh.

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