ISSN: 2617 – 8338 (Online)
: 2617 – 832X (Print)

EBAUB Journal
An Academic Journal of
EXIM Bank Agricultural University Bangladesh

Present Status, Problems and Prospect of Biofloc Fish Farming in Chapainawabganj District

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ARTICLE INFO

Received date: January 25, 2021
Accepted date: Sept. 18, 2021

ABSTRACT

The study was conducted to know the present scenario, problems and prospect of the biofloc fish farming of Chapainawabganj district in Bangladesh. The primary data were collected during November 2020 to January 2021 through interview and well-structured questionnaire. Fifteen farmers were included in the study who were directly involved in biofloc fish farming. Most of the farmers belonged to age category 21-30 years. All of the respondents had some form of education where highest (46.70%) was in higher secondary level. Eighty percent of the farmers had less than five family members where 40% of the respondents were solely depended on biofloc fish farming. Among the respondents, 93.3% invested their own money in the biofloc fish culture. Among the respondents, 100% introduced to biofloc technology directly or indirectly by YouTube and 53.3%of them started without any training. Highest production and return per cycle was found in respondent 15 (930 Kg, 125000 Tk), on the other hand lowest production and return per cycle was found in respondent14 (60 Kg, 7000 Tk). Highest BCR was found 2.665 whereas the lowest was 0.833 and average moderate BCR was 1.766. In the study, area 46.7% farmers faced diseases like fungal disease, tail, fin rot disease, and white spot disease. In the study area, problems like lack of nearby hatchery and lack of quality fingerlings were prominent. Assurance of good quality fingerlings, need based training, development of a community based fish farming should be taken into account on a priority basis to improve and utilize biofloc fish farming technology in Chapainawabganj district.

Keywords: Biofloc, Fish farming, Possibilities, Problems, Socio economic status

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1. INTRODUCTION

Bangladesh is a densely populated country of 148,460 square kilometers with a population of about 165 million people (BBS, 2020). It is fortunate to have an extensive water resource in the form of ponds, natural depressions (Haors and Beels), lakes, canals, rivers and estuaries covering an area of 4.712 million ha (DoF, 2020). Total fish production of Bangladesh in 2018-19 was 37.24 lakh MT where aquaculture contributes 56.76% (DoF, 2020). Bangladesh is now ranked 5th in world with aquaculture production (DoF, 2020). Fisheries sector contributes 3.61% to total GDP and 25.72% to the agricultural GDP (DoF, 2020). Total 18.5 million people are involved in this sector in which numbers of fish farmers are around 13.86 million. Total pond area of Bangladesh in 2018-19was 0.39 million ha and annual production of fish was 19.74 lakh MT (DoF, 2020). However, over exploitation of natural water resources, industrialization, and urbanization keep squeezing this water resource every day.

To Cite: Ali, M. S., Hossain, M. F., Hossain, M. M., Roy, A. & Shanto, K. (2022). Present status, problems and prospect of biofloc fish farming in Chapainawabganj district. *EBAUB J.*, 4, 24-30.

The necessity to increase aquaculture production has been activated by the increasing demand of global population (Avnimelech, 2009). With more than 165 million people in Bangladesh, the requirements for aquatic food is increasing accordingly and hence, expansion and intensification of aquaculture production are highly required. Aquaculture as a food-producing sector offers many opportunities to remove poverty, hunger and malnutrition, generates economic growth and ensures better use of natural resources (FAO, 2017). The prime goal of aquaculture expansion is to produce more aquaculture products without significantly increasing the usage of the basic natural resources of water and land (Avnimelech, 2009). The second goal is to develop sustainable aquaculture systems that will not damage the environment (Naylor et al., 2000). The third goal is to build up systems providing an equitable cost/benefit ratio to support economic and social sustainability (Avnimelech, 2009). One of the strategies to improve aquaculture production and sustainability should focus on enhancing feed nutrient utilization. This can be developed by two different approaches, i.e. (i) by increasing the feed quality and feeding strategy in a way that the nutrients can be efficiently delivered and finally utilized and (ii) by re-utilizing the nutrient waste through modifications in the culture system (Bossier & Ekasari, 2017). Biofloc technology application in aquaculture offers benefits in improving fish production that could help to contribute the achievement of these sustainable development goals. This technology can lead to higher productivity with less impact on the environment.

Biofloc technology, which is evolved to deal with wastewater management, maintains biochemical cycles, and upholds the nutritional levels of the aquatic life (Anis, 2020). Biofloc technology is mainly based on the principle of waste nutrient recycling, particular nitrogen, into microbial biomass that can be used in situ by the cultured animals or can be harvested and processed into feed ingredients (Kuhn et al., 2010; Avnimelech, 2009). The biofloc technology system provides the intensive aquaculture with no or minimum water renewal reducing its environmental impact (Poli et al., 2019). In this system, the management of the microbial community is determinant to keep the water quality, especially the development of heterotrophic bacteria, through the complementary carbon source, which stimulates its growth and improves the process of removing inorganic nitrogen from water, besides allowing its transformation into bacterial biomass (Robinson et al., 2019; Avnimelech, 2007). Heterotrophic micro biota is stimulated to grow by steering the C/N ratio in the water through the modification of the carbohydrate content in the feed or by the addition of an external carbon source in the water (Avnimelech, 1999), so that the bacteria can assimilate the waste ammonium for new biomass production. Hence, ammonium/ammonia can be maintained at a low and non-toxic concentration so that water replacement is no longer required. Applying biofloc technology in tilapia intensive cultures increased nitrogen recovery from 23% to 43% (Avnimelech, 2007). Biofloc systems provide a nutritious food source and can improve feed utilization efficiency in situ utilization of microbial flocs generated in biofloc systems by some aquaculture organisms as well as the utilization of processed bioflocs as a feed ingredient has been well documented (Anand et al., 2014; Kuhn et al., 2010). Levels in biofloc were found to be comparable to that of the shrimp commercial diet suggesting that biofloc are likely to be recognized as food particles by some aquaculture organisms (Bossier & Ekasari, 2017).

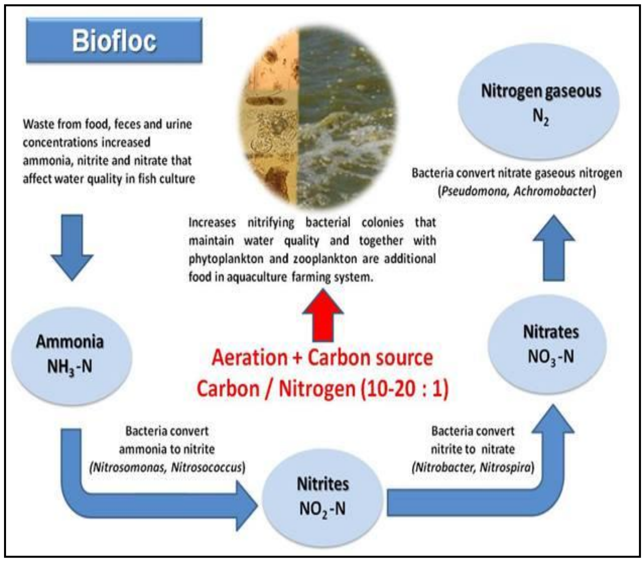

Fig. 1 Biofloc flowchart.

Also, biofloc technology application in larvi culture (at least to some species which can handle particles in suspension) may provide easily accessible food source for the larvae outside the regular feeding moments, thus minimizing possible negative social interaction during feeding (Ekasari et al., 2015). The reduction of protein content of the feed and the use of plant-based protein sources in the feed are considered more sustainable and eco-friendly because of the reduced production of nitrogenous and phosphorous waste. Biofloc may contribute to the supply of essential nutrients and digestive enzymes either through the stimulation of endogenous production or microbial secretion (Anand et al., 2014; Xu & Pan, 2012). According to Ekasari (2014), as a protein source, biofloc could be considered as a good protein source for shrimp and a useful protein source for tilapia and mussel. According to Ju et al. (2008), biofloc also contain various bioactive compounds including essential fatty acids, carotenoids, free amino acids and chlorophylls. In biofloc fish culture, the disease occurrence could be less. Some studies demonstrated that the presence of potentially pathogenic bacteria might be reduced in biofloc systems (Zhao et al., 2012; Crab et al., 2010). The traditional way of fish farming comes with its demerits like time consumption, dependence on nature, harmful effects on the environment, and not enough fulfillments of demands (Anis, 2020). On the other hand, biofloc fish farming has less to no harmful effects on the environment, fish can be harvested at a definite time, it provides artificial environment and is possible to cultivate fish 10 to 20 times more than traditional methods or any other process.

Above situation clearly indicates the necessity to observe the present status and potentiality of biofloc aquaculture in Bangladesh. Therefore, the present study evaluated socio-economic condition of the involving farmers and their production and economics of biofloc fish farms in Chapainawabganj district, Bangladesh. The study is undertaken to accomplish to explore the socio-economic condition of different respondents in study area and their impact of farming system, to evaluate the production and economics of different respondents of biofloc farming system, and to identify different problems of the respondents and recommend possible solutions.

2. MATERIALS AND METHODS

2.1. Study Area

The study was confined to Sadar upazila, Chapainawabganj District, Bangladesh (Fig. 2). Fifteen biofloc fish farms located in different villages were selected and monitored using random sampling method. Random sampling method is simple and best suited for smaller population (Moore et al., 2014). The entire process of data collection was conducted from November 2020 to January 2021.

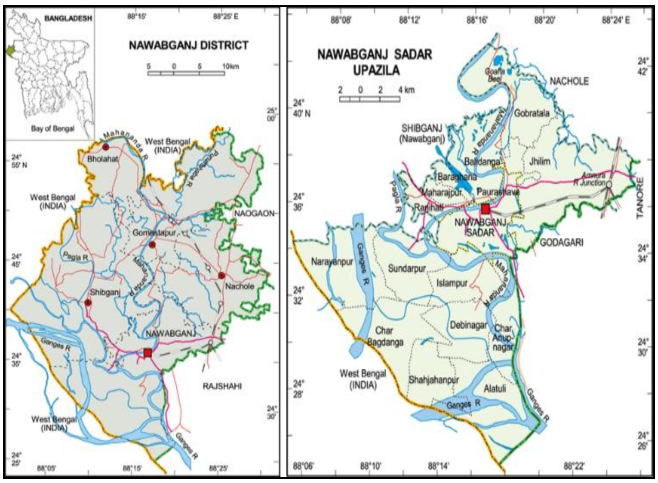

Fig. 2 Map of the study area.

2.2. Data Collection

The study was conducted by collecting data from biofloc fish farms. The data were collected by participant observations, group discussions, interviews and informal conversations and questionnaires.

For quantitative data collection, pre-structured questionnaire was used to address different issues of biofloc fish farms, fish culture and production, farmer's socio-economic conditions and problems related to biofloc fish culture and correlation between different independent variables (farmer's age, income, profession, information's sources, experience) in this study.

Age of a respondent was measured in terms of actual years based on their statement. Educational status was measured by the number of years of schooling. Uneducated respondents were scored nil (0).

2.3. Data Analysis

All collected data were carefully scrutinized, recorded and analyzed using SPSS data editor and Microsoft Excel using the simple statistical method and presented in both graphical and tabular form for ease of understanding. Outline of the methodological approach is presented in Fig. 3.

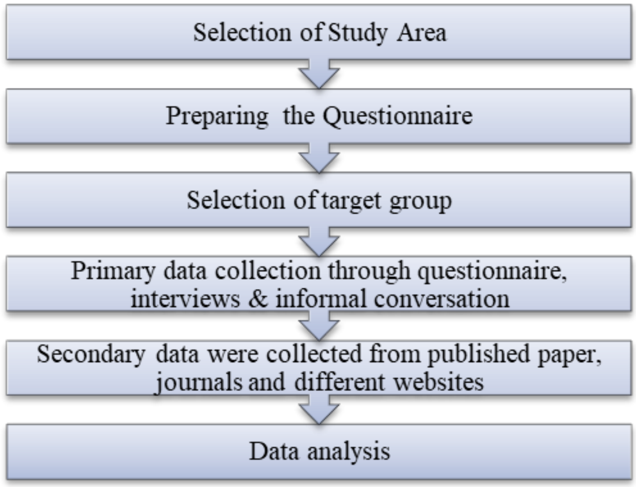

Fig. 3 Outline of the methodological approach.

3. RESULTS AND DISCUSSION

3.1. Demographic Profile of Fish Farmers

Different demographic status (age, family size, education level, occupation, primary information source etc.) of 15 farmers were measured in the present study (Table 1).

3.2. Age Group

In the present study, 6.7% of the respondents were old aged whereas 53.3% and 40% were young and middle aged, respectively. The young and middle aged people were more interested in biofloc than older farmers and it also indicated that older farmers were more cautious about this technology. This value was more or less similar to the finding of Ali et al. (2008) who got 52% respondents of young and middle aged in this fish farming.

3.3. Family Size

The family size usually has a considerable influence on the income and expenditure of the family. The family sizes of the farmers were divided into 2 categories according to the number of the family members (Table 2). Out of the 15 farmers, 80% had small (<5) sized family and 20% had large size (>5) family. The present finding has similarity with the findings of Das et al. (2018) and Ali et al. (2008).

3.4. Education

According to present study, no farmer was illiterate whereas 20%, 46.7% & 33.3% had secondary, higher secondary and graduation level of education, respectively. In the study, it was seen that the level of education of farmers hugely affected the adoption and utilization of biofloc technology. The similar views also expressed by Khan (1986).

Table 1 Demographic profile of biofloc fish farmers in the study area

Category	Frequency	Percentage
Age group		
Young	8	53.30
Middle	6	40
Old	1	6.70
Family size		
Small (<5)	12	80
Large(>5)	3	20
Educational level		
No formal education	0	0
Primary(I-V)	0	0
Secondary(VI-X)	3	20
Higher Secondary(XI-XII)	7	46.70
Graduation	5	33.30
Occupation		
Only biofloc fish farmer	6	40
Agricultural farmer	2	13.33
GO / private employee	2	13.33
Businessmen	5	33.33
Investment in biofloc		
Own	14	93.30
Bank loan	0	0
Share	1	6.70
Primary information source		
Department of Fisheries	0	0
Other nearby biofloc fish farmer	0	0
Internet	13	86.70
Nearby persons	2	13.30
Training on biofloc		
No training	8	53.30
Training only	2	13.30
Farm visit only	2	13.30
Training and visit only	3	20

3.5. Occupation

Total 40% respondents have chosen biofloc fish farming as their primary occupation. Most of them were students and trying to be self-employed and self-independent without hampering their studies. Whereas the rest of the respondents with13.3%, 13.3% and 33.3% were occupied in agriculture, service and business, respectively. As it was a newly adopted technology, the involvement of the farmers as main occupation was not huge. But it was moderate involvement in biofloc fish farming. The people were taken it on commercial purposes just like a business.

3.6. Investment

The study sketched that majority of the famers (93.3%) invested their own currency in the biofloc fish culture while the rest (6.7%) of the farmers combined. Quddus et al. (2000) reported that most of the farmers of Bangladesh culture fish with their own fund. Ali et al. (2008) found almost similar values (80%) in Bagmara upazila, Rajshahi for fish farming investment.

Table 2 Production and return of fish of respondents in 1 cycle

Respondents	Production (Kg)	RPC (`000)	RPC/Year (`000)	Total production (Kg)
R1	500	46	138	
R2	470	47	141	
R3	255	23.5	70.5	
R4	560	50.1	150.3	
R5	355	32	96	
R6	262	21	63	
R7	280	28	84	
R8	297	32.8	98.3	5783
R9	600	54	162	
R10	360	46.8	140.4	
R11	134	12	36	
R12	160	18.5	55.5	
R13	560	56.5	169.5	
R14	60	7	21	
R15	930	125	375	

*RPC= Return Per Cycle

Table 3 Variations in the mean values of different parameters of different respondents' economics

Respondents	Tank Establishment (Tk.)	Instruments (Tk.)	Subtotal (Tk.)	Cost/ cycle (Tk.)
R1	120000	40000	160000	2133.33
R2	70000	50000	120000	4000
R3	80000	30000	110000	1466.67
R4	40000	25000	65000	866.67
R5	40000	28000	68000	906.67
R6	30000	10000	40000	533.33
R7	110000	15000	125000	1666.67
R8	20000	12000	32000	426.67
R9	80000	35000	115000	1533.33
R10	32000	22000	54000	720
R11	30000	25000	55000	733.33
R12	60000	25000	85000	1133.33
R13	40000	11000	51000	680
R14	30000	15000	45000	600
R15	300000	220000	520000	6933.33

3.7. Primary Source of Information

From the study, it was found that 86.7%respondents got introduced to biofloc technology by YouTube, whereas rest

Table 4 Variations in the mean values of different parameters of different respondents' economics

Respondents	Fingerling (Tk.)	Feed (Tk.)	Others (Tk.)	Subtotal (Tk.)	Total Cost (Tk.)	Return/cycle (Tk.)	Return/ year (Tk.)	BCR
R1	12,000	10,000	2,000	24,000	26,133	46,000	138,000	1.760
R2	17,640	11,000	2,000	30,640	34,640	47,000	141,000	1.357
R3	8,800	8,000	2,000	18,800	20,267	23,500	70,500	1.160
R4	28,800	10,000	2,000	40,800	41,667	50,100	150,300	1.202
R5	26,000	9,000	2,500	37,500	38,407	32,000	96,000	0.833
R6	9,000	4,000	500	13,500	14,033	21,000	63,000	1.496
R7	4,800	12,000	2,000	18,800	20,467	28,000	84,000	1.368
R8	6,664	3,700	1,500	11,864	12,291	32,760	98,280	2.665
R9	13,200	14,240	2,000	29,440	30,973	54,000	162,000	1.743
R10	28,000	12,000	2,000	42,000	42,720	46,800	140,400	1.096
R11	3,840	2,800	800	7,440	8,173	12,000	36,000	1.468
R12	7,000	4,500	1,500	13,000	14,133	18,500	55,500	1.309
R13	36,000	7,500	1,500	45,000	45,680	56,500	169,500	1.237
R14	1,200	1,600	500	3,300	3,900	7,000	21,000	1.795
R15	79,000	22,000	3,000	104,000	110,933	125,000	375,000	1.127

13.3% by either friends or family members who also got the information from YouTube. So the data strongly indicates that internet played a vital role in dispersing this technology and it can play vital role in future expansion work of this type of technologies. A recent study by Islam et al. (2020) has also found, social media like YouTube and Facebook can be used to spread new techniques and culture practices to the field. So, building community network, developing community infrastructure and community based fisheries management will be also easy to implement through the utilization of social media.

3.8. Training on Biofloc Fish Culture

During the study, it was observed that most of the respondents (53.3%) did not receive any kind of biofloc fish culture training. Total 13.3% respondents took training from trainers and 13.3% gained information and experience by visiting different farms and only 20% of them took training as well as visited different established farms to gain information and experience about biofloc before starting. Das et al. (2018) also found similar results that most of the farmers (80%) do not get any kind of scientific fish culture training. Very little initiatives to conduct training are arranged by the DoF of Bangladesh (Rahman et al., 2015; Khatun et al., 2013).

3.9. Production

The first cycle harvest of the respondents is given in Table 2. The highest production was found 930 Kg followed by 600 Kg and 560 Kg. On the other hand, the lowest production was observed 60 Kg followed by 134 Kg and 160 Kg. The production varied because of the size and number of tanks as well as experience of farmer, management techniques, importantly the fingerling's quality and market price of the harvested fish.

3.10. Economics

In the present study, cost of production was divided into two types, one was fixed cost and another was variable cost. The fixed cost was considered for 25 years and 75 cycles and then a simple economic analysis was performed to estimate different costs of production and returns of all respondents (Table 3, Table 4).

Among the studied farms, the highest return/cycle was found 125,000Tk in respondent 15 and the lowest was 7,000Tk in respondent 14. On the other hand, the highest cost of production was found to be 110,933Tk and the lowest production cost was 3900Tk. The production cost varied due to the size, number & types of tanks as well as experience and management and importantly the fingerlings' quality and market price of the harvested fish. The highest BCR was observed 2.665. On the other hand, the lowest BCR was 0.833. Among the studies, the highest and the lowest BCR were exception. But the moderate values were found 1.795, 1.760 and 1.743. Among the moderate values, 1.795(respondent 14) was a very small-scale farmer. The other moderate farms showed 1.760 and 1.743 in respondent 9 and respondent 1, respectively were suitable candidate according to BCR for biofloc fish farming.

3.11. Diseases

In the study area, the farmers reported the occurrence of diseases like fungal disease, tail & fin rot disease and white spot disease during the culture period (Table 5).

Both the fungal disease like Saprolegnia disease and bacterial disease like Fin & Tail rot disease were observed equally (20%) among the respondents.

But most of these diseases occurred due to the injury during transportation of fingerlings. Other reasons include environmental condition and lack of management. 6.7% respondents had observed viral disease (white spot) in their tanks. Most of the respondents did not face any diseases during their production cycle (Table 5). Das et al. (2018) and Aftabuddin et al. (2016) found almost similar diseases in their study area in aquaculture.

Table 5 Different diseases occurrence in biofloc fish farming in the area

Disease type	Frequency	Percentage
No Disease	8	53.3
Fungal Disease	3	20.0
Tail & Fin rot	3	20.0
Others	1	6.7

Table 6 Problems faced by fish farmers during biofloc fish farming

Problems	Frequency	Percentage
1. Lack of nearby hatchery	15	100.0
2. Lack of Good quality fingerlings	15	100.0
3. High cost of fingerlings	12	80.0
4. Lack of proper training facilities from DoF and NGO	10	66.7
5. Low market price of fish	10	66.7
6. Diseases	7	46.7
7. Lack of proper transportation facilities of fingerlings	6	40.0
8. Lack of proper knowledge of tank construction	4	26.7
9. High cost of fish feed	4	26.7
10. Bad Water Quality	2	13.3

3.11. Diseases

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3.12. Present Emerging Problems

The major problems faced by the respondents in the study area were lack of nearby hatchery, lack of good quality fingerlings, high cost of fingerlings etc. (Table 6). Almost similar types of problems in pond aquaculture were found by Das et al., (2018) and Mazumder et al. (2013) which are major hinders for the progress of fish farming in Bangladesh.

5. CONCLUSION

Considering different areas of the study such as demographic status of farmers, production and economics it is concluded that the technology can be a great source of self-employment for the young people because the modern technologies are more adopted by educated persons at the starting point. Considering the BCR, biofloc aquaculture technology is a profitable farming and it can definitely contribute to the food production and fulfill the nutritional demand of the study area as well as whole country. However, this study also revealed poor utilization of the technology due to some major constrains which if solved, could increase fish production greatly and become more profitable. Therefore, governmental and nongovernmental initiatives are crucial to resolve the existing problems thus ensuring higher fish production and higher profit.

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