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Article

Contribution of aquaculture on livelihood development of fish farmer at Noakhali, Bangladesh

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Abstract: The present study was conducted to assess the contribution of aquaculture on livelihood status of fish farmer at Noakhali sadar upazila. This research work was carried out during the period of February 2013 to July 2013. A total of 50 fish farmers were interviewed with a well-structured questionnaire. The survey revealed that average pond size was 0.48 ha with 40% of the farmers having ponds of single ownership, 20% having ponds of multiple-ownership, 30% having ponds of single lease and 10% having ponds of multiple leases. Poly culture of Indian major carps and exotic carps has been practiced by most of the farmers. Fish fingerlings were stocked from April to June and average stocking density was 12,370 fingerlings/ha. The average fish production cost was Tk 69,870/ha/yr. Although the living condition of the rural fish farmers were poor, livelihood outcomes were found positive and 88% of the farmers have improved their socio-economic conditions through fish farming. The gross income and net profit were Tk. 1, 06,400 and Tk. 1, 00,000/ha/yr respectively. The average monthly income was in range of BDT 15,000-25,000. Their basic need like food, cloth, house, education and medical facility had changed after fish farming. The households have broadly improved their food consumption, family education, standards of living, purchasing power, choice and economic ability through fish farming. The constraints for sustainable pond fish farming in the areas were lack of technical knowledge of the farmers, disease of fishes, multiple ownership of the pond, higher production cost (mainly seeds and feed), in-sufficient supply of fry and fingerlings, lack of money and credit facilities and inadequate extension services. It is therefore essential to provide the necessary training facilities with institutional and organizational supports, credit facilities and extension services for sustainable fish production and livelihoods of rural fish farmers.

Keywords: livelihood development; aquaculture practice; socio economic study; Noakhali

1. Introduction

In Bangladesh, aquaculture practice is very precious and its future prospects are also very lucrative as our country is blessed with lots of fisheries resources. Bangladesh has a total of 260 freshwater fish species and 475 marine species (DoF, 2017). The climatic condition of the country (moderate temperature, heavy rainfall during monsoon seasons) is also suitable to support the culture of fish. Fisheries, the high growing sector, contributed about 3.61% of the total export earning, 4.39% to GDP and 24.41 % to agricultural sector (DoF, 2017).

Aquaculture sector contributes to food security, poverty alleviation and social well-being in many countries of the world *(*Jia *et al*., 2001). Noakhali is situated in the central coastal zone of Bangladesh along the northeastern coast of the Bay of Bengal. Huge quantities of sediments in the water make an essential feature of this region. Most of the land accretion and erosion occur in this coastal zone. The coastline is highly fragile and there is a series of islands and accreted lands (known in Bengali as 'char') formed by sediment deposits, connected to the mainland of Noakhali (Ahmed and Wilde, 2011). There are also newly accreted lands emerged from the sea recently in the last 10-15 years and have not yet consolidated (Demaine, 2011). The Noakhali river and the small Feni river have joined together with many canals, tributaries, creeks and stream corridors to flow in to the Bay. There are many canals and their tributaries which have crisscrossed. These rivers and canals are tide-fed and the tidal water can reach up to 20 km interior. The coastal zone of Noakhali consists of extensive flat, coastal and deltaic land of the Meghna river delta. The main sources of water in the area are rain, rivers, canals, swamps and ponds. Water stagnation is a common phenomenon during heavy rainfall. As the monsoon is very active, heavy rainfall cause flood/water logging. Early rainfall causes filling of water retention areas, ponds and ditches, tributaries, lakes and low lying areas and thus additional rainfall during the ongoing rainy season just over flow or cause water logging for about 6 months (May to October) in some parts of Noakhali. The mean annual rainfall is 2000 mm, of which approximately 70% occurs during the monsoon season. Temperature varies from 12 to 34°C. The relative humidity is high varying from 70% to 89% in July. Rainfall is abundant but seasonal. About two thirds of the annual rainfall evaporates and 15% percolates into the ground, raising the water table close to ground level. These changes may affect natural and human systems independently or in combination with other determinants to alter the productivity, diversity and functions of ecosystems and livelihoods as anthropogenic climate change is already affecting aquatic ecosystems and the human societies that depend on them (Perry *et al*., 2009).In Noakhali there are about 0.21 million ponds are present in the district, of which most of the ponds are suitable for culture (BBS, 2016). In recent years farmers are getting some support from the government and non-government organizations. The present study was planned with the objectives, to understand the existing systems of pond fish farming in some selected areas of Noakhali Sadar Upazilla; to know the socio-economic conditions and livelihoods status of pond fish farmers in the area; to observe the contribution of aquaculture practice on changing the livelihood status of fish farmer in the selected area; and to identify the constraints of pond fish production.

2. Materials and Methods

2.1. Study area and periods

The study was carried out throughout the fish farming area of the Noakhali sadar upazila under the district of Noakhali (Figure 1), Bangladesh from February 2013 to July 2013.

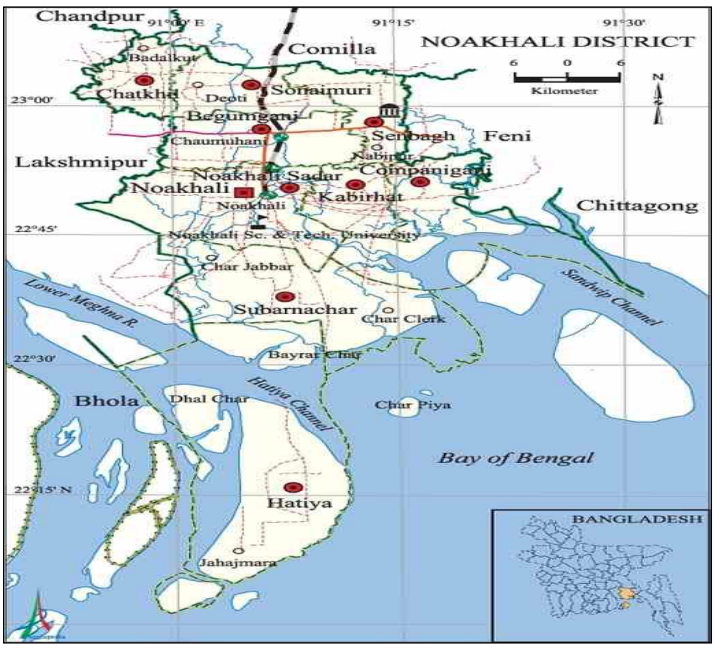

Figure 1. Map of study area Noakhali district.

2.2. Target group: fish farmers

A large number of fish farmers were known to be engaged in fish farming in Noakhali sadar upazila, Noakhali. Fish farming is the main occupation of most of these people.

2.3. Sample

The sample size of Fish farmers depends on several factors such as financial constraints, the importance of the study, its method of data collection etc. For this study, the data were collected from 50 randomly selected fish farmers.

2.4. Data collection method

2.4.1. Design and formulation of questionnaire

For data collection from fish farmers, a questionnaire was prepared in accordance with the objectives set for the study. Questions releted to culture system, stocking management, health management system, socio economic condition and other relevant aspects of Good Aquaculture Practices (GAP) were included in the questionaire. Questionnaire was constructed into english and translated to Bengali during face to face interview.

2.4.2. Questionnaire interviews

For questionnaire interviews, simple random sampling method was followed for fish farmers at Noakhali sadar in Noakhali. Farmer's were interviewed both at their farm sites and in their houses. Interview of each farmer required about 30-40 minutes.

2.4.3. Focus group discussion

For the present study, participatory rural appraisal (PRA) tool such as, Focus Group Discussion (FGD) was conducted with the farmers. FGD was used to get an overview of particular issues such as, pond size and depth, stocking density, proper farming management etc. FGD sessions were held on the dike where there was spontaneous gathering.

2.4.4. Cross-check interviews

After collecting of data through questionnaire interviews and FGD, it was necessary to check the information for justification of collected data, if there were such items which had been contradictory, then information's were collected from key informant. Cross-check interviews were conducted with key persons such as, upazilla fisheires Officer and relevant NGO workers for confirmation of the information. The interviews of key respondents were conducted in their offices.

2.5. Data processing and analysis

All the collected data were summarized and scrutinized carefully and recorded. After collection of data, these were edited and scored. Finally, relevant tables were prepared in accordance with the objectives of the study. Data presented mostly in the tabular form because it is simple in calculation, widely used and easy to understand. Data were analyzed using the Microsoft excel 2007.

3. Results

3.1. Background of fish farming

Among the 50 respondents 10% fish farmers started fish farming in 1995 or before, 14% farmers started between 1995 and 2000, 35% between 2001 and 2006 and 41% after 2006.

3.2. Current status of fish farmer

3.2.1. Age structure

Age of the respondents ranged from 20 to above 50 years. They were classified into four categories as young (20-30 years), middle aged (31-40 years), old (41-50 years) and old above 50 years. The highest proportions (36%) of fish farmer were middle aged and above 50 years was the lowest (14%) (Figure 2).

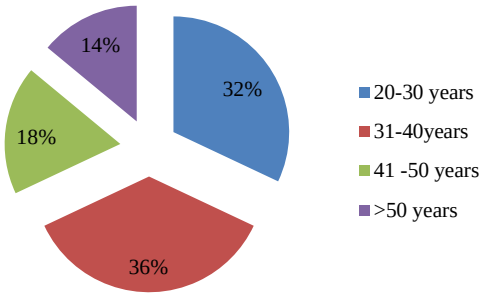

Figure 2. Age structure of the fish farmer.

3.2.2. Educational status

Most of the fish farmer had education up to primary level 44%, 24% fish farmer had secondary education, 18% had S.S.C passed, 14% had no education (Figure 3).

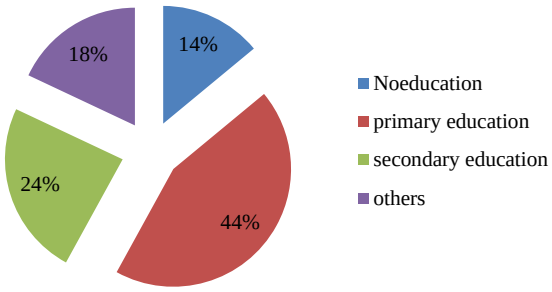

Figure 3. Educational status of the fish farmer.

3.2.3. Family types and sizes

Seventy seven percent fish farmer family was jointed and nuclear family was twenty three percent. Family was categorized as small family (members up to 5), medium family (members 6 to 10) and large family (members above 10). Small family was 24%, medium family was 54% and large family was 18% (Table 1).

Table 1. Family size of the fish farmer in the study area.

Family size	No. of fish farmer	Total fish farmer (%)
Small family (members up to 5)	14	24
Medium family (members 6 to 10)	27	54
Large family (members above 10)	9	18

3.2.4. Housing status

This present study indicates that 70% houses were owned, while 8% were free use and only 22% were rented. In the study area houses of fishermen were of three main types as I) *Katcha* ii) tin shed and iii) half building. Housing condition were dominated by *katcha* (23%), followed by tin shed (69%) and half building (8%) (Figure 4).

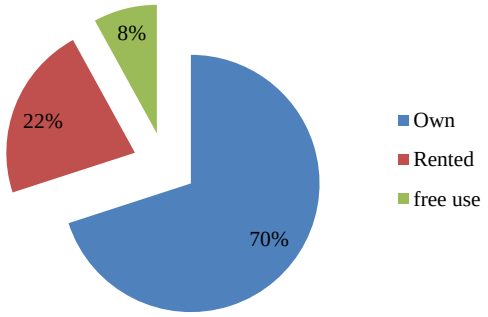

Figure 4. House dwelling unit ownership of the fish farmer.

3.2.5. Drinking water facilities

The study showed that 100% of the fish farmer households used tube-well water for drinking purposed and among them 64% fish farmer used their own tube-well, and 36% used neighbors tube-well (Figure 5).

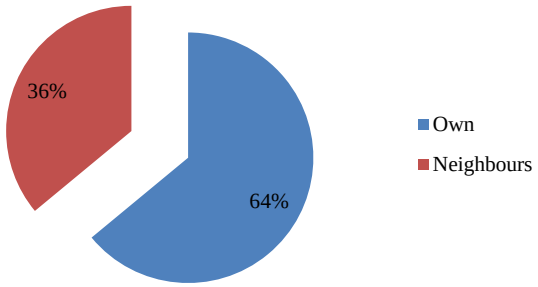

Figure 5. Drinking water facilities enjoyed by fish farmer.

3.2.6. Sanitary facilities

Three types of toilets were found to be used by fish farmer: i) *Katcha*–made of bamboo with leaf shelter and inadequate drainage disposal ii) Semi-puccha, made of brick with leaf or in tin shelter and inadequate drainage disposal and iii) Pucca-made of brick with good drainage disposal. In the study 20% of toilets were *katcha* while 56% were semi-pucca and only 24% were pacca (Figure 6).

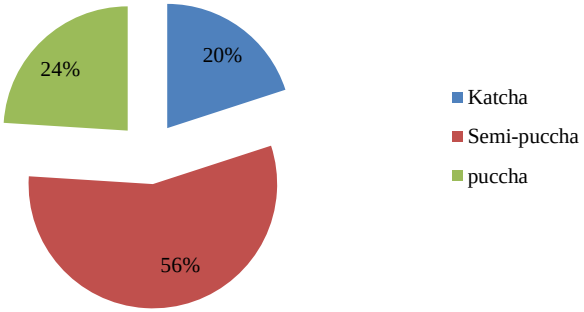

Figure 6. Sanitation facilities enjoyed by the fish farmer.

3.2.7. Health facilities

Health facilities enjoyed by the fish farmer were not at all satisfactory. Generally fish farmer took health suggestions from unskilled, nonprofessional *kabiraj*/village doctor. Health service status was categorized into four groups: *kabiraj*, village doctor, upazila health complex and MBBS doctor. A significant proportion (28%and52%) of fish farmer depends upon village *kabiraj* and village doctors who actually possess no knowledge on medical

science and 14% fish farmer go to upazilla health complex and only 6% got services from MBBS doctors (Figure 7).

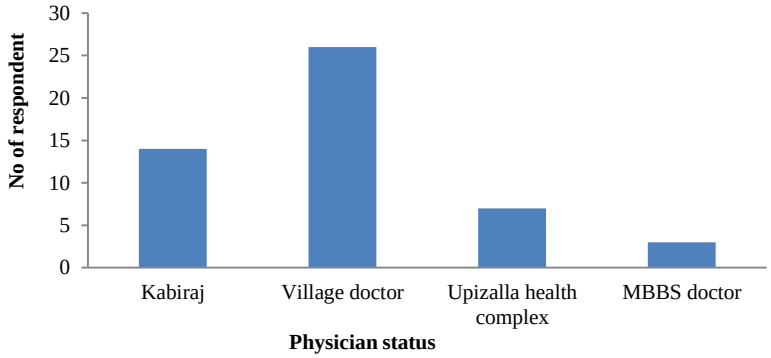

Figure 7. Source of health facilities for the fish farmer.

3.2.8. Electricity facility

There was no electricity in the study area. Maximum number (80%) fish farmer used solar panel. Others were used candle lights, hurricanes or other lighting instrument.

3.2.9. Source of credit

It was found that 76% of the farmers used their own money for fish farming, 16% of the farmers received loan from bank for farming activities and 8% of the fish farmers received loan from other sources like different NGOs (Figure 8).

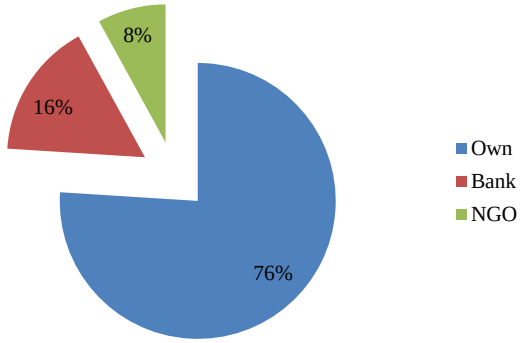

Figure 8. Source of credit of fish farmer.

3.2.10. Occupational status

The present study revealed that 24% of fish farmer were engaged in fish farming as their main occupation while 10% was in business, 50% agriculture and 16% in others (Figure 9).

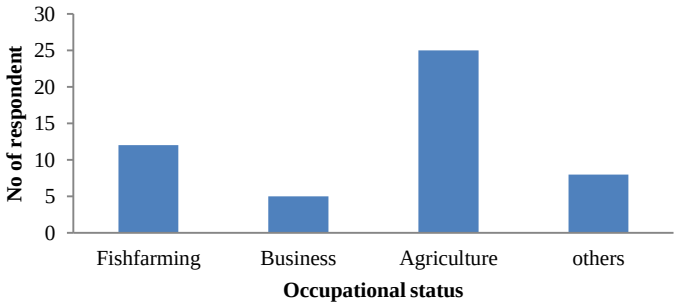

Figure 9. Occupational status of the fish farmer.

3.2.11. Fish farming status

In this study area, most of the fish farmer engaged in poly culture. Integrated fish farming was less. Average pond size was 3 meter. Most of the fish pond was small. Different types of fish like Rohu, (*Labeo rohita*), Catla (*Catla catla*), Mrigal (*Cirrhinus cirrhosus)* etc. were cultured. Stocking density was varied from 80 to 105 per decimal. Fry was released in the month of April to June. The cultured fish was harvested in the month of December.

3.2.11.1. Pond size and depth

In the present study, it was found that the average pond size was 0.48 ha (120 decimals). Maximum pond size was 2.18 ha (540 decimal) and minimum pond size was 0.24 ha (6o decimal). The average depth of pond, in the study area was found 3 meter. Maximum pond depth was 6 meter and minimum pond depth was 2 meter.

3.2.11.2. Ownership of the pond

In present study, it was observed that the highest number of ponds (40%) was occupied by the single owner, 20% was multiple owners, 30% was single lease and 10% was multiple leases (Figure 10).

Figure 10. Ownership of the pond.

3.2.11.3. Cultured fish species and stocking density

In the study area, the season of fish farming was from April to December. Fish fries were stocked when they became available in April to June and were harvested primarily from December to January (Table 2). Most of the farmers (99%) carried out poly culture and among them 1% ponds were under integrated culture system. In this system farmer cultured mainly Indian major carps like Rohu, (*Labeo rohita*), Catla (*Catla catla*), Mrigal (*Cirrhinus cirrhosus*) and Exotic fish silver carp (*Hypophthalmichthys molitrix*), Grass carp (*Ctenopharyngodon idella*), Common carp (*Cyprinus carpio var communis*), Bighead carp (*Hypopthalmithys nobilis*), Sarpunti (*Puntius sarana*) and Monosex Tilapia in the study area. Hatchery produced fingerlings were predominant in the fish culture of the study area. The average stocking density was found to be 12370 fry/ha.

Table 2. Time schedule of fish farming in pond system.

Farming Activities	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Pond preparation												
Stocking												
Rearing												
Harvesting												

3.2.11.4. Fish production cost and profit

The average total cost of fish production in the study area was observed as Tk.69870/ha/yr. The production cost of fish was higher due to the increase of the price of fingerlings, feed, fertilizers, drugs, chemicals and labor. Highest amount of production cost was spend for fish feed (18%) followed by fingerlings (24%), water pumping (11%), labor (5%), lime (10%), fish marketing (7%), fertilizers (12%), miscellaneous (5%), cow-dung/organic manure (4%) and drugs/chemicals (4%). The average profit/ha from fish culture was found to be Tk. 106400/yr (Figure 11).

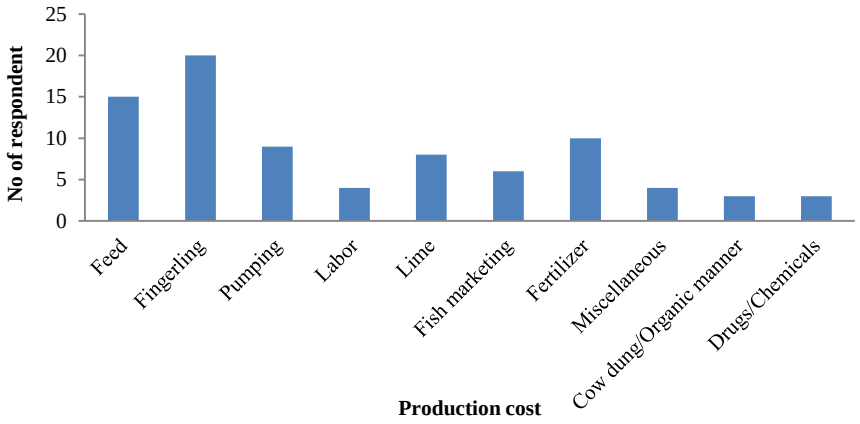

Figure 11. Fish production cost and profit of fish farmer.

3.3. Socio-economic condition

The survey suggested that farmers had improved their socio-economic conditions through fish farming, as confirmed by 88% fish-farmers. Only 12% of the farmers had not improved their socio-economic conditions due to poor knowledge on fish farming, high price of fish feed, poor marketing facilities and lack of money for fish farming (Figure 12).

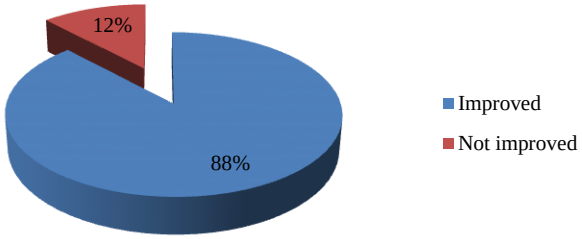

Figure 12. Improved socio-economic conditions through fish farming.

3.3.1. Income

Annual income of fish farmers were varied from 20,000 to 110,000 BDT. The selected fish farmers were grouped into five categories based on the level of their annual income. The highest percentage (34%) fish farmers earned BDT 75,000 to 100000 per year (Table 3).

Table 3. Annual incomes of the fish farmers in the study are.

Annual household income (BDT)	No. of Fish farmer	Total Fish farmer (%)
Up to 24,0000	3	6
24,000-50,000	8	16
50,001-75,000	12	24
75,001-100000	17	34
>100001	10	20

Among 50 farmers, it was found that before fish farming 48% fish farmer earned between Tk. 10,000-20,000 per month. Thirty four percent earned between TK. 20,000-30,000 per month and only 48% earned above TK. 30,000 per month. After fish farming their monthly income was increased. The survey suggested that 28% fish farmer earned TK. 10,000-20,000 per month, 41% earned TK. 20,000-30,000 per month and 30% above TK. 30,000 after fish faring. Average fish income was TK. 15,000-25,000 per month (Table 4).

Table 4. Variation in monthly income.

Before fish farming			After fish farming		
Monthly income	**No. of fish farmer**	**Total fish farmer (%)**	**Monthly income**	**No. of fish farmer**	**Total fish farmer (%)**
10,000-20,000	24	48	10,000-20,000	14	28
20,000-30,000	17	34	20,000-30,000	21	41
>30,000	9	18	>30,000	15	30

(Note: Time interval between before fish farming and after fish farming was 10 years)

3.3.2. Food

Food is a basic need of human being. In the study area the farmer ate rice, fish, meat, milk, egg etc. More than 50% fish farmer taken 3 times meal in a day. Most of them took fish as a meal in a day. In the study area it was found that, before fish farming 64% fish farmer taken 2 times meal per day, 24% fish farmer taken 1 time meal per day and only 12% farmer taken 3 times meal per day. It also found that, they had taken fish for meal only 0-1 day in a week and meat or milk rarely. After fish farming 57% fish farmer had taken 3 times meal per day, 27% fish farmer had taken 2times meal per day and only 16% fish farmer had taken 1 time meal per day. They also took fish for meal 5-6 days in a week and meat or milk once or twice in a week (Table 5 and 6).

Table 5. Variation in meal frequency.

Meal frequency/day					
Before fish farming			After fish farming		
Time/day	**No. of fish farmer**	**Total fish farmer (%)**	**Time/day**	**No. of fish farmer**	**Total fish farmer (%)**
1 time/day	12	24	1 time/day	8	16
2 times/day times/day	32	64	2 times/day	14	27
3 times/day	6	12	3 times/day	28	57

(Note: Time interval between before fish farming and after fish farming was 10 years)

Table 6. Variation of food taken facility.

Food items	Before fish farming	After fish farming
Rice	Daily	Daily
Fish	0-1 day/week	5-6 days/week
Vegetables	4-5days/week	4-5 days/week
Meat/milk	Rarely	Once or twice in a week every week

(Note: Time interval between before fish farming and after fish farming was 10 years)

3.3.3. Cloth

In the study area, before fish farming 68% bought cloth for their family 1time in a year, 24% bought cloth 2 times in a year and 8% bought cloth 3 times in a year. After fish farming 46% bought cloth 2 times in a year, 36% bought cloth 2 times in a year and 18% bought cloth 1 time in a year (Table 7).

Table 7. Variation in cloth buying facility.

Before fish farming			After fish farming		
Time/year	**No. of fish farmer**	**Total fish farmer (%)**	**Time/year**	**No. of fish farmer**	**Total fish farmer (%)**
1 time/year	34	68	1 time/year	18	36
2times/year	12	24	2times/year	23	46
3times/year	4	8	3times/year	9	18

(Note: Time interval between before fish farming and after fish farming was 10 years)

3.3.5. Home

In the study area, before fish farming 52% farmer's house were katcha, 34% had tin shed and 14% had puccha. After fish farming 62% farmer's house had tin shed, 24% had katcha and 14% had puccha (Table 8).

Table 8. Variation in home condition facility.

Before fish farming			After fish farming		
House condition	**No. of fish farmer**	**Total fish farmer (%)**	**House condition**	**No. of fish farmer**	**Total fish farmer (%)**
Katcha	26	52	Katcha	12	24
Tinshed	17	34	Tinshed	31	62
Puccha	7	14	Puccha	7	14

(Note: Time interval between before fish farming and after fish farming was 10 years)

3.3.4. Children education

In the study area, before fish farming only 46% fish farmers' children got primary education, 28% were illiterate, 18% got secondary education and only 8% got above secondary education. After fish farming 54% farmers' children got primary education, 24% got secondary education, 18% got above secondary education and only 4% were illiterate (Table 9).

Table 9. Variation in education facility.

Before fish farming			After fish farming		
Education level	**No. of fish farmer children**	**Total fish farmer children (%)**	**Education level**	**No. of fish farmer children**	**Total fish farmer children (%)**
Illiterate	14	28	Illiterate	2	4
Primary education	23	46	Primary education	27	54
Secondary	9	18	Secondary	12	24
>secondary	4	8	>secondary	9	18

(Note: Time interval between before fish farming and after fish farming was 10 years)

3.3.6. Medical

In the study area, before fish farming 72% fish farmer took medical facility from kabiraj, 22% got from village doctor, 4% took from upazilla health complex and only 2% got from MBBS doctors. After fish farming, 42% had taken medical facilities from village doctor, 28% from kabiraj, 18% from upazilla health complex and 12% from MBBS doctors (Table 10).

Table 10. Variation in taking medical facility by the fish farmer.

Before fish farming			After fish farming		
Physician status	**No. of fish farmer**	**Total fish farmer (%)**	**Physician status**	**No. of fish farmer**	**Total fish farmer (%)**
Kabiraj	36	72	Kabiraj	14	28
Village doctor	11	22	Village doctor	21	42
Upizilla health complex	2	4	Upizilla health complex	9	18
MBBS	1	2	MBBS	6	12

(Note: Time interval between before fish farming and after fish farming was 10 years)

3.4. Constraints of fish farming

Present survey revealed that 40% of the fish farmers identified fish disease as the single most important problem in fish farming in the study area. Here respondents identified that non availability of fish fry 20%, pouching

16%, poor technical knowledge 14%, lack of quality feed 4% and lack of money 6% to be the most important problems respectively (Figure 13).

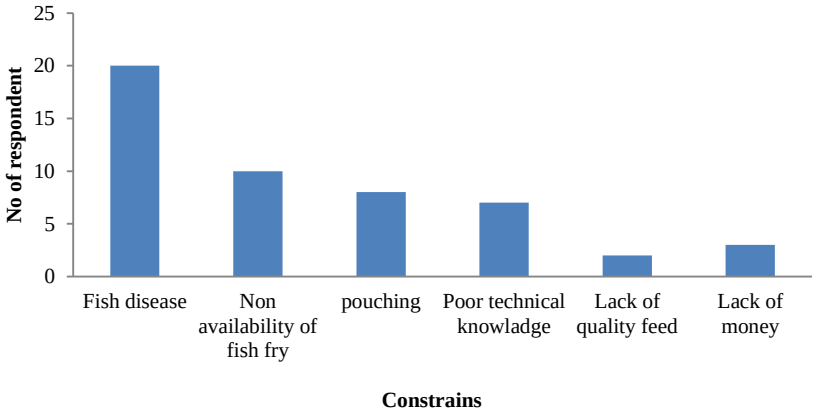

Figure 13. Constrains of fish farming in the study area.

4. Discussion

Among 50 farmers, it was found that the highest proportions (36%) of fish farmer were middle aged (31 years-40 years) and above 50 years was the lowest (14%). Kaiya *et al,* (1987) found that fish culture efficiency varied with the age and number of owners of pond in Tangail district. Vaumik *et al.* (2017) stated that, 30% farmers were 31-35 years old, 31% were between 36-40 in Lalmonirhat district. Sharif *et al.* (2015) concluded 85% farmer has the age of 40 and above in Jessore district. Islam *et al.* (2015) founded in sundarban the maximum age level was 20-30 years old. Islam *et al.* (2014) revealed 44% farmer had a age level 31-40 years as well as Asif and Habib (2017) research found the 38% people has an age group of 51-60 years which is similar with the present study. Present study revealed that fish farmer had 44% education up to primary level, 24% fish farmer had secondary education, 18% had S.S.C passed and 14% had no education. Zaman *et.al,* (2006) found that 23.3% farmers were illiterate whereas 14.4%, 8.9% and 6.7% were educated up to primary, secondary and higher secondary or above level respectively in Rajshahi district. Asif *et al.* (2015) 46% of traders have institutional education; Asif and Habib (2017) stated 36% had primary level, 42% had secondary level (up to X), 10% had S.S.C. level, 4% had H.S.C. level and 4% had bachelor level of education. Hossain *et al.* (2016b) found most of the respondents (40%) are illiterate. In Meherpur another study found 16% farmer had primary level, 36% had secondary level, 20% had S.S.C. level, 14% had H.S.C. level, and 6% had bachelor level of education. Hossain *et al.* (2015) mentioned only 18.33% are secondary educated in Dinajpur district. Rahman *et al.* (2017) mentioned that, 33% of the contact farmers had up to secondary level of education (S.S.C) and only 7% of the contact farmers had masters' degree and Sultana *et al.* (2015) revealed 44% of farmers had age of 36 to 50 years which is more or less similar with present study. In the study area 77% of fish farmer family was jointed and 23% percentage fish farmer family was nuclear. Joint family was predominant in the study area which also correspondents well with the findings of Ali *et.al,* (2009) in Mymensingh district; Ali *et al.* (2016); Asif *et al.* (2015); Asif and Habib (2017); Hossain *et al.* (2015); Hossain *et al.* (2015); Sharif *et al.* (2015); Vaumik *et al.* (2017) and Zaman *et al.* (2017) also found the similar family in their research. Moreover, it was found that Small family was 24%, medium family was 54% and large family was 18%. Farid *et al.* (2013) found that, 58% fishermen were lived in joint families which are similar with the present study. Masud (2000) observed in his study that average family size of farmers related to fish culture in inundated water bodies was 6.36 (members) in Kishorgonj district. The study indicated that 70% houses were owned, while 8% were free use and only 22% were rented. About 69% households of the fish farmer were tinshed, 23% katcha and only 8% half building. Rahman (2003) reported that 70% of were katcha, while 21% were semi-pucca and only 9% were pucca in Gazipur district. Ahmed (2001) also found that 62% of katcha housing structure of prawn farmers in Mymensingh area. Asif and Habib (2017) stated around 88% had concrete house in Jhikargachha upazila, Jessore which is not similar with the study. Sharif *et al.* (2015) found 54% farmers used semi pucca, 19% of fish farmers used to live pucca houses and rest of 27% farmers used to live earthen houses in Chaugachha, Jessore. Islam *et al.* (2014) revealed full katcha (17 %) houses were few, while the semipucca (40%) and pucca (43%) houses were more abundant. Hundred percentage of the studied fishermen used tube-wells' water for drinking purposes and among them 64% fishermen had own tube-well and 36% used neighbors tube-well. Kabir *et.al,*

(2012) found that the highest (100%) fishermen of the Old Brahmaputra River used tube-well water for drinking purposes, among them 40% had their own tube-well, 50% used shared tube-well and remaining 10% used neighbors tube-well. Same study conducted by Ali *et al.* (2016); Asif *et al.* (2015); Asif and Habib(2017); Hossain *et al.* (2015); Sharif *et al.* (2015); Rahman *et al.* (2014); Vaumik *et al.* (2017); Zaman *et al.* (2017); Shabuj *et al.* (2016a) and Razeim *et al.* (2017) also they have found the similar results. In the study 20% of toilets were *katcha* while 56% were semi-pucca and only 24% were pacca. The present study revealed that the sanitary conditions of the fish farmers were relatively satisfactory than fish farmers in Mymensingh district where Ali *et.al,* (2009) in his study found that 62.5% of the farmers had semi-*pucca*, 25% had *kancha* (made of bamboo with leaf shelter and inadequate drainage disposal) and 12.5% had *pucca* toilet. Asif *et al.* (2015); Asif and Habib (2017); Hossain *et al.* (2015) and Islam *et al.* (2014) also found the similar results. Among 50 fish farmers, it was found that respectively 52% and 28% fish farmer took medical facility from unskilled, nonprofessional village doctor and kabiraj. Fourteen percentage took medical facility from upazilla health complex and only 6% took medical facility from MBBS doctor. Ali *et.al,* (2008) found that 46% of the farmers received health service from village doctors, 18% from upazila healthcomplex, 14% from district hospitaland 20% from MBBS doctors in Rajshahi district. Asif *et al.* (2015); Asif and Habib(2017); Hossain *et al.* (2015); Sharif *et al.* (2015); Vaumik *et al.* (2017) and Islam *et al.* (2014) have had the similar results with present study. Maximum number (76%) fish farmer invested their own money, 16% took loan from bank and 8% took loan from NGO in the study area. Quddus *et al.,* (2000) found that, in Demra, Dhaka only 34% farmers got bank loan for fish culture while majority (53%) of farmers expend from their own sources. Sharif and Asif (2015) stated, 40% farmers got loan from bank whereas 35% farmers took loan from local moneylenders with high interest of credit. Asif *et al.* (2014) also stated that, 24% farmers got loan from bank whereas 31% farmers took loan from local moneylenders which is similar with the present study. In the study area it was found that 24% took fish farming as their main occupation, 10% in business, 50% in agriculture and 16% in others which was more or less similar to the findings of Alam and Bashar (1995). Asif and Habib (2017); Asif *et al.* (2015); Asif and Habib (2017); Islam *et al.* (2014); Razeim *et al.* (2017); Ali *et al.* (2016); Zaman *et al.* (2017) and Sharif *et al.* (2015) conducted survey on major occupation of fish farmer and their results is more or less similar with the present study. Present study revealed that average pond size was 0.48 ha (120 decimals). Khan (1986) stated that fish culture efficiency varied with the size of ponds in Bangladesh. The average depth of pond depth is 3 meter. Razeim *et al.* (2017) found farm size of the Pangas farmers varied from 0.20 to 6.06 hectares. The average farm size was 1.35 hectare with a standard deviation of 1.01. According to DoF (2010) the average depth of ponds in Bangladesh is between 2 and 5 meter which correspond well with the study. Highest number of pond (40%) occupied by single owner, 20% was multiple owner, 30% was single lease and 10% was multiple lease. Hossain *et al.* (2002) reported that multiple pond ownership was a major constrains for pond aquaculture in Naogoan. The average stocking density was found to be 12,370 fry/ha. Alam (2006) found the average stocking density was 17,262 fry/ha at Mithapuqur upazila in Rangpur district which was higher than the present study. Haq *et al*. (2017); Zafar *et al*. (2017) and Shajib *et al*. (2017) found the similar stocking densities with the present studies. The average total cost of fish production in the study area was observed as Tk.69870/ha/yr. Ahmed (2003) found average fish production cost of Tk. 23,210 to Tk. 24,790/ha in Bangladesh. The average profit/ha from fish culture was found to be Tk. 106400/yr. Quddus *et al.* (2000) observed that in case of extensive, improve extensive and semi-intensive categories of culture net profit from fish culture were Tk. 46,600, Tk. 63,000 and Tk.92,000 respectively in Demra, Dhaka. Similar findings are also found by the study of Hossain *et al.* (2016a); Islam *et al.* (2017c); Rahaman *et al.* (2015); Rahman *et al.* (2017) and Rahman *et al.* (2015). The income profile is the main economic indicator of natural development. Majority of farmers (48%) had income around BDT 10000-20,000 per month before fish farming and after fish farming 41% had above BDT 20,000-30,000 per month and income level of fish farmers increased and no one had income below BDT 10,000 per month. Average income of fish farmer was 15,000-25,000 per month. Okorie (2000) reported that average monthly income from cage culture was BDT 2250 (USD$30). The highest percentage (34%) fish farmers earned BDT 75,000 to 1,00,000 per year. It was higher than the national average BDT 28,430 (BBS, 2004). The present findings of annual income of fish farmers correspond well with the findings of Rahman *et al.* (2012) in Noakhali district. Khan *et al.* (1998) stated that levels of family income are important economic factor affecting utilization of pond fish farming in Mymensingh district. Before fish farming highest number (64%) of fish farmer ate 2 times in a day. One time of the day they starved. Little number (12%) could take 3 times meal per day. Siddika *et al.* (2016) reveals their study in Jessore district and found that maximum labor took nutrias food. After fish farming the highest number (57%) of fish farmer could eat 3 times meal per day. Lowest number (16%) could take 1 time meal per day due to their lack of technical knowledge, multiple ownership, pouching, non availability of fry and fertilizer etc. Cloth is another basic need. In the study area their cloth variation

unchanged. Usually they put on Lungi, Punjabi, Shirt, Gangi etc. However, their buying capability of cloth increased due to fish farming. It observed that maximum number (68%) of fish farmer had ability to bought cloth 1 time per year and 24% could 2 times before fish farming. This percentage changed respectively 36% and 46% after fish farming. Home is an area where people feel secured. Home condition indicates the socio economic condition of an area. This study revealed that maximum number (52%) fish farmers' home was katcha and 34% home was tin shed before fish farming. After fish farming, this condition was changed 24% and 62% respectively. In present study area it was found that before fish farming the percentage of illiterate child was 28%, 46% was primary going children, secondary education was taken by 18% children and 8% took above secondary education. After fish farming this condition was changed 4%, 54%, 24% and18% respectively. Asif *et al.* (2015) and Asif and Habib (2017) studied about farmer's children education and the result is similar with present study. The study showed that 18% fish farmer went to upazilla health complex and 12% went to the MBBS doctor after fish farming which is similar with the study of Asif *et al.* (2015) and Asif and Habib (2017). Dey *et al.* (2010); found the tendency of going to village doctor and *kabiraj* increases from 38% to 50% and 12% to 32% respectively in Monpura, Noakhali, Bangladesh. Khatun *et al.* (2013) stated ,74% the of fish farmers received health service from village doctors and remaining 22% and 4% got health service from upazila health complex and MBBS doctors respectively which is relevant with the present study . From the survey, it was found that, multiple ownership, lack of scientific knowledge, lack of carp seed, lack of feed, disease and proper treatment and pouching were most constraints for fish production. Similar study were conducted by Vaumik *et al.* (2017); Yeasmin *et al.* (2016); Zaman *et al.* (2017); Sharif *et al.* (2015); Chowdhury *et al.* (2015); Hossain *et al.* (2017); Neowajh *et al*. (2017); Islam *et al.* (2017b) and Shabuj *et al.* (2017b), their findings were lack of credit, technical knowledge and diseases emphasize the main constrain in aquaculture in respective study area.

5. Conclusions

This study was conducted to know the pond fish farming systems, livelihoods and socio-economic condition of rural fish farmers. The fish farming sector plays important economic role in Noakhali district through production of valuable cash crop, increasing food production, and increasing employment opportunities. However, concerns have arisen about the long-term sustainability of fish farming due to lack of technical knowledge, poor supply of fish seed and marketing problems. The lack of technical knowledge in fish farm management may have an effect on productivity.

Conflict of interest

None to declare.

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