Research in
AGRICULTURE, LIVESTOCK and FISHERIES
ISSN : P-2409-0603, E-2409-9325
An Open Access Peer Reviewed Journal

Open Access
Research Article

Res. Agric. Livest. Fish.
Vol. 3, No. 2, August 2016: 361-368

FISH FARMING STATUS AT SREEMANGAL UPAZILA OF MOULVIBAZAR DISTRICT, BANGLADESH

Baadruzzoha Sarker[1] and Muhammad Forhad Ali*[2]

[1]Production Officer, BRAC Fish Hatchery, Sreemangal, Moulvibazar-3214, Bangladesh and [2]Department of Aquaculture, Sheikh Fajilatunnesa Mujib Fisheries College, Melandah, Jamalpur, Bangladesh; *PhD Fellow, Department of Fisheries Biology and Genetics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

***Corresponding author:** Muhammad Forhad Ali; E-mail: mforhad.fc@gmail.com

ARTICLE INFO

Received
07.08.2016

Accepted
15.08.2016

Online
17 August 2016

Key words
Fish farming,
Stocking density,
Feed,
Fish production,
Sreemangal

ABSTRACT

The potential and prospect of fish farming of Sreemangal, Moulvibazar was carried out from January to December 2015 by interviewing of 90 fish farmers with a well-structured questionnaire. The survey revealed that 40% of the ponds were seasonal and 60% perennial, of which 85% with single ownership and 15% accompanied by multiple ownership. The average pond size was 0.13 ha and depth 2.6 m. The ponds were prepared using of lime, cow dung, urea and TSP at the rate of 250, 250, 40 and 20 kg/ha, respectively. Nearly all of the farmers practiced polyculture with Indian major carps and exotic carps. Fish was stocked from March to June and average stocking density was 15,500 fingerlings/ha. To sustain natural food production, farmers generally used cow dung, urea and TSP at the rate of 2,600, 300 and 150 kg/ha/yr, respectively. Healthy environmental condition was maintained by applying lime and salt at 600 and 60 kg/ha/yr, respectively. The fish were fed by supplementary feed (45% farm) e.g., rice bran and mustard oil-cake with an average quantity of 2,200 and 550 kg/ha/yr, respectively and artificial pellet feed (55% farm). The average fish production, production cost and profit were found 2,945 kg/ha/yr, 1,25,940 and 94,935 Tk./ha/yr, respectively. The major constraints for sustainable pond fish farming were non-availability of fish fingerlings during stocking period, insufficient water in dry season, high production cost, poor technical knowledge, lack of money etc. By establishing more hatcheries, arranging training at farm level, providing interest free or at lower interest loan to the farmers the existing fish production could be increased.

To cite this article: Sarker B and MF Ali, 2016. Fish farming status at Sreemangal upazila of Moulvibazar district, Bangladesh. Res. Agric. Livest. Fish., 3 (2): 361-368.

INTRODUCTION

Aquaculture and fisheries at the moment is one of the most important potential sectors of the national economy, accounting to 3.69% of national GDP, 22.60% of agricultural GDP and 2.09% of foreign export earnings (FRSS, 2015). In Bangladesh no other sector depicted progress prospective more visibly than fisheries. The total fish production in Bangladesh in the fiscal year 2013-14 was estimated as 3.55 million tons, of which 1.96 million tons (55.15%) were obtained from inland aquaculture, 0.99 million tons (28.07%) from capture fisheries and 0.60 million tons (16.78%) from marine fisheries (FRSS, 2015). Among the global food production systems, aquaculture is widely professed as a key weapon in the global struggle against poverty and hunger. Aquaculture production, particularly pond aquaculture may be are liable source of attaining increased fish production so as to provide and feed the continually rising population of the planet (FAO, 2010). Fish and fishery resources play a vital role in improving the socio-economic condition, combating malnutrition, earning foreign currency and creating employment opportunities in Bangladesh (Bhuiyan et al., 2011). More than 17.5 million people are engaged with this sector on full time and part time basis (FRSS, 2015).

In the country, around 46% of children between the ages 6 and 7 years are stunted and 70% are exhausted due to malnutrition (Ahmed et al., 2007). The greater importance should be given to meet the animal protein deficit among the people as well as to augment fish production in this country through proper management of open water fishery and aquaculture. However fish production from open water bodies is declining progressively (DoF, 2012). In the past, the natural ecosystems supported huge and diverse biodiversity. Currently, volume of the most natural water bodies were reduced due to siltation, construction of flood control dam and concurrently polluted by agricultural, industrial and metropolitan waste as a contaminant and those were accumulated by runoff into natural water bodies. Accordingly, aquatic organisms were silently suffered to the sub-lethal toxicity by different types of chemicals, heavy metals and pollutants (Bernet et al., 1997). Consequently, capture fish production is also falling down due to manmade interventions and natural disasters. On the other hand, it is hopeful that aquaculture practice has become a promising and gainful methodology to attain self-sufficiency in food sector and also to alleviate poverty in developing country like Bangladesh (Ahmed, 2003). Additionally, more returns also come from the pond aquaculture (DoF, 2012). Aside from steadfast self-employment opportunities from fish farming, pond fish farming offers various livelihood prospects for operators and employees of hatcheries and seed nurseries and for seed traders and other mediators. Pond fish farming has also been proved to be an advantageous business than rice cultivation. Thus many farmers in rustic areas are converting their rice field into aquaculture pond. A lot of people in rural areas have taken fish farming activities as their secondary profession and most of them occupied in pond fish farming to enhance their socio-economic status (Ahmed, 2003).

Sreemangal is an upazila of Maulvibazar District in the Division of Sylhet, located at north east part (24.3083°N 91.7333°E) in Bangladesh. It has a total area of 450.73 km², with a population of 3, 18,025 (BBS, 2011). Sreemangal is the business nucleus of the district of Moulvibazar. Her economy has made of world-class tea gardens and tourism. Presently fisheries sector is emerging here and a considerable number of people have been engaged in fish culture practices in this hilly riverine area. For the development of cultural system and future planning, the information concerning present aquaculture practices at the grass root level is an important criterion. This study observed the present fish farming status in Sreemangal upazila and sought any constraints associated with the culture systems.

MATERIALS AND METHODS

Study Area and Target Farmers

The study was conducted at Sreemangal upazila in Moulvibazar district for obtaining detailed information about pond fishery resources and constraints associated. The data were collected fortnightly from 90 randomly selected fish farmers of 9 unions covering the selected study area from January 2015 to December 2015.

Data Collection Methods

The necessary data were collected using questionnaire and crosscheck interviews. The draft questionnaire was tested by the opinion of 10 fish farmers and much awareness was given to any new information which was not designed to ask but was considerable and informative to accomplish the objectives. The questionnaire was changed, modified and rearranged according to the experiences. Data were collected from fish farmers to get comprehensive information on their fish farming systems and various obstacles concerned with it. For collecting data both individual and group interviews were conducted at the pond sites and or in the house of the farmers. In favour of this study one of the PRA (Participatory Rural Appraisal) tool and FGD (Focus Group Discussion) was conducted to obtain more accurate data (Chambers, 1992; Nabasa et al., 1995). A total of 10 FGD sessions were conducted where each group size of FGD was 8 to10 farmers. The FGD session was held in front of village shops, under the big trees, farmer's house and school premises. At the beginning of the interview, a brief introduction about the objectives of the survey was given to each of the farmers/FGD groups and assured them that all information would be kept confidential. Each question was explained clearly and asked systematically for their sound understanding. After collecting the data through questionnaire interviews and FGD, crosscheck interviews were conducted with Upazila Fisheries Officer, Assistant Fisheries Officer, relevant NGO workers, Chairman and Members of the Union Councils.

Data Processing and Analysis

The collected data were scrutinized and summarized carefully before the actual tabulation. Some of the data e. g., pond area and pond depth were collected into local units and converted into data with standard units. Then the data were tabulated into a preliminary data sheet of a computer and compared with computer spreadsheets to ensure the accuracy of the data entered. After data entry, the data were analyzed through statistical method using Microsoft excel.

RESULTS AND DISCUSSION

Pond Category and Ownership

In the study area, ponds were found of two categories-homestead and commercial. The homestead and commercial ponds were 75% and 25%, respectively. Between the two categories of ponds 40% were seasonal and 60% perennial. The water level of perennial ponds declined in dry season, then some farmers used pump water in their ponds. Seasonal ponds were found unsuitable for fish culture throughout the dry season. The pond types were found 46% seasonal and 54% perennial in Rajshahi district (Ali et al*.,* 2008), 37% ponds were seasonal and 63% perennial in Tangail sadar upazila (Saha, 2004). It was observed that the uppermost number of ponds (85%) was occupied by the single owners followed by multiple owners (15%). Whereas, about 54% of the total pond were in single ownership, 34% were belongs to joint ownership and the rest 12% ponds were under public or organization property in Demra, Dhaka (Quddus et al., 2000), and 52% ponds were found under single ownership, 21% in multiple ownership and remaining 27% as leased pond in Tangail sadar upazila (Saha, 2004). The multiple pond ownership was a main constraint for pond aquaculture (Ali and Rahman, 1986, Mollah et al., 1990 and Hossain et al*.,* 2002).

Pond Size and Depth

Pond size is a vital feature as every management events are intended allowing for the size of ponds. It was observed that the average pond size was 0.13 ha with a range from 0.05 ha to 0.81 ha in the study area. As well as, the average pond size was found as 0.12 ha in Gazipur (Rahman, 2003), 0.19 ha in Tangail sadar (Saha, 2004), 0.21 ha in Dinajpur sadar (Saha, 2003) and 0.22 ha in Trishal, Mymensingh (Sheheli et al., 2013). Fish culture efficiency diverse with the size of ponds (Khan, 1986). The average depth of pond in the study area was found 2.6 meter. However in Bangladesh it varied from 2 to 5 meter (DoF, 2010) which corresponds well with the present study.

Culture Season and System

In the study site, the duration of fish farming was from June to November in case of seasonal ponds and March to November in perennial ponds. Fish fry were stocked when they become available in March to June. The peak period of carp polyculture was observed from March to December (Rahman, 2003) and also commencing from April to December (Ahmed, 2003). Furthermore, two culture seasons were practiced at Fazilpur and Sunderban union under Dinajpur sadar upazila; one was from July to December and the another was from February to June (Saha, 2003). The majority of farmers (98%) adopted polyculture and only 2% ponds were under integrated culture system. The idea of polyculture was based on utilizing different niches by various fish species. Therefore, a more complete use was made of the food resources and space available in polyculture than in monoculture (Anil et al., 2010).

Pre-stocking Managements

Pond preparation is one of the important tasks to obtain more production in fish farming. Several steps were followed by the farmers before stocking of fish. These are dike repairing, removal of the excessive mud from pond bottom; aquatic weed control, eliminate predatory and undesirable species, lime and fertilizer application, etc. In pre-stocking management, about 95% of the farmers controlled aquatic weeds manually. For eradicating undesirable species, most of farmers (90%) used netting method. Some of them (10%) used rotenone and phostoxin but, did not follow any recommended dose. Almost all farmers dried their ponds after harvesting of fish in the dry season, and they used lime at 250 kg/ha. In Trishal, Mymensingh about 86% farmer dried their pond after deteriorating water quality and, among them 54% and 46% owner applied lime at 247 and 370 kg/ha, respectively during pond preparation (Sheheli et al., 2013). In the study area, farmers used fertilizers mainly in the form of cow dung @ 250 kg/ha, urea @ 40 kg/ha and TSP (triple super phosphate) at 20 kg/ha. The purpose of using fertilizers in the ponds was to increase the production of natural food (phytoplankton, zooplankton and benthic organisms), in that way to augment fish production. In the study area, the use of cow dung was widespread due to being fairly cheap and available.

Cultured Species and Stocking Density

In polyculture system, farmer cultured mainly Indian major carp such as rohu (*Labeo rohita*), catla (*Gibelion catla*), mrigal (*Cirrhinus cirrhosus*), kalibaush (*Labeo calbasu*), and exotic carps like, silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngodon idella*), punti (*Puntius gonionotus*) and common carp (*Cyprinus carpio var communis*), and other alien species viz., tilapia (*Oreochromis niloticus*) and pangus (*Pangasius sutchi*). It was found that all farmer stocked hatchery produced fry. The average stocking density was determined as 15,500 fingerlings/ha. The average stocking density was recorded as 14,675 fry/ha at Shahrasti upazila in Chandpur (Pravakar et al., 2013), 17,262 fry/ha at Mithapuqur upazila, Rangpur (Alam, 2006) and 25,250 fry/ha/yr in Gazipur (Rahman, 2003). The stocking density of carp was maintained 10,621-13,091 fry/ha (DoF, 2005). However, it was observed a range of stocking density from 10,000-31,000 fry/ha at a village of Mymensingh district (Hossain et al., 1992).

Farm and Fish Health Managements

To maintain natural food production, it is essential to apply both organic and inorganic fertilizer into pond throughout the culture period. It was observed that majority of the farmers used cow dung and only a few farmers used poultry droppings as organic fertilizer. The fish farmers generally used cow dung, urea and TSP at the rate of 2,600, 300 and 150 kg/ha/yr, respectively on a regular basis, or four to five times during the culture period. Also, the average dose of organic fertilizer (cow dung) was 2,330 kg/ha/yr and inorganic fertilizer such as, urea at 387 kg/ha/yr and TSP at 176 kg/ha/yr were used in Tangail sadar upazila (Saha, 2004) and the doses of same organic and inorganic fertilizers were 11,075 and 739 kg/ha/yr, respectively (Rahman et al., 1998). All the farmers frequently used lime to maintain suitable water quality and reduce deleterious gases on an average rate at 600 kg/ha/yr of the study area. To get more fish productions farmer used lime at the rate of 247 kg/ha/yr in Panchagar (Islam and Haque, 2010). In the present study, 70% farmers applied salt three to four times at the commencement and during the winter season at 60 kg/ha/yr to keep healthy environmental condition and avoid infections. Ten percent farmers used some of the chemicals like copper sulphate, $KMnO_4$, dipterex, methylene blue, malachite green and calcium hypochlorite to control aquatic weeds, pests, parasites and detrimental species and prevent different types of diseases. Cent percent

farmer used more or less similar chemicals and other medicinal substances for controlling aquatic weeds, pest, predators and harmful species in their ponds in Trishal, Mymensingh (Sheheli et al., 2013). In this study, it was observed that out of 90 farmers, 20% farmers used antibiotics for control of different diseases. It also appeared that 22% farmers used antibiotics (Sheheli et al., 2013). Subsequent to good health management just 25% farmers did not found fish diseases, 65% farmers reported that fish was occasionally affected by diseases, while 10% farmers found disease outbreak every year. The most common diseases were tail and fin rot, epizootic ulcerative syndrome (EUS), argulosis, saprolegniasis, edwarsielosis, and nutritional deficiency. There were 15% fish farmers who did not find fish diseases in the pond, 73% farmer reported that their cultured fish was sporadically affected by diseases, while 12% fish farmers found disease outbreak every year in Trishal, Mymensingh (Sheheli et al., 2013).

Feed and Feeding Practices

Different types of feeds were used in fish production. Farmers mostly used three types of feed such as loose, pellet and green grass. From the survey, it was recorded that 45% of the farmers applied farm made supplementary feed prepared with rice bran and mustard oil-cake (80% and 20% ratio) and 55% farmers used artificial pellet feed. Whereas, approximately 95% farmer used rice bran and mustard oil cake as supplementary feed in Shahrasti, Chandpur (Pravakar et al.,2013), and 80% farmer applied the similar feed in Mithanpukur, Rangpur (Alam, 2006). In the present study, the farmer usually used rice bran and mustard oil-cake to feed the fish at 2,200 and 550 kg/ha/yr, respectively. However, the supplementation of rice bran and oil cake was at 2,730 and 580 kg/ha/yr in Gazipur (Rahman, 2003), 1,250 and 1,212 kg/ha/yr in Rajshahi (Hassanuzzaman, 1997) and, 1,920 and 100-110 kg/ha/yr in Debigonj and Boda upazilas, Panchagar (Islam and Haque, 2010), respectively. In the investigated area, some farmers used green grass and duck weed to feed the fish at undetermined quantity. Typically farmer collected floating and sinking pellet feed from the local market. In the study area it was found that nearly 55% farmers provided feed twice a day, while 25% of farmers supplied thrice a day and 20% applied feed once daily. There were 75% farmers applied feed twice in a day, 20% of farmers applied thrice and only 5% applied feed once per day in Trishal, Mymensingh (Sheheli et al., 2013). The recommended feeding frequency was two or three times per day (DoF, 2009). Both artificial and supplementary feed was used by the farmers, which showed a good sign about the perception of fish culture by the farmers.

Harvesting and Marketing

Though fish were harvested all over the year but the peak harvesting season lied from December to February. In this season around 65% fishes was harvested and remaining 35% was harvested during other season. The similar peak harvesting season was from December to March in Mymensingh (Ahmed, 2003). Also, the peak harvesting season was observed from November to January in Tangail sadar upazila (Saha, 2004) and from October to January in Gazipur (Rahman, 2003). Farmers harvested their fish using cast net and seine net locally known as *berjal*. Farmers were widely used the same nets to harvest fish in Mymensingh (Ahmed, 2003), in Debigonj and Boda upazilas, Panchagar (Islam and Haque, 2010) and in Shahrasti upazila, Chandpur (Pravakar et al., 2013). Harvested fish were kept in aluminum containers or bamboo baskets. From the survey it was found that around 95% of the fishes were sold by the farmers to the local agent and the rest 5% consumed by the households and given to the relatives. Although, nearly 72.5% farmers sold their captured fish to the fish traders, while 17.5% of them sold the fish to the retailers (*Foria*) and the rest 10% of them to the fish agent (Islam and Haque, 2010) and around 80% fish were sold by the farmers to local *paikers* and the rest 20% consumed by the households and given to the relatives in Shahrasti upazila, Chandpur (Pravakar et al., 2013).

Fish Production, Cost and Profit

In Sreemangal upazila the average yield of fish was found 2,945 kg/ha/yr. Likewise, the average production was 2,900 kg/ha/yr in Shahrasti, Chandpur (Pravakar et al., 2013), 2,925 kg/ha/yr in Gazipur district (Rahman, 2003) and also the same carp production was found in Bhaluka, Mymensingh (Kamruzzaman, 2011) and 2,940 kg/ha/yr in Moulvibazar (FRSS, 2015). On the other hand, mean (±SD) fish production was found 3,598.72±785.83 kg/ha/yr in carp polyculture of Rajshahi and Natore districts (Mohsin et al., 2012) and 3,743 kg/ha/yr in Mymensingh (Biswas, 2003). The annual production varies because of

differences in pond size, depth, categories, feed, seed, other inputs and management practices. In the study area it was found that average total cost of fish production was 1,25,940 Tk./ha/yr. The mean total cost of fish production in Shahrasti, Chandpur was observed as 80,850 Tk./ha/yr (Pravakar et al., 2013). The production cost of fish was higher due to the increase of the price of fingerlings, feed, fertilizers, drugs, chemicals and labour. Maximum amount of production cost was spend for fish feed (31.80%) followed by labour (24.22%), fingerlings (20.49%), water pumping and electricity (5.34%), fertilizers (4.39%), lime (3.94%), fish marketing (2.54%), miscellaneous (2.38%), fish harvesting (2.06%), cow-dung/organic manure (1.59%), drugs/chemicals (0.79%) and salt (0.40%). Similar production cost was assessed in Shahrasti, Chandpur spend for fish feed (28%) followed by fingerlings (25%), water pumping and electricity (9%), labour (8%), lime (8%), fish marketing (7%), fertilizers (5%), miscellaneous (4%), fish harvesting (3%), cow-dung/organic manure (2%) and drugs/chemicals (1%) (Pravakar et al., 2013). The average profit from the study area was found 94,935 Tk./ha/yr. In case of extensive, improve extensive and semi-intensive categories of culture net profit was observed from fish culture were 46,600, 63,000 and 92,000 Tk/ha/yr, respectively in Demra, Dhaka (Quddus, et al., 2000). The mean profit from fish culture of Shahrasti, Chandpur was found as 1,19,400 Tk./ha/yr. (Pravakar et al., 2013). The profit in fish culture was found fairly similar to the previous study.

Constraints of Fish Farming

The interviewed fish farmers faced a diversity of difficulties and constraints that affected the fish farming activities as well as their livelihood. On the basis of the survey 30% farmers confronted by non-availability of fish fry during stocking period as the single most important problem for fish farming. The other problems raised by the farmers were insufficient water in dry season (23%), high production cost (16%), poor technical knowledge (15%), lack of credit source (8%), lack of money (4%), low price of the produced fish (4%). Beside these, some fish ponds were occasionally inundated by flash flood in the study area. In other survey in Shahrasti, Chandpur it was exposed that 30% of the fish farmers identified fish disease as the only most momentous trouble in fish farming, following non availability of fish fry (20%), insufficient water in dry season (16%), pouching (14%), poor technical knowledge (10%), lack of money (6%) and lack of quality feed (4%) (Pravakar et al., 2013). In addition, it was reported that lack of scientific knowledge and suitable technology, less extension services on aquaculture training, turbidity, non availability of quality fish seeds at proper time, occurrences of fish diseases, water scarcity during drought season, pond water irrigation for crop fields were found in Mohanpur, Rajshahi (Zaman et al., 2006).

RECOMMENDATIONS

According to the outcomes of the present study, the subsequent recommendations were made for sustainable pond fish farming of farmers in Sreemangal upazila under Moulvibazar district. The problem of multiple ownerships can be solved by leasing the pond to a person interested in fish culture or through cage or pen culture by different owners. Supply of net and other harvesting and marketing equipments to the farmers with less fare may reduce harvesting and marketing cost. Government and other organization should play their assigned task by disseminating technology to the farmers and arranging essential training for scientific methods of aquaculture. Such training will aid to identify and solve the problems related to the fish farming. To supply quality fish seed to the farmers more hatcheries should be established by the help of government and NGO. Money lending from bank is lengthy and bureaucratic process and also a question of bride. The accessibility of credit at a low interest rate from bank should be eased and existing problems should be removed. Government should take necessary measures for proper extension work, which will improve the social, moral and scientific education among the farmers and neighbors; therefore the fish production will ultimately be increased.

CONCLUSION

The study showed that fish production was satisfactory and all farmers made a profit from fish farming. While the potential benefits are great, lack of aquaculture friendly credit support and inadequate technical assistance were constraints to the sustainability of fish farming. It is therefore, necessary to provide

institutional, organizational, and government support for sustainable fish farming. Additionally, a cost effective research-extension-farmers association technique is a prime need to increase fish production.

REFERENCES

1. Ahmed F, 2003. Comparative study on carp polyculture of three different NGOs in Mymensingh district. MS Thesis, Department of Aquaculture. Bangladesh Agricultural University, Mymensingh. pp. 65.
2. Ahmed MNU, 2003. Fisheries sector in Bangladesh. Economy and Development of livelihood. Fish Fortnight Compendium, Department of Fisheries, Bangladesh, pp. 86.
3. Ahmed N, MA Wahab and SH Thilsted, 2007. Integrated aquaculture-agriculture systems in Bangladesh: Potential for sustainable livelihoods and nutritional security of the rural poor. Aquaculture Asia, 12: 14-22.
4. Alam G, 2006. Status of fish farming and livelihoods of fish farmers in some selected areas of Mithapuqur upazila in Rangpur district. MS Thesis, Department of Fisheries Management, Bangladesh Agriculture University, Mymensingh. pp. 59.
5. Ali MH and MI Rahman, 1986. An investigation on some socioeconomic and technical problems in pond fish culture in two districts of Bangladesh. Bangladesh Journal of Aquaculture, 8: 47-51.
6. Ali MH, MD Hossain, ANGM Hasan and MA Bashar, 2008. Assessment of the livelihood status of the fish farmers in some selected areas of Bagmara upazilla under Rajshahi district, Journal of Bangladesh Agricultural University, 6: 367-374.
7. Anil SK, B Gunalan, KL Jetani, GK Trivedi and P Soundarapandian, 2010. Determine the Economic Feasibility of the Polyculture System (Giant Tiger Shrimp and Mullet). African Journal of Basic and Applied Sciences, 2: 124-127.
8. BBS (Bangladesh Bureau of Statistics), 2011. Population and Housing Census 2011. Bangladesh Bureau of Statistics, Statistics and Informatics Division, Ministry of Planning.
9. Bernet D, H Schmidt, W Meier, P Burkhardt-Hol and T Wahli, 1997. Histopathology in fish, Proposal for a protocol to assess aquatic pollutions, Journal of Fish Diseases, 22: 25-34.
10. Bhuiyan AS, S Akther and N Aktar, 2011. Present status and fish seed production of the hatcheries of six upazilas of Rajshahi District. University Journal of Zoology Rajshahi University, 30: 29-32.
11. Biswas D, 2003. Study of the impacts of Aquaculture in and around fish farms in Mymensingh district. Progressive Agriculture, 11: 243-249.
12. Chambers R, 1992. Rural Appraisal: Rapid, Relaxed and Participatory, IDS Discussion Paper No. 311, Institute of Development Studies (IDS), Bringhton, UK.
13. DoF (Department of Fisheries), 2010. Fisheries Fortnight Compendium, Department of Fisheries, Ministry of Fisheries and livestock, Dhaka, Bangladesh.
14. DoF, 2005. Basic Training of Fish Culture, Department of Fisheries, Dhaka, Bangladesh. pp. 87.
15. DoF, 2009. Department of Fisheries, Ministry of Fisheries and Livestock, Jatiyo Matshya Saptaho, pp. 54-56.
16. DoF, 2012. Fishery Statistical Yearbook of Bangladesh. Fisheries Resources Survey System, Department of Fisheries, Dhaka, Bangladesh.
17. FAO, 2010. State of World Aquacultutre-2010. Fisheries Department. FAO Fisheries Technical Paper, 500: 21-26.
18. FRSS, 2015. Fisheries Statistical Report of Bangladesh. Fisheries Resources Survey System (FRSS), Department of Fisheries, Bangladesh. 31: 1-57.
19. Hassanuzzaman AKM, 1997. Comparative study on pond fish production under different management systems in some selected areas in Rajshahi district. M. S. Thesis. Department of Agricultural Production Economics. Bangladesh Agricultural University, Mymensingh. pp. 76.
20. Hossain MS, S Dewan, MS Islam and SMA Hossian, 1992. Survey of pond fishery resources in a village of Mymensingh district. Bangladesh Journal of Aquaculture, 14-16: 33-37.
21. Hossain MA, MAR Khan and MA Mannan, 2002. Present status of pond fishery in Dhamaihat upazila, Naogoan. University Journal of Zoology Rajshahi University, 21: 79-80.

22. Islam MR and MR Haque, 2010. Impacts of Northwest Fisheries Extension Project (NFEP) on pond fish farming in improving livelihood approach. Journal of Bangladesh Agricultural University, 8: 305–311.
23. Kamruzzaman M, 2011. Study of aquaculture practices of Bhaluka Upazila, Mymensingh. MS Thesis, Department of Fisheries Management, Bangladesh Agricultural University, Mymensingh.
24. Khan MS, 1986. Socio-economic factors in the development of fisheries. Bangladesh Journal of Agricultural Economics, 10: 43-47.
25. Mohsin ABM, MN Islam, MA Hossain and SM Galib, 2012. Constraints and prospects of carp production in Rajshahi and Natore districts, Bangladesh. University Journal of Zoology Rajshahi University, 31: 69-72.
26. Mollah AR, NSI Chowdhury and MAB Habib, 1990. Input output relation in fish production under various pond sizes, ownership patterns and constraints. Bangladesh Journal of Training and Development, 3: 87-101.
27. Nabasa J, G Rutwara, F Walker and C Were, 1995. Participatory Rural Appraisal: Practical Experience. Natural Resources Institute (NRI), Greenwich University, London.
28. Pravakar P, BS Sarker, M Rahman and MB Hossain, 2013. Present Status of Fish Farming and Livelihood of Fish Farmers in Shahrasti Upazila of Chandpur District, Bangladesh. American-Eurasian Journal of Agricultural & Environmental Sciences, 13: 391-397.
29. Quddus MA, MS Rahman and M Moniruzzaman, 2000. Socio-economic conditions of the pond owners of Demra, Dhaka. Bangladesh Journalof Fisheries Research, 4: 203-207.
30. Rahman MA, MZ Sofiquzzoha and M Nurullah, 1998. Efficiency of pond fish production in Bangladesh. Bangladesh Journal of Agricultural Sciences, 25: 235-239.
31. Rahman MM, 2003. Socio-economic aspects of carp culture development in Gazipur, Bangladesh. M. S. Thesis, Department of Agricultural Economic. Bangladesh Agricultural University, Mymensingh. pp. 83.
32. Saha MK, 2003. A study on Fish Production Technology in North-West Bangladesh. MS Thesis, Department of Aquaculture. Bangladesh Agricultural University, Mymensingh. pp. 71.
33. Saha SK, 2004. Socio-economic aspects of aquaculture in Tangail Sadar Upazila, MS Thesis, Department of Aquaculture. Bangladesh Agricultural University, Mymensingh. pp. 77.
34. Sheheli S, K Fatema and SM Haque, 2013. Existing Status and Practices of Fish Farming in Trishal Upazila of Mymensingh District. Progressive Agriculture, 24: 191-201.
35. Zaman T, MAS Jewel and AS Bhuiyan, 2006. Present status of pond fishery resources and livelihood of the fish farmers of Mohanpur Upazila in Rajshahi District. University Journal of Zoology Rajshahi University, 25: 31-35.