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

EBAUB Journal
An Academic Journal of
EXIM Bank Agricultural University Bangladesh

Present Status of Integrated Fish Farming with Crops in Chapainawabganj District

Md. Shaheb Ali[1*], Tonima Tasmim[2], Mst. Taslima Khatun[2], Md. Arifur Rahman[2] , Md. Shahajada Siraj Sompod[2]

[1]Department of Fisheries, EXIM Bank Agricultural University Bangladesh, Chapainawabganj-6300, Bangladesh
[2]Faculty of Agriculture, EXIM Bank Agricultural University Bangladesh, Chapainawabganj-6300, Bangladesh

ARTICLE INFO

Received date: October 12, 2023
Accepted date:Nov.12, 2023

ABSTRACT

This study was conducted to observe the present status of integrated fish farming with crops in Chapainawabganj district of Bangladesh during May to June 2022. Primary data were collected from farmers through interview and well-structured questionnaire. In this study, 40 farmers who were directly involved with integrated fish farming with crops. Most of the farmers belonged to age category 36-55 years. Majority 65% farmers (5-12 years) had fish farming experience which indicating that they are more experienced in integrated fish farming system. The 40% respondents belong to secondary education level. According to ownership of total cultivable land, 81% of the farmers were in marginal class. Prospect of pond size and land ownership, 40% of fish farmers had small land holding which was less than 0.75 ha and 35% of respondents having large land holding. The 52.5% took loan from different type of organization. From the observation it was found that about 55% of the farmers acquired training and 45% of the fish farmers got technical assistance from DoF and different types of organization. Maximum fish production and income depends on pond size. The average pond size and fish production was near about 2.5 ha and 8 tons. In the study area, 62.5% carp fish species was cultivated and 37.5% was mix fish species and most of the farmers cultivated fruits 57%, mix crops 40% and vegetables 13% as crop with fish. Farmers had maintenance issue and they faced different problems at different stages. Assurance of good quality fingerlings, sufficient bank loan arrangement, technical training, transportation facilities of fingerlings and formation of farmer`s organization where all the farmers are connected and develops their lacking. Therefore, the socio-economic conditions of the farmers can be uplifted by adopting improved farming systems through integrated approaches.

Keywords: Carp fish, Fish farmer, Integrated fish farming, Mix fish, Socio-demographic status

***CORRESPONDENCE**
shahebali98@yahoo.com
Department of Fisheries, EXIM Bank Agricultural University Bangladesh, Chapainawabganj-6300, Bangladesh

1. INTRODUCTION

The integrated system is a combination of crop and livestock or fish and also includes the combination of aquaculture with trees. Integrated fish farming helps to utilize the limited resources base of small-scale farmers and provides them fuller employment and generates surplus produce for scale. Integrated fish farming helps to break down the monoculture system and offers a good solution. It emphasizes the strong interdependence between different types of agricultural products which protects the natural resources, including maintaining water, soil and air quality (Mohammad & Hiroyuki, 2006). In Bangladesh, the number of marginal farms has been increasing and fisheries sector contributed

To Cite: Ali, M. S., Tasmim, T., Khatun, M. T., Rahman, M. A., M. & Sompod, M. S. S. (2024). Present status of integrated fish farming with crops in Chapainawabganj district. *EBAUB J.*, 6, 45-52.

3.57% to national GDP and 25.30% to the agricultural GDP (DoF, 2022).

Fish is one kind of staple food of Bangladeshi people and they are commonly known as "Mache-Bhate Bangali" and the fish alone supplies about 60% of animal protein (DoF, 2022). Bangladesh is now 5th in the world of fresh water fish production and annual fish production is 4503371tons (DoF, 2020). Aquaculture presents numerous chances to end hunger, poverty, and malnutrition. It also fosters economic growth and promotes better use of natural resources (FAO, 2017). Integrated fish farming, there is a considerable supply of animal protein in addition to a sufficient amount of carbohydrates, vitamins, and minerals. Small fish in particular are high in minerals and vitamins. Thus, consuming fish can significantly improve human nutrition (Roos et al., 2003; Larsen et al., 2000).

The main objective of fish farming combined with crops is to maximize the production of more aquaculture goods without considerably increasing the use of the basic natural resources of water and complementary use of land (Avnimelech, 2009). Fish farming is integrated with agriculture to increase diversification, intensification, production, and profitability as well as create environmentally friendly aquaculture systems (Ahmed et al., 2007; Nhan et al., 2007; Naylor et al., 2000). In Bangladesh, integrated fish farming with crops technology has been demonstrated successfully and a considerable number of farmers have been trained through various projects, this integration has yet to be widely practiced.

Integrated farming system "IFS" - farmers mainly focus on agricultural production, which has high income. In this competition, it is imperative to come up with a suitable strategy to increase the income of a farm throughout the year. Combination of different agricultural businesses in the agricultural system has great potential in the agricultural economy. These enterprises not only supplement farmers' income but also help increase employment for family workers all year round (Jayanthi et al., 2000; Singh et al., 1997; Singh et al., 1993). In this regard, goal is to establish integrated agricultural systems that provide affordable costs to support economic and social sustainability (Avnimelech, 2009).

Crops can be irrigated with the fish ponds and their residues and through commodities may be used for feeding livestock. The fish, after eating the plankton, produce their personal wastes which can be transformed obviously into vitamins that are an excellent fertilizer for terrestrial plants and is widely used by farmers. Where there is no adequate irrigation system, pond water can also be used to irrigate crops, if needed. Soil and environmental degradation can be controlled and improved directly through integrated agriculture. In Bangladesh, aquaculture production and sustainability should focus on improving the utilization of nutrients in the diet. This can be developed through two different approaches, namely (i) increasing food quality and feeding strategies so that nutrients can be efficiently distributed and ultimately utilized, and (ii) reuse of nutritional waste through cultural changes (Bossier & Ekasari, 2017).

As per study of the AEZ (Agro Ecological Zone) under 10, 11, 26 at Chapainawabganj is very drought prone area (Shil et al., 2016). In this area water scarcity is a major problem. So repeatedly use of water seems to make sense, especially in an area where fresh water resources are limited. At Chapainawabganj, river breakage is also a big problem that decreasing the land day by day (BBS, 2020). Our traditional farming is very risky and farmers try a lot to heavily invest in crop production to get maximum return. Bangladesh is one of the poorest and most densely populated countries in the world. The necessity to increase aquaculture production has been activated by the increasing demand of global population (Avnimelech, 2009).

From that conception, if the farmers will combine different production systems, they will be benefited and act as a competitive alternative to monoculture. The hypothesis here is that integrated fish farming with crops can provide socioeconomic benefits to the households of poor farmers and more broadly play a significant role in contributing to food security of Bangladesh. The study is undertaken to accomplish to analyse socio-demographic characteristics, to observe the present status in integrated fish farming with crops and to identify major problems in integrated fish with crop farming in Chapainawabganj, Bangladesh.

2. MATERIALS AND METHODS

2.1 Study area

The study area is Chapainawabganj District, Bangladesh. It is a north-western part of Bangladesh. It is comprised of 5 Upazila and 3 AEZ (Agro Ecological Zone) with an area of 1703 km^2 for obtaining detailed information about present status and problems of integrated fish with crop farming. This survey was conducted on 40 fish farmers of 25 villages under 10 unions. This study mainly covered 3 Upazila those are Chapainawabganj Sadar, Shibganj and Gomastapur (Fig. 1).

2.2 Data collection

Data collection for the study was mostly through primary sources. However, secondary data were explored from relevant publications, journal articles, published report and Upazila Fisheries Office (UFO). Random sampling method is simple and best suited for smaller population (Moore et al., 2014).

The entire process of data collection was conducted from May 2022 to June 2022. Data were collected from randomly selected 40 farmers by participant observations, interviews and informal conversations and questionnaires. For quantitative data collection, pre-structured questionnaire was used to address different issues of integrated fish with crop farm, socio demographic characteristics (farmer's age,

income, profession, information's sources, experience), fish and crop production, problems etc.

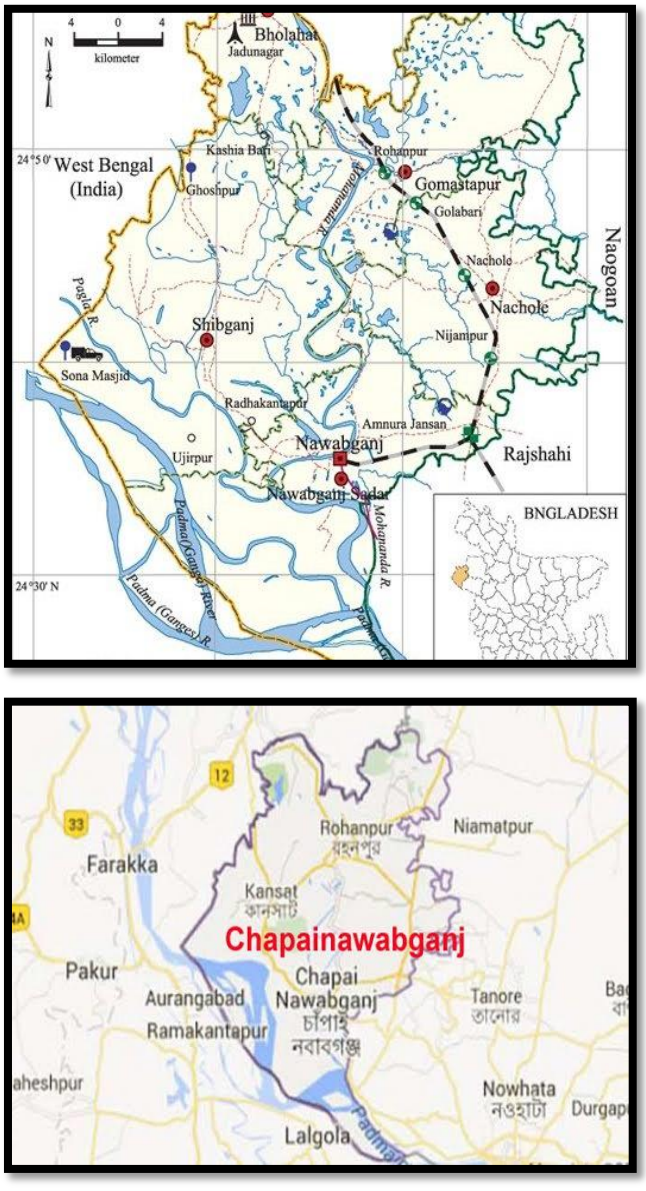

Fig. 1 Map of the study area Chapainawabganj Sadar, Shibganj and Gomastapur Upazila of Chapainawabganj district.

2.3 Data Processing and Analysis

All the collected data were tabulated, scrutinized carefully, analysed and presented graphically by Microsoft Excel (version 2010) SPSS data editor, 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. 2.

Non parametric statistics (mean, frequencies and percentages) were used to analyse the socio demographic characteristics of farmers.

3. RESULTS AND DISCUSSION

3.1 Demographic profile of integrated fish with crop farmers

Different demographic status (age, family size, occupation, education, farming experience, total cultivable land, pond size etc.) of 40 farmers were measured in the present study (Table 1).

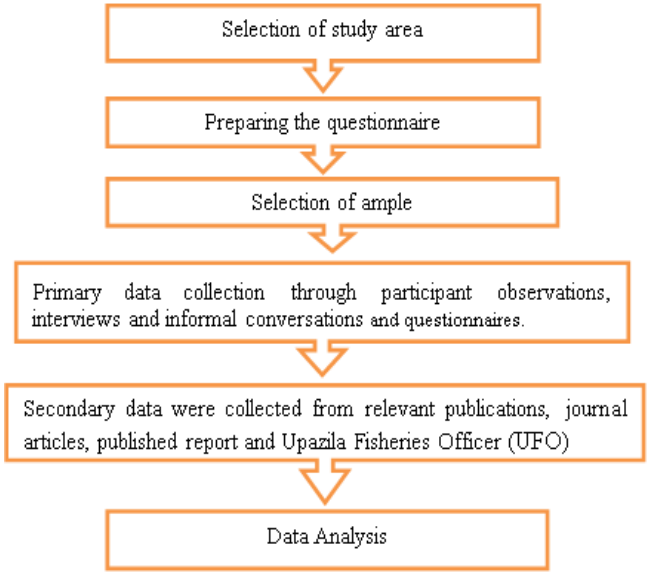

Fig. 2 Outline of the methodological approach.

3.2 Occupation

In the study area, fish culture was the main occupation for most of the fish farmers where 47.5% were involved in fish farming as a principal occupation. Whereas 30% of farmers were worked as businessman as their secondary occupation and 22.5% were jobholder. Most of the farmers have chosen fish farming as a principle occupation because of commercial purpose for getting more benefits and this results more or less similar with Quddus et al. (2000).

3.3 Education

According to the present study, no farmer was illiterate whereas 40% of farmers had secondary level of education, 27.5% primary pass, 20% HSC level and 12.5% attained Tertiary level of education. In this study, it is seen that level of farmer's education hugely affects the adoption and utilization of integrated farming technology they had a tendency to modernize their farm. The similar views also expressed by (Khan, 1986).

3.4 Age

In the present study area, 20% of the fish farmers were found less than 35 years or young aged, 57.5% between 35-55 years or middle aged, 22.5% of farmers more than 55 years or old aged. In the study it is seen that most of fish farmers were in the age group of 35-55 years that means middle aged farmers and they were most interested in integrated fish

farming system compare to young aged and old aged. This finding is more or less similar to Ali et al., (2008) who got 52% respondents were middle aged.

3.5 Experience of fish farming

According to present study, majority 65% had the fish farming experience of 5-12 years. Whereas15% and 20% fish farmers had the experience of 4 and 15 years, respectively. In this study it was found that 65% farmers belong to the middle age and they gathered a lot of experience by doing different types of agricultural activities. Akter et al., (2018) found majority 44% fish farmers had 16 years' experience.

Table 1 Demographic profile of integrated fish with crop farmers in the study area

Parameters	Category	Frequency	Percentage	Mean	S.D.
Occupation	Fish Farmer	19	47.5	1.7500	0.80861
	Farmer and Businessman	12	30.0		
	Farmer and Jobholder	9	22.5		
Education	Primary (<5)	11	27.5	3.1750	0.98417
	Secondary (6-10)	16	40.0		
	Higher Secondary (11-12)	8	20		
	Tertiary (>12)	5	12.5		
Age	Young(<35 years)	8	20.0	44.4250	1.03945
	Middle(35-55 years)	23	57.5		
	Old(>55 years)	9	22.5		
Farming experience	New(<5 years)	6	15.0	9.2500	5.06749
	Intermediate (5-12 years)	26	65.0		
	Expert(>12 years)	8	20.0		
Family size	Small(<4)	8	20.0	1.8250	0.44650
	Medium(4-8)	31	77.5		
	Large(>8)	1	2.5		
Total cultivable land	Marginal(<0.75 ha)	3	7.5	12.6800	1.13196
	Small(0.75-1.5ha)	17	42.5		
	Medium(1.75-7.5ha)	17	42.5		
	Large(>7.5 ha)	3	7.5		
Pond size	Small(<1 ha)	16	40.0	9.9562	9.53837
	Medium(1-2.5ha)	10	25.0		
	Large(>2.5ha)	14	35.0		
Involve with agricultural group	Yes	9	22.5	1.2250	0.42290
	No	31	77.5		

S.D., Standard deviation

Table 2 Annual income category

Category	Frequency	Maximum value(Tk)	Minimum Value (Tk)	Percentage
Low (<10 lakh)	19	7800000	260000	47.5
Medium (10 lakh-30 lakh)	14			35.0
High (>30 lakh)	7			17.5

3.6 Family size

The family size of respondents usually has a considerable influence on the income and expenditure of the family. On the basis of their household size (2-8 members) the families were classified into three categories; small (<4 members), medium (5-8 members) and large (above 8 members). Majority 77.5% of the farmers had medium sized family, 20% small and 2.5% in large sized. This finding has more or less similar with Ali et al., (2008) who showed that near about 75% family was medium family.

3.7 Total cultivable land status

According to the land ownership the respondents were classified into four categories; marginal (<0.75 ha), small (0.75-1.5 ha), medium (1.75-7.5 ha) and large (>7.5 ha). Most of farmers (81%) were in marginal class which was also a representative of typical land size of Bangladesh.

About 18% farmers were in small and 1% was in medium category. This finding indicates that if the cultivable land increases, the income will increase.

3.8 Pond size and land ownership

In the study area 40% of fish farmers had small land holding which was less than 1 ha, 35% of respondents having large land holding which was larger than 2.5 ha and 25% of fish farmer had medium land holding which was 1-2.5 ha. Here most of the farmers had small size pond. Majority of fish farmers 55% had leased land and 45% own land. Large size lands were leased which results more or less similar with Quddus et al., (2000).

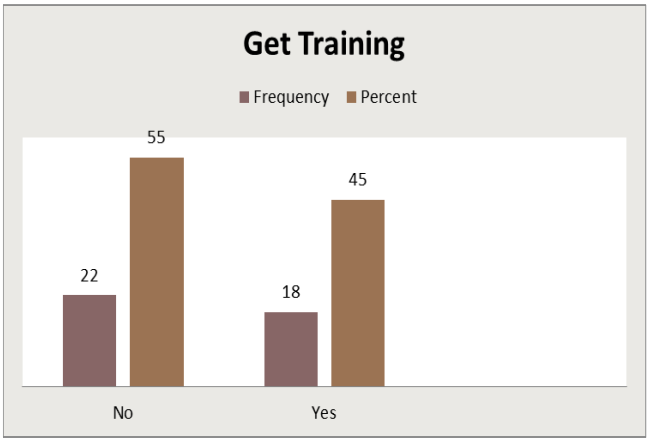

Fig. 3 Percentage and frequency of training received.

3.9 Annual income

Annual income depends on farmer's occupation. According to the occupation classified into 3 categories. These were: Fish Farmer, Farmer & Jobholder, Farmer & Businessman. The selected farmers were grouped into 3 categories based on the level of their annual income. In the study area, the maximum annual income of farmers was 7800000 Tk and minimum was 260000 Tk not only fish farming but also various sources such as, crop production, business, job etc (Table 2). In this study it is seen that 47.5% of farmers belongs to low category based on their farm size. If their knowledge can be increased on IFS, their income will increase further and national income also increase. The similar views also expressed by (Khan, 1986).

3.10 Training received

During the study, it was observed that most of the respondents (55%) did not receive any kind of training on integrated fish with crop farming. Total 45% respondents took training from DoF and different types of organization (Fig. 3). 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). The value is more or less similar to Ali et al., (2008) who found that about 60% farmers required training from DoF or NGO.

3.11 Source of water

From the survey, it was found that 22.5% pond didn't irrigate and the remaining 77.5% ponds irrigated by using ground water. It was found that the water level of the Chapainawabganj was declined during dry season and irrigation was needed then ponds were suitable for fish culture. The similar views also expressed by Shil et al., (2016).

3.12 Fingerlings

This study shows that near about 42.5% farmers produced fry for their own pond and they also sold these earn some extra, 57.5% of farmer didn't produce fry basically they collected from different types of sources (Table 3). Most of the farmers do not produce fry because it requires huge space and extra pond which is costly.

Table 3 Source of fingerlings

Parameters	Frequency	Percentage
Hatchery	8	20.0
Other Farmers	18	45.0
Warehouse	1	2.5
Hatchery & Other farmers	7	17.5
Hatchery &Warehouse	1	2.5
Other Farmer & Warehouse	3	7.5
All	2	5.0

3.13 Materials use for oxygen circulation

This study shows that materials used for O_2 circulation were classified in 3 categories those are aerator, manually and chemical substrate. 45% of the farmers used chemical substrate, manually 35% and 20% of farmers used aerator (Fig. 4). Generally, the farmers who had large land used aerator. Chemical substrates are easily available compare to others. Aerator is expensive but most of the educated farmers used this. Small pond owners were used manual process because of less income than the larger farm owner.

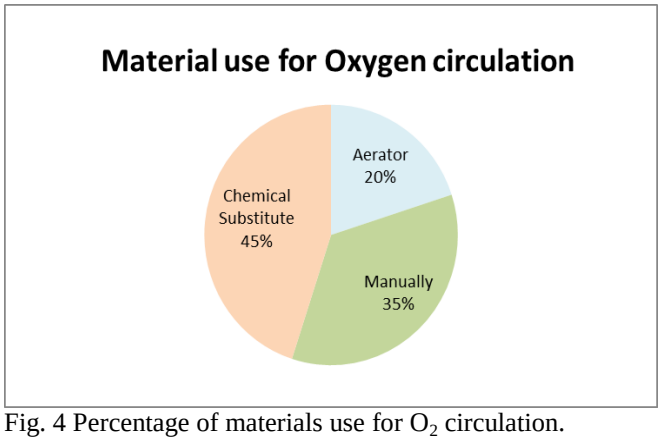

Fig. 4 Percentage of materials use for O_2 circulation.

3.14 Cultivated fish species

In this survey fish species were classified into 2 categories. 62.5% carp fish species was found and 37.5% was mix species (carp and other species) (Fig. 5). Carp species were most productive fish species. Silver carp, Grass carp, Catla, Rui fish are most cultivated carp fish species. This finding indicates that carp polyculture is more populated in the study area.

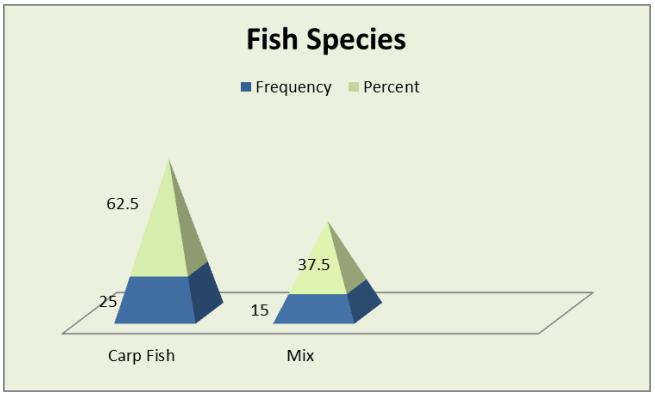

Fig. 5 Percentage and frequency distribution of fish species.

3.15 Fish production

The maximum pond size was 8.5 ha; minimum was 0.13 ha and average pond size was near about 2.5 ha. According to the study maximum fish production was 30 tons, minimum was 0.5 ton and average near about 8 tons. Here highest income from fish was 6750000 Tk and lowest 1125000 Tk. Here maximum fish production and income depend on pond size which given below (Table 4).

Table 4 Pond Size, production of fish, income from fish

Parameter	Pond size (ha)	Production of fish (ton)	Income from fish (Tk)
Maximum	8.5	30	6750000
Minimum	0.13	0.5	1125000
Mean	2.48	7.9712	17935316

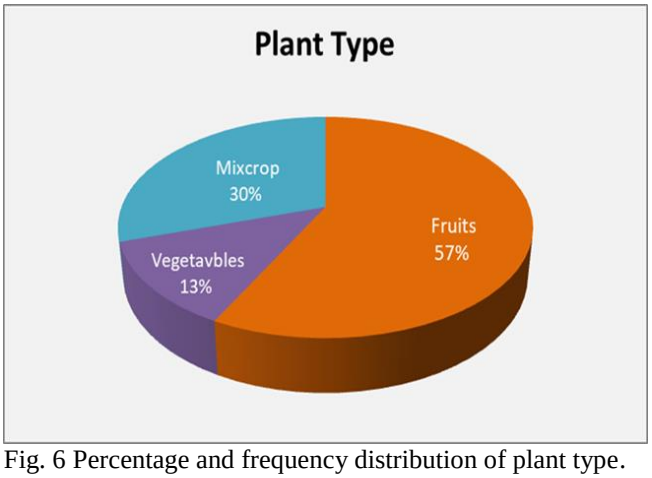

Fig. 6 Percentage and frequency distribution of plant type.

3.16 Crop cultivation with fish

According to this survey there were different types of crops integrated with fish. These were classified into 3 categories: fruits, vegetables, mix crops (fodder, fruits and vegetables). Majority of the farmers was involved in the cultivation of fruits 57%, mix crops 40% and vegetables 13% as crop with fish (Fig. 6). This study it is seen that fruits cultivation helps to make more profit and also utilize the land properly than anything else. This result is near about similar with Edwards (1988).

Out of 40 people, the maximum amount of crop cultivated land was 5 ha and minimum was 0.1 ha and average land size was 0.642 ha. Maximum income from crop was 300000 Tk; minimum was 7000 Tk and average income was 54525 Tk. This finding indicates that integration of crop with fish helps the farmers to get more/excess income from the dike crop.

Table 5 Crop cultivated area and income from crops

Parameter	Land size (ha)	Income from crop (Tk)
Maximum	5.00	300000
Minimum	0.1	7000
Mean	0.642	54525

Table 6 Problematic stages of integrated fish and crop farming

Problematic Stages	Percentage
During Pre-stocking stage	30
During stocking stage	7
During harvesting stage	10
During Transportation stage	50
During marketing stage	3

3.17 Take Loan

47.5% respondents didn't take any kind of loan while remaining 52.5% took loan from different type of organization such as: NGO, Bank, and Cooperative etc. 22.5% farmers took loan from Bank, 17% from NGO and 12.5% loan from cooperative. The similar views exposed by Ali et al., (2008) who found near about 50% used own money. This finding indicates that a large number of farmers outside of loan functioning.

3.18 Present emerging problems

Farmers faced different types of problems at different stage of farming. 50% farmers faced the problem during transportation stage, 30% during pre-stocking stage, 10% during harvesting stage, 7% during stocking stage and 3% during marketing stage (Table 6).

3.19 The major problems faced by respondents in the study area

Low market price

Most of the farmers stated that low market price of fish is a limit in the study area. In Bangladesh, farmers often sell the fish in local markets. In addition, farmers do not have a

special refrigerator to keep the harvested fish. Therefore, most of the farmers are forced to sell the harvested fish immediately at a low price. The price of a fish is determined on the basis of the demand for fish and the volume of its supply in retail markets.

Lack of hatchery

Lack of hatchery is a big problem in the study area. Farmers usually relied on remote areas as a source of fingerlings. Thus, the creation of hatchery in the study area is necessary to overcome limits for aquaculture. In addition, local residents do not have the financial opportunity to create hatcheries on private ownership. This is why a community initiative is needed to create hatcheries in the study area. An established hatchery can guarantee the cost of seeds by reducing the average travel distance. In addition to a local source of good quality seeds, employment for the local population will also be provided.

Shortage of labour

For the smooth running of a pond fish and crop culture enterprise, there is an inevitable need for manpower support. Farmers cited this problem as a hindrance because the increasing migration of labour from the agricultural sector to the non-agricultural sector makes fishermen face many challenges when they need work.

Lack of technical knowledge

The availability of the relevant technical knowledge is very important for integrated aquaculture management. Training is necessary to improve technical knowledge and the extension officer can control this level.

Unavailability of fish feed material

A balanced diet is necessary in a pond for optimal fish productivity. But the lack of nutrition for fish production is an impediment to fish production. Most farmers use only urea and rice bran when fish feed in their ponds. Currently, there is ready-made fish food on the market, but its supply is insufficient and the price is high. Therefore, it is very difficult for small and marginal farmers to harvest fish.

Unavailability of loan from different organizations

Public sector credit facilities for farmers in Bangladesh are very weak. Lack of access to credit is a major obstacle for entrepreneurs in Bangladesh. To get a loan from commercial banks, need a mortgage of land or other property. It is very difficult for poor farmers to get credit from banks or other institutions. In addition, NGOs usually give loans to landless, marginal and small farmers, but the interest rates are very high.

Manifestation of fish diseases

In Bangladesh, manifestation of fish diseases is one of the major problem of poor fish production. 15% of income loss occurred due to fish diseases reported by Faruk et al., (2004). These data indicate that a large number of fishermen consider the spread of fish diseases a limitation in the development of fish farming. In Bangladesh, most farmers do not have adequate knowledge of fish disease control, do not understand disease symptoms, and are unable to properly report disease effects to the Upazila Fisheries Officer (UFO).

Lack of good quality fingerlings

The poor quality of fingerlings is the main obstacle to the development of fish farming. In Bangladesh, although large numbers of fish fry can be produced through the private sector and public hatcheries or fisheries, the supply of fingerlings is seen as a real obstacle to increasing catches, working against efforts to increase fish production.

Poor market facilities

In Bangladesh, the marketing facilities are really very poor. It acts as a major barrier in the way of undertaking fish culture successfully. As a result, exploitation by intermediaries, like wholesalers is high in the secondary and higher secondary markets. Consequently, fishing communities remain poor. The broadly used fish market channel is: Fisherman, Bepari, Aratdar, Paiker and Consumer.

Poor transport facility

In Bangladesh, constructions of roads are very poor quality and it is a major problem in fish production. During transferring of fingerlings, fish to the market is very hard through the road. Due to poor transport facility many fingerlings, fish die.

Lack of government initiative for encouraging aquaculture and training facility

In Bangladesh, Government has an important role to maintain favorable environment for all types of entrepreneurship. For getting more benefit, farmer needs proper training which can enrich their knowledge. Lack of training by different organizations creates a major barrier in the fish production.

Unavailability of water and bad water quality

In Chapainawabganj district, it is a very draught prone area and water level is decreasing day by day. So, getting water for fish production is very tough. Almost similar types of problems in the integrated fish with crop framing were found by Das et al., (2018) and Mazumder et al., (2013) which are the major hinders for fish farming in Bangladesh.

4. CONCLUSION

In Chapainawabganj, it is revealed that integrated fish with crop farming could be a great solution of self-employment and helps to improve farmer's life style. Integrated fish with crop farming is a profitable farming which definitely contributes to the food production and fulfils the nutritional demand of the whole country and could be a viable option for diversification. Although management practice is not properly followed in all the sampling ponds, they somehow

managed to cope with the present productivity status of their farm. Apart from some adverse socio-economic condition and constraints of fish and crop farming, farmers in this region contribute a remarkable part of inland integrated fish and crop production in Bangladesh. Therefore, governmental and nongovernmental initiatives are crucial to resolve the existing problems thus ensuring higher fish production and higher profit. It is concluded that integrated fish with crop farming a fruitful business which is sustainable alternative to monoculture practice.

REFERENCES

Ahmed, N., Wahab, M. A. & Thilsted, S. H. (2007). Integrated aquaculture-agriculture systems in Bangladesh: Potential for sustainable livelihoods and nutritional security of the rural poor. *Aquaculture Asia*, *12*(1), 14.

Akter, S., Ferdousi, S. S., Haque, M. A. & Sarker, M. A. A. (2018). Present status of traditional aquaculture and socio-economic condition of fish farmers at Pabaupazila in Rajshahi District, Bangladesh. *Research in Agriculture Livestock and Fisheries*, *5*(2), 269-277.

Ali, M. H., Hossain, M. D., Hasan, A. N. G. M., & Bashar, M. A. (2008). Assessment of the livelihood status of the fish farmers in some selected areas of Bagmara upazilla under Rajshahi district. *Journal of the Bangladesh Agricultural University*, *6*(2), 367-374.

Avnimelech, Y. (2009). *Biofloc technology: a practical guide book.* World Aquaculture Society. USA.

BBS, (2020). *Statistical Yearbook of Bangladesh.* Statistic Division, Ministry of Planning. Government of People's Republic of Bangladesh. Dhaka.

Bossier, P. & Ekasari, J. (2017). Biofloc technology application in aquaculture to support sustainable development goals. *Microbial Biotechnology, 10*(5), 1012-1016.

Das, M., Islam, M. R., Akter, T., Kawser, A. Q. M. R. & Mondal, M. N. (2018). Present status, problems and prospect of fish farming at Gazipur Sadar upazila in Bangladesh. *Progressive Agriculture, 29*(1), 53-63.

DoF, (2022). *Fisheries Statistical Yearbook of Bangladesh 2020-2021.*Fisheries Resources Survey system, Department of Fisheries, Ministry of Fisheries and Livestock. Dhaka.

DoF, (2020). *Fisheries Statistical Yearbook of Bangladesh 2018-2019*. Fisheries Resources Survey system, Department of Fisheries, Ministry of Fisheries and Livestock. Dhaka.

Edwards, P. (1988). A review of recycling organic wastes in fish with emphasis on the tropics. *Aqaculture, 21*, 261-279.

Faruk, M. A. R., Sarker, M. M. R., Alam, M. J. & Kabir, M.B., (2004). Economic loss from fish diseases on rural freshwater aquaculture of Bangladesh. *Pak. J. Biol. Sci, 7*, 2086-2091.

FAO, (2017). "FAO and the SDGs, Indicators: Measuring up to the 2030 Agenda for Sustainable Development", available at: https://www.fao.org/3/a-i6919e.pdf (accessed 10 January 2021).

Jayanthi, C., Rangasamy, A. & Chinnusamy, C. (2000). Water budgeting for components in lowland integrated farming systems. *Madras Agricultural Journal, 87*(7/9), 411-414.

Khatun, S., Adhikary, R. K., Rahman, M., Sikder, M. N. A. & Hossain, M. B. (2013). Socioeconomic status of pond fish farmers of Charbata, Noakhali, Bangladesh. *International Journal of Life Sciences Biotechnology and Pharma Research, 2*(1), 356-365.

Khan, M. S. (1986). Socio-economic factors in the development of fisheries. *Bangladesh Journal of Agricultural Economics,10*, 43-47

Larsen, T., Thilsted, S.H., Kongsbak, K. & Hansen, M. (2000). Whole small fish as a rich calcium source. *British Journal of Nutrition, 83*(2), 191-196.

Mazumder, M. T., Rabbane, G., Rahman, A. A., Minar, M. H. & Hasan, M. (2013). A study on fish culture system in Kotalipara upazila, Gopalganj. *International Journal of Life Science Biotechnology and Pharma Research, 2*, 59-69.

Uddin, M. T., & Takeya, H. (2006). Comparative study on integrated farming in Bangladesh and other countries. *Bangladesh Journal of Agricultural Economics, 29*, 81-92.

Moore, D. S., McCabe, G. P.& Craig, B. A. (2014). *Introduction to the Practice of Statistics*. W.H., Freeman & Co. Ltd. USA.

Naylor, R. L., Goldburg, R. J., Primavera, J. H., Kautsky, N., Beveridge, M. C., Clay, J. & Troell, M. (2000). Effect of aquaculture on world fish supplies. *Nature, 405*(6790), 1017-1024.

Nhan, D. K., Phong, L. T., Verdegem, M. J., Duong, L. T., Bosma, R. H.& Little, D. C. (2007). Integrated freshwater aquaculture production in the Mekong delta, Vietnam: Determinants and the role of the pond. *Agricultural Systems, 94*(2), 445-458.

Quddus, M. A., Rahman, M. S., & Moniruzzaman, M. (2000). Socio-economic conditions of the pond owners of Demra, Dhaka. *Bangladesh Journal of Fisheries Research*, *4*(2), 203-207.

Rahman, M. M., Mondal, M. N., Shahin, J., Fatema, J. & Fatema, M. K. (2015). Potentialities of pond fish farming in Kaliakair upazila under Gazipur district, Bangladesh. *Research in Agriculture Livestock and Fisheries, 2*(3), 517-528.

Roos, N., Islam, M. M. & Thilsted, S. H. (2003). Small indigenous fish species in Bangladesh: contribution to vitamin A, calcium and iron intakes. *The Journal of Nutrition, 133*(11), 4021S-4026S.

Shil, N. C., Saleque, M. A., Islam, M. R. & Jahiruddin, M. (2016). Soil fertility status of some of the intensive crop growing areas under major agro-ecological zones of Bangladesh. *Bangladesh Journal of Agricultural Research*, *41*(4) 735-757.

Singh, S. N., Saxena, K. K., Singh, K. P., Kumar, H. & Kadian, V. S. (1997). Consistency in income and

employment generation in various farming systems. *Annals of Agricultural Research*, *18*(3), 340-43.

Singh, K. P., Singh, S. N., Kumar, H., Kadian, V. S. & Saxena, K. K. (1993). Economic analysis of different farming systems followed on small and marginal land holdings in Haryana. *Haryana Journal of Agronomy*, *9*(122), 25.