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ORIGINAL RESEARCH ARTICLE

Economic analysis of tilapia-carp polyculture in a selected area of Bangladesh

Mohammad Ataur Rahman[1*], Md. Tanzim Toky[1], Mohammad Shahidul Islam[2] and Mezamun-Ara Mukta[1]

[1]Department of Agricultural Finance and Banking, Bangladesh Agricultural University, Mymensingh - 2202, BANGLADESH
[2]Senior Upazila Fisheries Officer, Phulpur, Mymensingh, Ministry of Fisheries and Livestock, BANGLADESH
[*]Corresponding author's E-mail: marahman@bau.edu.bd

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ABSTRACT

Aquaculture is moving on the way of intensification to fulfill the increasing demand of protein as capture fisheries are declining. The study was conducted to identify the socioeconomic characteristics, analyze the tilapia-carp polyculture system, profitability of tilapia-carp polyculture, and credit profile of the stratified randomly selected 50 sample farmers from Sherpur district in Bangladesh. Primary data were collected through field survey using an interview schedule. Some statistical measures like average percentage and ratios were calculated. The findings revealed that 36% of the respondents belonged to the age group of 25-29 years, 68% belong to medium family size (5 to 6 people), 44% respondents' education level was higher secondary, 44% respondents' primary occupation was fish farming and 46 % of were belonged to in annual income level of Tk. 150001-200000 ($1770 - $2360). Average fingerlings released in the tilapia-carp polyculture were 24240 per hectare per year. Most of the fingerlings collected from private hatcheries. The annual per hectare production of tilapia and carp were 8028 kg and 11085 kg., respectively. Per hectare per year gross cost, gross margin, gross return and net return were Tk. 1093008 ($12897), Tk. 759447 ($8961), Tk. 1735455 ($20477) and Tk. 642447 ($7580), respectively. The BCR of tilapia-carp polyculture for cash cost was 1.78 and full cost was 1.59. About 20% of the respondents took loan from different sources and they received 84.51% of their applied amount and 84.73 % of the loan money used in productive purposes. Mortality of fingerlings, the high price of the ingredient, low price of fish, high interest rate and non-availability of good quality fingerlings at proper time were identified to be the major problems in conducting pond fish production. Government and other agencies should come forward to provide subsidized feed, technical supports and credit facilities for the tilapia-carp fish farmers to make the enterprise effectively.

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INTRODUCTION

Bangladesh's agricultural sector contributes 14.2% of GDP, employing 47% of the working population, with 17 million people (1.4 million women) betting on fisheries sector for his or her livelihoods through fishing, farming, fish handling, and processing (BBS, 2018). The agricultural sector has experienced significant growth over the last number of decades, with the fisheries sector following suit. Consistent with FAO report, "The State of World Fisheries and Aquaculture 2018", Bangladesh ranked 3rd in inland open water capture production, and 5th in world aquaculture production. Currently Bangladesh ranks 4th in Tilapia production within the world and 3rd in Asia. Tilapia is the second most farmed fish world-wide and its production has augmented over the past decade because of its appropriateness for aquaculture, marketability and stable market prices (Elangovan *et al*., 2019). National fish Hilsa as one species has been making the very best contribution (around 12 percent) to

the country's total fish production. In FY 2017-18 fisheries sector contributes 3.57 you have to the GDP and 25.30 % of the country's total agricultural products (DoF, 2018). Fisheries are one among the main components of agricultural activities in Bangladesh and play a significant role in nutrition, employment, income generation and interchange earnings (Bhuiyan *et al.* 2011). In Bangladesh, Fish contributes 56% in culture, 28% in capture and 16% of marine. Fisheries is one among the main sub -sector within the agricultural sectors and plays a significant role within the socioeconomic development of geographical region, fulfilling the animal protein demand, creating employment opportunity, alleviating poverty and earning interchange for the country. About 1.2 million people are directly employed during this sector and another 12 million people indirectly earn their livelihood out of activity associated with fisheries (Ibrahim, 2010). Fish and fisheries are linked to the event of the human's earliest civilization. There's a preferred Proverb "Fish and Rice makes a Bengali." The fisheries sector provides livelihoods and income to the vast majority of the poor in Bangladesh. It plays a very important role among disadvantaged groups as a main and supplementary source of employment, livelihoods and income. An enormous majority of the poor people sleep in rural areas with very limited employment opportunities. The poverty reduction strategy paper and national fisheries indicated that income generating opportunities for rural households are most promising within the fisheries sector (DoF, 2017). About 73% of the agricultural households are somehow involved in some reasonably freshwater aquaculture on the floodplains throughout the country (BBS, 2018). The fisheries sector is that the second largest part-time and full-time employees within the rural areas, directly engaging the 58% of the agricultural population, as estimated supported agriculture census data (BBS, 2018). An estimated 1.2 million people are directly employed during this sector further 12 million people are indirectly earning livelihood from fisheries related activities, like the downstream activities of fish trading and processing (Hossain, 2014). Bangladesh is assumed one among the foremost apposite countries within the world for pond fisheries, due to its blessed resources and agro-climatic environments. The concept of polyculture of fish is founded on the thought of total exploitation of diverse trophic and spatial places of a pond so as to realize all-out fish production per unit area. Different compatible species of fish of various trophic and spatial niches are raised together within the same pond to utilize all forms of natural food available within the pond (FAO, 2016). The chances of accelerating fish production through carp polyculture are found highest in comparison with other systems (Talukdar *et al.* 2012). Different species combination with polyculture system effectively contributes also to boost the pond environment. Algal blooming is common in most tropical manure fed ponds. For giving emphasis on the practicing tilapia-carp polyculture relevant and adequate information on different aspects of polyculture system at farm level are required. Like Semi-intensive fish culture (SIC) systems are adopted mainly in herbivorous and omnivorous fishes that feed low down in the food chain, such as tilapias and carps (El-Sayed, 2020). Such knowledge of polyculture is additionally necessary to form an appropriate decision by the fish farmers, especially when several alternatives are receptive them. However, little systematic economic investigations on the tilapia-carp polyculture are undertaken either by the government or private organization so as to satisfy the demand of extension workers, policy makers, research personnel, NGO officials and therefore the farmers. Any research should be conducted to find answers to some questions. The aim of research was to work out some new facts through a scientific way of labour. The research questions can provide the direction to manoeuvre on the way of finding answers. By answering research question a researcher/researchers reach to the goal. The research questions of this study were: what are the carp species release in their pond and what are the proportions? What's the relative profitability of tilapia-carp polyculture? Is there any loan receive by the farmers? What are the issues and constraints faced by the tilapia-carp polyculture farmers? On the premise of the research questions, this research was focused on to analyze the socioeconomic characteristics of sample households, analyze the tilapia-carp polyculture system, determine the profitability of tilapia-carp polyculture, analyze the credit profile of the borrowers, and identify the issues and constraints face by the tilapia-carp polyculture farmers.

MATERIALS AND METHODS

A sample of 50 tilapia-carp polyculture pond fish farmers was selected randomly from Sultarpur, Mirzapur, Bazitkhila, Modipara and Hossainkhila villages of Sherpur Sadar upazila in the Sherpur district of Bangladesh. Required data were collected through field survey using interview schedule. Focus group discussion and observation techniques also were used for collecting relevant information. A stratified random sampling technique was followed in this study. Simple statistical techniques such as percentage and arithmetic mean or average were employed to analyze the data. Activity budgets were calculated. There are 40 farmers had no credit constraints and 10 farmers had credit constraints. Data were collected for a period of three months from January 2020 to March 2020.

Analytical techniques

Data were presented mostly in the tabular form in simple in calculation, widely used and easy to understand. Some statistical measures like average percentage and ratios were calculated as these were simple to understand and easy to calculate. These analyses also included socio- demographic characteristics of the sample farmers, production practices and input use, costs and return of tilapia fish culture. Per hectare profitability of tilapia-carp fish production from the viewpoint of individual farmers was measured in terms of gross return, gross margin, net return and benefit-cost ratio (undiscounted).

Gross return (GR)

Gross return was calculated by multiplying the total volume of

output of an enterprise by the average price average price during the harvesting period.

The following equation was used to estimate GR.

$$GR_i = \sum_{i=1}^{n} Q_i P_i$$

Where,

GR_i= Gross return from i-th product (Tk./ha)

Q_i = Quantity of i-th product (kg/ha)

P_i= Average price of the i-th product (Tk./kg)

i = 1, 2, 3 ....., n

Gross margin (GM)

Gross margin has given an estimate of the difference between total return and variable costs. That is,

GM =TR – VC

Where,

GM = Gross Margin

TR = Total Return

VC = Variable Costs

Net return (NR)

The net return analysis considered fixed costs; cost of land rent, interest on operating capital, etc. Net return was calculated by deducting all cost (variable and fixed) from gross return. A profitability measure of the tilapia-carp polyculture was prepared using the following algebraic equation:

$$\pi = P_y Y - \sum_{i=1}^{n} (P_{xi} X) - TFC$$

Where,

π = Net return (Tk./ha);

P_y = per unit price of the product (Tk./kg);

Y = Quantity of the production per hectare (Kg);

P_{xi}= Per unit price of i-th inputs (Tk.);

X_i =Quantity of the i-th inputs per hectare (kg);

TFC= Total fixed cost (Tk.);

i= 1,2,3……,n (number of inputs).

RESULTS AND DISCUSSION

Socioeconomic characteristics

Socioeconomic condition of sample farmers is very important for production because there are numerous interrelated and constituent attributes that characterizes an individual and influences the development of decision making behavior. Therefore, an attempt was made to analyze the socioeconomic profile of the sample farmers in the study area. This section provides information on the socioeconomic characteristics of selected tilapia farmers such as age distribution, family size, educational attainment, occupational structure, and annual household income.

In this study, the age groups of the selected sample farmers are classified into four categories according to the working age classification of Bangladesh Bureau of Statistics (BBS, 2015). These categories: age between 25 to 29 years of old, age between 30-45 years old, age between 46-65 years old and above 65 years old. Age classification of sample tilapia-carp farmers are presented in Table 1. It was found that 36 % of the respondents belonged to the age group of 25-29 years. About 30% of the respondents were belonged to age group of 30-45 years, about 24 % of the respondents were belonged to age group of 46- 65 years and the rest 12 % of the respondents belong to age above 65 years. This information implies that more than half of the sample farmers were in active age of 25-45 years, indicating that they provided more physical efforts for tilapia-carp fish culturing.

A family size has been defined as the total number of persons of either sex living together and having meals from the same kitchen under the administration of a single head of the family. The farm family includes husband, wife, sons, unmarried daughters, parents, brothers, etc. About 68% of the respondents belong to medium family size (Table 1).

The literacy level is generally considered as an index of social advancement of the community. From the literacy point of view, fish farmers were classified into four groups, i.e., illiterate, primary level, secondary level and higher secondary level. It is revealed from the Table 1 that, the level of education of fish farmers up to illiterate, primary, secondary and higher secondary were 6%, 14%, 36 % and 44%, respectively. Overall fish farmers in general are literate persons.

Occupation is the important aspect among the socioeconomic characteristics of the respondents. The pond fish possessors were involved in various types of livelihood. The main occupation of farm family considered in the present study was the occupation from which most of the income was earned. The occupations of fishpond owners are presented in Table 1. It appears that fish farming, agriculture, service and business represented main occupation for 44 %, 32 %, 10 % and 14 %, respectively of the tilapia-carp fish farmers.

The socioeconomic status of a household is measured by income level. In the study, it was found that about 8% of the farmers were belonged to in annual income level of Tk. 75000-100000 ($885-$1180). About 12% of farmers were belonged to in annual income level of Tk.100001-150000 ($1180-$1770). About 46% of farmers were belonged to in annual income level of Tk. 150001-200000 ($1770-$2360). About 34% of farmers were belonged to in annual income level of above Tk. 200000 ($2360). Rahman *et al.* (2019) stated that levels of family income are important economic factor affecting utilization of pond fish farming.

Tilapia-carp polyculture system

Stocking density

Most of the farmers stocked fish fingerling in the month of June -July when the pond had accumulated about 5-8 feet of rain

Table 1. Age, family size, education, primary occupation and annual household income of the respondents.

Variable	Group	No. of respondents	Percentage
Age group (year)	25-29	18	36
	30-45	15	30
	46-65	12	24
	>65	5	12
Family size	Small family (3 to 4)	11	22
	Medium family (5 to 6)	34	68
	Large family (>6)	5	10
Education level	Illiterate (no schooling)	3	6
	Primary (from grade 1 to 5)	7	14
	Secondary (from grade 6 to 10)	18	36
	Higher secondary (from grade 11 to 12)	22	44
Primary occupation	Fish farming	22	44
	Agriculture	16	32
	Service	5	10
	Business	7	14
Annual household income (Tk.)	75000-100000 ($885-$1180)	4	8
	100001-150000 ($1180-$1770)	6	12
	150001 – 200000 ($1770-$2360)	23	46
	Above 200000 ($2360)	17	34

Source: Author's estimation, 2020; Note: (Tk. 84.75 = USD 1).

Table 2. Composition of stocking density of tilapia–carp polyculture/ha/year.

Species	Tilapia–carp polyculture	
	Number of released	Average size (cm)
Tilapia	21300	9.00
Rui	910	15.24
Catla	430	17.78
Mrigal	320	14.78
Silver carp	780	11.50
Grass carp	65	14.50
Common carp	95	14.75
Bata	210	11.55
Calbaus	130	12.85
Total	24240	

Source: Author's estimation, 2020.

Table 3. Distribution of sample pond according to size.

Pond size (decimal)	Number of respondents	Percentage
05-50	28	56
51-100	13	26
101-500	9	18
Total	100	100

Source: Author's estimation, 2020.

water. Farms with a perennial water source were stocked as early as the month of April-May. Generally, farmers were released of fish fingerlings to pond in around June and cultured as long as sufficient water retained in the pond. Total number of Tilapia fingerlings released in the tilapia-carp polyculture was 21300 per hectare per year. The different carp fingerlings released were rui ,catla, mrigal, silver carp, grass carp, common carp, bata and calbaus respectively number of 910, 430, 320, 780, 65, 95, 210 and 130 (Table 2). The farmer selected those fish species, which have quicker growth, good market demand and more social adequacy (Islam *et al*., 2019). But Hassan *et al.* (2007) found in their research that the carp-polyculture; silver carp was the dominant species at harvest contributing 73% of the total net fish production compared to 9% and 19% by rohu and mrigal, respectively. Silva *et al.* (2006) found in their research in Brazil that the most promising polyculture ratio for the initial growing season seems to be 15% common carp, 30% grass carp, 5% silver carp, 10% bighead carp, 20% jundia and 20% Nile tilapia.

Tilapia-carp polyculture pond size

Pond size may vary in different locations on the basis of physical and socioeconomic conditions. A suitable pond size is required to minimize the production cost and maximize the production. The Table 3 shows the distribution of areas the majority of pond sizes were in 5 to 50 decimals which represents 56% of pond fish farms. There are no fish ponds occupying below 5 decimals and above 500 decimals.

Table 4. Distribution of owned and leased pond operators.

Type of ownership	Tilapia – carp polyculture	
	No.	Percentage
Owner	22	44
Leaseholder	28	56

Source: Author's estimation, 2020.

Table 5. Sources of fingerlings of fish farmers.

Technology	Species	Sources							
		Private hatchery		Govt. hatchery		Own nursery		Hapa	
		No.	%	No.	%	No.	%	No.	%
Tilapia – carp polyculture	Tilapia	40	80	1	2	3	6	6	12
	Rui	35	70	-	-	4	8	11	22
	Catla	26	52	-	-	3	6	12	24
	Mrigal	17	34	-	-	4	8	5	10
	Silver carp	32	64	-	-	5	10	15	30
	Grass carp	2	4	-	-	-	-	3	6
	Common carp	5	10	-	-	2	4	2	4
	Bata	1	2	-	-	-	-	-	-
	Calbaus	4	8	-	-	-	-	1	2

Source: Author's estimation, 2020.

Distribution of owned and leased pond operators

Table 4 shows that distribution of farmers, according to ownership. In the study area, about 44% of the tilapia-carp polyculture farmers cultured their fish in their owned ponds and the rest 56% farmers did the practice using leased pond. It appears from the Table 4 that frequency of tilapia-carp polyculture practice is more in the leased ponds.

Sources of fingerlings

There are many sources of fingerlings to the farmers. From the Table 5, it is found that most of the Tilapia fingerlings collected from private hatcheries (80%) followed by hapa (12 %), owned nursery (6 %) and government hatchery (2%). The trend was similar pattern in case of carp fingerlings. In the case of collection of carp fingerlings, farmers were mainly dependent on private hatcheries followed by the hapa and owned nursery.

Profitability of tilapia-carp polyculture

Tilapia-carp fish farmers in the study area did not maintain any written records of costs and returns of fish culture. However, it is presumed that they possess a sharp memory and can calculate everything related to their farm business. The purpose of this section is to determine per hectare cost and return of tilapia-carp fish which were determined for whole production period, i.e., one year. Considering its importance, the present study placed emphasis on different cost items. There are two types of costs: variable costs and fixed costs. In this study, variable cost items included were hired labor, fingerling, feed and interest on operating cost. On the other hand, fixed cost was the land use cost. On the return side, per hectare yield, gross return, gross margin, net return and benefit-cost ratio also estimate and analyze.

Variable costs

Human labor was the most important and one of the largest inputs used for tilapia-carp fish production. There were broadly two different categories of human labor, i) family labor and ii) hired labor (permanent hired labor, temporary hired labor, pond repairing labor, harvesting labor). The intensity of labor depends on how carefully and what operations have to be done by the farmers. In this study, human labor was measured in terms of man-days, which usually consisted 8 hours of work by an adult man. For women and children, the man equivalent day was estimated. This was computed by converting all women and children day into man equivalent day. This was performed as follows (Yang, 1965): 1 adult man = 1.5 adult women = 2 children. In the study area, the average wage rate was Tk. 300 ($3.54) per man-day. The costs of family labor had been calculated according to the wage rate at which the farmers could hire labor. Per hectare total cost of hiring labor was calculated from per hectare labor used in different operations multiplied by wage rate. Table 6 shows; per hectare cost of hiring labor was Tk. 256800 ($3030) for tilapia-carp farming, which comprised of 23.50 % of the total cost.

The stocking rate of fingerlings varies with the fertility of the pond. Tilapia-carp fish farmers in the study area used to purchase fingerlings and the cost was calculated on the basis of farm-gate price. Per unit price of fingerlings depends on their sizes as well as the concerned fish species. The selected species of fingerlings were Rui, Catla, Mrigal, Karfu, Silver carp, Grass carp, Mirror carp, Shrimp, Chetol, Tilapia, Pangus, Kalabous and Sharpunti used for fish culture. Per unit price of fingerlings depends on their sizes as well as the concerned fish species. Table 6 shows that, per hectare average cost of fingerlings were estimated at Tk. 25180 ($297) which constituted 2.30 % of the total cost.

Table 6. Per hectare per year total cost of tilapia-carp polyculture.

Items	Units	Quantity	Price/ Unit	Cost (Tk.)	% of Total
A. Variable cost	Tk.	-	-	976008 ($11516)	89.30
Hired labor	Man-day	856	300.00	256800 ($3030)	23.50
Fingerlings	No.	5036	5.00	25180 ($297)	2.30
Fertilizer					
Urea	Kg	371	18	6678 ($79)	0.62
TSP	Kg	193	22	4246 ($50)	0.39
MP	Kg	89	15	1335 ($16)	0.12
Manure	Kg	1663	1.00	1663 ($20)	0.16
Feed cost	Tk.	7183	80	574640 ($6780)	52.57
Oil cake	Tk.	408	70	28560 ($337)	2.61
Rice bran	Tk.	1337	17	22729 ($268)	2.08
Lime	Kg	350	22	7700 ($91)	0.70
Interest on operating capital	Tk.	-	10%	46477 ($548)	4.25
B. Fixed cost	Tk.	-	-	117000 ($1381)	10.70
Land use cost	Tk.	-	-	117000 ($1381)	10.70
Total cost(A+B)	Tk.			1093008 ($12897)	100

Source: Author's estimation, 2020; Note: (Tk. 84.75 = USD 1).

Table 7. Per hectare per year gross return from tilapia-carp polyculture.

Production	Main product			Gross return (Tk.)
	Quantity (kg)	Price (Tk./kg)	Value (Tk.)	
Yield of Tilapia	8028	85	682380 ($8052)	682380 ($8052)
Yield of Carp	11085	95	1053075 ($12425)	1053075 ($12425)
Total				1735455($20477)

Source: Author's estimation, 2020; Note: (Tk. 84.75 = USD 1).

Table 8. Per hectare per year cost, return and benefit-cost ratio.

Particulars		Tilapia–carp polyculture
A. Gross return (Tk.)		1735455 ($20477)
B. Variable cost (Tk.)		976008 ($11516)
C. Total cost (Tk.)		1093008 ($12897)
D. Gross margin (A-B)(Tk.)		759447 ($8961)
E. Net return (A-C)(Tk.)		642447 ($7580)
BCR (A/B)	Cash cost	1.78
BCR (A/C)	Full cost	1.59

Source: Author's estimation, 2020; Note: (Tk. 84.75 = USD 1).

Fertilizer was generally used in the fish pond to create conditions, which facilitates an increase in production of good quality natural fish feed, thereby increasing fish production. Farmers used three kinds of chemical fertilizers namely, Urea, Triple Super Phosphate (TSP) and Mutate of Potash (MP). The costs were Tk. 6678 ($79), Tk.4246 ($50) and Tk.1335 ($16), respectively per hectare per year. Manure was important for fish production. It is observed that, farmers used cow-dung in fish ponds as manure in the study area. Cow-dung was home supplied and purchased. The cost of cow-dung was calculated Tk.1/kg. It observed that farmers used 1663 kg manure per hectare per year. So, the average cost of manure per hectare was Tk. 1663 ($20).

It is important to supply of artificial supplementary feeds, which contribute to increase fish production. Tilapia-carp fish farmers, mostly used rice bran and oil cake, as supplementary feed for fish. The cost of feed was charged at the prevailing market. Tilapia-carp polyculture per hectare cost of feed was Tk. 574640 ($6780) which was 52.57% of the total cost. Farmers also added oil cake and rice bran as feed which added the additional cost of Tk. 28560 ($337) and Tk. 22729 ($268), respectively.

Lime was used mainly to neutralize acidity in the soil and water of the pond. Lime assists in the release of the nutrient from the soil and promotes the bacterial breakdown of water material including green manure. The average cost of lime was Tk.7700/ha/year. Interest on operating capital for tilapia-carp polyculture was Tk. 46477 ($548) per hectare, which shared 4.25 % of the total cost.

Fixed cost

The cost of land use was different from one plot to another, depending upon location, distance and topography. In the present study, the cost of land use was estimated on the basis of cost rental value. The land use cost per hectare was Tk. 117000 ($1381) which was 10.70% of the total cost (Table 6).

Gross return

Gross return is the money value of total output. The gross return was calculated by summing up all the returns earned from selling fishes. Per hectare gross return was calculated by multiplying the total amount of products and byproducts of farm-gate price. Per hectare per year gross return from Tilapia-carp fish production was Tk. 1735455 ($20477) (Table 7).

Table 9. Sources of received loans.

Sources	Number of respondents	Percentage
Grameen Bank	3	30
Bangladesh Krishi Bank	2	20
Mahajan	4	40
Relatives	1	10
Total	10	100

Source: Author's estimation, 2020.

Table 10. Loan requirements and adequacy.

Category	No. of loanee farmers	Average Amount Applied for Loan(Tk.)	Average Amount Received Loan (Tk.)	Amount Received in % of Amount Applied
Tk.50000-100000 ($590 -$1180)	5	77540.00 ($915)	65606.59 ($774)	84.61%
Tk.100001 -200000 ($1180 - $2360)	3	134085.00 ($1582)	111733.03 ($1318)	83.33%
Above Tk.200000($2360)	2	219420.00 ($2589)	187824.52 ($2216)	85.60%
All	10	122879.50 ($1450)	103845.47 ($1225)	84.51

Source: Author's estimation, 2020; Note: (Tk. 84.75 = USD 1).

Gross margin

Gross margin is defined as the difference between gross return and variable costs. The argument for using the gross margin analysis is that the farmers are interested to get returns over variable cost. Table 8 reveals that gross margin for farming was Tk. 759447 ($8961).

Net return

In general net return is termed as entrepreneur's income. The net return is the difference between gross return and total costs. Table 8 reveals that per hectare per year net return of production of tilapia-carp fish was Tk. 642447 ($7580) which indicates that tilapia-carp polyculture is profitable business.

The benefit-cost ratio for tilapia-carp fish was determined as the ratio of total return to total cost. From Table 8 reveals that the benefit-cost ratio of tilapia-carp farming for cash cost was 1.78 and benefit- cost ratio of tilapia-carp farming for full cost was 1.58 (overall). These values are higher than the findings of Ferdoushi *et al.* (2019) which were 1.34 for polyculture and 1.51 for tilapia monoculture. On the basis of the above discussion, it could be concluded that tilapia-carp polyculture is profitable.

Requirements, adequacy, sources and utilization of credit

Requirements, adequacy, sources and utilization of credit were very important factors for both lenders and receivers of credit. Adequacy of loan showed the sufficiency of fund which makes borrowers anxious free to invest in productive activities. Proper use of loan promotes increased production and benefits the borrowers involved. If the borrowed funds were employed in unproductive purposes, the repayment in the normal course would become uncertain. The repayment of credit showed that the borrowers were utilized credit properly and earned profit from their investment.

Sources of credit

The farmers of Sherpur district are not so solvent. Although they do not get a loan easily; they somehow try to manage continue farming without taking a loan from various sources (Table 9). From 50 farmers; 10 farmers took loan from following sources:

a. Institutional source (Grameen Bank and Bangladesh Krishi Bank).
b. Non- institutional source (Mohajan and Relatives).

Loan requirements and adequacy

The farmers who applied loan amount between Tk. 50000 ($590) -Tk. 100000 ($1180) received almost 84.61% of the applied amount. The farmers who applied Tk. 100001($1180) to Tk. 200000 ($2360) received 83.33% of the applied amount. The farmers who applied above Tk. 200000 ($2360) received 85.60% of the applied amount (Table 10).

Utilization of credit

Credit plays an important role in farm business; many people do not start a business without taking a loan. It helps people to be self-employed. It increases farm productivity and income if it properly utilized. So, the pattern of credit utilization is very important in farming. To make profit bank or NGO must ensure that the borrowed funds are used for productive purposes. Proper use of credit promotes increased production and benefits the borrowers involved. Use of credit for unproductive purposes very often results in overdue of loans and weakens the financial viability of the concerned financial institution. In this chapter an investigation has been made to see the pattern of utilization of their loan money (Table 11).

Proper utilization of credit is a prerequisite to attain aims and targets of both credit disbursement and credit receipt as well as for growth of income. In this subsection, a thorough investigation has been made to see the pattern of loan utilization in which sampled borrowers spent their loaned money received from the institutional and non-institutional sources during the year under study.

Problems and constraints associate with tilapia-carp polyculture

The pond fish farmers in the study area were facing various problems during polyculture of fish. These problems broadly categorized as economic, natural, technical and societal. The farmers confronted the problems during pond fish farming were ranked in the Table 12. Water was essential for pond fish culture. Bangladesh belongs to the monsoon region, sufficient water was in the monsoon season, but insufficient water was in the dry season. About 30 % of the pond fish farmers complained that the insufficient water was the problem in the selected area. High feed cost was the main problem of the respondents. As a result of high feed cost farmers, the cost of production was increased and profitability decreased. The highest 90% of the respondents claimed that high feed cost were there big problem.

The lack of fingerlings was found as another problem for the farmers. 14 % of the respondents claimed that non-availability of seed fish was another problem in the selected area. Fingerlings are the most vital material component in tilapia-carp polyculture. But suitable size of fingerlings is not at all times accessible in the culture time, because of insufficient of fingerlings nursery in Bangladesh. Government, private organizations and non-government organization could establish new nurseries to solving this problem. Predators were other minor problem in the selected area. Only 8% of the respondents claimed predators as the fourth problem. Some kind of birds and some animals live in the water were the predators of fish. This problem was not so big for the farmers. Theft of fish was another problem in the selected area. About 12% of the respondents claimed that the theft was a problem for them. This problem was raised where 'Night Guard' was not available. About 70% of the respondents claimed that unexplained mortality of fish was their major problem due to lack of proper knowledge of the relevant technology. This problem arises when farmers are not able to find the causes of mortality of the fish. Fisheries expert could help to solve this problem. About 88% of the respondents claimed that diseases of the fish were the major problem in pond fish culture. Agricultural extension workers and Upazila Fisheries Officer can help to the farmers in solving this problem. Higher labour demand was another problem in pond fish culture technology. Here, higher labour demand means higher human labour demand. Especially in the harvesting period more human labour was demanded in the selected area, 18% of the respondents claimed that higher human labour demand were another problem in the selected area. This problem could be solved by exchanging their labour to other farmers. Higher costs in general were another major problem in pond fish culture technology, 44% of the respondents complained that higher costs in general were a major problem. In the pond fish culture, technology needs to prepare pond excavation. This pond excavation takes a proportion of the total costs of the pond fish culture, 68% of the respondents claimed that the higher cost of a pond excavation for pond fish culture was another major problem. Similar problems also found by Rahman *et al.* (2015).

Table 11. Percentage of utilization of loan in different purposes.

Item of expenditure	Percentage amount of loan used (Tk.)			
Capital expenditure	**Loan amount (50000-100000) ($590 $1180)**	**Loan amount (100001 –200000) ($1180 -$2360)**	**Loan amount (Above 200000) ($2360)**	**All**
Pond excavation	12.50	10.10	9.57	10.72
Pond re-excavation	6.57	4.50	10.34	7.14
Operating expenditure				
Purchase of fingerlings	20.43	25.70	20.85	22.32
Purchase of fertilizer	35.30	31.20	27.84	31.45
Purchase of feed	2.70	22.95	13.62	13.09
Total operating expenditure of farming	77.52	94.45	82.22	84.73
Non-farm expenditure				
Purchase of food	18.48	-	5.54	8.01
Investment in business	4.00	2.95	2.75	3.23
Repayment of old debt		2.60	9.49	4.03
Total non-farm expenditure	22.50	5.55	17.78	15.27
Grand total	100	100	100	100

Source: Author's estimation, 2020.

Table 12. Problems and constraints of tilapia-carp polyculture as ranked by farmers (Percentages are in parentheses).

Problem	Number of times problem was ranked				
	First	**Second**	**Third**	**Fourth**	**Total (n = 50)**
Insufficient water	5	3	4	3	15(30%)
High feed cost	18	8	12	7	45 (90%)
Non availability of seed fish	-	1	4	2	7 (14%)
Predators	-	-	1	3	4 (8%)
Theft	-	1	2	3	6 (12%)
Unexplained mortalities	8	13	9	5	35 (70%)
Disease	11	14	10	9	44 (88%)
High labor demand	1	-	5	3	9(18%)
High cost in general	4	5	8	5	22 (44%)
High cost of pond excavation	7	4	10	13	34 (68%)

Source: Author's estimation, 2020.

Conclusion

Tilapia-carp polyculture is an operational way to exploit benefits from available natural food in a pond. In the study area, the tilapia -carp polyculture is profitable. So, there is a great scope to utilize a profit in tilapia-carp farming to reduce poverty and create employment opportunity. Although the farmers identified some problems and constraints in tilapia-carp polyculture, such as insufficient water, diseases, theft, high feed cost etc. Therefore, the findings suggested that in order to increase the area under culture fish as well as its most rapid expansion the above problems should be solved as far as possible.

Conflict of interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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