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A COMPARATIVE PROFITABILITY ANALYSIS OF PANGAS AND KOI FISH CULTURE IN A SELECTED AREA OF BANGLADESH

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ABSTRACT

Pangas and Koi fish make an important contribution to rural livelihoods for both food security and cash income in Bangladesh. The purpose of the study was to examine socio-economic factors, estimate profitability, evaluate the feed conversion ratios, and determine the types of issues and limitations faced by 60 pangas and koi fish farmers who were chosen at random from the Mymensingh area of Bangladesh. Primary data were collected through a field survey using an interview schedule. Tabular, profitability, and feed conversion ratio analyses were applied for data analysis. The findings revealed that the majority of the respondents belonged to the age group of 30-64 years. The average family size was 5.37 and 5.35 for pangas and koi farmers, respectively. The pangas fish farmers were less educated than the koi fish farmers. Total cost, total return, gross margin, and net return per hectare per season (six months) were Tk. 3164529, 4469731, 1433026, and 1305202 for pangas culture and Tk. 3318823, 4968733, 1771708, and 1649910 for koi culture, respectively. For pangas and koi fish culture, the benefit-cost ratios were 1.41 and 1.50, respectively. The pangas farming indicates a variation in feed efficiency across different feed companies, namely Narish, CP, and Ruposi Bangla, with the feed conversion ratio (FCR) values of 1.18, 1.07, and 1.21, respectively, and for the koi fish farming, the FCR values were slightly higher, with quality, CP, and Ruposi Bangla feeds of 1.19, 1.11, and 1.26, respectively. Diseases, high feed costs, and insufficient water were the main problems and constraints faced by both pangas and koi fish farmers in the study area. The government needs to provide subsidised feed and technical support for pangas and koi fish farmers.

KEY WORDS: *Bangladesh, Feed conversion ratio, Fish culture, Profitability*

INDRODUCTION

Bangladesh is a riverine country. In Bangladesh, aquaculture plays a significant role in rural development by supporting households' income and means of subsistence in a variety of ways. In order to supply the dietary protein needs of the growing human population, the fishing industry is unavoidably involved. By exporting fish and fish products, the fisheries industry made up 2.43% of the country's GDP, 22.14% of its agricultural GDP, and 1.05% of its foreign exchange earnings in 2021–2022. 67.80% of the country's animal protein intake comes from fish. Additionally, the fishing industry contributes significantly to the creation of jobs and the reduction of poverty in rural areas. In 2021–2022, the overall fish production was 47.59 lakh metric tons (MT). The Department of Fisheries' need-based extension services and the spread of adaptive technology have resulted in a significant increase in production from closed water bodies (DoF, 2023).

Table 1: Fish production in Bangladesh 2017-2018 to 2021-2022

Year	Unit: lakh MT; 1 lakh =100000			
	Inland open	Closed	Marine	Total
2021-2022	13.22	27.31	7.06	47.59
2020-2021	13.01	26.39	6.81	46.21
2019-2020	12.48	25.84	6.71	45.03
2018-2019	12.36	24.89	6.60	43.84
2017-2018	12.17	24.05	6.55	42.77

Source; DoF, 2023

Major fisheries resources fall into three categories: marine capture (14.83%), inland culture (57.39%), and inland capture (27.78%) (DoF, 2023).

Globally, aquatic species are a fantastic source of dietary protein and delicacy.

With a record aquaculture production of 122.6 million metric tons (MT), fisheries production in 2020 surpassed 60 percent of 1990s production (FAO, 2022). With 91.6% of that record production, Asian nations—including China, India, Vietnam, Indonesia, and Bangladesh—dominated the global aquaculture industry (FAO, 2022).

Overfishing and climate change are the primary causes of capture fisheries' vulnerability to decline. With 2583.9 thousand MT of aquaculture animal production in 2022, Bangladesh was the fifth-largest producer of aquaculture in the world (DoF, 2022; FAO, 2022). This country's potential for prosperous fisheries and aquaculture operations is further enhanced by the presence of river systems, other interior waters, and a sizable coastline region. For the past 20 years, Bangladesh has been the world's third-largest producer of inland aquaculture, after China and India (FAO, 2022).

Unquestionably, aquaculture has been supporting human nourishment and livelihood in this growing country for the past few decades. Importing animal protein from foreign nations would be expensive for a developing country like Bangladesh. Thankfully, Bangladesh is a self-sufficient country in terms of fisheries production; in 2022, aquaculture accounted for 57.39% of overall fisheries production, and 60% of the daily animal protein consumption (per capita 62.5 g/day) came from this sector (DoF, 2022). One of the most popular and affordable protein sources in the nation is freshwater fish. Bangladesh exported 74.04 thousand MT of fish and fishery products in 2022, bringing in almost 0.5 billion USD. Additionally, over 12% of Bangladesh's population, primarily from rural and coastal populations, depends on aquaculture in one form or another for their livelihood (DoF, 2022). For Bangladesh's poor and the underprivileged, the growth of aquaculture can provide both job possibilities and food security (E-Jahan *et al*., 2010).

Because Bangladesh has a sizable inland freshwater area, inland aquaculture is the most common farming method there. Notably, Bangladesh's inland aquaculture area totals 845.4 thousand hectares (DoF, 2022), or over 5.7% of the country's total land area. Pond fish farming, seasonal waterbody culture, *baor* culture, shrimp/ prawn farming, crab farming, pen culture, and cage culture are the main aquaculture methods used in Bangladesh. In Bangladesh, pond fish farming is the most traditional and widespread aquaculture method. According to DoF (2022), Bangladesh's total pond area is 410.7 thousand hectares, or about half of the nation's entire inland aquaculture area. Pond culture is constantly growing even though it is an old farming method. For example, the productivity and production of pond fish farming increased by 104.5% and 216.26% between 2001 and 2022 (DoF, 2022).

Small-scale aquaculture systems are essential for rural livelihoods and poverty reduction in many developing nation contexts, according to several researches (Kawarazuka and Béné, 2010; Hernandez *et al*., 2018). First, small-scale aquacultures systems help generate revenue by selling fish and aquatic products to both domestic and international markets (Shrestha and Pant, 2012). Second, there is evidence that small-scale aquaculture systems enhance household food and nutrition security through a number of ways. For example, they can improve household food access by making it easier for them to buy food items with the money they make from selling fish (Béné, 2007; Beveridge *et al*., 2013; Dam Lam *et al*., 2022) or increase household food availability throughout the year (Ahmed and Lorica, 2002; Bondad-Reantaso and Subasinghe, 2010; Béné *et al*., 2016). Third, by enabling households to eat wholesome food, these systems can enhance food utilisation (Kawarazuka and Béné, 2010; Chan *et al*., 2019). In certain situations, they can also help many small-scale aquaculture households cope with shocks like the recent COVID-19 pandemic (Manlosa *et al*., 2021). Equally significant is the potential for small-scale aquaculture systems to produce other socio-economic advantages, such as enabling women to participate in food production and marketing operations by developing their capabilities (Dam Lam *et al*., 2022). Rossignoli *et al*., (2023) contend that more thorough research is necessary to fully comprehend the traits and capabilities of these small-scale aquaculture systems.

In addition to being a significant source of protein for low-income families, the growth of fish farming has produced a large number of jobs and revenue opportunities in both rural and suburban locations. Fish farming and its associated value chain employ about 20 million people nationwide. In rural Bangladesh, a growing number of farmers have been engaged in small-scale aquaculture using koi and pangas in recent years. These two fish species have seen a notable increase in output. For example, koi production increased by 350 % to reach 57,244 tons during the same period, but in fiscal year 2021–2022, the annual production of cultured pangasius increased from 0.155 million tons in 2010–11 to 0.395 million tons (DoF, 2023).

Concerns about environmental effects such as water contamination and excessive feed and pesticide use have been among the obstacles to Pangas fish farming's development. For pangas farming to grow sustainably, these problems must be resolved. Pangasius are a vital source of animal protein, and their popularity among middle- and lower-class consumers as well as the nation's urban poor can be attributed in large part to the Bangladesh Fisheries Research Institute's (BFRI) introduction of artificial breeding in the 1990s. Farmers around the nation have been further encouraged to pursue fish farming by the remarkable survival rate (almost 100%) of pangasius juveniles. Around 0.112 million fish farmers are located in different upazilas of the Mymensingh district (DoF, 2023). Since ancient times, koi fish have been a popular and nutrient-dense fish among the populace. Koi fish used to be abundant in Bangladesh's canals, tiny rivers, wetlands, and submerged land. Of all the fish in Bangladesh, koi are the most well-liked and delicious. These days, this fish is also extremely valuable. Koi fish are typically freshwater fish. Swamps, canals, and tiny rivers are home to this fish. Commercial koi fish rearing in ponds is fairly common these days. The Thai koi fish grows really quickly. As a result, make sure there is an adequate supply of feed. The farmer must be proficient in managing tough feed if koi fish are to grow as intended. Designed primarily for low-income fish farmers, this is the principal feed management method. This technique can be used with rice dust, cake, toad minnows, snail or oyster flesh, tripe, or fishmeal (not often). It can be beneficial to use at least one of the feeds listed above and to use others from time to time. Thai fish can be fed high-quality rough feed by combining 25% fishmeal, 30% rice dust, 25% cake, and 20% roughage (FAO, 2022). The farmer must guarantee a sufficient supply of high-quality pellet feed for both commercial and normal koi fish farming in order to achieve the desired level of production. Protein should make about 30–35% of this pellet feed. Koi fish can also be fed shrimp and lobster feed if this feed is unavailable. In commercial Thai Koi fish production, feed must be used at a high rate for the first few days and then progressively reduced. According to the fish's body weight, use roughly 10% feed in the first month, 6% in the second, 4% in the third, and 3% in the fourth month (FAO, 2022).

The profitability evaluations of pangas and koi fish are crucial for small-scale aquaculture agribusiness since they are both extensively cultivated in Bangladesh's Mymensingh district and have distinct cultural management practices. These were the research questions based on the discussion above: Which socio=economic conditions apply to the farmers in the sample? How profitable is it to raise pangas and koi fish in the research area? What are the koi and pangas fish cultures' feed conversion ratios? And what kinds of issues and limitations do the pangas and koi fish growers in the research area face? Analysing the socioeconomic characteristics of the sample pangas and koi fish farmers, estimating the profitability of pangas and koi fish culture, evaluating the feed conversion ratios of pangas and koi fish cultures, and determining the types of issues and limitations that the pangas and koi fish farmers in the study area faced were the specific goals, taking into account the research questions.

MATERIALS AND METHODS

A sample of 60 pangas and koi farming pond fish farmers were selected (30 pangas farmers and 30 koi farmers) randomly from Syedpur, Chandar Bazar, and Rambhadrapur villages of Muktagacha upazila; Dhani Khula, Boiler, and Rampur villages of Trisal upazila; and Madho Barara, Dapunia Bazar, and Uzan Barara villages of Mymensingh Sadar upazila in Mymensingh district of Bangladesh. To collect the data, we employed a semi-structured interview schedule. To gather pertinent data, focus group discussions (FGDs) and observational methods were also employed.

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FUNCTIONAL ANALYSIS

Gross Return

By multiplying an organisation's total output by the average farm gate price during the harvest season, we may get the gross return (Dillon and Hardaker, 1993). The gross return was estimated using the following formula —

$$GR_i = \sum_{i=1}^{n} Q_i P_i \quad \text{………………………………………………………. (i)}$$

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

The difference between total return and variable costs is the gross margin
That is,
GM = TR - VC ……………………………………………(ii)
Where —
GM = Gross Margin
TR = Total Return
VC = Variable Costs

Net Return

Variable and fixed costs were subtracted from gross return to determine net return. The current study employed the following formula to calculate the net return on pangas and koi fish production —

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

Where —
π = Net return (Tk./ha/season);
P_y = Price of the product (Tk./kg);
Y = Amount of the production per hectare/season (Kg);
P_{xi} = Price of i^{th} inputs (Tk.);
X_i = Amount of the i^{th} inputs per hectare/season (kg);
TFC = Total fixed cost (Tk.);
i=1,2,3……………..n (number of inputs).

Benefit Cost Ratio (BCR)

Benefits per unit of cost are compared using the BCR, a relative metric. The ratio of gross returns to gross costs is used to estimate the BCR.
The following formula is used to determine BCR:

$$\text{Benefit-cost ratio} = \frac{Gross\ Benefit}{Gross\ Cost}$$

Feed Conversion Ratio (FCR)

A useful tool for figuring out how much feed is required to raise an animal to a given weight is the feed conversion ratio calculator. The following formula can be used to determine FCR in aquaculture:
FCR = Weight of Feed Intake/ Weight Gained by animal

$$Or\ FCR = \frac{Total\ feed\ used}{Final\ body\ weight\ (gm) - initial\ body\ weight\ (gm)}$$

RESULTS AND DISCUSSION

Given the multitude of interconnected and constituent characteristics that define an individual and impact the evolution of decision-making behaviour, the socio-economic status of sample farmers is crucial for output. As a result, an effort was made to examine the socio-economic characteristics of the farmers in the research region. The socio-economic traits of a few chosen pangas and koi farmers are detailed in this section. These traits include age distribution, family size, level of education, yearly household income, and pond size.

Age distribution of the respondents

In the present study, the sample farmers were classified into three age groups: 15–29 years, 30–64 years, and above 65 years. 10% of the pangas farmers in the sample were found to be between the ages of 15 and 29. About 90% of fish farmers fell into the 30- to 64-year-old middle age group, and about 0% of fish farmers fell into the above 64-year-old age group (Table 2). And it was found that out of the total sample of koi farmers, 6.7% belonged to 15–29 years age group. About 93.3% of fish farmers fell into the 30- to 64-year-old middle age group, and about 0% of fish farmers fell into the above-64-year-old age group (Table 2). It suggests that most farmers in the research area are in the active age range. According to this data, most of the sample farmers were between the ages of 30 and 64, which suggest that they put in more physical work when raising fish.

Table 2: Age distribution of the sample farmers

Age group (years)	Pangas		Koi	
	Number	Percentage	Number	Percentage
15 – 29	3	10	2	6.7
30 – 64	27	90	28	93.3
Above 65	0	0	0	0
Total	30	100	30	100.0

Source: Field Survey, 2024

Family size of the sample households

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 (Cutright, 1971). The family includes husbands, wives, sons, unmarried daughters, parents, brothers, etc. The national average family size in Bangladesh is 4.26 members; the average family size in rural areas obtained is 4.30, and in urban areas it is 4.18 (HIES, 2022). Based on family size, the farmers were classified into three categories: 1) 1-4 members; 2) 5-6 members; 3) more than 6 members.

In the case of pangas farmers, Table 3 shows that the average family size in the small groups was 3.53 people; in the medium group, the average family size was 5.2 people; and the average family size in a large group was 7.4 people. For koi fish farmers, the average family size in the small groups was 3.5 people; in the medium group, the average family size was 5.23 people, and in a large group, the average family size was 7.25 people.

Table 3: Family size of the households

Family Size	Pangas			Koi		
	No. of households	Total members	Average family	No. of households	Total members	Average family
Small family (1 to 4)	15	53	3.53	13	46	3.50
Medium family (5 to 6)	10	52	5.20	13	68	5.23
Large family (above 6)	5	37	7.40	4	29	7.25
Total	30	142	5.37	30	143	5.35

Source: Field Survey, 2024

Level of education of the respondents

Education enables one to accurately apply the knowledge and comprehend the production requirements. It improves a man's ability to maximise profit and manage limited resources. Farmers who receive an education are also better able to manage their income for housing, children's education, family consumption, and other expenses. The farmers' educational status was categorised into three tiers based on data from the Bangladesh

Bureau of Statistics (BBS, 2022). Primary (grades 1–8), secondary (grades 9–10), and upper secondary (grades above 11) are these levels. Table 4 shows that among the pangas fish farmers, about 43.33% had primary level of education; about 23.33% had secondary level of education; and about 33.33% had higher secondary and above level of education in the study areas. Table 4 also shows that about 16.67% had a primary level, about 26.67% had a secondary level, and about 56.67% had a higher secondary and above level of education among the koi fish farmers in the study areas. At the national level, the literacy rate for both the sexes among those aged 7 and older is 74.0%. The percentage of the population that can read and write is known as the literacy rate. Rural areas have a somewhat lower literacy rate than the national average, at 70.3%. Urban literacy is higher than the national average at 82.0% (HIES, 2022).

Table 4: Educational status of the respondents

Education level	Pangas		Koi	
	Number of farmers	Percentage (%) of farmers	Number of farmers	Percentage (%) of farmers
Primary	13	43.33	5	16.67
Secondary	7	23.33	8	26.67
Higher secondary and above	10	33.33	17	56.67
Total	30	100.00	30	100.00

Source: Field Survey, 2024

Income level of the sample households

The socio-economic status of a household is measured by its income level. In the study, it was found in Table 5 that about 30%, 40%, 13.33%, 13.33%, and 3.33% of the pangas farmers had an annual income level of Tk 200,000–300,000, 300,001–400,000, 400,001–500,000, 500,001–600,000, and 600,001–700,000, respectively. And it was found that about 26.66%, 40%, 16.66%, 13.33%, and 3.33% of the koi farmers had an annual income level of Tk. 200000–300000, 300001–400000, 400001–500000, 500001–600000, and 600001–700000, respectively. According to Rahman *et al*. (2019), family income levels have a significant economic impact on the use of pond fish farming. HIES (2022) reports that the average annual household income in the country was Tk. 389064, in rural areas it was Tk. 313956, and in urban areas it was Tk. 549084.

Table 5: Annual Income of the sample households

Income Range (Tk)	Pangas		Koi	
	Number of respondents	Percentage (%)	Number of respondents	Percentage (%)
200000 – 300000	9	30.00	8	26.66
300001 – 400000	12	40.00	12	40.00
400001 – 500000	4	13.33	5	16.66
500001 - 600000	4	13.33	4	13.33
600001 - 700000	1	3.33	1	3.33
Total	30	100.00	30	100.00

Pond Size

Depending on the physical and economic circumstances, pond sizes might fluctuate in different places. To optimise productivity and reduce production costs, the pond size must be appropriate. The distribution of areas is displayed in Table 6. About 50% of pond fish farms raising pangas fish were between the decimal range of 91 and 120. Approximately 20% of pangas pond fish farms fall into the 61–90 decimal range, and roughly 30% fall into the 121–150 decimal range. About 60% of pond fish farms had pond sizes between 61 and 90 decimal places, which is where most koi fish ponds were found. The 91–120 decimal range comprises roughly 23.33% of koi fish farm ponds, while the 121–150 decimal range comprises roughly 16.67% of ponds constituting koi fish farms.

Table 6. Pond size (decimal)

Pond size (decimal)	Pangas		Koi	
	Number of farmers	Percentage (%)	Number of farmers	Percentage (%)
61 – 90	6	20	18	60.00
91 – 120	15	50	7	23.33
121 – 150	9	30	5	16.67
Total	30	100	30	100.00

Source: Field Survey, 2024

Profitability of pangas and koi fish culture (per hectare per season)

A net return is sometimes referred to as an entrepreneur's revenue. The difference between gross return and total costs is known as net return. The study area's pangas and koi fish farmers did not keep any written records of the expenses and profits associated with fish culture. They are thought to have a keen memory, nevertheless, and be able to calculate every aspect of their farm operations. The costs and return per hectare per season of Pangas and Koi fish, calculated over the course of the six-month production period is tabulated in Table 7.

Given its significance, the current study emphasises various cost elements. Variable costs and fixed costs are the two categories of costs. Hired labour, fingerlings, feed, lime, salt, fertiliser, cow dung, pesticides, electricity, fuel and oil, nets, and other expenses were all considered variable cost components in this study. Conversely, land usage expenses and interest on operating expenditures were considered fixed costs. Per-hectare yield, benefit-cost ratio, net return, gross return, and gross margin are also assessed on the return side.

Table 7: Average costs and return from pangas and koi fish production per hectare, per season

Items of cost	Pangas			Koi		
	Quantity	Price/ unit	Total cost (Tk)	Quantity	Price/ unit	Total cost (Tk)
Human labour (man-day)	344	388	133472	225	385	86625
Fingerling (nos.)	43968	0.61	26820	1362289	0.325	442743
Feed (kg)	36734	75	2755050	30733	84	2581572
Lime (kg)	1189	20	23780	494	20	9880
Salt (kg)	321	23	7383	154	23	3542
Fertilizer (kg)	53	30	1590	50	30	1500
Cow dung (kg)	83	5	415	66	5	330
Pesticide			12210			11330
Electricity			46784			37246
Fuel and oil (litter)	43	120	5160	45	120	5400
Nets			14805			8899
Others			9236			7958
Total variable cost			3036705			3197025
Fixed Cost						
Land use cost			51906			41872
Interest on operating capital (Tk.) 10% interest rate			75918			79926
Total fixed cost			127824			121798
Total cost			3164529			3318823
Return						
Yield (Gift and Consumption)	244	133	32452	140	173	24220
Yield (Sale)	33363	133	4437279	28581	173	4944513
Total return	33607		4469731	28721		4968733

Source: Field Survey, 2024

Table 8 reveals that per hectare per season (six months), total cost, total return, gross margin, and net return were Tk. 3164529, 4469731, 1433026, and 1305202 for pangas fish culture and Tk. 3318823, 4968733, 1771708, and 1649910 for koi fish culture, respectively. The benefit-cost ratios were 1.41 for pangas and 1.50 for koi fish culture, which indicate that pangas and koi fish farming is a profitable business. The sum of all variable and fixed costs determines the overall cost of any production (Kohinoor et al., 2016). In the same study area, Haider *et al*. (2023) calculated that the cost of producing pangas farming was Tk. 5320826 (US$ 48939.95) per hectare.

Table 8: Per hectare per season (six months) costs and return on pangas and koi fish culture

Particulars	Pangas	Koi
	Costs and return	Costs and return
Yield (Y) kg	33607	28721
Gross Returns (GR) Tk.	4469731	4968733
Total Variable Cost (TVC) TK.	3036705	3197025
Total Fixed Cost (TFC) Tk.	127824	121798
Total Cost/Gross Cost TC=(TVC+TFC) Tk.	3164529	3318823
Gross Margin GM=(GR-TVC) Tk.	1433026	1771708
Net Return NR=(GR-TC) Tk.	1305202	1649910
BCR(GR/TC) (Undiscounted)	1.41	1.50

Source: Field Survey, 2024

The ratio of total return to total cost was used to calculate the benefit-cost ratio for pangas and koi fish farming. The benefit-cost ratios for raising pangas and koi fish were 1.41 and 1.50, respectively, according to Table 8, showing that the production of these species was lucrative. Based on the discussion above, it can be said that while raising pangas and koi fish is profitable, in the research region, koi fish farming is more lucrative than pangas. A thorough investigation into the profitability and variables affecting the gross return of Pangas fish farming in Bangladesh's Mymensing district was carried out by Haider *et al*. in 2023. They discovered that the production of Pangas fish has favourable socio-economic effects, such as creating jobs and revenue. According to Faruk *et al*. (2018), the benefit-cost ratio was 1.43 and the net income of Vietnam koi was Tk 5,48,455. It may be possible and financially viable to nurse and raise Vietnam koi (Anabas testudineus) in clay ponds using artificial feed in a monoculture system.

Feed conversion ratio (FCR) of pangas and koi fish culture

The use of appropriate feeds is crucial to the success of intensive and semi-intensive fish farming. Fish meals give fish the nourishment they need to thrive. In a semi-intensive or intensive grow-out farming operation, feed expenditures are typically the largest single operating expense. The feed must offer the highest production efficiency at the lowest possible cost. The quality and cost of feed in relation to the market value of the farmed product will determine the relative importance of growth rate and feed conversion efficiency. Before choosing a feed type, it is necessary to examine the unit costs of different feed types, the cost of producing fish using each of these feeds, and the unit profitability of each fish production system. For this reason, it is crucial for fish farmers to make the best use of their feed inputs.

Table 9: Feed brand used in pangas farming by the respondents

Feed Company	No. of respondents	Percentage (%)
Narish	14	46.7
Charoen Pokhand (CP)	4	13.3
Ruposi Bangla	12	40.0
Total	30	100.0

Source: Field Survey, 2024

Table 10: Feed conversion ratio (FCR) of pangas fish weight

Feed Company	Per kilogram (kg) feed fish weight gain (kg)	Price (Tk)	Total Cost (Tk)
Narish	1.18	74	87
Charoen Pokhand (CP)	1.07	90	96
Ruposi Bangla	1.21	62	75

Source: Author’s estimation

Table 10 demonstrates that feed efficiency varies throughout feed businesses, specifically Ruposi Bangla, CP, and Narish, with FCR values of 1.18, 1.07, and 1.21, respectively for pangas fish farming. When it comes to converting feed into fish weight, CP feed has the best efficiency; for every kilogram of CP feed, roughly 1.07 kilograms of pangas by weight are obtained. This effectiveness is essential for lowering feed expenses and enhancing pangas farming's sustainability. Even though CP feed costs more per kilogram, its improved feed efficiency makes it somewhat more expensive overall per kilogram of fish weight acquired than Ruposi Bangla, but it is more economical than Narish when the FCR is taken into account. This analysis emphasises how crucial it is to optimise production expenses by striking a balance between feed efficiency and costs.

Table 11: Feed brand used in Koi farming by the respondents

Feed Company	No. of respondents	Percentage (%)
Quality	15	50.0
Charoen Pokhand (CP)	9	30.0
Ruposi Bangla	6	20.0
Total	30	100.0

Source: Field Survey, 2024

Table 12: Feed conversion ratio (FCR) of Koi fish weight

Feed Company	Per kilogram (kg) feed fish weight gain (kg)	Price (Tk)	Total Cost (Tk)
Quality	1.19	86	102.00
Charoen Pokhand (CP)	1.11	90	99.90
Ruposi Bangla	1.26	74	93.24

Source: Author's estimation

The FCR values for koi farming were marginally higher, as indicated in Table 12, with FCRs of 1.19, 1.11, and 1.26 for Quality, CP, and Ruposi Bangla feeds, respectively. In this instance, CP feed has the highest feed efficiency of the three, meaning that less feed is needed to provide the same weight increase as the others. This efficiency is especially important in the context of koi farming, as feed costs have an impact on the fish's development, colour, and general health—all of which are crucial for the market for decorative fish. Koi farmers who are interested in improving their feeding strategy may find that the CP feed is a more cost-effective option because, despite its higher price, it offers a competitive cost per kilogram of weight growth because of its superior FCR, according to the total cost analysis. According to Faruk *et al*. (2018), the total artificial feed's Feed Conversion Ratio (FCR) was 1.63. Vietnam koi fish had a 70% survival rate and a net yield of 167 kg/ decimal.

Problems and constraints faced by the pangas and koi farmers

Fish culture in ponds requires water. Bangladesh is in a monsoon zone; during the monsoon season, there was enough water, but during the dry season, there was not enough. In the chosen area, almost 30% of the pond fish growers expressed dissatisfaction over the lack of water. Ten percent, six percent, nine percent, and four percent, respectively, reported the first, second, third, and fourth issues (Table 13). Khan *et al*. (2018) looked into the production risk associated with pangas farming in a few Bangladeshi regions. The man and risk functions are estimated using a just-pope stochastic production function. According to the test results, pangas farming carries a considerable production risk, with the risk varying according on the size of the farm.

For the respondents, the biggest issue was the high cost of feed. High feed prices led to higher production costs and lower profitability for farmers. Previous research demonstrated that obtaining loans for production purposes and having access to credit facilities could greatly increase earnings (Khan *et al*., 2021). According to Table 13, the majority of respondents (90%) stated that their largest issue was the high cost of feed. Out of 90%, the first, second, third, and fourth issues were reported by 45%, 13%, 20%, and 12% of respondents, respectively. To solve this issue, the government should enact suitable legislation.

Another issue for the farmers was the scarcity of fingerlings. Another issue in the chosen area, according to 14% of the respondents, is the lack of seed fish. Out of this, complaints of second, third, and fourth issues were made by 12%, 2%, 7%, and 3% of respondents, respectively (Table 13). The most crucial material input for the pond fish culture method is fingerlings. But because there are not many fingerling nurseries in Bangladesh, the culture does not always have the right stocking size. To address this issue, governments, businesses, and non-governmental organisations could set up new nurseries. The availability of fingerlings remains a challenge in the production process, according to Zaman *et al*. (2017), and is connected to a number of socio-economic problems.

Another small issue in the chosen area was predators. Predators were cited by just 8% of respondents as the fourth issue (Table 13). The fish were preyed upon by some aquatic creatures and bird species. For the farmers, however, this issue was not that serious.

Another issue at the chosen location was fish theft. According to Table 13, 12% of those surveyed said they had a problem with theft. Of these, complaints about the second, third, and fourth issues were made by 12%, 2%, 3%, and 7% of respondents, respectively. The lack of "Night Guard" was the reason for this issue. Neighbours occasionally performed that task solely for adversaries.

Table 13 also reveals that 70% of the respondents stated that their biggest issue was fish mortality that could not be addressed since they did not know enough about the appropriate technologies. Out of the 70% – 13%, 30%, 17% and 10% reported first, second, third, and fourth issues, respectively. This issue occurs when farmers are unable to identify the reasons for the fish's death. Experts in fisheries could assist in resolving this issue. 88% of respondents stated that fish infections were the main issue with pond fish cultivation, as seen in Table 13. Out of this, the first, second, third, and fourth issues were identified as 18%, 25%, 25%, and 20%, respectively. The Upazila Fisheries Officer and agricultural extension agents can assist the farmers in resolving this issue.

Table 13: Problems and constraints of pangas and koi fish farming

Problems	Number of times problem was ranked				
	First	Second	Third	Fourth	Total (n = 60)
Insufficient water	06 (10)	04 (7)	05 (9)	03 (4)	18 (30%)
High feed cost	27 (45)	08 (13)	12 (20)	07 (12)	55 (90%)
Non availability of seed fish/ fingerlings	00	01 (2)	04 (7)	02 (3)	07 (12%)
Predators	00	00	02 (3)	03 (5)	05 (8%)
Theft	00	01 (2)	02 (3)	04 (7)	07 (12%)
Unexplained mortalities	08 (13)	18 (30)	10 (17)	06 (10)	42 (70%)
Dieses	11 (18)	15 (25)	15 (25)	12 (20)	53 (88%)
High labour demand	00	01 (2)	06 (10)	04 (6)	11 (18%)
High cost in general	04 (7)	07 (11)	10 (16)	06 (10)	27(44%)
High cost of pond excavation	07 (11)	04 (7)	15 (25)	15(25)	41 (68%)

Source: Field Survey, 2024. Figures within parentheses indicate percentages of total.

Another issue with pond fish farming technique was the increased demand for manpower. In this case, a higher labour demand translates into a larger demand for human labour. The chosen area required more supply of human labour, particularly during the harvest season. According to Table 13, 18% of the participants stated that increased demand for human labour was an additional issue in the chosen area. Of these, the second, third, and fourth difficulties were reported by 18%, 2%, 10%, and 6% of respondents, respectively. By trading labour with other farmers, this issue might be resolved. Another significant issue with pond fish culture technologies was the general increase in costs. According to Table 13, 44% of the participants expressed dissatisfaction over the general issue of rising costs. Of these, the first, second, third, and fourth difficulties were claimed by 44%, 7%, 11%, 16%, and 10% of respondents, respectively. Fish culture technology must get ready for excavation work in the pond. The entire expense of the pond fish culture includes this pond excavation. According to Table 13, 68% of the participants stated that another significant issue was the increased expense of excavating ponds for pond fish farming. Of these, the first, second, third, and fourth difficulties were claimed by 68%, 11%, 7%, 25%, and 25% of respondents, respectively.

CONCLUSION

Production of pangas and koi is profitable in the research area. The profitability of koi fish is higher than that of pangas. Therefore, there is a lot of potential to use koi farming profits to alleviate poverty and generate jobs. Even However, there are a number of issues in the fish farming research area, including a lack of water, illnesses, theft, excessive feed prices, etc. These issues affect the majority of producers. Thus, the results indicated that the aforementioned issues should be resolved to the maximum extent feasible in order to expand the area under fish culture and its quick growth. Based on the current study's findings, the following suggestions are offered for sustainable pangas and koi farming and to preserve the long-term financial stability of pangas and koi fish farmers in the study area: The price of feed should be lowered, and more high-quality feed should be available; the water supply should be expanded; the cost of excavating ponds should come down; diseases should be treated with high-quality medications; and the government and other organisations should fulfil their mandates by informing farmers and setting up the required training for scientific fish farming practices in ponds. This kind of training will help farmers recognise and address issues pertaining to fish farming.

CONFLICT OF INTEREST

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

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