Profitability of Tilapia Farming in Southern Regions of Bangladesh

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Abstract: This study explored whether tilapia farming in southern Bangladesh yielded sustainable profits for the rural households in a context of high input cost and weak institutional support. Data were collected from 120 tilapia fish farmers using structured questionnaires in the four district, while a mixed method of financial indicators net profit, profit margin ratio, benefit–cost ratio (BCR), and return on investment (ROI) was combined with the Relative Importance Index (RII) to rank the challenges. The findings revealed that tilapia farming was profitable in all the districts with an average net profit margin of 21.80%, a BCR of 1.28 and ROI of 28%. But profit was limited by the cost of feeds that represented nearly 78% of total cost and lack of technical knowledge, climate effect and insufficient access both to credit and infrastructure. The results highlight the significance of input cost control and resource utilization. Policy interventions to favor lower cost feed, farmer training and facilitate access to credit were recommended as measures, which can improve profitability and contribute to the sustainability of tilapia culture.

Keywords: Bangladesh, Benefit-Cost Ratio (BCR), Feed Management, Financial Performance, Tilapia Farming.

Introduction

Aquaculture has emerged as a cornerstone of the global agri-food system, playing a critical role in meeting the rising demand for animal protein while supporting livelihoods, income generation, and economic development. According to recent estimates, aquaculture contributed approximately 59% of total global fish supply in 2022, with production reaching around 131 million tons (FAO 2024). This growth has been driven by technological advances, rising demand for healthy food products, higher incomes, and increased per capita fish consumption worldwide. From a theoretical perspective, aquaculture development aligns with the broader framework of agricultural transformation and commercialization, where intensification and market integration drive productivity gains and income generation. Aquaculture expansion also supports socio economic development and poverty alleviation, aligning with national and international sustainable development goals (Islam et al. 2006; Adewuyi et al. 2010; Paul et al. 2011; Ibengwe et al. 2016).

In Bangladesh, the fisheries sector plays a vital role in the national economy, contributing 0.91% to total exports (EPB 2024), 22.26% to agricultural GDP, and 2.53% to overall GDP (BER 2024). Over the past decades, aquaculture has become the dominant source of fish production, with total output exceeding 4.92 million tons in 2022 (DoF 2024). Within this expanding sector, tilapia has gained prominence as one of the most widely cultivated species globally and Bangladesh now ranked third among Asian countries and fourth in the world in tilapia production (FAO 2024). Tilapia farming has grown rapidly because of its fast growth rate, adaptability to diverse environments, and low input requirements. These features make it well-suited for smallholder farmers who operate under limited resources and need efficient production systems. As a result, tilapia farming provides a useful context for studying farm-level economic performance in developing countries, where improving efficiency and returns is essential.

The economic performance of aquaculture systems can be explained using production economics, where profitability depends on the relationship between inputs, outputs, and market prices (Sunny et al. 2019). Under profit-maximizing behavior, farmers aim to achieve the highest possible net returns given their resource and technological constraints. In this context, effective cost control and efficient resource use are essential for improving farm profitability and reducing production risk. Therefore, understanding cost structures, returns, and efficiency is important for evaluating the sustainability of aquaculture enterprises.

Empirical studies on tilapia farming across different countries have identified several factors influencing farm performance. Evidence from China, Ghana, Uganda, and Saudi Arabia highlights the importance of input costs, managerial experience, and production practices in determining profitability and efficiency (Yuan et al. 2017; Boateng et al. 2013; Hyuha et al. 2011; Elhendy et al. 2001). In Bangladesh, the literature has largely focused on broader socio-economic and environmental dimensions, including poverty alleviation, livelihood improvement, climate vulnerability, and farm management practices (Ferdoushi et al. 2019; Rahman et al. 2005; Rahman et al. 2021; Bhuiya et al. 2023; Ahmed et al. 2022). While these studies provide important insights, they offer limited evidence on detailed economic outcomes at the farm level.

A key limitation in the existing literature is the lack of region-specific economic analyses of tilapia farming, particularly in southern Bangladesh. Aquaculture production is inherently context-dependent, shaped by environmental factors such as salinity, water quality, and climate variability, as well as socio-economic conditions including market access and input availability. These factors can lead to substantial variation in production costs, productivity, and profitability across regions. The absence of localized empirical evidence constrains the ability of policymakers and stakeholders to design targeted interventions and make informed investment decisions.

To address this gap, the present study conducts a comprehensive economic analysis of tilapia farming in southern Bangladesh, focusing on cost structures, returns, and profitability. Specifically, the objectives are to: (i) estimate the costs and returns associated with tilapia production; (ii) assess farm-level profitability; and (iii) identify key economic factors influencing production performance. By addressing these objectives through a mixed-method financial analysis, the study makes two key contributions. First, it provides context-specific empirical evidence on the economic performance of tilapia farming in a coastal production environment, thereby addressing an important gap in existing research. Second, it generates policy-relevant insights to support more efficient resource allocation, improve farm-level profitability, and promote sustainable aquaculture development. By explicitly linking production economics theory with localized empirical data, the study advances a more nuanced understanding of aquaculture economics in developing country contexts.

The paper is structured as follows: Section 2 details the Materials and Methods. Section 3 presents the empirical results, which are discussed in Section 4. The final section (Section 5) states the conclusion.

Materials and Methods

Questionnaire Design and Data Collection procedure

The fish market in Bangladesh relies on both wild-caught and farmed species, with tilapia emerging as one of the most important products in the aquaculture sector in recent years (E-Jahan et al. 2010; Fitzsimmons et al. 2011). The southern regions, particularly the coastal and semi-coastal districts, have developed into key hubs for tilapia farming, benefiting from abundant water resources such as ponds, canals, and low-lying rice fields, as well as a readily available labor force.

To evaluate the economic performance of tilapia farming in these areas, a structured questionnaire was meticulously developed. The design process began with a comprehensive review of relevant literature on aquaculture economics and tilapia production systems. An initial draft of the questionnaire was then refined through focus group discussions with farmers, consultations with local experts, and a pilot survey involving 12 tilapia farmers in the Barishal region. Insights from the pilot phase were instrumental in clarifying questions, optimizing their sequence, and improving the measurement of economic variables.

The final version of the questionnaire was organized into four sections. The first section outlined the study objectives and obtained informed consent from participants. The second section collected socio-economic and demographic information, including gender, age, education, household composition, sources of income, and farming experience. The third section focused on the economics of tilapia farming, collecting data on fixed and variable costs, yields (per decimal), and gross revenue (calculated as the total fish sold multiplied by the prevailing market price in BDT). The fourth section examined production challenges, where respondents rated the severity of various constraints using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), following established survey practices (Lavuri et al. 2023). This approach captures both the prevalence and intensity of constraints by allowing respondents to express varying degrees of agreement. Unlike binary responses, it enables the assessment of not only whether a challenge exists but also the extent to which it affects farming operations, thereby providing a more understanding of farmers' experiences.

Data collection was conducted through face-to-face interviews administered by trained enumerators. Prior to fieldwork, enumerators received comprehensive training in interview techniques, questionnaire administration, and ethical guidelines to ensure data reliability and consistency. Due to the scattered distribution of aquaculture households and constraints such as limited time and financial resources, a convenience sampling technique was applied. While this approach facilitated efficient data collection and allowed exploratory analysis, it may limit the broader generalizability of the findings.

To mitigate potential sampling bias, a multi-district sampling strategy was implemented. Four leading tilapia-producing districts Patuakhali, Barguna, Barishal, and Bagerhat were purposively selected to capture regional diversity in farming practices and resource availability. Approximately 30 farmers were sampled from each district, with efforts made to include a range of farm sizes, experience levels, and management systems. This approach increased variation within the sample and helped to partially address selection bias.

In this study, the absence of a complete sampling frame of tilapia farmers made probability-based sampling impractical. Combined with field constraints such as limited time, financial resources, and the dispersed nature of farming households, this necessitated a more feasible sampling design. Accordingly, a total of 120 farmers were surveyed. This sample size is consistent with prior farm-level economic studies that commonly use 60–100 or slightly higher observations, depending on field conditions and analytical requirements (Türkten et al. 2023; Paudel et al. 2018; Ngoc et al. 2016; Sarker et al. 2022). Distributing the sample evenly across the four districts further enhanced the representativeness of the dataset and helped to account for regional variations in farming systems.

In addition to the primary survey data, secondary information was collected from reputable sources such as the Bangladesh Bureau of Statistics (BBS), Bangladesh Economic Review, FAO publications, fisheries yearbooks, scholarly journals, and relevant online databases. These secondary data sources complemented the primary data and provided broader context for understanding tilapia production trends and the economic environment of the sector in Bangladesh.

Analytical Frame Work

There will be a variety of analytical techniques employed to accomplish the study's goals. Among the basic statistics used to measure demographic traits are frequency distributions, tables, averages, and percentages. Net profit, profit margin ratio, ROI and benefit-cost ratio are some of the methods used to calculate the financial performance of farm.

A farm's net profit is the amount of money left over after deducting all of its costs from all of its sales. Total revenue is the sum of the money a farmer makes from all of the fish sales. The entire cost was separated into two categories: total variable cost (TVC) and total fixed cost (TFC). The entire fixed cost includes the pond lease price, net, permanent labour cost, and other equipment costs.

To calculate the net profit, we have used the following formula-

$$\textit{Net profit} = TR\text{-}TC \qquad (1)$$

Where, TR=Total Revenue

TC= Total cost

Further, TR = (average price per unit sold) x (number of units sold)

TC =TFC+TVC

where, TFC = Total fixed cost,

TVC=Total variable cost

Net Profit Margin ratio is a financial ratio used to determine the percentage of profit earned by a farm against its total sales revenue. The profit Margin Ratio was further used to determine how much profit a farmer can earn from total sales.

To calculate the Net profit margin ratio, we have used the following formula -

Profit Margin Ratio = (Net Income ÷ Total Revenue) × 100 ------------------------ (2)

The profit margin ratio, Benefit-cost ratio will be used to show whether tilapia fish farming is financially profitable or not. A higher ratio means the farm is higher profitable. The benefit-cost ratio is a relative measure that will use to compare benefits against cost.

To calculate the benefit-cost ratio we use the following formula-

Benefit-Cost ratio = Total Revenue ÷ Total cost..(3)

The formula for the return on investment (ROI) used is stated below:

ROI = annual net profit÷ total capital investment .... (4)

The Relative Importance Index (RII) technique was employed to assess and rank the major challenges affecting the performance of tilapia farming in the study area. Farmers' perceptions regarding different production, financial, environmental, technical, and marketing constraints were measured using a five-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree. A total of thirteen key challenges influencing tilapia farming performance were included in the analysis.

The RII method enabled the identification and prioritization of the most critical constraints faced by tilapia farmers based on their relative severity and perceived impact on farm performance. Higher RII values indicate greater importance of a particular challenge in limiting tilapia farming productivity and profitability. The Relative Importance Index (RII) was computed using the standard formula adopted from previous studies (Kometa et al. 1994; Gündüz et al. 2013; Opele 2021):

$$RII = \frac{\sum w_i \times f_i}{M \times T} \quad \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

where w_i is the weight of category i, f_i is the frequency of responses in category i, M is the maximum weight, and T is the total number of respondents. Values of RII may vary from 0 to 1, and higher value indicates higher relative significance of the challenge in relation to the farmers.

Empirical Results

Descriptive analysis of Socio-economic factors

The success of a fish farm is closely linked to farmers' socio-economic conditions, as these influence management practices, resource use, and ultimately farm performance and income. The socio-economic profile of tilapia farmers shown in table 1 indicates that aquaculture in the study area is overwhelmingly male-dominated (98%), highlighting that decision-making and operational responsibilities in tilapia farming are largely concentrated among men, reflecting prevailing socio-cultural norms in rural Bangladesh. The age structure reveals that tilapia farming is mainly undertaken by economically active and mature individuals, with the largest share of farmers falling within the 36–44 years (48.33%) and 45–54 years (25.22%) age groups. This concentration implies that engagement in aquaculture requires a combination of physical capacity, managerial experience, and financial stability, which are more common among middle-aged farmers. The relatively low participation of younger farmers (2.24% below 24 years) may indicate limited entry of youth into the sector.

Table 1: Analysis of socioeconomic factors affecting farmers (Respondents; N=120)

Factor	Percentage %	Variable	Percentage %
Gender		**Number of ponds**	
Male	98	1-2	52.29
Female	2	3-4	29.17
Age of Farmer		5-6	10.83
Up to 24 Years	2.24	7+	7.71
25-34 Years	24.21	**Working Hours**	
36-44 Years	48.33	1-2 Hours	22.92
45-54 Years	25.22	3-4 Hours	39.58
Above 55 Years		5-6 Hours	22.92
Educational status		Above 7 Hours	14.58
No Formal Schooling	10.42	**Area of Pond**	
Primary Education	23.79	1-20 Decimal	12.5
Secondary Education	34.38	21-40 Decimal	30.79
Higher Secondary Education	24.08	41-60 Decimal	24.25
Graduation	7.33	61-80 Decimal	10.08
Family Size		80-100 Decimal	13.84
1-3 members	4.17	Above 100	8.54
4-6 members	73.96	**Land Condition Before**	
7-9 members	19.79	Agricultural land	44.83
10 above	2.08	Unused Land	55.17
Occupation of the farmer		**Training on Fish Farming**	
Fish Farmer	13.4	Yes	38.86
Agriculture	32.99	No	61.14
Service	4.12	**Sources of Capital**	
Business	36.09	Own	57.08
Others	13.4	Collected from Family	15.38
Years of experience		Relatives	2.08
1-5 Years	29.04	Brow from Financial Institutions	25.46
6-10 Years	40.75		
11-15 Years	20.83		
16-20 Years	8.33		
21 Years and above	1.04		

Source: Field survey (May to June 2024)

Educational attainment shows that a substantial proportion of farmers have at least secondary (34.38%) or higher secondary (24.08%) education, while only a small share have no formal schooling (10.42%). This suggests a moderate level of literacy, which can facilitate basic farm management and adoption of improved practices. However, the limited proportion of graduates (7.33%) may constrain more advanced decision-making and technology adoption. Household size appears to support farming activities, as the majority of farmers belong to medium-sized families (4–6 members: 73.96%). Such family structures typically provide sufficient labor for routine aquaculture operations, reducing dependence on hired labor and lowering production costs. Larger households (7–9 members: 19.79%) may further strengthen labor availability, although they may also increase consumption pressure. Occupational patterns indicate that tilapia farming is rarely a standalone activity. Only 13.4% of respondents identify as full-time fish farmers, while a larger proportion are engaged in business (36.09%) and agriculture (32.99%). This demonstrates that aquaculture is largely integrated into diversified livelihood strategies, allowing farmers to spread risk but potentially limiting specialization and investment in fish farming.

Experience in aquaculture is relatively well established, with a significant share of farmers having 6–10 years (40.75%) and 11–15 years (20.83%) of experience. This indicates a strong base of practical knowledge, which can enhance farm management and resilience to production challenges. However, despite this experience, a majority of farmers (61.14%) have not received formal training, pointing to a gap between experiential learning and technical knowledge. Farm structure further reflects the small-scale nature of tilapia production. More than half of the farmers (52.29%) operate only 1–2 ponds, and the most common pond size falls within 21–40 decimals (30.79%). These figures suggest limited resource endowment and restricted capacity for large-scale production. Nevertheless, the fact that 55.17% of ponds were established on previously unused land highlights the role of aquaculture in converting idle resources into productive assets.

Farmers demonstrate a moderate to high level of engagement in aquaculture activities, with the largest proportion (39.58%) spending 3–4 hours daily on pond management. This indicates that even when practiced as a secondary occupation, tilapia farming requires consistent attention and labor input to maintain productivity. Financially, the sector is largely self-reliant, as 57.08% of farmers depend on their own capital, while only 25.46% access formal financial institutions. This reliance on personal savings suggests limited access to institutional credit, which may constrain expansion, technological adoption, and input optimization. At the same time, it reflects a cautious investment behavior among farmers.

Overall, the results suggest that tilapia farming in southern Bangladesh is characterized by small-scale, semi-commercial operations managed by experienced but resource-constrained farmers. While the sector benefits from moderate education levels, family labor support, and accumulated experience, its growth is potentially hindered by limited access to formal training and financial resources. Strengthening institutional support in these areas could significantly enhance productivity and profitability.

Tilapia farming's financial performance analysis

This study provides a comprehensive assessment of the financial condition of tilapia farming in southern Bangladesh by examining the cost and return structure across different districts. Tilapia is among the most highly demanded aquaculture species in the country, and Bangladesh’s favorable environmental conditions offer strong potential for expanding production to serve both domestic and export markets. The analysis emphasizes key profitability indicators net profit, profit margin ratio, benefit-cost ratio, and return on investment to evaluate the economic viability of tilapia culture. Table 2 presents a district-wise breakdown of revenues, cost structures, and profitability metrics, providing a detailed overview of tilapia aquaculture performance throughout the southern region.

Table 2: Profit/Loss, ROI, profit margin ratio, benefit-cost ratio, and revenue and expense analysis in the study areas.

		Patuakhali	**Barguna**	**Barisal**	**Bagherhat**	**Total**
	Average Price in BDT (Per kg)	***Amount in BDT***	***Amount in BDT***	***Amount in BDT***	***Amount in BDT***	***Amount in BDT***
Revenues: Revenues:						
Sales Revenue	120 to170	91712530	87009000	21907353	37987868	231400717
Others Revenue		218153	147032	222443	205286	1097150
Total Revenue		***91930683***	***87156032***	***22129796***	***38193153***	***232497867***
Expenses:						
Fixed Cost:						
lease Value		16717	35535	20497	15965	88714
Measurement Tool Cost (Weight Machine)		89385	89082	74538	84133	337138
Pump Machine Cost		762340	865260	370696	603253	2601548
Total fixed cost		***868442***	***989877***	***465731***	***703351***	***3027400***
Operating costs:						
Pond Preparation:						
Labor cost		6514992	3944376	928044	1078326	12465738
Water Supply cost		557333	451140	152646	251011	1412130
Expense for Net Round Fencing		585796	1010988	244044	253000	2093828
Pond Management:						
Cost of Fingerlings		2241478	4579380	831412	1799324	9451593
Transportation cost		335754	273240	75348	268686	953028
Medicine and Fertilizer		497107	328589	137155	179015	1141866
Feed Cost		57073117	53945349	13177947	23605610	142455045
Harvesting Costs:						
Catching Fish cost		304973	299250	254100	546315	1404638
Transportation Cost		1224600	1778400	177736	514592	3695328
Catching Net costs		695991	666600	276841	364408	2003840
Total Operating Costs		***70031140***	***67277312***	***16255273***	***28860286***	***177077033***
Others Cost		480043	535181	319872	393344	1705581
Total Costs = TFC+ TOC + others		**71379625**	**68802370**	**17040875**	**29956982**	**181810014**
Net Profit/loss = TR-TC		***20551058***	***18353662***	***5088920***	***8236172***	***50687853***
Profit Margin Ratio = (Net Income ÷ Total Revenue) × 100		22.35%	21.06%	23.00%	21.56%	21.99%
Benefit-Cost ratio = Total Revenue ÷ Total cost		1.29	1.27	1.30	1.27	1.28
Feed Cost percentage = (Feed cost/ Total Cost) × 100		79.96%	78.41%	77.33%	78.80%	78.35%
ROI = annual net profit÷ total capital investment × 100		29%	27%	30%	27%	28%

Source: Field survey (May to June 2024)

Revenue Pattern across Districts

District-level analysis shows that income generation from tilapia farming varied across the study areas. The main source of revenue was the sale of tilapia fish, while other income sources contributed only a very small share of total revenue. The market price of tilapia ranged from Tk. 120 to Tk. 170 per kg across all districts, which influenced the overall level of revenue.

Among the selected districts, Patuakhali recorded the highest revenue at Tk. 91.7 million, followed by Barguna at Tk. 87.0 million. In comparison, Bagerhat generated Tk. 38.0 million, while Barisal recorded the lowest revenue at Tk. 21.9 million. Altogether, the four districts generated Tk. 238.6 million from tilapia farming. The higher revenue in Patuakhali and Barguna was mainly due to their larger production scale and higher quantity of fish sold. On the other hand, Barisal and Bagerhat earned lower revenues because of comparatively smaller production volumes. This pattern indicates that total income from tilapia farming was largely determined by the quantity of fish produced and sold. At the same time, sale price also affected district-level revenue, as farmers receiving a higher price per kg could earn more from the same quantity of fish. However, higher revenue does not always mean higher profitability or production efficiency, because profit also depends on production and other costs such as feed, labor, seed, pond preparation, and other management expenses.

Other revenue sources, including income from supplementary activities, remained below 1% of total income in all districts. This shows that farmers depended almost entirely on direct fish sales as their primary source of income. However, there is an opportunity to increase additional earnings through integrated farming practices. For example, farmers can cultivate vegetables or other agricultural crops on pond banks or dykes. This would allow them to earn extra income from the same farm area and improve overall farm profitability. Therefore, better use of pond-side land could create a reasonable additional income source for tilapia farmers in the study areas.

Costs Analysis

Operating costs formed the largest part of total production costs in all districts. These costs were divided into three main stages: pond preparation before culture, pond management before harvesting, and harvesting costs. Pond preparation costs included labor cost, water supply, and net fencing. Pond management costs included fingerlings, transportation, medicine and fertilizer, and feed. Harvesting costs included fish catching, transportation, and catching-net expenses.

Among all cost items, feed was the most important component. Feed cost accounted for 79.96% of total cost in Patuakhali, 78.41% in Barguna, 77.33% in Barisal, and 78.80% in Bagerhat, with an overall average of 78.35%. This shows that nearly four-fifths of total tilapia production cost was spent on feed. Therefore, feed management is the most critical factor affecting profitability. Small changes in feed price, feed quality, or feeding efficiency can strongly influence farmers' net profit. However, this study did not collect detailed data on feed type, feed source, management practices, infrastructure quality, or market distance, which is a noted limitation. Other operating costs, such as fingerlings, pond preparation, water supply, fencing, medicine, fertilizer, transportation, and harvesting, were also necessary for successful production. These costs supported pond preparation, fish stocking, pond maintenance, disease control, and final delivery of fish to buyers. Although harvest-related costs were smaller, they were important for post-production handling and marketing.

District-level cost variation was also observed. Pond preparation or labor cost was highest in Patuakhali, possibly because of larger production scale. Fingerling cost was comparatively higher in Barguna and Bagerhat, which may be related to stocking density, seed quality, or local fingerling prices. Harvesting and transportation costs also differed across districts due to possible differences in market distance, road access, labor availability, and local harvesting practices. Overall, operating costs accounted for about 95.39% to 98.11% of total costs, while fixed and other costs represented only a small portion. This indicates that tilapia farming in the study areas was mainly driven by recurring production expenses rather than long-term capital expenses.

Fixed costs represented a small but important part of the total production costs in tilapia farming. These costs included lease value, measuring or weighing instruments, and pump machines. Compared with operating costs, fixed costs were relatively low in all districts, accounting for only about 1.5% to 2.0% of total costs. This indicates that tilapia farming in the study areas was mainly driven by operating expenses rather than large fixed capital investments.

Within the category of fixed costs, pump machines represented the most critical item, as a reliable water supply and regular water exchange are vital for successful pond-based tilapia farming. Among the surveyed districts, total fixed costs were highest in Barguna, followed in order by Patuakhali, Bagerhat, and Barisal. While fixed costs comprised a minor share of overall expenditure, they played a key role in influencing fish survival, growth, and overall production outcomes.

Profitability Indicators Analysis

The net profit was positive in all districts, confirming that tilapia farming was financially viable in the study areas. Patuakhali earned the highest net profit, followed by Barguna, Bagherhat, and Barisal. This was mainly because Patuakhali and Barguna had larger production and higher total revenue.

The profit margin ratio shows how much profit is earned from total revenue after covering all production costs. In this study, the overall profit margin ratio was 21.99%, which means that for every BDT 100 earned from tilapia farming, farmers kept about BDT 22 as net profit after paying all costs. Among the districts, Barisal had the highest profit margin ratio at 23.00%, followed by Patuakhali at 22.35%, Bagerhat at 21.56%, and Barguna at 21.06%. Although Barisal had lower total revenue and net profit compared with Patuakhali and Barguna, it achieved the highest profit margin because its cost was relatively lower compared with its revenue. This indicates better cost efficiency in Barisal. On the other hand, Barguna had the lowest profit margin ratio, mainly because its production cost was comparatively high. Overall, the profit margin ratios indicate that tilapia farming was financially profitable in all districts, but farmers need to control operating costs, especially feed cost, to improve profitability further.

The Benefit-Cost Ratio compares the total revenue generated to the total cost incurred. A BCR greater than 1 indicates that the enterprise is profitable, as revenues exceed costs. In this analysis, the BCR values range from 1.27 to 1.30 across the districts, with a total average of 1.28. This means that for every 1 BDT invested in production, the farmers receive between 1.27 and 1.30 BDT in return. Such values reflect the economic viability of tilapia farming in the study areas, showing that the investment not only covers costs but also generates a substantial surplus.

Return on Investment (ROI) expresses the annual net profit as a percentage of the total capital invested. It is a key indicator of how effectively capital is being used to generate earnings. In this study, ROI values range from 27% to 30%, with an overall average of 28%. This means that for every 100 BDT invested, the fish farmers are earning about 28 BDT as profit annually. High ROI figures highlight the strong earning capacity of tilapia farming relative to the capital outlay, making it an appealing option for investors and farmers seeking solid returns on their investments.

Challenges affect the performance of tilapia farming

The analysis indicates that the profitability of tilapia farming in southern Bangladesh is characterized by a chain of interdependent challenges (table 3). The lack of affordable feed (mean = 0.96) is the most serious constraint, mentioned by 84% of respondents rank as first. In addition to this problem, there is a related lack of quality feed (mean = 0.85), resulting in both an affordability as well as nutritional adequacy issue, which directly influences fish growth and survival. Besides feed, the other two biggest operational hurdles are lack of knowledge and infrastructure needed. Low technical assistance and extension (mean = 0.97) Poor knowledge of fish farming (mean = 0.87) with limited training facilities (mean = 0.81), showed a systemic failure in the delivery of such services to farmers. Water shortages in the dry season (mean = 0.86) further compounded this, which have a marked effect on pond management and fish health.

Table 3. Perceived challenges faced by tilapia farmers in the study areas (Respondents; N=120)

Sl. No		*Percentage of Rating as Strongly agree*	*Mean*	*Rank*
1	Higher cost of commercial and local cost Feed	84.17	0.96	*1*
2	Inadequate knowledge of fish farming	54.17	0.87	*2*
3	Water supply problems in the dry season	55.00	0.86	*3*
4	Lack of quality feed	46.67	0.85	*4*
5	Lack of training facility	45.00	0.81	*5*
6	Lack of credit facilities	30.83	0.80	*6*
7	Fish disease	20.00	0.75	*7*
8	Higher interest on the loan	25.00	0.74	*8*
9	Market Price Fluctuation	22.50	0.70	*9*
10	Higher labor cost	14.17	0.68	*10*
11	Environmental problems (climate change, flood, drought)	9.17	0.67	*11*
12	Lack of storage and transportation facilities	12.50	0.66	*12*
13	Labor shortage	18.33	0.65	*13*

There are also important financial and market barriers. Credit accessibility is poor (mean = 0.80) and credit availability, to farmers, carries a high interest burden (mean = 0.74), thus inhibiting investment by farmers. (Postharvest, mean = 0.66) and output prices (mean = 0.70) have led to lower incomes and increased financial risk. Further production risks from especially fish disease (mean = 0.75) will further decrease potential profit.

At the end, the economics of tilapia aquaculture are still mostly limited by the cost feed, technology and developing infrastructure. This highlights the importance for specific interventions (for example, access improvement to inputs, strengthening of extension services and investment in rural infra-structure) that can increase the effectiveness of farmers, reduce their risk and provide more stable incomes for small and medium farmers.

Discussion

Tilapia farming in southern Bangladesh consistently delivers strong profits, driven by the region’s favorable aquatic conditions, reliable water resources, and accessible markets. This success marks a clear transition from subsistence-oriented production to a commercially established rural enterprise. The findings demonstrate not only steady profitability but also reveal a structurally robust, input-sensitive production system one where economic outcomes depend heavily on cost efficiency and institutional support. This conclusion aligns with recent literature showing that smallholder aquaculture can provide stable income, even as it remains vulnerable to input price volatility and imperfect market structures (Ahmed et al. 2022).

Financial performance indicators profit margin, Benefit-Cost Ratio (BCR), and Return on Investment (ROI) confirm the economic viability of tilapia farming in the study area. The profit margin demonstrates consistent net returns; reinforcing earlier evidence that small-scale aquaculture contributes significantly to rural livelihoods and food security (Islam & Sarker 2018; Sarker et al. 2022; Zannatul et al. 2019). Favorable BCR values show that revenues exceed production costs, aligning with previous findings on pond-based aquaculture profitability (Mukta et al. 2019). The ROI further indicates strong capital efficiency, supporting the view that well-managed aquaculture systems can yield competitive investment returns (Safina et al. 2017). Together, these indicators establish that tilapia farming is financially viable, although outcomes vary across locations and management conditions.

However, profitability varies across locations due to differences in input costs, management practices, and market access. Similar spatial disparities have been documented in Bangladesh, where local conditions play a decisive role in shaping aquaculture outcomes (Sumon et al. 2022; Saha et al. 2022). This evidence emphasizes the need for location-specific interventions rather than uniform development strategies. The dominance of feed cost within the total cost structure further reflects a defining feature of intensive aquaculture systems. Global studies consistently identify feed as the largest cost component and a key determinant of profitability (Rahman et al. 2012; Tacon & Metian 2015). This finding highlights the importance of improving feed efficiency, as even marginal gains in feed management can produce substantial economic benefits. From a production economics perspective, this aligns with the principle that optimizing the most critical input yields the highest marginal returns.

Despite its potential, tilapia farming in the study area faces several structural challenges. High feed costs and concerns about feed quality reveal inefficiencies in input supply chains, a challenge widely reported in developing aquaculture systems (Byabasaija et al. 2025; Haji et al. 2021). Limited access to technical knowledge and extension services further restricts the adoption of improved farming practices, thereby constraining productivity (Munguti et al. 2021). These constraints suggest that current profitability is achieved under suboptimal conditions, leaving considerable scope for efficiency improvement.

Environmental and infrastructural factors also shape production outcomes. Seasonal water scarcity and inadequate rural infrastructure, exacerbated by climate variability and development gaps, increase production risks and reduce long-term resilience (Rahman et al. 2019;). Limited access to affordable credit further restricts farmers' ability to invest in better inputs and technologies, perpetuating inefficiencies (Ahmed et al. 2022; Sumon et al. 2022).

From a theoretical perspective, the findings support the Resource-Based View (RBV), which emphasizes that performance differences arise from the effective utilization of available resources. Farms that manage key inputs especially feed and labor more efficiently achieve superior economic outcomes, even within similar production environments. The results are also consistent with production theory, where profitability depends on the relationship between input costs and output prices. However, persistent inefficiencies indicate that farmers do not operate at optimal equilibrium due to market imperfections and institutional constraints, highlighting the need for targeted policy interventions.

The practical implications of this study are highly relevant for stakeholders across the tilapia value chain. Farmers can increase efficiency and profits by improving feed management through choosing suitable feeds, minimizing waste, and using locally sourced, cost-effective alternatives. With ongoing volatility and inconsistent feed quality in Bangladesh's market, community-based feed preparation and local sourcing offer more practical solutions than sole reliance on commercial suppliers. Expanding access to technical knowledge, such as through mobile-based training videos, provides an immediate and flexible alternative to traditional extension services. Exporters and processors can benefit from direct procurement links with farmer cooperatives, which stabilize supply chains and promote the production of higher-value products. Initiatives like contract farming and targeted technical support can further enhance farm-level quality.

Policymakers can enhance the tilapia aquaculture sector by expanding access to low-interest loans through microfinance institutions and mobile banking platforms, enabling smallholders to invest in essential inputs without the burden of collateral requirements. Subsidizing key inputs particularly feed via voucher systems managed by cooperatives or local authorities offers a practical solution and can be further supported by tax incentives for small and medium feed mills, as well as public-private partnerships that utilize local agro-industrial by-products. Additionally, prioritizing investments in rural infrastructure such as feeder roads, local markets, and cold storage through public-private collaboration will help address supply chain bottlenecks and foster the sector's long-term growth.

Conclusion

This study confirms that tilapia farming in southern Bangladesh is a financially sustainable and economically promising rural enterprise. The consistent performance of key indicators such as profit margin, BCR, and ROI demonstrates that aquaculture contributes significantly to household income and rural livelihoods. However, profitability is not uniform and depends largely on input-use efficiency and local production conditions rather than on production scale alone.

The dominance of feed cost highlights a structural dependency that strongly influences farm profitability and positions feed efficiency as a central determinant of economic success. At the same time, spatial differences in financial outcomes indicate that location-specific factors such as infrastructure, market access, and input availability play a critical role in shaping performance. These findings suggest that improving technical efficiency at the farm level is as important as expanding production capacity.

Despite its profitability, the sector operates under persistent constraints related to input supply inefficiencies, limited technical knowledge, weak extension services, inadequate infrastructure, and restricted access to credit. These constraints limit productivity gains and reduce the overall efficiency of the system. Overall, tilapia aquaculture in southern Bangladesh offers strong economic potential, but its long-term sustainability depends on efficiency improvements and targeted institutional support rather than on scale expansion alone.

From a policy perspective, the study emphasizes that future interventions should move beyond production expansion and focus on structural improvements. Priority areas include enhancing feed quality and affordability, strengthening extension and training systems, improving access to finance, and investing in rural infrastructure. Additionally, promoting collective action and value chain integration improves market access and enhances income stability for farmers.

Importantly, these findings provide valuable insights for national policy formulation by highlighting the need for integrated strategies that align technical, financial, and institutional support to foster sustainable aquaculture growth. Scaling these initiatives at the national level can bolster food security, rural employment, and economic resilience. Policymakers should consider tailored regional approaches that address local challenges while leveraging successful models identified in this study.

However, the study is limited by its focus on a specific region, which restricts broader generalization. Reliance on self-reported financial data may also introduce measurement bias. Future research should incorporate multi-regional and longitudinal datasets to capture temporal and spatial dynamics more effectively. Further studies should also examine socio-environmental impacts, gender and equity dimensions, and the effectiveness of policy interventions across different contexts. Such evidence would strengthen national-level aquaculture planning and support more inclusive and resilient sector development.

Declaration

The author confirms the submission of this original work and affirms that there are no conflicts of interest.

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