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Research article

Socio-Economic and Environmental Dimensions of Crab Farming in Coastal Bangladesh: Insights from a Case Study in Khulna

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ABSTRACT

Crab farming has gained prominence as a crucial aquaculture practice in coastal Bangladesh, driven by its high export demand and income potential. This study assessed the socio-economic conditions, farming practices, and environmental impacts of crab cultivation in Batiaghata Upazila, Khulna District. Data were collected through surveys of 100 crab farmers to document their demographic profiles, farming systems, and associated challenges. Results revealed that 59% of farmers were young adults, and 96% were male, indicating a male-dominated sector. Most farmers had limited formal education, typically limited to secondary education, and practiced crab farming alongside fish culture or agriculture. The seasonal income of most respondents (68%) ranged between Tk. 70,000 and 100,000. Access to electricity (98%) and sanitary latrines (74%) reflected improved living standards; however, institutional support was scarce, with only 3% receiving training and 5% accessing loans. Crab seed supply was largely dependent on wild sources (91%), and 87% of farmers used natural feed, while average production ranged from 50-60 kg per bigha, yielding moderate profits. Major constraints included disease outbreaks, water quality issues, and flood inundation. Environmental consequences such as salinity intrusion, land-use change, biodiversity loss, and deforestation were also evident. Overall, the study highlights how crab aquaculture enhances coastal livelihoods yet introduces ecological and management challenges that require urgent attention. Strengthening hatchery-based seed production, farmer capacity-building, financial inclusion, and environmental regulation is essential to guide the sustainable development of Bangladesh's rapidly growing crab farming sector.

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Introduction

Crab is considered one of the leading aquatic species in Bangladesh, after tiger shrimp, owing to its high demand and lucrative prices in global markets (Rout & Kumar, 2023). The mud crab (*Scylla olivacea*), locally known as 'Habba Kakra,' 'Silla Kakra,' or 'Kankra,' belongs to the family Portunidae, class Crustacea, phylum Arthropoda (Islam et al., 2015). Among the marine crab species found in Bangladesh, the mud crab is the most commercially important species and is widely distributed in estuarine and mangrove ecosystems (Macintosh et al., 2002). In Bangladesh, mud crab occurs throughout the coastal belt, especially in estuaries, shrimp ghers, and the Sundarbans mangrove region (Khan & Alam, 1992). Because of its high export value and growing demand, mud crab farming has become an increasingly important livelihood activity in coastal Bangladesh (Molla et al., 2009; Salam et al., 2003; Jahan & Islam, 2016).

In the coastal regions of Bangladesh, mainly in the southwest (Bhola, Bagerhat, Barguna, Khulna, Satkhira, Patuakhali, Pirojpur) and southeast (Cox's Bazar, Chattogram, and Noakhali), aquaculture of mud crab has been practiced for many years using traditional methods such as pen and cage fattening (Kamal, 2002; Sujan et al., 2021; Rahman et al., 2020; Hasanuzzaman et al., 2021). The expansion of mud crab farming in Bangladesh has been driven by environmental stressors such as salinity intrusion and disease outbreaks in shrimp aquaculture, which have encouraged farmers to shift toward more resilient and profitable crab-based livelihoods (Karim & Stellwagen, 1998; Rahman et al., 2020). Currently, crab farming is becoming increasingly popular across the greater Khulna, Barishal, Noakhali, and Chattogram regions, contributing to food security and income diversification (Chakraborty et al., 2018). Approximately 70% of mud crab production originates from Khulna, with

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the remainder from Barishal, Chattogram, and Noakhali, primarily for export (Istiak, 2018; Bhuiyan et al., 2021). More recent value chain analyses confirm that mud crab fisheries support a large employment network involving fishers, traders, transporters, and exporters, with an estimated several hundred thousand people directly or indirectly dependent on the sector for their livelihoods (Islam et al., 2015; Bhuiyan et al., 2021; Sujan et al., 2021).

Batiaghata Upazila in Khulna District is among the foremost crab-producing regions of Bangladesh. Farmers in this region predominantly practice extensive and semi-intensive crab farming in *ghers* (enclosed water areas) and ponds, using wild-caught crab seeds mainly sourced from the Sundarbans (Hasanuzzaman et al., 2022). These farming systems are often integrated with fish culture or crop cultivation, helping households diversify income sources and improve food security. However, rapid expansion of crab farming has also created several challenges, including limited technical knowledge, disease outbreaks, poor water management, and environmental degradation. Unplanned expansion may increase soil and water salinity, cause land-use change, reduce vegetation cover, and threaten biodiversity. Although several studies have examined crab farming in coastal Bangladesh (Islam et al., 2015; Khan & Alam, 1992; Rahman et al., 2015; Molla et al., 2009; Jahan & Islam, 2016; Kar et al., 2016; Salam et al., 2003; Rahman et al., 2020; Kibria et al., 2022), research specifically focusing on the socio-economic conditions, farming practices, and environmental impacts in Batiaghata Upazila remains limited. This local-level evidence is essential for designing appropriate policies and management strategies for sustainable aquaculture development in the region. Therefore, this study aims to assess the socio-economic profile of crab farmers, document farming and management practices, identify key constraints, and evaluate the environmental impacts of crab farming in Batiaghata, Khulna. The findings of this study are expected to support policymakers, extension agencies, and researchers in promoting sustainable and environmentally responsible crab farming in coastal Bangladesh.

Materials and Methods

Study area

The study was carried out in Batiaghata Upazila under Khulna District, Bangladesh, one of the key coastal areas known for aquaculture and mud crab farming. Data were collected from five villages across the Upazila, namely Goriardanga, Roypur, and Surkhali under Surkhali Union, and Halia and Shiyaldanga under Bhanderkot Union. These villages were purposively selected because they are among the principal crab farming areas of Batiaghata Upazila, with a high concentration of active farms and households engaged in crab cultivation. They also represent variation in farming systems, resource ownership, and management practices, allowing broader representation of local production conditions. In addition, their accessibility during the survey period facilitated effective field data collection. Therefore, the selected villages were considered suitable and representative sites for assessing the socio-economic and environmental dimensions of crab farming in the Upazila. For analytical purposes, data from these sites were aggregated at the Upazila level. Geographically, Batiaghata Upazila is located between 22°34′ and 22°46′ N latitude and 89°24′ and 89°37′ E longitude (Shah Siddiq, 2023). The map of the study area showing the selected villages is presented in Figure 1. The area experiences a subtropical monsoon climate with high rainfall, warm temperatures, and seasonal flooding, which strongly influence water availability and crab farming practices. Salinity intrusion during the dry season also makes the area favorable for mud crab cultivation (Mazhar et al., 2024; Jahan, 2024).

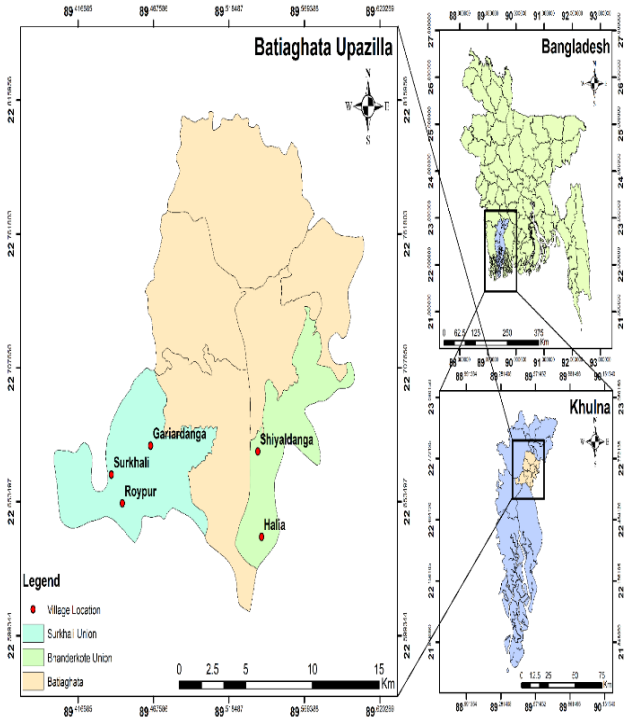

Figure 1: Study area map indicating the locations of selected villages in Batiaghata Upazila

Survey design and data collection

This study employed both qualitative and quantitative survey approaches to assess the socio-economic conditions of crab farmers and the prevailing crab cultivation practices in Batiaghata Upazila. Primary data were collected through face-to-face interviews using a structured questionnaire. The questionnaire included information on age, gender, marital status, religion, education, occupation, seasonal income, land ownership, housing condition, electricity access, sanitation, drinking water sources, farming experience, seed sources, feeding practices, pond management, production, marketing, and farming constraints. For management-related variables, pond preparation status was classified into two categories based on farmers' reported pre-stocking practices. Proper preparation referred to ponds where both liming and disinfectant treatment were applied before stocking. Partial preparation referred to ponds where only one of these measures was applied, or preparation was incomplete. In addition, ponds were categorized as perennial when water was retained year-round and seasonal when culture was limited to certain months of the year, mainly during the monsoon season. The

questionnaire was pre-tested in a nearby village and refined before final data collection.

A list of active crab farmers in the selected villages was prepared with the assistance of local community leaders, village representatives, and field observations. This list served as the study's sampling frame. From this frame, 100 crab farmers were selected using a simple random sampling technique, ensuring that each farmer had an equal probability of selection and minimizing potential sampling bias. The sample size of 100 was considered adequate for capturing variability in socio-economic and farming practices, consistent with similar studies conducted in coastal Bangladesh, and appropriate given field feasibility, time constraints, and available resources. It also provided sufficient coverage of variability across the study area. To complement the survey data, two Focus Group Discussions (FGDs) were conducted, each comprising 8 to 10 purposively selected participants. Discussions were guided by a checklist, recorded through field notes, and analyzed using thematic content analysis. Prior to the final survey, a reconnaissance visit was conducted to gain preliminary insights into local crab farming practices and identify potential challenges in data collection. Participation was voluntary, and informed consent was obtained from all respondents.

Data processing and analysis

All collected primary data from the questionnaire surveys and FGDs were carefully compiled, verified, and processed in Microsoft Excel and MS Office. Descriptive statistical techniques were applied to summarize the data, with results expressed primarily in percentages and frequency distributions. Tables and figures were prepared to present the findings clearly. Due to the aggregated nature of the dataset, the analysis was limited to descriptive statistics. However, this approach is appropriate for summarizing socio-economic patterns in the study area. Future research may employ respondent-level data to enable inferential statistical analyses such as regression and correlation to further examine variable relationships.

Results and Discussion

Socio-economic profile of crab farmers

The socio-economic profile of the respondents is presented in Table 1. Most participants (59%) were young adults aged 21-40 years, representing the economically active working-age group, while 39% were middle-aged and only 2% were above 60 years. This age structure suggests that crab farming is attracting younger individuals who are physically capable of performing labor-intensive activities and are generally more willing to adopt improved production techniques and accept market risks. In coastal areas where traditional agriculture is increasingly constrained by salinity intrusion and climate variability, crab farming may therefore serve as an alternative livelihood opportunity for rural youth. Similar age patterns have been reported among crab farmers in Satkhira and Paikgacha, where younger fishers dominate due to their adaptive capacity and entrepreneurial interest (Rahman et al., 2015; Sarker et al., 2023). However, the strong dependence on younger male labor also suggests the need for greater inclusion of women and older household members through training, value addition, and post-harvest activities. This age structure may also be associated with differences in income and productivity, as younger farmers are generally more adaptable to new farming practices compared to older age groups.

Crab farming in the study area was strongly male-dominated, with 96% male and only 4% female respondents. This is mainly because most key activities such as pond preparation, dyke maintenance, water management, harvesting, transport, and marketing require intensive physical labour and are traditionally performed by men in coastal Bangladesh. Women's participation remains limited due to structural barriers including restricted access to land and assets, lower mobility, limited financial control, and weak access to training and market networks. However, women contribute indirectly through feed preparation, grading, processing, and household financial management. Similar patterns have been reported in earlier studies by Molla et al. (2009) and Zafar and Ahsan (2006). Expanding training opportunities and microcredit support for women could help enhance inclusivity in this emerging sector.

Regarding marital status, 85% of respondents were married and 15% unmarried. The high proportion of married farmers suggests that household responsibilities may encourage participation in comparatively profitable livelihood activities, such as crab farming, to ensure income security. Regarding religion, 61% of respondents were Hindu and 39% were Muslim. This distribution primarily reflects the local demographic composition of the surveyed communities and does not appear to directly influence farming practices.

Educational attainment was relatively modest, 44% had primary education, 31% secondary, 16% higher secondary, and 9% had no formal schooling. The pattern is consistent with earlier studies in Khulna and Satkhira, where limited literacy constrained technical knowledge and adoption of improved aquaculture practices (Islam et al., 2015; Kibria et al., 2022). This finding underscores the importance of using practical, visual, and demonstration-based training materials for effective technology transfer. Lower educational attainment may also limit technical understanding of improved crab-farming practices, thereby indirectly affecting productivity and income levels.

Occupationally, 53% of respondents combined crab farming with fish culture, 36% practiced it alongside agriculture, and 11% engaged in other complementary activities. Such diversification indicates that crab farming functions as part of a mixed livelihood strategy that helps reduce dependence on a single income source. Similar observations were reported by Jahan & Islam (2016), who found that crab culture often supplements agricultural earnings and helps households cope with climate-related uncertainties.

Seasonal income was moderate (Tk 70,000-100,000) for most respondents (68%), while 20% reported high income (>Tk 100,000) and 12% low income (Tk 40,000-70,000). This suggests that crab farming contributes substantially to household earnings, although income differences may arise from farm size, productivity, market access, and management experience. Income variation among respondents may be associated with differences in

farm size, experience level, and access to technical knowledge, although these relationships could not be statistically tested due to the dataset's descriptive nature.

Table 1: Socio-economic status of crab farmers in the study area

Parameter Types	Respondents Attributes	Category	Respondents (%)
Social Parameters	Age (Years)	Young adults (21-40)	59
		Middle-aged (41-60)	39
		Senior citizens (>60)	2
	Gender	Male	96
		Female	4
	Marital status	Married	85
		Unmarried	15
	Religion	Muslim	39
		Hindu	61
	Educational level	No schooling	9
		Primary level	44
		Secondary level	31
		Higher Secondary level	16
Economic Parameters	Occupation	Crab with fish	53
		Crab with agriculture	36
		Crab with others	11
	Seasonal income (Tk)	Low income (40,000-70,000)	12
		Moderate income (70,000-100,000)	68
		High income (>100,000)	20
	Crab farming experience (Years)	Beginner (<5)	72
		Intermediate (6-10)	21
		Experienced (11-15)	4
		Veteran (>15)	3
	House ownership	Owner	77
		Non-owner	23
	Cultivable land ownership	Owner	73
		Non-owner	27

(Source: Field Survey)

Crab farming experience was concentrated among beginners (72% with <5 years), followed by intermediate (21%, 6-10 years), with only a small fraction being experienced (4%, 11–15 years) or veteran farmers (3%, >15 years). This indicates that crab farming is a relatively recent and rapidly expanding enterprise in the study area. While this creates opportunities for income generation and sectoral growth, it may also increase production risks because inexperienced farmers often have limited knowledge regarding stocking density, feed management, water quality control, and disease prevention. Therefore, structured extension services, farmer field schools, and demonstration farms would be valuable for building technical capacity and reducing avoidable losses.

House ownership was reported by 77% of respondents, whereas 23% did not own a house, indicating

that most households have relatively stable residential conditions, while a minority remains economically vulnerable. Similarly, 73% owned cultivable land, with 27% lacking land ownership. Land ownership represents an important productive asset that may support pond development, livelihood diversification, and access to finance for farm improvement.

Access to facilities and institutional support

Access to basic facilities by the respondents is summarized in Table 2. Nearly all farmers (98%) had electricity connections, which reflects significant progress in rural electrification. Only 2% relied on solar energy, and none lacked access to electricity. Such infrastructural development has contributed to improved quality of life, as also observed in coastal Khulna by Rahman et al. (2015). Despite infrastructural advances, access to training and financial support remained critically low; only 3% of respondents had received formal training, and 5% had taken loans. This scarcity of institutional support mirrors national trends, in which crab farming often develops informally without government or NGO technical assistance (Rahman et al., 2020). The absence of formal training not only limits productivity but also increases vulnerability to disease and environmental stress.

Healthcare access was satisfactory, with 98% depending on allopathic treatment and only 2% preferring homeopathy. Sanitation conditions were also good, 74% of farmers used sanitary latrines, while 26% used pit latrines. Improved sanitation, compared with older studies (Molla et al., 2009), suggests better living standards and greater awareness. Regarding drinking water, 67% of households used deep tube wells and 33% used shallow tube wells, reflecting an increasing preference for safer water sources. These socio-economic conditions have important implications for sustainable crab farming. Despite improved basic infrastructure, limited access to training and institutional credit remains a key constraint for enhancing productivity and income stability in crab farming. Without adequate credit and technical support, farmers may struggle to improve farm management and disease control. Therefore, future policies should prioritize farmer training, access to credit, and local aquaculture extension services.

Crab cultivation practices

Seed collection and feeding management

Crab seed collection remained largely dependent on wild sources, accounting for 91% among this 54% from the Sundarbans, 37% from other natural water bodies, and only 9% from hatcheries (Figure 2). This overreliance on wild juveniles is consistent with findings from Molla et al. (2009) and Sarker et al. (2023), who highlighted ecological risks such as overharvesting and biodiversity loss. The low use of hatchery-produced seed may be attributed to limited hatchery infrastructure, higher production costs, lack of technical capacity, and insufficient policy and institutional support in the region. Developing hatchery-based seed supply systems is therefore critical for sustainability (Karim & Stellwagen, 1998; Kibria et al., 2022). Feeding practices were also largely traditional, around 87% of farmers used natural feed such as fish scraps or mollusks, while 13% used prepared or commercial feed. Although natural feed was cost-effective, inconsistent nutrient content can affect growth performance. Similar feeding trends were reported in Khulna and Noakhali (Chakraborty et al., 2018).

Table 2: Facilities utilized by crab farmers in the study area

Existing Facilities	Statement	Respondents (%)
Electricity facility	Access to electricity	98
	Reliant on solar system	2
	No access to electricity	0
Training facility	Received formal training	3
	Didn't receive training	97
Treatment facility	Access to Allopathic care	98
	Use of Homeopathic Treatment	2
	Dependency on traditional (Kabiraji) care	0
Drinking water facility	Sourced from a deep tube well	67
	Sourced from a shallow tube well	33
Loan facility	Obtain from the Bank or NGOs	5
	No loan taken	95
Sanitation facility	Use of sanitary latrines	74
	Use of pit latrines	26

(Source: Field Survey)

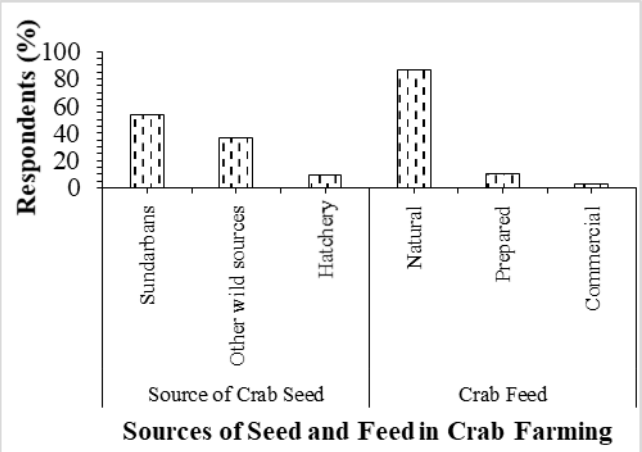

Figure 2: Sources of seed and feed used in crab farming

Pond characteristics and management practices

Most ponds (79%) were perennial, and 21% seasonal (Figure 3). Seasonal ponds were primarily used during the monsoon months, while perennial ponds enabled year-round culture and higher yields. About 62% of farmers owned their ponds, 26% leased them, and 12% practiced joint ownership. Ownership status directly influenced long-term investment and management decisions, similar to patterns reported by Dhillon & Moncur (2023) in small-scale aquaculture systems. Pond preparation is a crucial determinant of productivity.

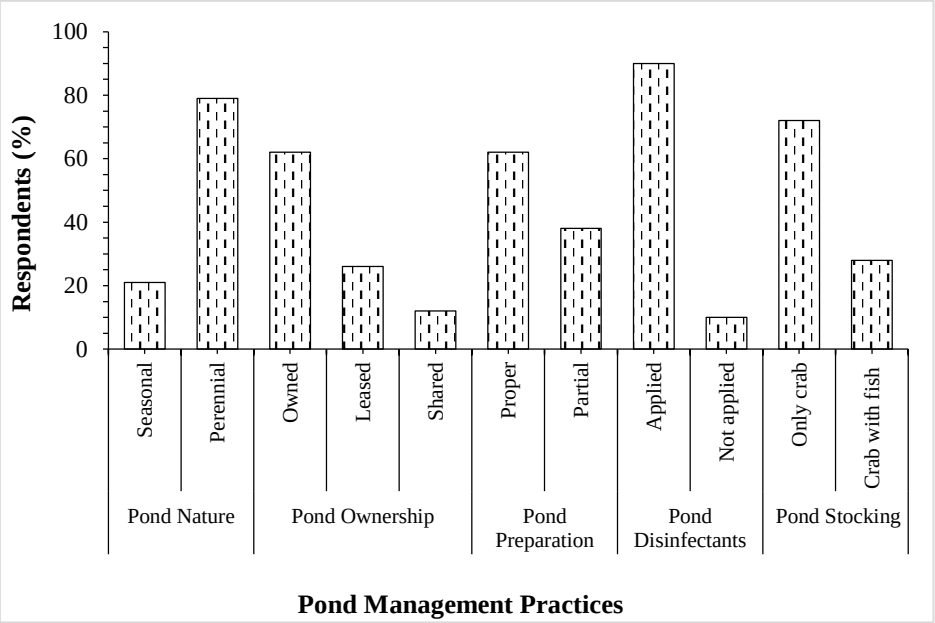

Figure 3: Pond characteristics and management practices of crab farmers in the study area

In this study, based on predefined criteria, 62% of farmers carried out proper pond preparation (i.e., applying the full set of recommended pre-stocking measures, such as liming and disinfection), whereas 38% practiced partial preparation, following only some preparation steps. Around 90% applied bleaching powder, potash, or aquazel powder for disinfection, reflecting improved awareness of pond hygiene. However, incomplete preparation among nearly two-fifths of farmers suggests gaps in technical knowledge. Regarding culture systems, 72% of farmers practiced mono-culture of crab, while 28% adopted mixed culture with fish or shrimp. Mixed systems were mainly used to optimize pond resources and diversify income, similar to integrated approaches observed in shrimp-fish-crab systems across coastal Bangladesh (Salam et al., 2003).

Farm size and production

Crab farming in Batiaghata was predominantly small to medium-scale (Figure 4). Approximately 41% of farms covered 0.13-0.67 ha (1-5 bighas), 23% ranged from 0.80-1.34 ha (6-10 bighas), and 17% were below <0.13 ha (below 1 bigha). Only 7% of farms operated on a large scale, exceeding >2.0 ha (15 bighas). This distribution shows the dominance of smallholders, a pattern consistent with observations in Noakhali and Satkhira (Chakraborty et al., 2018). Average crab production ranged from 50-60 kg per bigha, indicating a moderate yield.

These findings suggest that policies and interventions should be designed with farm size in mind. For small-scale producers, emphasis should be placed on low-cost technologies, training opportunities, and collective marketing mechanisms, whereas medium-and large-scale farmers would benefit more from improved access to credit, infrastructure, and integration into commercial value chains (Dhillon & Moncur, 2023). Compared with previous years, production has shown a slight improvement, largely attributed to enhanced management and pond preparation practices. The majority of farmers (59%) reported earning moderate profits ranging between Tk. 20,000 and 50,000 per bigha (approximately Tk. 150,000-375,000 per hectare), reinforcing the financial viability of crab farming in the region, consistent with the findings of Rahman et al. (2020).

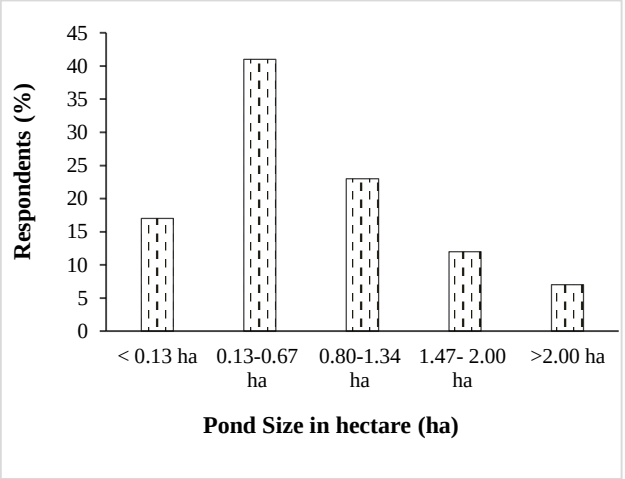

Figure 4: Size of pond area used for crab cultivation (1 bigha = 0.1338 hectare)

Crab production and marketing

Marketing of crabs encompasses all post-harvest activities, including transportation, sale, storage, and pricing. In this study, the marketing practices of crab farmers in Batiaghata are presented in detail in Table 3. About 53% of the farmers sold their crabs to depots, 36% sold them to arotdars, and the remaining 11% sold their crabs in the market. The owners of depots and arotdars typically resold the crabs to factories. This highlights the marketing channel through which crabs are sold. The survey also revealed that around 98% of crab farmers sold their crabs multiple times to factories or depots, while the remaining 2% sold all their crabs in a single transaction. This pattern aligns with the harvesting methods. Crab farmers and traders use different types of containers and vehicles for

storing, carrying, and transporting crabs (Lorenzo et al., 2020). Among the storage and carrying containers, bamboo baskets were the most commonly used around 69% because they were cheap, locally available, and suitable for short-distance handling, although they were less durable compared to plastic. Plastic crates, used by 23% of respondents, were valued for their durability and ease of handling, while gunny bags (8%) were less preferred due to poor durability and ventilation, making them less suitable for storing live crabs; similar results were stated by Bhuiyan et al. (2021) and Ferdoushi, et al., (2010). In terms of transportation, pick-up vans were the most frequently used around 40% as they balance carrying capacity, accessibility, and cost efficiency. Motor vans also play an important role, around 37%, particularly for medium to large quantities, while small trucks were used less only 15%, often due to higher costs or limited availability. Motorcycles were rarely used (5%) and were only suitable for carrying small quantities over short distances (Bhuiyan et al., 2021).

In the study year, the majority of farmers about 61% harvested between 50-60 kg of crabs per bigha, which indicates a higher overall production compared to the previous year. Last year, most of the farmers, around 65%, harvested between 40-50 kg per bigha. There was an increase in the percentage of farmers producing 50-60 kg per bigha in the study year, while fewer farmers produced 40-50 kg. This suggests an overall improvement in crab production in the study year. Regarding investment, the survey revealed that in the last year, around 90% of farmers spent approximately 25,000-30,000 tk per bigha, 7% invested over 30,000 tk, and 3% spent less than 25,000 tk. The results showed that nearly all farmers were making a profit from crab farming, confirming that it was a profitable venture. Production levels (50-60 kg/bigha) and profitability (20,000-50,000 Tk per bigha for 59% of farmers) suggest that crab farming is financially viable, consistent with Rahman et al. (2020), who reported similar income ranges for crab farmers in Satkhira.

Table 3: Summary of crab production and marketing practices

Aspects	Category	Respondents (%)	Key Insights
Place of crab selling	Depot	53	Dominate the marketing system, indicating a highly centralized value chain structure
	Arotdar	36	Function as secondary intermediaries within the distribution network
	Market	11	Direct market access is limited, reflecting weak producer-level market integration
Selling frequency	Multiple sales	98	Predominance of multiple sales indicates continuous harvesting and stable cash flow generation
	Single sale	2	Bulk selling is rare, suggesting small-scale and flexible harvesting practices
Storage/ carrying containers	Plastics crate	23	Partial adoption of improved handling practices is observed
	Bamboo basket	69	Traditional storage systems remain dominant in post-harvest handling
	Gunny bags	8	Limited use reflects lower suitability for maintaining crab quality
Vehicles for transportation	Motor van	37	Widely used, reflecting semi-commercial transport operations
	Motorcycle	05	used by small-scale farmers with low production volumes
	Pick up	40	most commonly used transport mode due to cost-efficiency and capacity balance
	Small trucks	15	Limited use reflects higher operational costs and accessibility constraints
Crab production in study year (per bigha*)	30–40 kg	7	Low productivity farms indicate constrained production efficiency
	40–50 kg	29	Moderate production reflects average farm performance
	50–60 kg	61	Dominance of this category indicates generally stable and moderately efficient production systems
	>60 kg	3	High-yield production is limited, suggesting scope for technological and managerial improvement
Crab production in last year (per bigha*)	30–40 kg	18	Higher proportion of low output reflects inter-annual variability in production
	40–50 kg	65	Concentration in mid-range output indicates overall production stability
	50–60 kg	15	Limited high-performance farms suggest uneven adoption of improved practices

	>60 kg	2	Very few farms achieve high productivity, indicating structural constraints
Investment (per bigha*)	< 20,000 Tk	3	Very low investment is uncommon, reflecting limited subsistence-level farming
	25,000-30,000Tk	90	Medium investment dominates, indicating standardized input use across most farms
	> 30,000 Tk	7	Higher investment remains limited due to capital constraints
Profit (per bigha*)	<20,000 Tk	10	Low profitability exists among a small group of farmers, indicating vulnerability to cost fluctuations
	20,000- 50,000 Tk	59	Moderate profitability dominates, confirming the economic viability of crab farming
	>50,000 Tk	31	A considerable proportion achieves high profitability, reflecting efficiency and better market positioning

*1 bigha = 0.1338 hectare

Crab marketing and supply chain

Figure 5 illustrates the crab value chain from farming to consumers. This establishes a clear flow of crabs from the farms to the final processing stages, passing through depots, arotdars, or markets before reaching consumers. It begins with inputs like feed, seed crabs, labour, and equipment used in crab farming. Once crabs reach marketable size, they are harvested, often with the help of middleman collectors. Post-harvest, crabs enter various distribution channels: they may be sold directly in local markets to retailers and consumers, pass through depots or wholesalers before reaching retailers, or be processed in factories and exported to international markets. The diagram shows multiple channels, highlighting that crabs reach both local and international markets. Middlemen and depots aggregate supply, while wholesalers and retailers manage distribution. The system ensures efficient movement of crabs from production to consumption, with different actors responsible for logistics, processing, and sales (Haque et al., 2024; Zafar and Ahsan, 2006).

Constraints in crab culture

As shown in Figure 6, crab farmers faced multiple constraints, with viral diseases (96%), flooding (93%), and poor water management (91%) being the most severe. Inadequate disinfection and poor pond maintenance practices were identified as major causes of disease outbreaks. These problems are consistent with those reported in other coastal aquaculture systems (Salam et al., 2003; Rout & Kumar, 2023). The frequency of flood inundation further underscores farmers' vulnerability to climatic extremes, particularly in low-lying areas of southwest Bangladesh. Limited access to quality feed and credit also emerged as critical barriers to sustainable production. Similar constraints were highlighted by Rahman et al. (2020), who emphasized that the absence of technical guidance and financial inclusion hampers expansion and productivity in crab aquaculture.

Environmental impacts of crab culture

The expansion of crab farming has produced several environmental impacts, as illustrated in Figure 7. The most frequently reported issues included salinity intrusion (26%), land-use change (22%), vegetation decline (20%), biodiversity loss (18%), and forest degradation (14%). These findings are based on farmers' perceptions and reported experiences rather than direct field measurements.

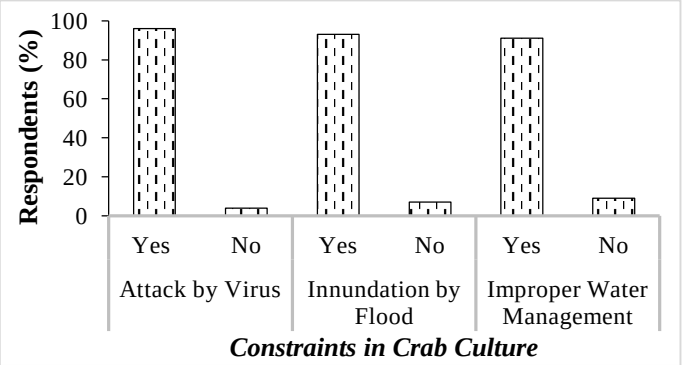

Figure 6: Major constraints reported by crab farmers in the study area

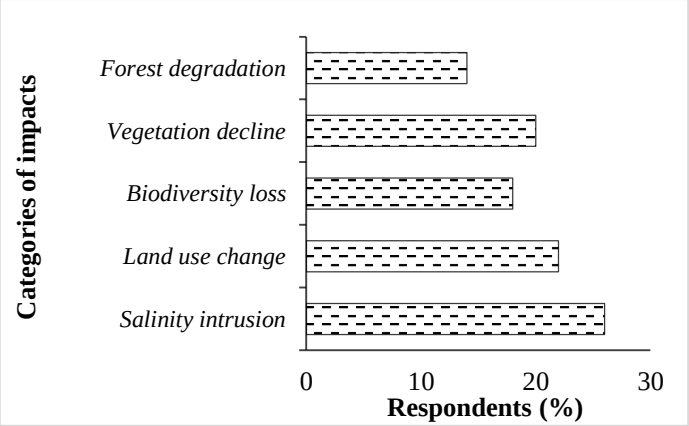

Figure 7: Environmental impacts of crab farming in the study area

These impacts reflect the ecological footprint of unplanned aquaculture expansion. Comparable findings were reported by Rahman et al. (2015) and Karim & Stellwagen (1998), who warned that uncontrolled pond construction and the use of saline water contribute to soil degradation and mangrove destruction. These environmental changes reduce crop productivity, alter soil properties, and contribute to habitat loss and ecosystem degradation. They are also closely linked to socio-economic conditions, as disease outbreaks, flooding, and poor water quality reduce production efficiency, increase costs, and lead to income

instability, thereby limiting farmers' capacity to reinvest and adopt improved practices. Thus, while crab farming has improved livelihoods and enhanced rural electrification, sanitation, and healthcare access, its environmental footprint poses serious challenges for future sustainability. From a global perspective, these findings highlight a gap between local practices and sustainable aquaculture principles, which emphasize environmental protection, biosecurity, and resource efficiency. Addressing this gap requires stronger environmental regulation, hatchery-based seed supply, and climate-resilient farming practices. Future research should include direct environmental assessments, such as soil, water, and biodiversity analysis to validate these perceived impacts.

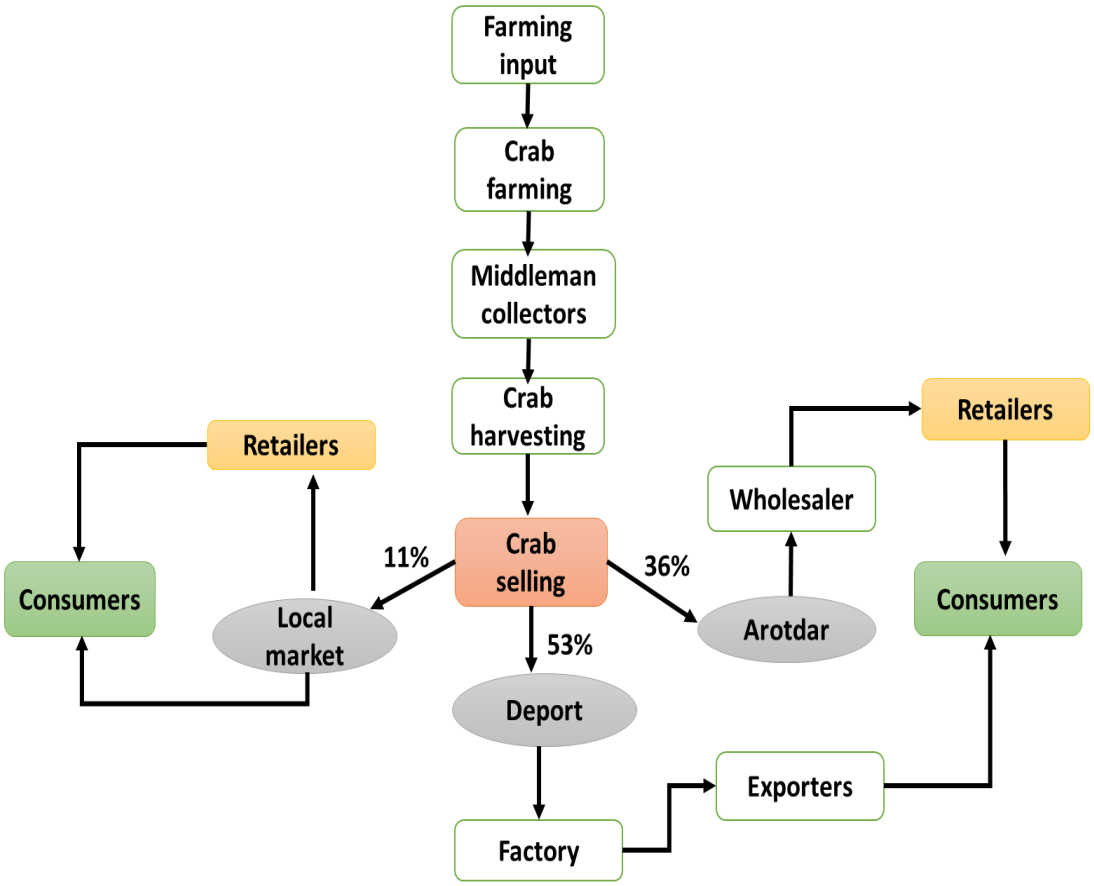

Figure 5: Marketing and supply chain of crab in the study area

Conclusion

Crab farming has become a crucial livelihood option in coastal Bangladesh, particularly in salinity-affected areas where agricultural productivity is declining. Yet, its rapid growth has generated new socio-economic and environmental challenges that demand careful evaluation. This study revealed that crab farming in Batiaghata Upazila is dominated by young and middle-aged men, reflecting gender and educational disparities in participation. Although most farmers reported moderate to high incomes and improved access to electricity, sanitation, and healthcare, institutional support remained minimal; only 3% received formal training, and 5% accessed loans. Crab seed supply was found to be overwhelmingly dependent on wild collection from the Sundarbans, while 87% of farmers relied on natural feed, reflecting an ecologically sensitive but low-input production system. Most farms were small to medium in size, with yields averaging 50-60 kg per bigha and maintaining moderate profit margins. Environmental impacts included increased salinity, land-use change, vegetation decline, and deforestation linked to unplanned pond expansion. Disease outbreaks, flooding, and poor water quality management further constrained productivity. These findings indicate that while crab farming enhances rural livelihoods, it also poses significant sustainability risks. To improve long-term sustainability, policy support is needed to expand hatchery-based seed supply, promote farmer training, improve access to credit, strengthen water management, and enforce environmental regulations. The study was limited to Batiaghata Upazila and may not represent all coastal regions of Bangladesh. Future research should cover wider areas, long-term environmental impacts, and women's participation in crab farming. To ensure sustainable development of the sector, researchers and policymakers must collaborate to balance livelihood gains with ecosystem protection, enabling crab aquaculture to remain both economically viable and environmentally responsible.

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Conflict of Interest

The authors confirm that there are no competing interests related to this study.

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