

VALUE CHAIN ASSESSMENT OF MUD CRAB IN BANGLADESH

FINAL REPORT



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Final Report

Value chain assessment of mud crab in Bangladesh

Prepared by

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Acronyms and Abbreviations

Abridged form	Elaborated form
BFD	Bangladesh Forest Department
BLC	Boat License Certificate
DoF	Department of Fisheries
EPB	Export Promotion Bureau
FGD	Focus Group Discussions
FIQC	Fish Inspection and Quality Control
KII	Key Informant Interview
KU	Khulna University
MoFL	Ministry of Fisheries and Livestock
NGF	Nowabenki Gonomukhi Foundation
PC	Plenary Consultancy
SOP	Standard Operating Procedures
SPS	Sanitary and Phytosanitary
ToR	Terms of References
VCD	Value Chain Development

Executive Summary

This report presents the findings and recommendations from an assessment of mud crab value chain in Bangladesh, conducted as part of the "Promotion of Sustainable Crab Farming in the South-West Region of Bangladesh" project, which has been funded by Feed the Future Bangladesh Aquaculture and Nutrition Activity, WorldFish, and is being implemented by Nowabenki Gonomukhi Foundation (NGF) in five coastal districts: Shyamnagar, Koyra, Bagerhat, Bhola, and Cox's Bazar. The objective of this assignment was to evaluate the current value chain of mud crab in Bangladesh, recommend actions to support it, and identify areas for intervention to increase production and export performance. The assignment was carried out for a total of 24 man-days and involved visiting five coastal districts.

Various rapid appraisal techniques were used to collect and/or verify information from different sources. Essentially, information was collected through focus group discussions, key informant interviews using checklists, consultation with hatchery managers and technicians, site observation and critical appraisal of an extensive list of secondary literatures. Information collected through these methods was validated by direct interviews involving some crab farmers.

The report provides an overview of the mud crab industry in Bangladesh, including wild harvesting and farming practices. It also discusses the value chain of mud crab production in Bangladesh and identifies key actors and processes involved in mud crab production and distribution. The report concludes with a set of recommendations for the sustainable development of the crab industry in Bangladesh.

Mud crab production in Bangladesh involves both wild harvesting and farming using various methods. In the southwest coastal districts, harvesting primarily takes place in and around the Sundarbans, while crab collectors in the southeast region focus on the estuaries of the Bay of Bengal. Based on stakeholder consultations, it was found that crab harvesting from the forest are significantly higher during the monsoon season compared to other seasons. The wild harvest includes adult, juvenile, underweight, soft-shell crabs, and mature females with empty gonads, which do not meet the export standards and are used for farming. There are three distinct practices for crab farming: fattening, grow-out and soft-shell production. Fattening is the primary practice, followed by grow-out culture and the emerging trend of soft-shell crab production.

The study reveals that one of the main challenges of the mud crab industry is the unsustainable harvesting of seed stock from the wild. The report discusses how the current level of seed stock harvesting from the wild is not sustainable and might lead to depletion of the resource, threatening the livelihoods of a large number of coastal people. Successful hatchery production at a commercial scale would reduce the pressure on wild stock and increase the availability of seed stock to serve a growing demand. This would lead to higher and uninterrupted production and improved livelihoods for those involved in the value chain, especially the producers. The report also mentions that there have been attempts to produce crablets through captive breeding in Satkhira by NGF since 2015, with gradual increase in berried production over the years. Despite promising results, efforts should be continued to increase survivability at Zoea-V stage in hatcheries so as to ensure commercial viability. Apart from lack of skilled hatchery technicians, major problems encountered by NGF staffs include sourcing of berried female crab and sea water, water quality maintenance, development of natural and artificial diets for crab seeds, prevention of fungal and protozoan pathogens and high rate of mortality during larval transformation from zoea-V to megalopa stages.

Another challenge is the lack of a structured marketing system for mud crabs, with many intermediaries making it a complex system for crab farmers to navigate. Various actors such as wild collectors, farmers, traders, processors, and exporters are involved in the crab value chain. Farias play a crucial role in the local crab value chain, while small depots collect crabs from collectors, farmers, and farias and send them to larger depots. These larger depots act as intermediaries between the local market and exporters in Dhaka. However, it's important to note that the crab value chain is not a linear process. Actors can have multiple roles within the marketing chain, and products often move laterally in both directions. Interestingly, field studies revealed that some large depot owners purchase large quantities of crabs during October and November and store them in ponds. They do this in anticipation of high market prices due to the significant demand during the New Year period in international markets.

Besides, the mud crab industry in Bangladesh faces a host of other challenges that hinder its growth and profitability including environmental issues such as ecosystem degradation, limited investment, high production costs, and lack of integration within the value chain. At a larger scale, there are challenges related to policies regarding cooperation among government agencies for crab harvesting, conservation measures, market diversification, infrastructure development, and fiscal incentives for private sector involvement. Improving mud crab hatchery

technology alone could address some of these issues and lead to resolving others. Another important challenge is the lack of reliable and consistent data on mud crab production, trade, and stock status that hinders effective planning, management, and policy making for the industry. Despite these challenges, collaboration among stakeholders and government support can create opportunities for expansion through policy measures that promote innovation, value-added processing, and provide financial and technical assistance to farmers.

The recommendations presented below are based on a comprehensive analysis of existing literatures and the findings of the current study:

- Conduct comprehensive stock assessment of mud crab using traditional catch composition studies and modern molecular biotechnology tools.
- Continue research and development efforts to refine and scale up the hatchery protocols for mud crab farming.
- Develop formulated feeds of mud crabs is essential not only for addressing biodiversity concerns but also to reduce the pressure on tilapia and other wild resources that are increasingly being used for human consumption.
- Using standardized methods and indicators, regular and comprehensive surveys of mud crab resources, both wild and cultured, should be conducted.
- Promote adoption of improved management practices and biosecurity measures among mud crab farmers to mitigate high mortality rates caused by diseases, predators, cannibalism, handling stress, and environmental changes.
- A national database and information system for mud crab industry that integrates data from various sources, such as government agencies, research institutions, private sector, and NGOs, should be established. This would enable data sharing, analysis, and dissemination among relevant stakeholders, as well as to support evidence-based decision making and policy formulation for the industry.
- Studies should be undertaken to determine the domestic consumption trend and pattern and appropriate promotion measures should be taken. Domestic market among the urbanites could act as a cushion against international market price volatility. Piloting an initiative to establish a mobile app and/or web-based e-marketing system for both domestic and international markets should be carried out.

1. Background and Rationale

1.1 Country and sector context

The coastal zone of Bangladesh is considered as one of the most productive ecosystems of the world due to regular upstream flush of nutrient-rich silts and downstream supply of organic matters from the Sundarbans. The ecosystem of the coast provides habitat and sustenance for many fish, shrimp, crab and other aquatic organisms and thus fishing and aquaculture related activities have been the major livelihoods means of the coastal community of Bangladesh since ancient times. Apart from being a major source of employment and food security, the coastal fisheries also provides substantial amount of foreign exchange mainly through exporting shrimp. However, in the backdrop of an increasing incidents of disease and other production related problems in shrimp farming, the export of mud crab has been contributing steadily and significantly in the export basket of the country.

Traditionally, crabs are consumed by tribal community and, to some extent, by a small fraction of coastal communities who are not strongly bound by custom and religion. The domestic consumption was primarily based on crabs collected as part of subsistence fishing activities by a section of coastal fishermen from tidal flats, peripheral dykes and mangrove swamps. Equally important was the fact that shrimp farmers were disturbed by crabs which damaged their embankments and preyed on the then much priced shrimp. Therefore, following final harvest and during preparing for the next cycle, local communities were allowed to collect crabs from muddy waters in shrimp farms. Entrepreneurial shrimp farmers even engaged paid laborers to gather the crabs from the farms and the peripheral dykes so as to minimize the damage caused by their burrowing behaviors¹. Such subsistence harvesting of mud crab turned into a commercial proposition in 1977 when a sustainable export market for live mud crab was found in some Southeast Asian countries². Eventually, mud crab has become the second highest export earning commodity in the fisheries sub-sector.

¹ Zafar, M. and Ahsan, M.N. (2006). Marketing and Value Chain Analysis of Mud Crab (*Scylla* sp.) in the Coastal Communities of Bangladesh, Project report, Bangladesh Fisheries Research Forum, Dhaka, 67p.

² Ahmed, M. K. (1992). Mud crab-a potential aqua-resources of Bangladesh. *In*: C.A. Angell (ed.), Report of the seminar on the Mud Crab Culture and Trade. Surat Thani, Thailand, Nov. 5-8, 1991. Bay of Bengal Programme, Brackish water culture, BOBP/REP/51, Madras, India, 95-102pp.

1.2 Study context

In response to an increasing demand and great export potential currently mud crabs are being cultured in addition to wild harvest in the coastal areas of mostly greater Khulna, Bagerhat, Satkhira and Cox's Bazar regions. The main species being harvested and cultured is *Scylla olivacea*, which has been and still continues to be wrongly referred to as *S. serrata* in various scientific and grey literatures. While harvesting of mud crab in the southwest coastal districts mainly takes place in and around the Sundarbans crab collectors in southeast regions set their trips mostly towards the estuaries of the Bay of Bengal.

Many coastal communities have become reliant on such farming, and there has been a considerable expansion in area under farming: about 10,000 ha in 10 coastal districts but mostly in greater Khulna region producing around 12,000 MT of crabs³. On the other hand, about 25,000 MT crabs are being annually collected from the Sundarbans mangrove forest as well as from estuarine canals and rivers⁴ albeit with a declining trend in recent years suggesting an exhausted natural stock in one hand while on the other hand it signifies the need for increasing production from crab farming using hatchery produced seeds to realize the full export potential of this species.

Bangladesh exported crabs worth US \$32.41 million in 2021-22, which was only US \$7.2 million in 2010-11. Not only does this crop earn valuable foreign exchange, but the sector also employs about 0.3 million throughout the value chain⁵ whose livelihoods are linked to the sector. Therefore, any disruption in the export markets of crab is bound to have severe and important implications for the poor coastal communities including women and widows, who are more visible in crab related activities for their livelihoods than in other economic activities.

Despite the high demand and export potential of mud crabs, a structured marketing system has yet to be developed. The value chain of mud crabs is composed of many intermediaries, making it a complex system for crab farmers to navigate. Value chain analysis is crucial for the mud crab industry as it would help identify the key actors

³ DoF (2018). National Fish Week 2018 Compendium (*in Bangla*), Department of Fisheries, Ministry of Fisheries and Livestock, The Government of the People's Republic of Bangladesh.

⁴ FRSS (2017). Fisheries Resource Survey System, Department of Fisheries, Ministry of Fisheries and Livestock, The Government of the People's Republic of Bangladesh.

⁵ Rahman, M. M., Islam, M. A., Haque, S. M., & Wahab, A. (2017). Mud crab aquaculture and fisheries in coastal Bangladesh. *World Aquaculture*, 48(2), 47–52.

and processes involved in mud crab production and distribution, as well as the challenges and opportunities along the value chain. The analysis can reveal bottlenecks and inefficiencies in the value chain, which can be addressed through targeted interventions such as improved access to credit and technical support for farmers and investments in infrastructure and logistics. Moreover, it can help to identify areas where value can be added to the product, such as the development of new processing technologies or marketing channels, increasing the profitability of the industry and creating new income opportunities. Finally, a value chain analysis can facilitate collaboration and coordination among actors at different stages of the value chain to share knowledge and resources, reduce costs, and increase overall efficiency.

Given the foregoing, the Nowabnki Gonomukhi Foundation (NGF) has recently initiated a project entitled “Promotion of Sustainable Crab Farming in South-West Region of Bangladesh.” Funded by Feed the Future Bangladesh Aquaculture and Nutrition Activity, WorldFish, the project is being implemented in five coastal districts of Bangladesh. Now that the project has been officially launched and mobilization of project resources have taken place, NGF assigned Plenary Consultancy (PC) with specific Terms of References (ToR) to identify key actors in the mud crab value chain, understand their roles and relationships, and identify any constraints within the value chain to transform mud crab into a sustainable export commodity. This is an output of the aforementioned work and this report describes the objectives, scope, methodology and findings of this assignment.

1.3 Structure of the report

This report is organized into seven sections. Following the general context, the second section describes the objectives, scope and limitation of the study. The third section explains the approach and methods used to generate data and information for this study. A brief analysis of current mud crab collection and farming practices together with relevant production data is provided in section four. The actors involved in the value chain of mud crab and their roles and responsibilities are described in the fifth section. The sixth section identifies the challenges and issues that are crucial for the sustainability of the mud crab sector. The final section offers a set of recommendations that are expected to have significant impacts on the sustainable development of the crab industry in Bangladesh.

2. Objectives, Scope and Limitation

2.1 Objectives

The mud crab industry in Bangladesh has great potential for growth due to increasing domestic and international demand. The industry has already seen growth and is expected to grow further provided enabling conditions exist. The overall objective of the current assignment was to provide an overview of mud crab sectors with potential areas for intervention and identify the critical drivers of change that could progressively improve the sector performance on a sustainable and equitable manner. The specific objective of this assignment was to evaluate the current value chain of mud crab in Bangladesh, recommend actions to support the value chain, and identify areas for intervention to increase the production and export performance of mud crab industry.

2.2 Scope

The scope of the current assignment, as stipulated in the ToR, was to assess existing practices, identify gaps and accordingly suggest about the capacity building needs for crab farmers, and nursery operators on better management practices; identify factors that would facilitate market linkages between farmers and market actors; and suggest measures so that farmers would have access to better quality inputs including crablets, feed and other necessary aqua inputs. In tangible terms, the scope includes reviewing relevant documents and stakeholder consultations to collect and validate necessary information which will provide an updated picture of the sector performance, identify the bottlenecks and suggest the way forward.

2.3 Limitation

The assignment was carried out for a total of 24 man-days and involved visiting the entire coastal belt covering five coastal districts in between. The timing was not ideal as it coincided with Ramadan and Edi-ul-Fitar, which made it harder to get stakeholders' participation in interviews and meetings. The limited timeframe and spatial distribution posed some challenges in relation to the sheer volume of activities required for a comprehensive study including planning, inception, field visits, stakeholder consultations, data analysis, interpretation and reporting. This could be avoided had the study been commissioned earlier so as to allow a less compressed period for consultation and more conducive environment for field activities.

3. Approach and Methodology

This report combines descriptive and analytical approaches to examine the crab sub-sector in Bangladesh, with a focus on the types and trends of farming, production and export. Various rapid appraisal techniques were used to collect and/or verify information from different sources. The report also analyzes the official statistics or their absence, and the empirical evidence on the sustainability of current practices

Pertinent information was collected, distilled and compiled from an extensive source of secondary literatures, both published and unpublished, to help set the stage for this study, which were further substantiated by field observations. Description of the study areas, evaluation issues and further methodological details are given in the following sub-sections.

3.1 Study areas

The field survey for this study was conducted in southwest coastal districts, Khulna, Bagerhat and Satkhira where most of the crab culture related activities are taking place. Data were also collected from Bhola and Cox’s Bazar districts as well.

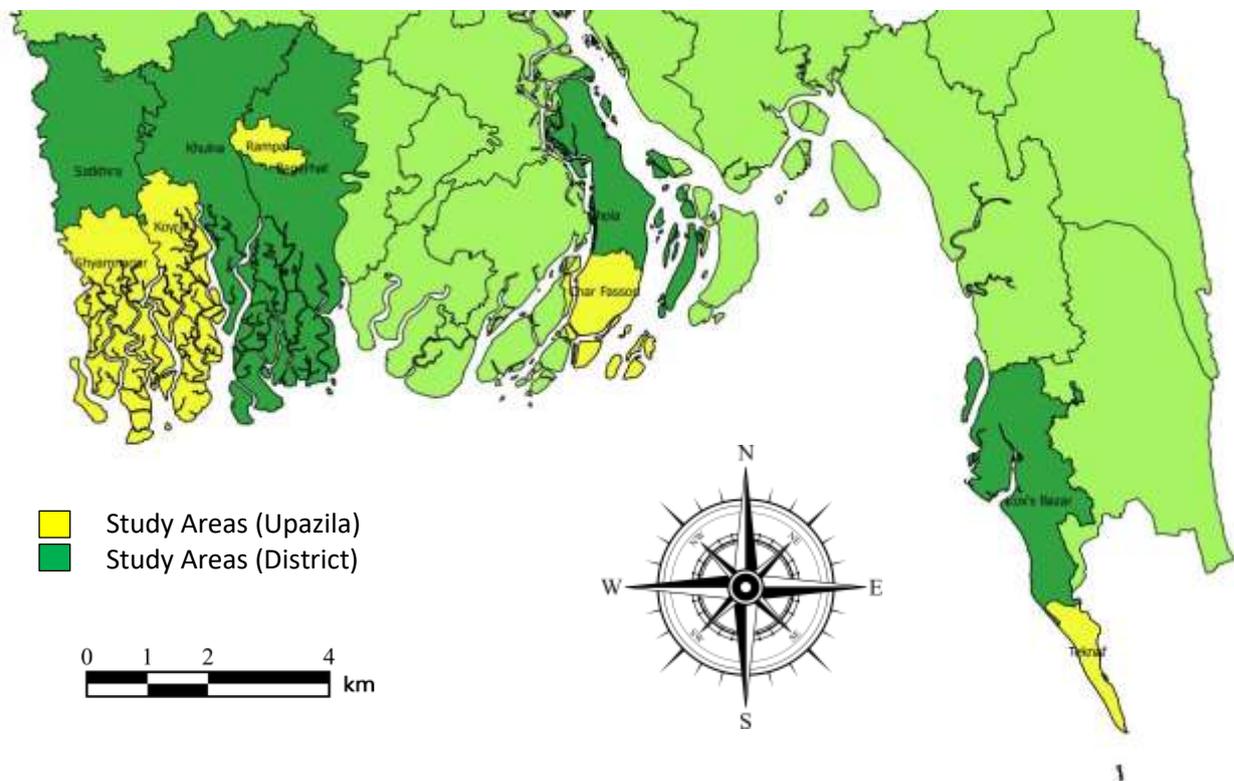


Fig. 1. Map showing the study areas

3.2 Data collection tools and methods

A variety of techniques were employed to gather necessary information to achieve the specific objectives and within the scope of this assignment. There is a growing body of literatures on the Bangladesh crab sub-sector with few studies focusing on the crab culture systems (fattening and/or grow-out) having redundant and outdated information but none on crab domestic market consumption or international export market diversification. It was therefore necessary to retrieve and analyze data from different government sources and employ a variety of PRA tools including focus group discussion (FGD), key informant interview (KII) using checklist, consultation with NGF hatchery manager and technicians, site observation, and most importantly collation, analysis and interpretation of an extensive list of secondary literatures concerning Bangladesh and other crab producing countries of the world.

Information collected through FGD and KII as well as through literature review were validated by direct interview involving some crab farmers. The number of respondents were determined arbitrarily with the assistance from NGF staff and the respondents were identified through convenient sampling method as the responses were expected to be the same irrespective of the number of respondents or the study areas. As has been mentioned under Section 2.3, due to limited timeframe which coincided with the Ramadan and Eid vacation, a comprehensive questionnaire survey involving all five study areas was beyond the scope of this study. It should rather be considered as a means for triangulation of information gathered through critical appraisal of available literatures and project reports on mud crab and through KII and FGDs involving crab farmers, traders and hatchery operators and government officials.

4. Mud Crab Industry of Bangladesh

In Bangladesh, the production of mud crabs involves wild harvesting and farming employing different methods. While harvesting of mud crab in the southwest coastal districts mainly takes place in and around the Sundarbans, crab collectors in southeast regions set their trips mostly towards the estuaries of the Bay of Bengal. It should be mentioned at the outset that irrespective of whether harvested from the wild or farmed in ponds mud crab production in Bangladesh is essentially of wild origin because the crablets or juvenile crabs for farming are also sourced from the wild except a few crablets that are being supplied from hatchery as described later.

4.1 Wild harvesting of mud crab



Mud crabs inhabit the muddy coastal areas of Bangladesh, particularly in the Sundarbans mangrove forest, where they live in burrows and are typically caught using different types of fishing gears by the coastal fisherfolks. A Boat License Certificate (BLC) is required for fishermen who want to harvest crab and

other fish in the Sundarbans. Each boat with a BLC can get 8 permits per year, with a limit of 3 permits per month. Usually, a permit allows fishing for 5–7 days. The Bangladesh Forest Department (BFD) regulates the fishing areas and the use of destructive gears within the Sundarbans. The fishermen have to get a clearance certificate from the BFD before they leave the forest when the permit time is over. The Revenue Officer from BFD checks the boat, measures the weight of the aquatic resources that were caught, and collects revenue based on the fixed rate for each type of aquatic resource as set by BFD.⁶

The boat used for crab fishing is a roofed, dinghy type of boat, 6.1 -7.6 m long and operated by two persons. During spring tide, when the catch is higher, fishermen go out on 2-3-day trips, while during neap tides they go on 5-7 days trips to catch crab. Different types of traps are used to capture crab: boom (bamboo trap), don (angling without hook), iron hook and net. The major catch occurs during the rainy season

⁶ Hossain, M and Rashid, AZMM (2022). Non-wood Forest Products of the Sundarbans, Bangladesh: The Context of Management, Conservation and Livelihood. *In* AZMM Rashid et al. (eds.), Non-Wood Forest Products of Asia, World Forests 25, https://doi.org/10.1007/978-3-030-99313-9_5

when, during each trip of 2-3 days' duration, they collect 300-400 kg/boat. But in winter the catch falls to 100 kg/boat for the same duration.

According to BFD Khulna Forest Circle data as compiled by Hossain and Rashid (2022)⁷, the annual mean harvested amount of crabs is $1,151 \pm 177$ MT while from 2001-02 to 2018-19, the crab harvest fluctuated between 71 and 2,570 MT per year, with a significant upward trend.

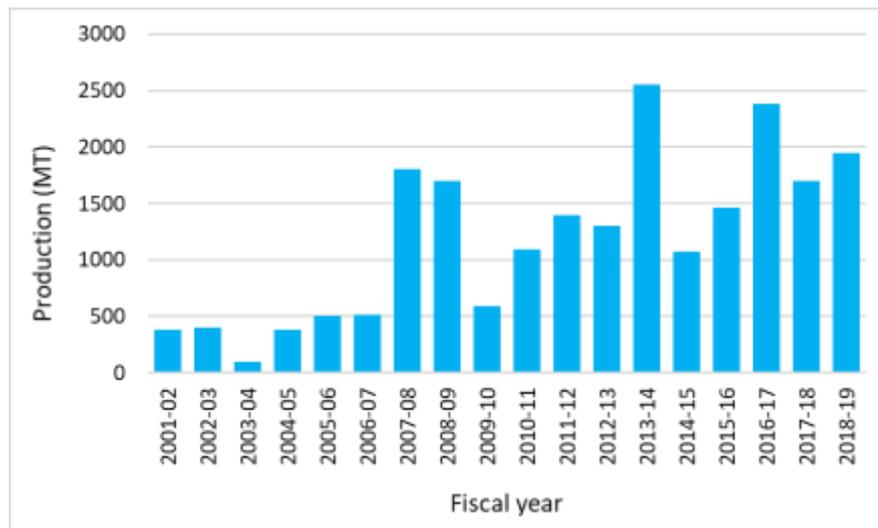


Fig. 2. Mud crab production from the Sundarbans

Stakeholders consultation in the present study revealed that mud crab landing from the forest is substantially higher during the monsoon (June-September) compared to other seasons. This is because the heavy rainfall during this season increases the freshwater inflow into the estuaries, creating an ideal environment for mud crab growth and reproduction.

4.2 Farming system of mud crab

As has been mentioned, the crab fishery in Bangladesh is almost entirely based on wild harvest from waterbodies in and around the Sundarbans in the southwest and estuarine waterbodies in the southeast. The juvenile, underweight and soft-shell crabs as well as mature females with empty gonad from wild harvest do not qualify for export and are used by the crab farmers for various types of culture depending on their size, weight and maturity of gonads.

⁷ *Ibid* 6.

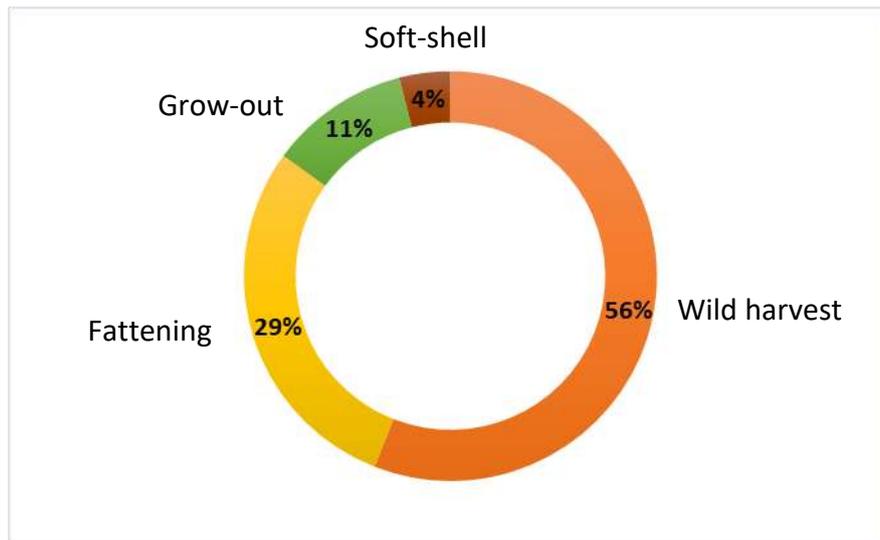


Fig. 3. Share of mud crab production from different sources

Apart from wild harvesting which comprises about 60% of the current total production, mud crab farming also contributes substantially (Fig. 3).⁸ The crab farming system involves three different practices: fattening, grow-out and soft-shell production. Fattening is the predominant practice followed by grow-out culture and the recent trend of soft-shell crab production.

4.2.1 Crab fattening

In Bangladesh, crab fattening started in the early 1990s, initially in ponds⁹ and later in bamboo cages and pens¹⁰ but is now practiced widely in ponds in the southwest coastal districts. Soft-shell male crab (also known as PD or water crab), eggless female (also known as KS or *kbosha*), and immature (non-gravid) female (also known as *hijra*) are rejected for export and thus are used for fattening for a period of 1-4 weeks depending on their size, gonadal development and molting phase. Most farmers purchase such crabs from depots, while some collect directly from the crab collectors. In most cases, crabs are stocked in ponds in polyculture with other finfish with a stocking density of 10-20,000 crabs/ha depending on the size and a male to

⁸ Rahman, M.M., Haque, S.M., Wahab, A., Egna, H. and Brown, C. (2018). Soft-Shell Crab Production in Coastal Bangladesh: Prospects, Challenges and Sustainability, *World Aquaculture*, 49: 43-47.

⁹ Kamal, D. (2003). Development of fattening technology for the mud crab (*Scylla serrata*) in small ponds with special reference to biology, nutrition, microbial quality, marketing and transportation from the southwestern region of Bangladesh. Final Report, Action for Poverty Alleviation Project. Green Trust. Dhaka, Bangladesh, 91p.

¹⁰ Khatun, M.M. (2007). Comparisons of growth and economic performance among monosex and mixed-sex culture of mud crab (*Scylla olivacea*) using locally available feeds in pens in the tidal flats of mangrove forests, Bangladesh, MS Thesis, Faculty of Aquaculture and Aquatic Resource Management, Asian Institute of Technology, Thailand.

female ratio of 1:4. Crabs grow by molting its exoskeleton. Within 1 week the shell hardens and the crabs can be graded and exported, whereas smaller crabs require 2-3 weeks to molt. Female crabs develop gonads partially or completely within 2-4 weeks.



To avoid cannibalism during molting, some farmers use various shelter materials such as PVC pipes, mangrove twigs, bamboo pieces, unused nets and coconut leaves in the pond. Mortality at stocking because of poor quality and handling of crab seeds and lack of knowledge on best management practices hampers production and income in crab farming systems. Nevertheless, the system has a demonstrated reputation to vulnerable impoverished households and small-scale farmers.

4.2.2 Crab grow-out culture

Some farmers practice grow-out by stocking small crabs weighing 1-50 g to grow to market size. Crab seeds are mostly collected by a section of coastal poor women with a push net in the marshes of the Sundarbans mangrove forest, estuaries, canals, and tidal rivers and sell to grow-out farmers. The farming can be practiced in



dedicated crab pond or in one or more isolated portion(s) of a shrimp *gher* (pond) called 'points.' The ponds or 'points' are enclosed by nylon netting with bamboo slate fence locally known as *pata* to prevent the crabs from escaping. Farmers generally provide daily feed including trash fish, small tilapia, broken appendages of shrimp, offal, eel, snails etc. at 5-10% of

the total body weight of stocked crabs. Farmers follow traditional farming practices without maintaining any specific stocking density or measures to improve growth and survival. Absence of separate nursery and grow-out ponds increases predation through cannibalism due to large size variation, resulting in lower production than dedicated fattening system as described above. On average, farmers realize 100-150 kg/acre/cycle.

4.2.3 Soft-shell crab farming



The production of soft-shell mud crabs in coastal Bangladesh is a new addition to established fattening practices for hard-shell crab production. Although soft-shell farming first started in 2011 in the southeast coastal district, Cox's Bazar this later shifted to the southwest coastal district, Satkhira¹¹. At present, there are an

estimated 42 soft-shell mud crab farms in Bangladesh, of which 39 farms are located in Satkhira covering an area of about 100 ha while only three small farms (0.7-1 ha) remain in operation in Cox's Bazar. Recently, a small soft-shell farm with processing facility was established in Koyra, Khulna.

Soft-shell crabs are produced in a series of small perforated plastic boxes floating on pond surface with the aid of PVC-pipe raft structure. Each box is stocked with a single crab weighing 50-150 g and fed with chopped meat of small but fresh tilapia. Following stocking, operators monitor crab boxes at 3-4 hr intervals to check for molting. Crabs are harvested immediately after molting and moved to clean water to remove dirt, followed by blast freezing and cold storage for shipment. About 30-45 days are required to complete each cycle, depending on the size and stage of stocked crabs, food and feeding regime and water condition. Production calculations for soft-shell crabs are complicated because harvesting and stocking are continuous operations with variable rates and somewhat unpredictable timing.

4.3 Farming area and volume

Except soft-shell farming, crab farming has increased dramatically in the coastal regions of Bangladesh as a means to improve food security and provide livelihood options for coastal people who are highly vulnerable to natural calamities, including climate change impacts. Unfortunately, however, statistics with regard to areas under crab farming and total production thereof are inconsistent and unreliable. According to Department of Fisheries (DoF), an estimated 19,408 ha area was under crab farming in 2015-16, which increased to over 27,000 ha in the next year but dramatically decreased again in the following year. However, a consistent production volume hovering around 12-13,000 MT per year was recorded during this time

¹¹ *Ibid* 6.

(Table 1)¹². These data are highly inconsistent with those from wild harvest for the corresponding year (see Fig. 2). The production data also do not match with the export data provided by Export Promotion Bureau (EPB; see below). It appears that the country lacks reliable and consistent data on crab farming, production, domestic consumption and export.

Table 1. Mud crab area and production according to DoF

Year	Area farmed (ha)	Crab production (MT)
2015-2016	19,408	13,160
2016-2017	27,010	14,421
2017-2018	9,854	11,787
2018-2019	9,377	12,084
2019-2020	9,535	12,562

4.4 Source of crablets for farming

Mud crab farming is becoming an important source of livelihood for impoverished coastal communities in southwest coastal districts of Bangladesh. It is considered an adaptive response to climate change as mud crab is less prone to disease and climate change effects. While mud crab production offers significant return on paper, the industry is yet to achieve sustainability as it relies heavily on crablets sourced from nature. Initially it was the gravid female and the adult male crabs that had export value and, therefore, fishermen used selective gears leaving at least a portion of the population to mature and take part in recruitment. Subsequently, however, forest-dependent community started indiscriminate harvesting of all types of crabs as various forms of crab aquaculture system spread in the coastal area.

As the industry develops and the production area expands (mainly through a shift from shrimp farming to crab fattening), the demand for seed stock increases. Although there are no reliable figures with regard to off take and population trends, there is serious concern that the current level of seed stock harvesting is not sustainable and might lead to a depletion of the resource. In response to recall questions during FGDs, most of the farmers expressed their concerns over

¹² DoF (2020). Annual Report 2020. Department of Fisheries, Ministry of Fisheries and Livestock, The Government of the People’s Republic of Bangladesh

availability of crabs in the wild. In fact, in a recent survey it was found that crab harvesting from the coastal waters of Bangladesh has been declined by about 20% over the four years during 2013-2016¹³. Besides unsustainable wild collection of crabs and indiscriminate destruction of other species in the process, the farming system poses many threats to the larger ecosystem of the coast.

Besides putting the integrity of the Sundarbans' eco-system and biodiversity under pressure, a crash in the wild population, from overharvesting, would also lead to a situation where the existing industry can no longer be sustained, which in turn would threaten the livelihoods of a large number of coastal people. Hatchery production of crabs is practiced successfully in a number of Asian countries but requires considerable technical skills and knowledge, which was until recently not available in Bangladesh. Successful hatchery production at a commercial scale would reduce the pressure on wild stock from the Sundarbans and increase the availability of seed stock to serve a growing demand. This would in turn lead to higher and uninterrupted production and improved livelihoods for those involved in the value chain, especially the producers.



A critical appraisal of official documents, organization reports and KII revealed that since 2015 NGF has been trying to produce crabs through captive breeding in Satkhira. Earlier attempt by Bangladesh Fisheries Research Institute, Brackish water station, Paikgacha, Khulna did not continue¹⁴. Similarly, despite initial success

crab hatchery operated by DoF in Kolatoli, Cox's Bazar also did not result in commercial production of crabs.¹⁵

After years of trial and error, NGF established a crab hatchery in Shyamnagar, Satkhira and piloted nursing of hatchery-reared seeds in earthen ponds managed by coastal crab farmers. Trial runs in NGF hatchery during 2018 to 2021 revealed gradual increase in berried production over the years, starting from 14.76% in 2018

¹³ DoF. 2018. National Fish Week 2017 Compendium (In Bangla). Department of Fisheries, Ministry of Fisheries and Livestock, Bangladesh. 160p.

¹⁴ GIZ (2017). Hatchery-based Mud Crab Production at BFRI Paikgacha Station, Bangladesh: Experiences, lessons learnt and way forward, GIZ, Dhaka.

¹⁵ DoF (2019). National Fish Week 2017 Compendium (In Bangla). Department of Fisheries, Ministry of Fisheries and Livestock, Bangladesh. 175p.

to 26.25% in 2021. The hatching performance ranged from 47.17% in 2018 to over 75% in 2021 with, however, a sudden drop in 2020 (45.98%) due to Covid-19 pandemic situation. The survivability rate of crabs from Zoea-I through megalopa to crablet stages was also increased as the hatchery operation continued suggesting an overall progress over the years (Table 2).

Table 2. Survivability (%) of crabs at different stages of NGF mud crab hatchery operation

Year	Zoea-I	Zoea-V	Megalopa	Crablet
2018	61.33%	10.31%	4.98%	1.21%
2019	65.19%	13.25%	5.11%	1.58%
2020	69.70%	17.41%	5.81%	2.88%
2021	72.16%	19.22%	6.96%	3.21%

In field trial with farmers, hatchery produced crablets stocked at a density of 1,000 per decimal earthen ponds for a total period of 12 weeks resulted in juvenile mud crabs weighing over 40 gm each with an average survivability of about 60%, which suggests that the crablets produced in hatchery are of similar quality in comparison with those found in the wild.

Despite promising results efforts should be continued to increase survivability at Zoea-V stage so as to ensure commercial viability of the hatchery. Apart from lack of skilled hatchery technicians, major challenges encountered by NGF staffs include sourcing of berried female crab and sea water, water quality maintenance, development of natural and artificial diets for crab seeds, prevention of fungal and protozoan pathogens and high rate of mortality during larval transformation from zoea-V to megalopa stages. Building on the success achieved so far, adapting international best practices into local context as well as development of local technicians through international and national expert twinning seems essential. Further recommendations with regard to the challenges of crab hatchery are provided below.

It is also worth mentioning that the NGF mud crab hatchery has a yearly output of 2 million crablets, which can hardly satisfy the current and future demand for crablets. Currently, about 10,000 ha of water bodies are used for crab farming or fattening. Assuming a mixed culture of 50 juvenile crabs and 30-40 other fish or shrimp species per hectare, at least 123 million juvenile crabs are necessary. The total

area suitable for crab cultivation in the country is 228,000 ha¹⁶. Therefore, the country needs about 2.8 billion juvenile crabs. This corresponds to 22 billion crablets from hatchery considering 8 cycles per year consisting of 30 days each for producing juvenile crabs from hatchery produced crablets. It seems highly impractical to produce such huge number of crablets but the shrimp industry also went through the same transition and currently shrimp hatchery produces over 7 billion post larvae 44 shrimp hatcheries.¹⁷ A possible solution is to develop and transfer the hatchery technology to small scale entrepreneurs who can set up hatcheries at the household level. This can help meet the existing demand and also increase the income and employment opportunities for small scale entrepreneurs.



¹⁶ Salam, M.A., Ross, L.G. and Beveridge, C.M.M. (2003). A comparison of development opportunities for crab and shrimp aquaculture in southwestern Bangladesh, using GIS modelling, *Aquaculture* 220 (2003) 477 – 494.

¹⁷ DoF (2022). National Fish Week 2022 Compendium (*in Bangla*), Department of Fisheries, Ministry of Fisheries and Livestock, The Government of the People's Republic of Bangladesh.

5. Mud Crab Value Chain

In Bangladesh, farming of mud crab has been an inevitable livelihood shift by the poor coastal community due to recurrent production loss and grave environmental and socio-economic consequences of shrimp farming that have not been internalized by the shrimp industry. Instead the negative consequences have been passed on to certain disadvantaged groups jeopardizing the already limited livelihood means of millions in an altered coastal landscape. However, as with other aquatic products the main problem of pro poor entrepreneurship development in the crab industry is that vertical integration between the wild collectors and crab farmers and the consumers in the marketing system is yet to develop. The activities of a number of intermediaries having no stakes in the production and processing of mud crabs often make such integration really difficult. In addition, coastal communities are more vulnerable to lose out in the marketing chain as they usually suffer more from lack of access to credit sources from formal financial institutes.

The nascent mud crab industry has already proven its efficacy in providing alternative income generation opportunities to many poor community members of the coastal districts. In spite of its increasing demand and great export potential proper value chain has not been developed. By conducting a value chain analysis, the industry's key actors and processes involved in mud crab production and distribution can be identified, together with the challenges and opportunities along the value chain.

5.1 Value chain actors

The value chain for mud crab production in Bangladesh can be divided into four main stages: input supply, production, processing, and marketing. Each stage involves different actors, including wild collectors, farmers, traders, processors, and exporters. The actors involved in the crab value chain have various market share and quite often, if not always, having redundant roles without adding any value in the supply chain.

A schematic diagram depicting the actors involved in the marketing channel of mud crab and the direction of product flow from each actor is shown in Fig. 4.

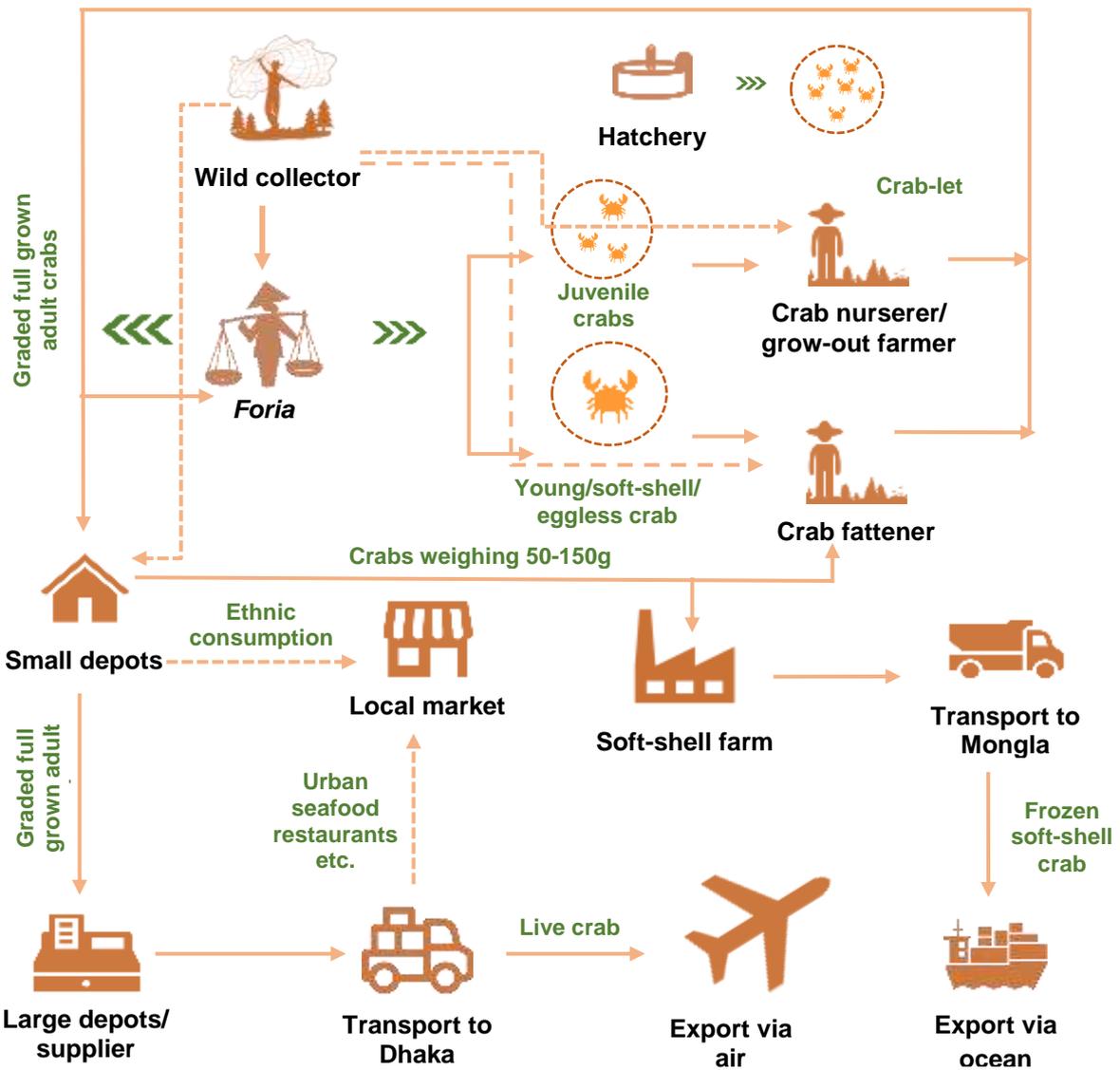


Fig. 4. Schematic diagram depicting the actors and product flow in the value chain of mud crab in Bangladesh

The value chain of the mud crab begins in the poorer households in the village. The most marginalized segment of coastal population especially landless people, widow and orphan earn their livings for several months by collecting crabs from the wild. Crab collectors comprise the first link of crab value chain who harvest crabs from coastal water bodies in and around the Sundarbans mangrove forest who, depending on the location, crab size composition and other factors, sells crabs either to *faria* or brings to specific depot. *Farias* are those who buy crab from the collectors or farmers and sell the crabs to other stakeholders downstream the supply chain. They usually collect crabs in the morning and sell in the afternoon to the depots.

Together, *farias* and small depots collect bulk of the crab products although *farias* in remote areas are more active accounting for majority of the total production. Suppliers, depots play a vital role in the value chain as they are in charge of gathering and segregating the crabs according to their grades in different baskets for forwarding to the exporters in Dhaka.

It should be mentioned, however, that the value chain of crab is not as linear as it seems. The same actor can take on different roles in the marketing chain and quite often products move laterally in both directions along the chain. For example, there are some *farias* who collect crabs from the producers in the early hours of the day while in late afternoon he operates from a small depot that he owns. On the other hand, farmers may at times collect juvenile crabs from the peripheral waterbodies of the Sundarbans in addition to buying from *farias*/depots for fattening and/or grow-out farming. Similarly, some depot owners have their own fattening/grow-out farms. Interestingly, FGDs and KII revealed that this is particularly the case for some large depot owners who buy large numbers of crabs during October and November and stock them in their ponds in anticipation of high market price due to huge demand for New Year in the international markets.

Another aspect of marketing system worth mentioning is that collectors and farmers sell their crabs to any depots they want unless they are not bound by otherwise. In general, poor and marginal crab collectors and farmers take conditional loan (known as *dadon*) from *faria* or depot for crab production or during lean season for other livelihood purposes. According to the terms and conditions of the conditional loan, crab collectors and farmers have to sell their products to the specific *faria* or depot at a price that is often less than the actual market price. Similarly, *farias* also take loan from depot owner where they sell their purchased crabs. There are some collectors and farmers who do not have any *dadon* but regularly sell to a particular *faria* or depot on account of proximity and personal relationship.

KEY VALUE CHAIN ACTORS

Farias are the most important local actors in crab value chain. They buy crabs directly from the crab collectors as soon as they return from the forest and sell them mainly to the small depots. They also buy from the crab fatteners and grow-out farmers at farmgate.

Small depots collect crabs from the collectors, farmers and farias and forward to large depot (supplier), who maintains the link between the local market and the exporter in Dhaka. Supplier depot segregates the crabs according to their grades in different baskets, pack them and send them to Dhaka to the exporters.

DADON

Ironically, while the mud crab industry is supply driven the pricing of crab is highly buyer driven where poor crab collectors and farmers have little bargaining power to influence the price at which they sell their product as they are often locked into informal loan agreements known as 'Dadon' that limit the price they receive compared with that they could freely obtain in auction market.

In general, pricing in the crab marketing system is highly buyer driven and not transparent at all. Exporters in Dhaka set the price on a daily basis based on demand from foreign buyers and then circulate the price by mobile text message to suppliers and depot holders. Later, farmers and collectors are informed of the price through text messages or direct communications. Besides price exploitive behaviors of these market intermediaries, the survivability of live crab also stands to decrease as the number of intermediaries increases. Intermediaries may provide essential services in remote settings but in many cases their redundant roles cause improper post-harvest handling, delayed transportation and stress of live crabs during

transportation to Dhaka that ultimately results in death of live crabs before and during shipment to overseas market.

The domestic market of mud crab in Bangladesh has been traditionally confined to some ethnic and minor Hindu communities in the coastal districts. Interestingly, however, a paradigm shift in demand for mud crab consumption in Bangladesh is evident. This has been in tune with the rise of the middle and affluent class population of about 35 million¹⁸. This has contributed to greater consumption of seafood, including demand for crab-based dishes in Bangladesh. Currently, there are over 110 restaurants in Dhaka that sell crab-based dishes to both locals and expatriates¹⁹. Unfortunately, however, there is no official statistics on the volume of domestic consumption of mud crab and as yet no systematic study has been undertaken to determine, in tangible term, the current market structure and future market potential of mud crab in the domestic market. Nevertheless, this is expected to be a key driver of demand of mud crabs in Bangladesh in near future.

¹⁸ BCG (2015). Bangladesh: the surging consumer market nobody saw coming, The Boston Consulting Group, <https://www.bcg.com/publications/2015/bangladesh-the-surging-consumer-market-nobody-saw-coming>.

¹⁹ LightCastle (2019). The Curious Case of Crab Sub-sector in Bangladesh. <https://www.lightcastlebd.com/insights/2019/10/the-curious-case-of-crab-sub-sector-in-bangladesh/>

5.2 Export market of mud crab

In response to an increasing demand for high quality seafood across globe and a corresponding intensification in wild harvesting and farming in southwest coastal districts, Bangladesh has witnessed a gradual increase in the export market for crab over the last couple of years. According to EPB, Bangladesh exported crabs worth US\$ 32.41 million in the last fiscal year, which was almost double a decade ago.²⁰ As shown in Fig. 5 the overall total export value indicates a perceptible increase over the last ten years despite some noticeable fluctuations being recorded throughout the analyzed period. The highest export value of over US\$ 45 million was recorded in 2018-19, which failed to regain momentum. Apparently, the increase can be attributable to a sharp increase in revenue from frozen crab export, which continued till 2019-20 but dropped again to 2017-18 level.

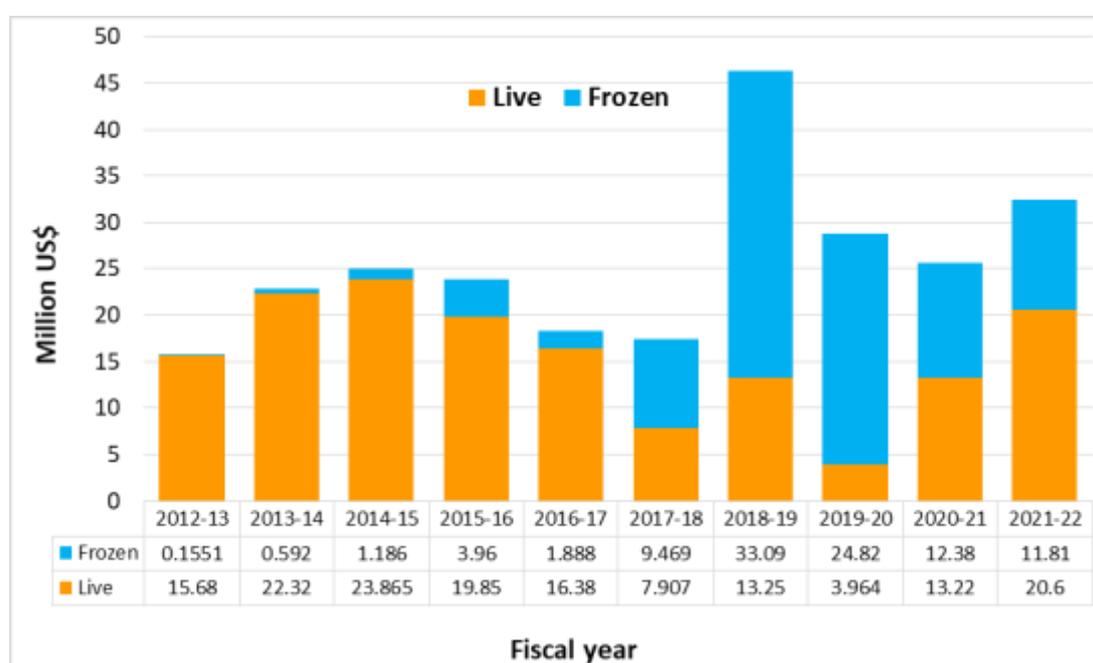


Fig. 5. Export value of mud crab over the last ten years

Analysis of the importing countries for the mud crab products from Bangladesh reveals a global distribution albeit with varying amount and type of imports. The crab export industry lies at the wild harvesting, farm production and processing end of an extended global commodity chain dominated by restaurants, supermarkets, seafood companies and buying agencies located mostly in Southeast Asian countries (70%) followed by USA, Netherlands, UK and Australia (Fig. 6).

²⁰ EPB (2022). Export Promotion Bureau, Ministry of Commerce, The Government of the People's Republic of Bangladesh.

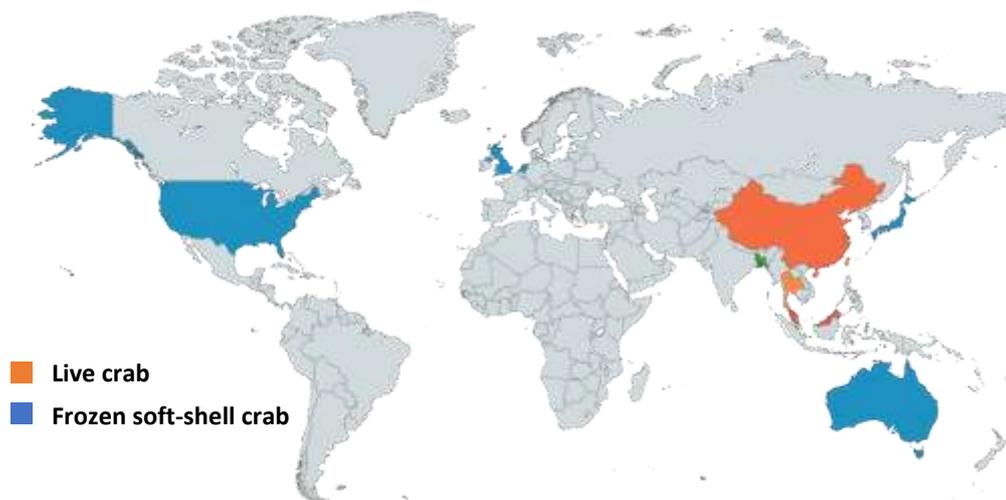


Fig. 6. Global distribution of live and frozen crabs from Bangladesh

As evident from EPB data compiled in Fig 5, the historical export values show paradigm shift from live crabs to frozen ones. Live crabs are usually exported to Asian countries because of high demand and logistical limitations. Frozen soft-shell crabs, on the other hand, are popular among western countries with USA, Netherlands and UK leading the way as major exporting destinations (Fig. 6). Interestingly, a close inspection of the importing countries in 2021-22 reveals that less than 4% of the total export values came from 10 countries and all these countries imported frozen crab products (Fig. 7). Although insignificant but this suggests that frozen soft-shell crab products have the potential to diversify the export markets to avoid over dependency on a single country like China. As has been pointed out, however, soft shell-farming requires the collection of young crabs from the wild before they have reproduced. This is resulting in severe population depletion and if major interventions are not taken, the industry will supposedly crumble in the future.

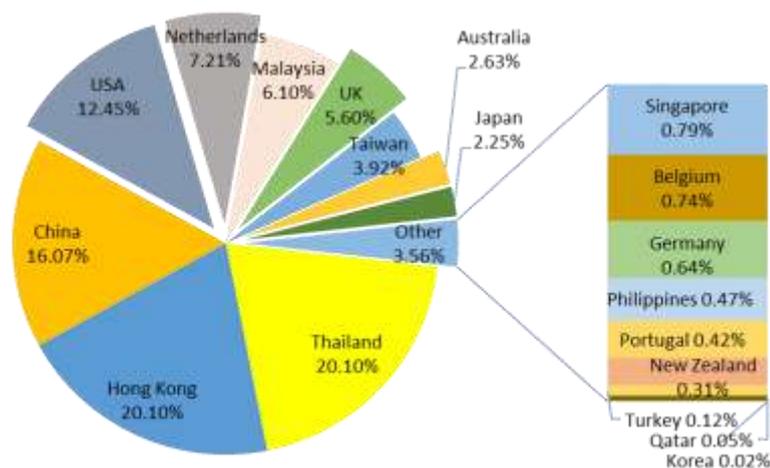


Fig. 7. Expanding niche market for frozen soft-shell crab

6. Sustainability Challenges

Despite potential growth opportunities, the mud crab industry in Bangladesh faces multiple challenges that can impede its growth and profitability. These challenges include ecosystem and biodiversity degradation, changes in salinity and temperature regime in coastal areas, lack of industry-focused investment, lack of crab hatcheries, high production costs, and lack of vertical integration in the crab value chain. At the micro level, the followings are the major challenges/ limitations associated with the main actors across the value chain as distilled from the stakeholder consultations.

Table 3. Challenges associated with actors in crab value chain

Key Actors	Challenges
Wild collectors	<ul style="list-style-type: none"> - Sundarbans BLC and permit issues are not transparent - Risks to assets and lives due to wild lives and piracy - Lack of customized weather forecasting and shelter during extreme weather conditions - High maintenance costs for crafts and gears - Lack of bargain power over price due to conditional loan - Lack of social safety net during ban period/ lean season
Farmers	<ul style="list-style-type: none"> - Lack of mud crab hatcheries and dependence on wild stocks for seed supply - High costs for fencing, net, cage etc. - Lack of cost-effective alternative to live feed - Crop failure due to disease and water quality fluctuations - Lack of bargain power over price due to conditional loan - Lack of social safety net during ban period/lean season
<i>Farias</i>	<ul style="list-style-type: none"> - Limited access to credit - Poor market intelligence - Lack of knowledge on live crab handling
Depots	<ul style="list-style-type: none"> - Limited access to credit - Inadequate and substandard storage facilities - Lack of knowledge on live transportation - High transportation costs
Exporters	<ul style="list-style-type: none"> - High freight charge - Lack of market intelligence - Evolving compliance issues from the importing countries - Limited access to credit

The mud crab industry also faces a number of challenges at the macro and meso levels including policies related to cooperation and coordination among different government agencies regarding crab harvesting from the Sundarbans, conservation measures, export market diversification, infrastructure development, fiscal incentives for private sector engagement in crab hatchery operation and artificial crab feed business. However, optimization and expansion of mud crab hatchery technology appears to be the single most challenge at hand that would immediately mitigate some of these challenges while creating an impulse to address other issues by the relevant actors. For example, there is an unmet demand for frozen soft-shell crabs, which does not suffer from logistic limitation, ensures diversification of export market, fetches premium prices in the international market and is amenable for value added processing. However, it is highly unsustainable as the lack of mud crab hatcheries and dependence on wild stocks for seed supply poses serious threat to the natural population and biodiversity of the mangrove ecosystem.

Expansion of commercial crab hatcheries would not only safeguard the ecosystem and biodiversity of the Sundarbans but would also conserve overall fisheries biodiversity of the productive coast. Besides, it will create an opportunity to develop artificial crab feed as wild crablets do not grow well without fresh meat like tilapia, eel, snail meat etc. Development of artificial feed for mud crabs is becoming increasingly important as, besides biodiversity concern, use of tilapia as live feed come under pressure for use as food for human consumption. Critical appraisal of scientific literatures suggests that formulated feeds for mud crab may be advantages over live feeds in terms of price, storage and water quality management. Considering the availability of well-established aquafeed companies in Bangladesh with their excellent marketing network and farmer base, development and marketing of an artificial feed for mud crab should not be an issue once hatchery technology spreads.

Another important challenge is the lack of reliable and consistent data on mud crab production, trade, and stock status. This data gap hinders effective planning, management, and policy making for the industry. Despite the challenges and issues summarized above, the mud crab industry in Bangladesh presents various possibilities for expansion and progress that require cooperation among the various stakeholders in the value chain, as well as support from the government. For instance, the government can promote technological innovation and value-added processing through its policies while facilitating access to credit and technical assistance can encourage farmers to invest in and expand their production. To this end, relevant research and policy issues are recommended in the following section.

7. Conclusion and Recommendations

The mud crab industry in Bangladesh has emerged as a potential alternative livelihood option for vulnerable coastal communities, as well as a lucrative export earner for the country. Since fishing and aquaculture related activities remain the only economic activities in altered coastal landscape due to past anthropological and recent climate-induced changes, addressing the challenges of mud crab industry with appropriate technology and policy supports is fundamental to ensuring sustainable livelihoods of the community as well as the management and conservation of the Sundarbans and the larger coastal ecosystem that the forest is part of. While many coastal communities have become reliant on crab farming, it has yet to realize the sub-sector's full potential. The farming operation can spread over to ten times than the area currently being used. Nevertheless, crab production can be doubled even without further horizontal expansion if supply of crablets from hatchery can be ensured while, in the meantime, adhering to best management practices in crab farming and ensuring vertical integration in the existing crab value chain. The following recommendations are a distillation of those emerging from a critical appraisal of available literatures and best practices and further refined through consultation with relevant stakeholders for this assignment.

- Apart from revenue-based fish catch data arbitrarily maintained by the BFD, no scientific study has ever been conducted to determine the population structure of mud crab or any other commercially important aquatic species for that matter in the Sundarbans. Stock assessment of mud crab through application of traditional catch composition study together with modern molecular biotechnology tools is highly imperative for science-based conservation measures including seasonal ban, gear selectivity, catch quota etc. BFD implements ban on crab fishing from the forest in January and February but recent studies from Khulna University suggest that this ban period needs to be revised^{21,22}. The current ban period coincides with the peak export season. Thus, revising the ban period would also speed up motivation of local community to adhere to the sustainable management plan.
- Propagation of crab seed under captive condition has already been made possible through pioneering efforts by NGF. For the first time in the country, farmers belonging to Shyamnagar, Satkhira area have started stocking crablets produced

²¹ Ali, M. Y., Hossain, M. B., Sana, S., Rouf, M. A., Yasmin, S. & Sarower, M. G. (2020) Identifying peak breeding season and estimating size at first maturity of mud crab (*Scylla olivacea*) from a coastal region of Bangladesh. *Heliyon*, 6(6), e04318

²² Rouf, M. A., Shahriar, S. I. M., Antu, A. H. & Siddiqui, M. N. (2021) Population parameters of the orange mud crab *Scylla olivacea* (Herbst, 1796) from the Sundarbans mangrove forest in Bangladesh. *Heliyon*, 7(2), e06223

in NGF hatchery and they are highly satisfied as the artificial seeds ensure uniform size and register good growth. The NGF hatchery initiative can be considered as a highly laudable accomplishment. Research and development efforts should be continued to optimize the hatchery protocol to scale up and scale out this novel initiative throughout the coastal area.

- Development of formulated feeds for mud crabs is likely to become increasingly important as, besides biodiversity concern, tilapia and other wild resources come under increasing pressure for use as food for human consumption. Use of such fresh feeds requires proper management to avoid deterioration of water quality. In addition, the problem of availability of fresh feeds restricts their usefulness as a regular diet. In the backdrop of current and potential future demand for crab feeds finding other sources of nutritious food items including development of a completely formulated diet using locally available ingredients are indispensable.
- Wild collectors use boat deck, bamboo box, jute bag and even polyethylene bags for transporting live crabs from the wild to the depots. Plastic carts or boxes made of Styrofoam materials with small perforations allow crabs to absorb oxygen and remain alive for longer time. Thus, knowledge and capacity development trainings on scientific collection of crab from wild sources are essential.
- The mud crab farming is prone to high mortality rate due to various factors such as diseases, predators, cannibalism, handling stress, and environmental changes. The farmers need to adopt better management practices and biosecurity measures to reduce the mortality rate and increase the survival rate. In this regard, technology and best practice demonstration on various crab culture methods and inputs and establishment of Information Centre for technology and market price dissemination should be considered.
- While anecdotal evidences suggest that there has been an annual growth in demand among the urban population of Bangladesh, crab is still not a commodity that is purchased by households. Major demand originates from restaurants that serve unique crab-based dishes. Studies should be undertaken to determine the domestic consumption trend and pattern and appropriate promotion measures should be taken. Establishment of domestic market among the urbanites could act as a cushion against international market price volatility. Piloting an initiative to establish a mobile app and/or web-based e-marketing system for both domestic and international markets should be carried out.

- Providing flexible credit to enable small farmers and depots to invest, upgrade, and adopt better management practices would alleviate *dadon* burdens and free them to seek better price in free and competitive market. PKSf should take initiative so that banks and other financial institutes provide credits to farmers and collectors through specialized agriculture financing scheme. Further, credits should be offered with technical assistance and tied to specific investment needs at depot and/or farm levels. Credit should be graduated and lending should be extended to groups if individuals do not have sufficient capital or assets for collateral.
- Lack of reliable and consistent data on mud crab production, trade, and stock status hinder effective planning, management, and policy making for the industry. Using standardized methods and indicators, regular and comprehensive surveys and assessments of mud crab resources, both wild and cultured, should be conducted. This will help to monitor the trends and impacts of mud crab harvesting and farming on the natural populations and ecosystems, as well as to evaluate the economic and social benefits of the industry.
- A national database and information system for mud crab industry that integrates data from various sources, such as government agencies, research institutions, private sector, and NGOs, should be established. This would enable data sharing, analysis, and dissemination among relevant stakeholders, as well as to support evidence-based decision making and policy formulation for the industry.
- The quality and consistency of data collection and reporting will be enhanced by strengthening the capacity and coordination of data collection and management agencies, such as BFD, DoF, EPB and BBS. Duplication and discrepancies among different data sources will also be avoided by this.
- Data collection and management should be promoted using participatory and collaborative approaches, involving local communities, farmers, traders, exporters, and other actors in the mud crab value chain. This will increase the ownership and accountability of data generation and use by them, as well as to improve the accuracy and timeliness of data reporting.

Annex I: Terms of Reference (ToR)

Terms of References (ToR) Value Chain Assessment (VCA) of Mud Crab

1. Background:

Coastal Bangladesh has the most commercially important species of mud crabs *Scylla* spp., from the family Portunidae. The 734-km long coastline of Bangladesh, with the world's largest mangrove forest, is a hotspot for diverse aquatic organisms, including mud crabs, providing suitable breeding, feeding and nursery grounds. Presently mud crab farming has emerged as an alternative livelihood, a source of income and nutrition and an innovative way of helping vulnerable littoral communities adapt to a changing climate. There are about 300,000 people directly or indirectly connected with mud crab farming activities. Over the last ten years, production from mud crab fisheries has increased gradually, mainly related to more coastal people becoming interested in crab farming. In addition, at present years crab farming transformed into a new mode of soft-shell crab farming as the global demand increasing day by day and earning of handsome foreign currency.

Since the mid-70s, the crab marketing system has developed in Bangladesh with a view to export mud crab to foreign markets. According to Export Promotion Bureau (EPB), Export of mud crab from Bangladesh started in 1977 and the first consignment was worth \$2,000 only. The export volume grew over the years and Bangladesh shipped crabs worth US\$ 42.93 million In 2018-2019. The value chain of mud crab is composed of a series of intermediaries like the crab catcher, farmer, foria, depot/ aratdar, supplier, exporter and the consumer. The presence of too many actors makes the value chain a complex system to exploit crab farmer. A well-structured marketing system for mud crab is yet to develop despite the demand and export potential is significantly higher. Regarding the aforesaid circumstance Feed the Future Bangladesh Aquaculture and Nutrition Activity supported and NGF implemented intervention "Promotion of Sustainable Crab farming in South-West Region of Bangladesh" is looking for an experienced consultant to conduct value chain assessment of mud crab.

2. Objectives of the study:

The value chain of mud crab is composed of a series of intermediaries like the crab catcher, farmer, foria, depot/ aratdar, supplier, exporter and the consumer. In southwest coastal belt of Bangladesh, 0.25-0.3 million people, mainly landless poor collectors, crop farmers, traders and suppliers are directly or indirectly dependent on the crab fishery (FRSS, 2017). The presence of too many actors makes the value chain a complex system to exploit crab farmer. A well-structured marketing system for mud crab is yet to develop despite the demand and export potential is significantly higher. So, it is essential to identify major actors of mud crab value chain, their roles and interrelationship, constrains inside the value chain in order to make mud crab a sustainable export commodity for increasing national export earnings.

Specific objective are-

- To assess the existing mud crab value chain in Bangladesh

- To provide recommendations for actions to support the value chain of mud crab, for example technical support to farmers or to mud crab buyers and exporters
- To identify the demand to increase the mud crab production in Bangladesh

3. Scope of the work:

- Assess existing practices, identify gaps and accordingly develop capacity building materials for crab farmers, and nursery operators on better management practices
- Facilitate market linkages between farmers and market actors
- Support farmers accesses to better quality inputs including crablets, feed and aqua medicinal products through promotion and marketing
- Facilitate pond demonstration on better management practices and share learnings

4. Study Area:

To get a clear picture of Mud Crab Value Chain an assessment (VCA) study will be conducted in present crab culture prospective areas namely Satkhira, Khulna, Bagerhat, Cox's bazar and Bhola district to know the existing scenario on market demand, problems and constraints of the sector, identify risks and challenges, sources of seed crab collection, cultural practices of all farming methods, profitability of all market actors, constraints and opportunities of export market. To conduct the crab value chain assessment 10 Focus Group Discussion (FGD), 15 Key Informant Interview (KII) and questionnaire survey will be executed from the crab culturing location of the mentioned five district.

5. Approach and Methodology:

Both quantitative and qualitative approach of assessment will be followed for this study. Personal Interviews of the value chain stakeholders, Focus Group Discussion (FGD) and key Informant Interviews (KII) methods consisting will be employed for collection of primary data. In addition, specific information will also be collected, distilled and compiled from an extensive source of secondary literatures, both published and unpublished, to help set the stage for this study and which will further substantiated by field observations.

6. Deliverables:

Report and documents to be delivered-

- Estimation of present demand for mud crab seed
- Assessment report on existing scenario of mud crab value chain in Bangladesh, Potential market actors and their roles and interrelationship in value chain
- Report on cultural practices of all farming methods
- Report on profitability of all market actors
- Report on mud crab value chain mapping
- Report on opportunities and challenges of mud crab value chain
- Report on constraints and opportunities of export market

7. Timeline:

The study should be completed and a draft report must be submitted by the consultant within 25 days from the date of contract signing. The final report will have to be submitted within 10 days of presentation of the draft report after incorporating clarifications and additional information in response to the comments given by NGF and WorldFish officials.

8. Selection process:

The Quality and Cost Based Selection (QCBS) method will be applicable for the selection of the consulting firm.

9. Consultant Requirements:

Local consulting firm with 10 years of demonstrated experience in conducting baseline, mid-term and impact studies of different development projects. The team of consulting firm to be involved in the study that includes i) Value Chain Specialists, ii) Fisheries and Aquaculture Specialists, iii) Statisticians, iv) Data Analyst and other required personnel with adequate academic qualification and professional background. Value Chain Specialist, Fisheries and Aquaculture Specialist, Statistician and Data Analyst should have at least master degree in Fisheries/ Aquaculture/ Agro-Economics/ Business Education/ Management/ Marketing/ Statistics and other relevant subjects. The study team members should have at least 10 years of total working experience with at least 3 years in relevant field of study.

The team leader of the study team will have overall responsibility for the quality and timely submission of the final report to NGF.

10. Financial Proposal:

The consultant is requested to propose an estimated cost outlining the details of the task. The consultant budget should cover consultancy fees, local travels, per diem, Accommodation etc. The Financial Proposal shall specify a total delivery amount (in USD/BDT) including mentioning taxes & Vat. Tax and VAT shall be deducted from the contract amount according to the Government Rules and Regulations.

11. Mode of Payment:

NGF will pay the cost of the consultant subject to the completion of all outputs and acceptance. Payments will be made based on the following-

Percentages and milestones:

- 1st Payment (30% of total contract value): The 1st payment will be made upon submission and acceptance of the inception report by NGF.
- 2nd Payment (30% of total contract value): The 2nd payment will be made upon submission and acceptance of the draft report by NGF.
- Final Payment (40% of total contract value): The final payment will be made upon acceptance of the final report by NGF.

Annex II: FGD checklist

FGD checklist

Value chain assessment of mud crab in Bangladesh

1. What is the percentage of women in your workplace?
2. Are there any full-time and paid child labourers (under 14) in your workplace?
3. Give us your opinion on the availability or demand for qualityful mud crab seed.
4. What measures are taken to identify crab diseases and reduce mortality?
5. Do you sell product individually or in group?
6. What are the comparative cost benefit analyses of crab culture single or with other two crops (shrimp, crab, fish monoculture etc.)?
7. Are there adequate safety measures in farms and also in vehicles that used for transportation?
8. Is there any ice factory near the enterprise?
9. What about the transportation system and facilities?
10. Have you communicated with any service providers (input market actors, output market actors, depots, company, exporters) in last three months? (Yes/ No) If yes, then mention about those in details.
11. Could you please share your ideas about technological intervention that we need to strengthen crab sector enterprises?
12. Could you discuss a value chain map for Crab in the project areas, including potential market actors and their roles and interrelationship in value chain?
13. What are the linkages of crab wholesale market, depot, soft shell processing outlets and crab hatchery?
14. Discussion on the positive forces that drive the actions/ behaviour of the stakeholders and stir the growth of the sector.
15. Discussion on the negative forces/ issues that limit/ hinder the growth of the stakeholders and sector.
16. Discussion on any other critical issues that need to be addressed and/ or kept in mind while implementing the project.
17. Share your thoughts on opportunities and challenges of mud crab value chain.
18. Discuss on constraints and opportunities of export market.
19. Provide recommendations for actions to support the value chain of mud crab.
20. Suggest measures so that farmers would have access to better quality inputs including crab-lets, feed and aqua medicinal products through promotion and marketing.

Annex III: KII checklist

Checklist and probe questions of KII Value chain assessment of mud crab in Bangladesh

1. What type of beneficiaries are mostly available in your area?
2. What type of culture practices are available in this area?
3. Did COVID Pandemic affect their business or crab industry?
4. Do you know about E-marketing? Is there any E-marketing established?
5. New market linkages? Or, tell us something about value chain of crab or crab related products.
6. Main key role player in the value chain of mud crab and mention the interrelationship with other actors.
7. Mention the factors that would facilitate market linkages between farmers and market actors.
8. Provide recommendations for actions to support the value chain of mud crab.
9. Any policy development on crab or crab related activities or products?
10. Any linkages with national and export market?
11. Discuss on constraints and opportunities of export market.
12. Any modern technology for farmers and collectors?
13. Consumers awareness on crab nutritional benefits, food quality, crab recipe etc. through billboard, print and electronic media advertisement?
14. Suggest measures so that farmers would have access to better quality inputs including crab-lets, feed and aqua medicinal products through promotion and marketing.

Annex IV: Survey Questionnaire

SURVEY QUESTIONNAIRE FOR CRAB FARMERS/ FATTENERS/ GROWERS (PARTICIPANTS)

Identification Number:

Survey Year:

1. General Information

1.1	Name of the crab farmer (Participant)								
1.2	Name of the father/ husband								
1.3	Address	District:				Upzilla:			
		Union:				Village:			
1.4	Religion	Muslim	Hindu	Christian	Buddha	Others			
1.5	Sex	Male		Female		1.6	Age		
1.7	Contact no.								
1.8	Mode of business	Mobile feature				Fixed place			
1.9	Ownership status of this business	Single	Joint	If joint, then no. of owner					

2. Socio-economic Condition

2.1	Profession of the household (HH)									
2.2	Educational status		Primary	Secondary	College	University	Others			
2.3	No. of household members	All eating together for last six months								
2.4	Area of dwelling house (decimal)		2.5	Status of dwelling	Own	Rented	Others			
2.6	Total area of land under your possession (decimal)		Own		Leased in/ out		Mortgage in/ out			
2.7	Total area of pond/ gher (decimal)		2.8	Pond status:	Own	Rented	Others			
2.9	Total no. of ponds									
2.10	Earning person of your family	Male		Female		Child				
2.11	Total monthly/ yearly income of your family (BDT)									
2.12	Major occupation in terms of your income		2.13	Monthly/ yearly income from major occupation						
2.14	Secondary occupation of the HH		2.15	Income from secondary occupation						
2.16	Total income from aquaculture	White fish/ Carp/ Crab/ Shrimp/ Prawn/ Cuchia/ Nursery								
2.17	Monthly expenditure for family						BDT			
2.18	Major HH assets						BDT			
2.19	HH savings	Yes	No		Amount (BDT)					

2.20	HH loans/ Have any dadon (Taka/ seeds) from market	Yes	No	Amount (BDT)	
2.21	Bank account	Yes	No	Bank name	
2.22	No. of workers for your business	Permanent staff:			Total:
		Temporary staff:			
		Full time:			Total:
		Part time:			
2.23	Net income (BDT/ Per year)				
2.24	Supply chain of this business				(Who buys from whom and sells to whom)

3. Technological Information

3.1	Type of crab production/ collection	Wild harvest	Farming		Soft shell
			Fattening	Grow-out	
3.2	Mode of crab fattening	Juvenile crabs		Khosha kakra	
		Grow-out culture		Crab fattening in cage/ plastic box	
3.3	Fattening	Starting Month		End Time	
3.4	Culture type	Monoculture	Polyculture	Species:	
3.5	Ponds for crab culture	Numbers		Area (in decimal)	
3.6	Number of cages/ Plastic box				
3.7	Expenditure of business				BDT
3.8	Gross sales	BDT			
3.9	How many cycle you culture per year				
3.10	Customers of this business	Farias	Small depots	Suppliers	Crab farmers/ Fattening
		Depots cum suppliers	Exporters	Others	Retailers/ Domestic consumption
3.11	Do you collect crabs from wild stock	Individual	In group	Mention the number of persons in your group	
3.12	Crab collection is performed	Daily basis		Weekly basis days
3.13	Average amount (Kg) of crab transected through this business				
3.14	Drainage system for ponds	Yes	No	Where do drain waste/ water go	
3.15	Type of waste produced in crab farm				
3.16	Amount of waste generated (Kg/ Day)			
3.17	Sources of crab-lets/ crab seeds	Depots	Wild crab collectors	Hatchery	Nature Own collection

3.18	Any difficulties to get crab	Yes	No	Type of difficulties						
3.19	Pre-stocking measures	Dike repairing			Liming					
		Pond drying			Fertilizing					
3.20	Post-stocking management	Water quality monitoring		Water exchange		Periodic liming and fertilization				
		Crab health check		Feeding formulated diet		Feeding fresh/ live feed				
3.21	Crab Feed	Natural Feed					Commercial Feed	Suppliers Name		
		Tilapia	Snails	Trash fish	Cuchia	Oysters		Quantity		
		Wheat	Maize	Poultry entrails	Boiled rice	Other fishes				
3.22	Feeding rate and frequency		Rate		Frequency					
3.23	Stocking ratio (%)		Male		Female		Others			
3.24	Mortality rate (%)		Male		Female		Reasons			
3.25	Adequate transport facilities nearby enterprise									
3.26	Experience in crab aquaculture/ crab related business (Months/ Years)									
3.27	Involvement of any family member/ close relative in crab business		Yes	No	Related person:					
3.28	Beneficiary of any crab culture program		Yes	No	Details:					
	Name of the Program/ Institution		Nature of Support (If Training, give subject of training)			Frequency	Training days	Kind supports		
								Tk.	Kg	No.
3.29	Farmers Knowledge Level on Crab Fattening									
Which of the following statements apply to the crab culture practice (1-5 to indicate strength of agreement: 1 = Strongly disagree, 5 = Strongly Agree, 0 = N/A)										
Statement					Score					
The kind of crab fattening/ culture practice is:					5	4	3	2	1	0
a) Is crab culture easy to learn?										
b) Is crab culture risky compare to others aquaculture?										
c) Is crab culture time consuming?										
d) Complementary to the other aquaculture practices?										
e) Is crab culture required a lot of investment?										

f) Has improved my HHs standard of living?						
g) Contributes to my children's education?						
h) Are crab seeds available in your area?						
i) Future of crab culture is promising?						

4. Challenges and Issues: Crab Collection and Marketing

4.1 Economic Analysis		
SL.	Challenges and Issues	Mitigation Measures

Interviewee Signature:

Interviewer Signature:

Date of Interview:

--- Thanks for giving us your valuable time ---

Annex V: List of FGD

List of FGDs conducted

Date	Place	Area
18.04.2023	Kolbari, 9 No. Burigoalini	Shyamnagar, Satkhira
18.04.2023	Kolbari, 9 No. Burigoalini	Shyamnagar, Satkhira
18.04.2023	Mina Bazar, Nhillia	Teknaf, Cox's bazar
18.04.2023	Noapara, Whykong	Teknaf, Cox's Bazar
19.04.2023	Katmarchar, North Bedkashi	Koyra, Khulna
19.04.2023	Katmarchar, North Bedkashi	Koyra, Khulna
20.04.2023	Srifaltala, Rampal Sadar Union Parishad (UP)	Rampal, Bagerhat
20.04.2023	Srifaltala, New Market, Rampal Sadar UP	Rampal, Bagerhat
20.04.2023	Babuganj, Char Kukri Mukri	Char Fasson, Bhola
20.04.2023	Abdullahpur, Char Kukri Mukri	Char Fasson, Bhola

Annex VI: List of KII

List of KII Consulted

Name	Designation	Address
Md. Habibur Rahman	Ex DFO and Consultant	Shyamoli, Dhaka
Dr. Md. Golam Sarower	Professor, Fisheries and Marine Resource Technology Discipline, Khulna University	Khulna University, Khulna
Dr. Md. Mojibar Rahman	Program Manager	UNDP, Khulna
Md. Zahidul Hasan	Senior Assistant Director	DFO, Bagerhat
Anisur Rahman	Hotel Owner, Kolbari, 9 No. Ward, Burigoalini	Shyamnagar, Satkhira
Muktar Rahman	Member, 9 No. Ward, Burigoalini	Shyamnagar, Satkhira
Monsur Alam	Chairman, Katmarchor Union	Koyra, Khulna
Bodruddin Sarker	Chairman, 4 No. Ward, Katmarchor	Koyra, Khulna
Aftab Uddin	Fish Businessman, 4 No. Ward, Katmarchor	Koyra, Khulna
Md. Moniruzzaman Hawlader	Crab Faria	Srifaltala, Rampal, Bagerhat
Abdul Kader Sorder	Crab Farmer	Srifaltala, Rampal, Bagerhat
Md. Sofiqul Islam	Crab Small Depot	Srifaltala, Rampal, Bagerhat
Md. Tariqul Islam	Crab Farmer and Faria	Srifaltala, Rampal, Bagerhat
Md. Shahjahan	Manager, IRAWAN Soft Shell	Cox's Bazar
Abu Naiem	Project Manager, Coast Foundation	Cox's Bazar
Sayod Alam	Crab Business, Mina Bazar, Nhilla	Teknaf, Cox's Bazar
Nurul Bashar	President, Fishermen Association and Union Jubo League, Mina Bazar, Nhilla	Teknaf, Cox's Bazar
Mozammel Haque	President, Noapara Fishermen Association, Noapara, Whykong	Teknaf, Cox's Bazar
Md. Abul Hashem	Chairman, Char Kukri Mukri	Char Fassion, Bhola