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Market Channel Analysis of Mud Crab (*Scylla Olivacea*) in the Southwest Coastal Region of Bangladesh

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ABSTRACT

The study has been conducted to identify the existing marketing channel of the mud crab (*Scylla olivacea*) business in the southwest coastal region of Bangladesh. Both qualitative and quantitative data were collected through 180 individual interviews, 15 focus group discussions, and 10 key informant interviews conducted from March to December 2022. The results revealed that around 95% of crabs were harvested from wild sources and the highest amounts of crabs are harvested in the rainy season. However, 80% of the total harvested mud crab was primarily distributed to farias, 9% to soft-shell crab farms, and 11% to the depots. Around 51% of the total harvest comes to the depots and about 60.78% of those landed crabs were sent to the exporter in Dhaka city. The marketing map divulged that soft-shell crab farms have collected 58% of the total harvested mud crab through different market actors. However, after farming only 39.5% of total harvested crabs were exported as frozen soft-shell crabs while 24% of the total harvest was exported as live crabs. Crab is a growing sub-sector in this region but the involvement of too many market actors creates a complex market system, especially for live carb. Moreover, lack of mud crab hatcheries, export regulation, and government support as well as insufficient knowledge and awareness are thwarting the sustainable improvement of this sector.

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INTRODUCTION

Salinity intrusion due to climate change into the coastal areas of Bangladesh threatening the agricultural crop production system, coastal biodiversity and livelihoods of the coastal farmers (Hoque and Hoque, 2016; Kabir et al., 2016; khanom, 2016; Alam et al., 2017). Mud crab farming gained momentum as an adaptation strategy to cope with the changing climatic condition (Rahman et al., 2017; Basu and Roy, 2018) due to its high salt tolerance, low investment and lower susceptibility to

diseases (Mahmud and Mamun, 2012; Hasanuzzaman, 2014; Istiak, 2018). In recent years, mud crab farming has emerged as a means of livelihood option and food security for the coastal community in Bangladesh who are highly vulnerable to climate change impacts (Rahman et al., 2017). Mud crab farming is now a common activity among coastal communities (Rahman et al., 2017) and is expected to rise with the growing demand worldwide (Azra and Ikhwanuddin 2016; Hungria et al., 2017). In the global market, the crab commodity is available in various forms including live, chilled, frozen, and processed (Hungria et al., 2017). Over the last five years, Bangladesh has seen a rise in live and frozen crab exports as a means to earn foreign currency (Bangladesh Bureau of Statistics, 2018; Shamsuzzaman et al., 2020). The growing demand for mud crabs in both local and international markets has led to the expansion of crab fishery in the coastal communities of the Khulna region, involving around 300,000 people directly or indirectly in the cultivation activities (Rahman et al., 2017).

In Bangladesh, the export of live crabs to international markets began in the late 1970s, specifically between 1977 and 1978 (Rahman et al., 2020). Since 1982, live crab exports have depended entirely on wild catches (Rahman et al., 2017) but coastal ponds covering 27,010 hectares are now used for crab production (Fisheries Resources Survey System, 2017). The annual harvest of live crabs is around 25,000 metric tons (FRSS, 2017), with the greater Khulna region contributing 12,000 metric tons (Department of Fisheries, 2018). Crab farming (live and soft-shell) played a significant role in the country's crab export earnings, generating approximately $42.93 million in the 2018-2019 fiscal year (BBS, 2018). Recently, Bangladesh exported 11,000 metric tons of (live and frozen) crabs to various international markets, including Malaysia, Singapore, China, Japan, Hong Kong, and South Korea (Ahamad, 2019). The top five biggest crab consumers are China, USA, Japan, Korea, and Thailand (Hossain et al., 2018). However, the overseas crab market in Bangladesh is gradually expanding. As a result, this sub-sector has become a promising and growing source of foreign currency.

The mud crab marketing channel in Bangladesh involves several intermediaries, including crab catchers, farmers, farias, depots, suppliers, exporters, and consumers. The presence of these multiple actors complicates the business and leads to the exploitation of crab farmers. Despite the high demand and export potential for mud crab, a well-established market system has not been developed in Bangladesh (Sultana et al., 2019). Recognizing the need for a sustainable market system to boost the country's export earnings, it is imperative to understand the distribution pattern of harvested mud crab, analyze the marketing channel, and identify constraints within the existing system. Research on the marketing channel of mud crab, particularly in the southwestern region of Bangladesh, is inadequate. In light of this, the current study aims to identify the existing marketing channel of the mud crab (*Scylla olivacea*) business in the southwest coastal region of Bangladesh.

MATERIALS AND METHODS

Study Area

This research was conducted from March to December, 2022 in the Southwestern part of Bangladesh. Shyamangar upazila, located between 21°36' and 22°24' north latitudes and between 89°00' and 89°19' east longitudes in the coastal district Satkhira is well-known for crab catching; crab farming, and trading. Therefore Shyamnagar upazila was identified as the study area for this research. In this region, the mud crab marketing system is divided into two categories: live crab marketing, also called hard-shell crab export as live form, and soft-shell crab marketing, which is exported as frozen form.

Sampling and Data Collection

Both quantitative and qualitative data were collected from the market actors including crab catchers, farmers, farias, depot owners, suppliers, and exporters to accumulate primary data. The random sampling method has been executed as a sampling procedure and a total of 180 people were interviewed face-to-face with structured and semi-structured questionnaires. Before finalizing, the questionnaire was pre-tested in the field and edited during preparation until we reached the final version.. Additionally, fifteen (15) focus group discussions (FGD) were organized with crab catchers, crab farmers, farias, depot owners, and buyers to gather collective opinions on the mud crab distribution pattern and marketing system in the study area. Ten (10) key informant interviews (KII) were also conducted with the researchers, Upazila Fisheries Officer, representatives of local buyers, and local NGO representatives. The activities of the market actors were observed closely to gain a comprehensive understanding of the functioning of the existing market system. Furthermore, to identify the peak crab harvesting season, the entire year is classified into three seasons i.e., summer (March - June), rainy (July - October), and winter (November - December) except the ban period (January - February). Moreover, the quantitative market share of different market actors was also estimated in this research based on the opinions of the respondents. Secondary information has also been assembled from research articles, the fisheries statistical yearbook of Bangladesh, the Export Promotion Bureau of Bangladesh (EPB), etc.

Data Processing and Analysis

The collected raw data were carefully entered into a Microsoft Excel sheet. Before the final tabulation, necessary pre-tabulation tasks were completed based on the predetermined objectives. Following data processing, the tabulated data were analyzed using Microsoft Excel, Office 2010 version. The descriptive statistical method

of analysis was applied to explain the study results using means and percentages. Additionally, some diagrams were also created to explain the results.

RESULTS

Mud Crab Harvesting

The crab catchers in this study area harvested both matured and immature crabs indiscriminately mainly from the tidal rivers of Sundarbans mangrove forests, canals, and shrimp farms. This study observed that around 95% of crabs were harvested from the mangrove forest adjacent to tidal rivers and estuaries whereas the other 5% were harvested from other sources i.e., shrimp farms, crab fattening farms, local canals, etc.

Seasonal Variation in Mud Crab Harvesting

The crab catcher responded that crabs were caught around the year except for the ban period (January-February). It was observed that crabs were harvested in this region by individual catchers and groups of 2-3 catchers. The study result revealed that the highest amount of crabs were harvested in the rainy season and the lowest amount of crabs were harvested in the winter season. The harvesting volume in a single day by the individual catchers and a group (2-3 catchers) on a single trip (3 days) are presented in Figures (1a &1b).

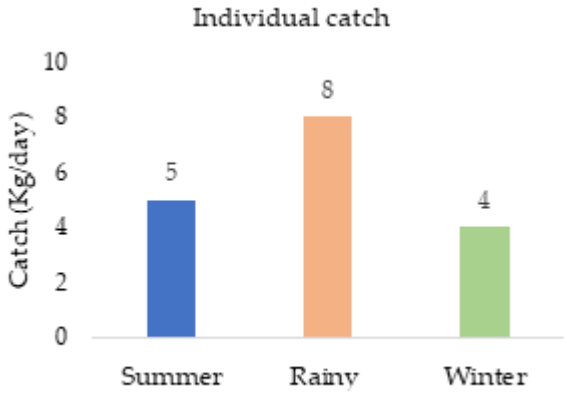

Figure 1a. Seasonal variation of crab

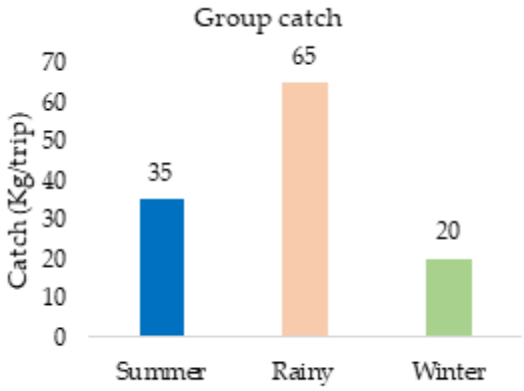

Figure 1b. Seasonal variation of crab

Primary Distribution of Mud Crab

In the study area primary distribution of harvested mud crabs starts immediately after the harvest by catchers. The harvested mud crabs were distributed to farias, depots, and soft-shell crab farms. The study revealed that 80% of harvested crabs were distributed to the farias, 9% directly to soft-shell crab farms, and 11% to the depot directly.

Existing Marketing Channel Analysis

The initial crab market starts from the local depots and the initial market analysis is done in two ways (a) supply to the depots and (b) distribution from the depots. Middlemen who are locally called faria mainly maintain the link between catchers and depots. Usually, most of the farias were from villages near the Sundarbans and they buy the harvested crabs from the catchers and sometimes from the fatteners too (Ferdoushi et al., 2010).

Supply of Mud Crab to The Market

The present study identified that the initial mud crab market was supplied mostly by catchers, Farias, and others (mud crab fattening farms, shrimp farms, local canals, etc.). Around 51% of the total harvested mud crabs landed at the depots of which 40%, 6%, and 5% were supplied by farias, catcher and shrimp farms, fattening farms, and the local canals, etc. (Figure 2).

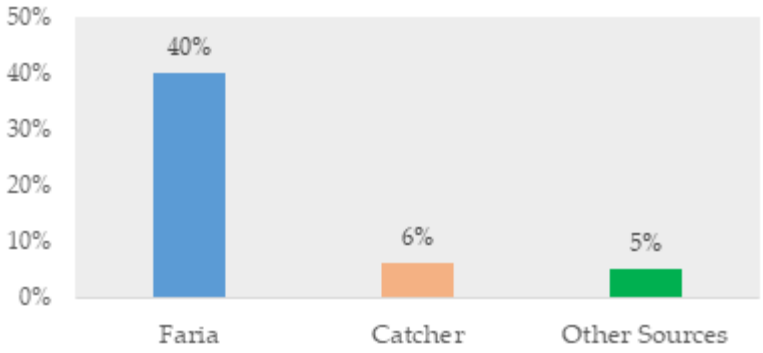

Figure 2. Supply of crab to initial market or depot

Distribution of Mud Crab From The Depot

The local mud crab depots act as the initial market. After purchasing from different actors, the depots initially made sorting, weighing, and grading and then the matured crabs were sent to the upper market. In this study, it was observed that about 60.78% of the total landed crabs of the depots were sent to the exporter in Dhaka city (Figure 3). About 2.94% of the underweight, soft, and immaturely gonad-developed crabs were sold to the crab fattening farm owners. Moreover, 3.92% of the total landed crabs became unavailable to the next value chain level due to mortality loss. About 29.41% of the sorted underweight crabs (locally called pich Kakra) were distributed to soft-shell crab farms (Figure 3). However, the damaged crabs were sorted as rejected for export and were sold to the retailer and ultimately consumed by the local people.

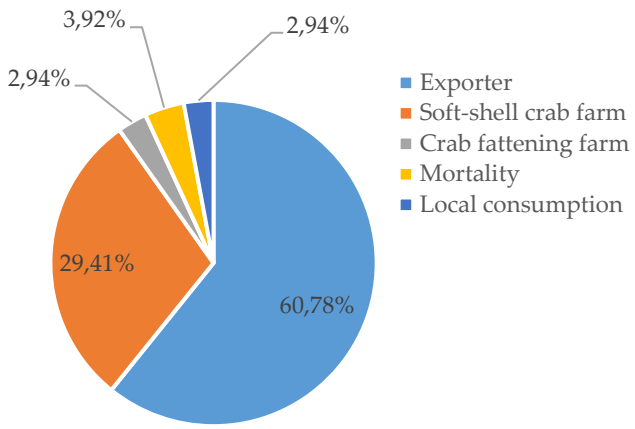

Figure 3. Distribution of mud crab from the initial market

Marketing Map

The crab catchers harvest matured crabs and immature crabs indiscriminately. It was observed from the survey that the total harvested crab was initially distributed to faria, depot, and soft-shell crab farms respectively. The farias purchased around 80% of the total harvest of which 40% was sold to depots, about 19% was supplied to the soft-shell crab farms, 16% was distributed to the supplier which ultimately reached to the soft-shell crab farms and about 2% went off to the crab fattening farm (Figure 4). Through this distribution around 4% of mud crabs become excluded from the market channel due to mortality, damage, or injury. The depots ultimately received 51% (6% directly from the catcher, 5% from the other sources, and 40% from the farias) of the total harvest. Depot were sold 31% (68.78% of depot landing) to live crab exporters at Dhaka, 15% (29.41% of depot landing) to soft-shell crab farms, 1.5% (2.94% of depot landing) to crab fatteners, 2% (3.92% of depot landing) became unavailable to the channel due to mortality and 1.5% (2.94% of depot landing) rejected mud crabs were reached to local market for local consumption. In total soft-shell crab farmers were purchased 58% of the total harvested mud crabs of which 9% cames from crab catchers, 15% from depots, 19% supplied by farias, and 15% supplied by suppliers (Figure 4). Live crab exporters rejected 2% of their purchases during sorting and grading which were sold to different local markets and restaurants of Dhaka city. However, 5% of their total collection was discarded due to mortality during transportation. Finally, 24% of the total harvested mud crab was exported to foreign countries. The soft-shell crab exporter obtained their product from the soft-shell crab farmers directly. About 98.28% of the total soft-shell mud crab production was purchased by the local buyers or exporters which accounted for 42% of the total harvested mud crabs. About 1.72% of the total produced soft-shell mud crabs were consumed locally which accounted for 1% of the total harvested mud crabs. However, the soft-shell crab exporter exported 92.43% of their total purchase to foreign buyers which was equivalent to 39.5% of the

total harvested mud crabs. The rest 7.57% (2.5% of the total harvest) of their total purchases was sold to different hotels and restaurants in the country for city consumption (Figure 4).

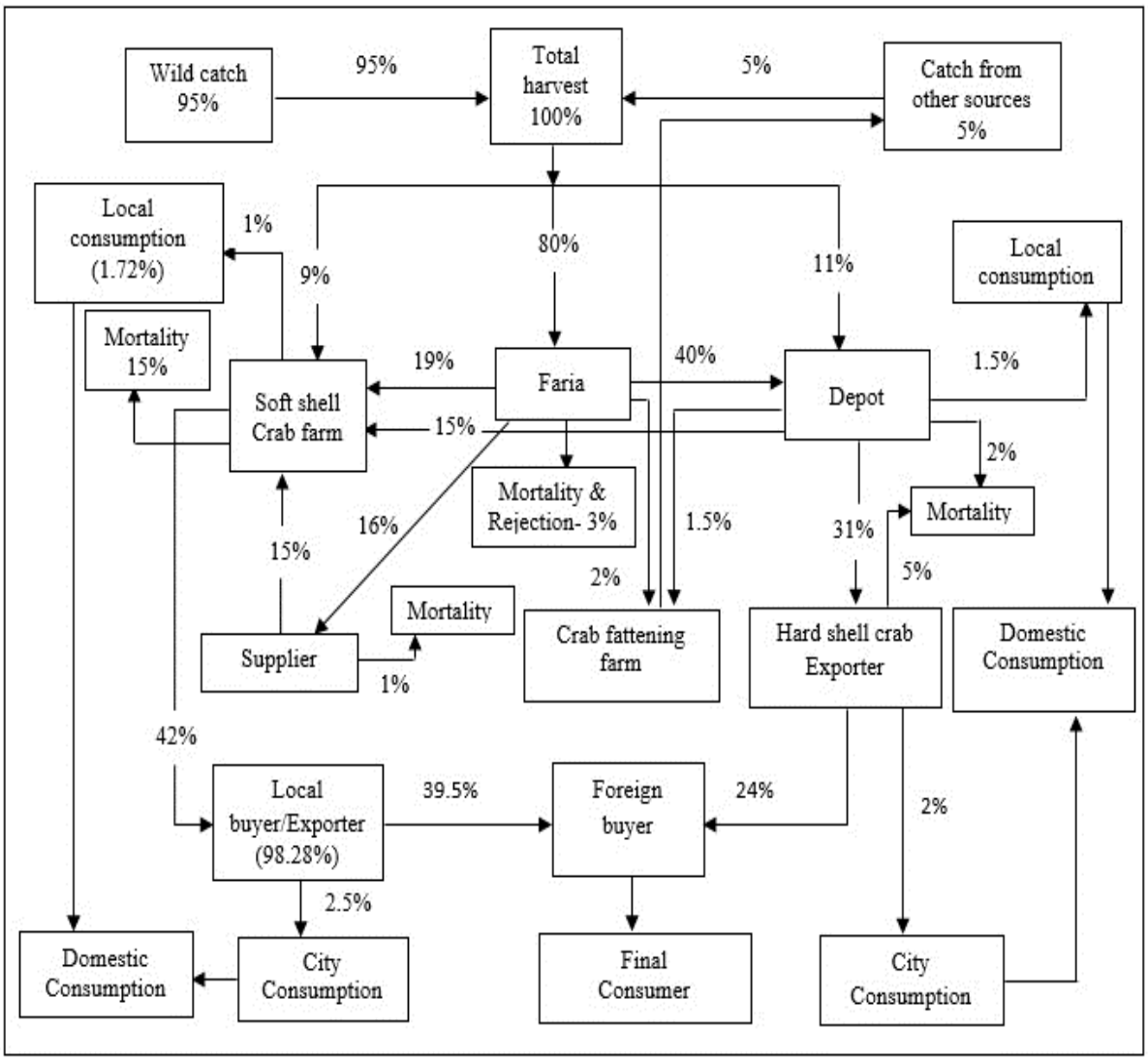

Figure 4. Marketing map of mud crab (*Scylla olivacea*) in the southwest coastal region of Bangladesh

Grading and Pricing

The study result shows that the price of live mud crab varies on different factors such as sex, grade, size, development of gonad, season, and international market demand. However, live crab traders usually exercised 5 types of grading for male crabs i.e., extra-extra-large (XXL), extra-large (XL), large (L), and small (SM), and grade fail/super small (SSM). In comparison, 6 types of grading are exercised for female crabs i.e., FF1, F1, KS1, F2, F3, and KS3 (Table 1). The study results revealed that China is the biggest importer of Bangladeshi live crab. During the New Year in China, the highest market price of live crab prevailed at 3000 Tk/Kg of FF1 grade crab in January and

February. The exporter mainly determined the market price based on the international demand and price. The respondents reported that the price of soft shell (Frozen) crab fluctuation varies from 200 to 3000 Tk/Kg depending on different factors. The soft-shell crab farmers enjoyed 6 grades offered by the local buyers depending on the weight range and hardness namely A1(40-60 gm), A2 (61-90 gm), A3 (91-140 gm), up grade (>145 gm), B (60-250 gm with a little bit hard and injured) and C (60-250 gm with more hard and injured). In July, 2022 the price of A1 grade soft-shell crab was 300Tk/Kg, whereas A2, A3, Up grade, B and C grade offered 750Tk./Kg, 850Tk./Kg, 600Tk./Kg, 308Tk./Kg and 150Tk./Kg respectively.

Table 1. Price (Depot price) of live mud crab according to grades in July/2022

Sex	Size	Weight	Claw	Shell	Depot Price (TK/Kg)
Male	XXL	>500	Full meat	Hard	950
	XL	>400	Full meat	Hard	700
	L	>300	Full meat	Hard	500
	SM	>180	Partially developed	Soft	300
	SSM	>150	Partially developed	Soft	220
Female	FF1	>200	Full gonad	Hard	1000
	F1	>180	Full gonad	Hard	700
	KS1	>180	Partial gonad	Soft	250
	F2	>150	Partial gonad	Hard	450
	F3	>120	Partial gonad	Hard	300
	KS3	>120	Immature gonad	Soft	100
Pich kakra	-	40-150	-	-	370

Export Trend of Mud Crab From Bangladesh

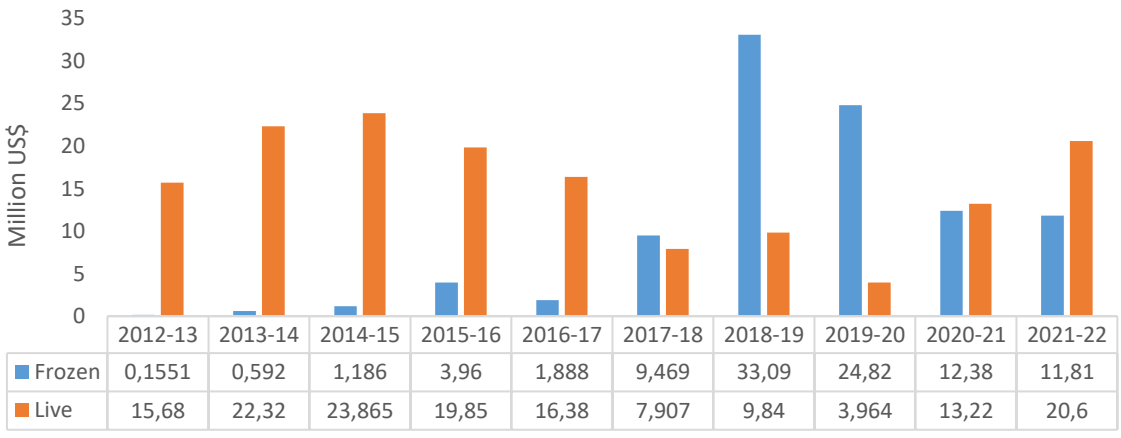

Figure 5. Export value of mud crab over the last ten years

In Bangladesh, the crab export market has been steadily growing over the past few years. Bangladesh earned US$ 32.41 million in the last fiscal year by exporting both live and frozen soft-shell crabs valued almost double a decade ago (EPB, 2022). Figure 5, specifies a noticeable increase in overall export value during the analyzed last ten years despite some perceptible fluctuations. Nonetheless, the highest-ever value of mud crab exports worth over US$ 42 was recorded in 2018–19, but the trend did not continue. It appeared that there has been a noticeable increase in soft-shell crab export revenue, which has been growing since 2017–18. Figure 6, illustrates the shift in export revenue from live crabs to frozen soft-shell crabs and gaining popularity in Western and European countries along with Asian countries.

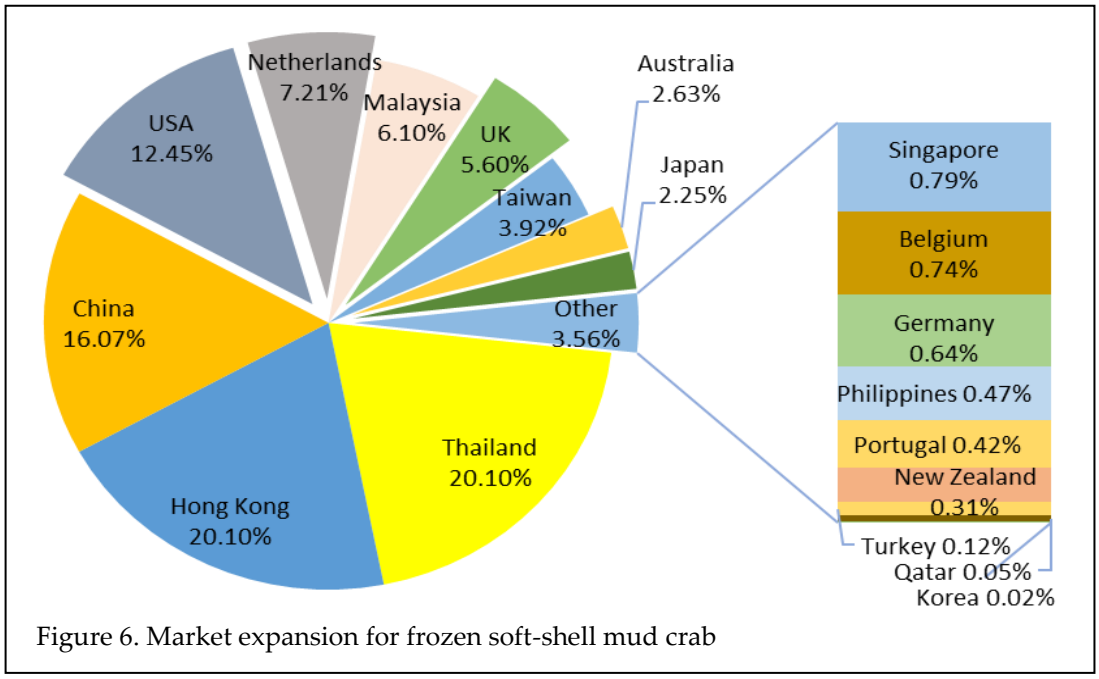

Figure 6. Market expansion for frozen soft-shell mud crab

(*Source, report on value chain assessment of mud crab in Bangladesh, NGF, 2023)*

Payment System

The payment system depends on the mutual understanding of the crab market actors. Both cash and installment payments existed. The study explored that about 55% of the catchers got payment in instant cash and the rest 45% within 2-3 days. Furthermore, the advance money which is locally called dadon that the catcher received from the farias and depot owners was adjusted from the total revenue. About 80% of the farias got payment in partial cash and some amount by installment within 5-7 days. However, 5% of the farias got payment in cash, and 15% in installments. Around 100% of the soft-shell crab farm owners purchased semi-adult live crab (pich kakra) from catchers, farias, suppliers, and depots in installments and they provide payment

within 7 days after purchase. Only 10% of the crab fatteners purchased pich kakra from depots by cash and the rest 90% of crab fatteners accounted for cash-installments transactions. In this research area, about 10% of the depots provided cash immediately after purchasing crab but 90% of them provided payment after 2-3 days of purchase. The same payment pattern for live crab was also identified at the exporter level. In the case of soft-shell crab selling the farmers got payment within 3-5 days after selling.

Mode of Transportation and Package

Live crabs can survive several days under cool and moist conditions. Therefore, they do not necessitate any sophisticated transport facilities. The crab catcher carried the harvested crab to the locality by boat from the mangrove forest. The crab catchers and farias transported the harvested live crab to depots or soft-shell crab farms by van or motorcycle, packaged in gunny bags with small pores or bamboo baskets. Following this, all the live crabs from depots were transported to Dhaka using bamboo baskets covered with gunny bags by trucks or pickup vans. The crabs were kept moist by spraying water over them to reduce mortality during each transportation. Each bamboo basket contains 55-60 kg of live crab. Transportation cost generally depends on the volume of transport baskets. The average transportation cost requires 800Tk/60kg of product volume. Various types of containers i.e., plastic baskets, styrofoam cartons, bamboo baskets, etc. are usually used in exporting live crabs. Each container weight varies from 14 to 20 Kg of crabs and is exported by Air.

The soft-shell crab farmers transport their harvested crabs by plastic trays covered with moist cotton cloth to the specified point mentioned by the local buyers. The local buyers, after weighing and grading purchased from the farmers and transported to their processing plant by freezing van. After processing and packaging, transport these to Mongla or Chittagong seaport by freezing car. Frozen soft-shell crabs were exported to foreign countries by ship.

Constraints of Mud Crab Marketing (*Scylla Spp*.)

The main issues that the market participants in the mud crab industry faced were the shortage of capital, inferior prices from farias and depots, unstable crab prices, no crab exporting regulations, and the absence of subsidies like shrimp. The main obstacles that the market participants in the mud crab industry must overcome are shown in Table 2.

Table 2. Major constraints of mud crab (*Scylla olivacea*) marketing channel

Market actors	Constraints	Response
Crab catchers	Low harvest	82%
	Increasing Govt. ban period	100%
	Lack of capital cost	55%
	Deceived in grading and pricing	65%
	Insufficient market information	53%
	Inferior price from farias and depots	93%
Hard shell Crab farmers	Shortage of capital	40%
	Deficiency in technical knowledge	45%
	Insufficient supply	64%
	Insufficient market information	35%
Soft-shell crab farmers	Insufficient seed crab supply	90%
	Lack of crab hatcheries	100%
	Natural disaster	87%
	Lack of operation cost	55%
	Low market price	70%
Farias	Unstable market price	75%
	Lack of technical knowledge	52%
	Delay payment	85%
Depot owners	Poor in quality and high rejection rate	74%
	Absence of government support	71%
	Increasing ban period	86%
	High transport cost	67%
Suppliers	lack of sufficient supply during high demand	91%
	Mortality during transportation	72%
	Increasing ban period	69%
Exporter	High transportation cost	74%
	Having no exporting regulation	100%
	Absence in subsidy like shrimp export	100%
	Complex in getting NOC	84%

DISCUSSION

Bangladesh exports both live crab and soft-shell frozen crab, therefore marketing channel becomes complicated as the market actors execute multiple marketing functions. The marketing channel of mud crab in Bangladesh is initiated by the catchers and passes through several market actors such as catchers, farias, crab fatteners, soft-shell crab farmers, suppliers, depots, and finally from the exporters to foreign countries. In this study, it was identified that about 95% of the total harvested mud crab comes from wild sources means the adjacent mangrove forest system and the other 5% of mud crab was harvested from shrimp farms, crab fattening farms, local canals, etc. Zafar and Ahsan (2006) observed the similar result and reported that 90% of the exported crab comes from natural sources while the rest comes from fattening farms. Still, crab trading is dependent on wild sources therefore crab hatchery

establishment is essential for sustainable improvement of this sector. This study also explored the seasonal variability of crab catching and found that the maximum (nearly 70%) numbers of mud crabs are harvested from July to September. Bhuiyan et al. (2021) concluded that around 90% of crabs are harvested during August, September, and October nearly similar to the present study.

Primarily 100% of the harvested wild crab landed at the depots in Mongla and Rampal upazila of Bagerhat district (Sultana et al. 2019). However, this study found that around 80% of the total harvested crab goes to the farias primarily and they control the distribution of mud crab through supply in different market actors. Zafar and Ahsan (2006) showed that 60% of the crab harvesters sold their catches to the depots, 14% to the Farias, and 26% to the local markets. Therefore, policymakers should take the necessary steps to establish a well-structured market system to reduce exploitation by a single group. It is also revealed that the existing marketing channel of mud crabs in the study area is divided into two wings such as soft-shell crab marketing and live crab marketing.

Sultana et al. (2019) reported that in the year 2017-18 Bangladesh exported live crabs worth 7.91 million ($) whereas frozen crabs accounted for 9.47 million ($). Still, no competitive soft-shell crab market exists in this region therefore the farmers have to enjoy the market price offered by the local buyers as there are no intermediaries between farmers and buyers. It is evident from the study that soft-shell crab farming is growing gradually and the crab fatteners are migrating to soft-shell crab farming but the farmers are exploited by a few local buyers as the market system is not developed yet in this region. Thus government should take action to regulate this market. Several studies reported that China is the biggest market for Bangladeshi mud crab (both live and soft-shell crab). although the Soft-shell crab market is growing in Australia, the USA, the UK, Japan, South Korea etc. Sultana et al. (2019) also identified that Bangladeshi frozen crab marketing is expanding in Australia, the USA, the UK, etc.

This study has identified the potential constraints to the sustainable mud crab industry to which the policymaker needs to pay attention. The major challenges were inadequate capital, inferior price from farias and depots, lack of mud crab hatcheries, insufficient seed crab supply, unstable market price, lack of technical knowledge, high transport cost, increasing ban period, no crab exporting regulations, absence of subsidy similar to shrimp export, dadon system, etc. Similar obstacles were noted by Sultana et al. (2019) for the mud crab value chain. Rahman et al. (2017), reported that the main obstacles to Bangladesh's mud crab industry were lack of investment, entrepreneurship, and technical knowledge gaps in hatchery technology and farming systems. Major issues faced by Bangladeshi mud crab operators include overexploitation, capital shortage, and low domestic market demand (Ferdoushi et al., 2010). The findings of the study indicate that government support and the

development of a formal crab exporting policy could be an important approach to improve crab trading as well as increase earnings of foreign currency. However, soft-shell crab farming needs a huge number of seed crabs per month and therefore catchers are over-exploiting the wild sources therefore establishment of crab hatcheries is urgent to smooth the operation of soft-shell crab farms as well as frozen crab export.

CONCLUSION

Through the market channel analysis, marketing has been depicted with the integrated responses by the market actors. Mud crab business in this region is segregated into two wings i.e., live mud crab business and soft-shell mud crab business. However, the farias play a critical role in mud crab trading in this region as they receive most of the harvested mud crab primarily and they supply those to different market actors like soft-shell mud crab farm owners, depot owners, suppliers, and crab fatteners. Soft-shell mud crab farming is a growing sector in this region creating employment for thousands of people besides hard-shell crab business. However, the mud crab business sector is hindered because of sufficient knowledge and awareness, lack of mud crab hatcheries, lack of export regulation, and government support. Therefore, multilayered support from the government, NGOs, dynamic entrepreneurs, and research organizations might be needed for the sustainable expansion of this sector.

Conflict of Interest

The authors have declared no competing interests.

Authors Contribution

All authors contributed to the study's conception and design. Material preparation, data collection, and analysis were performed by Md. MH, SNI SS, and SC. The study was supervised by Anirban Sarker. The first draft of the manuscript was written by Md. MH and all authors commented on the previous version of the manuscript. Md AB finally reviewed and edited the manuscript. All authors read and approved the manuscript.

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