Mollusc Marketing System through Value Chain Analysis with Special Emphasis on Livelihood of the Poor Fishermen

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Executive Summary

A study has been carried out to evaluate the marketing of marine mollusc in Bangladesh coast during April-December, 2005. Different Participatory Rural Appraisal (PRA) tools, namely – questionnaire interview, Focus Group Discussion (FGD), market visit and case studies have been employed in the coastal areas of Cox's Bazar, Chittagong, Khulna, Satkhira and Bagherhat. This study identified a range of mollusc species exploited at the Bangladesh coast and investigated their utilizations for edible and non edible purposes. Mollusc species of commercial importance identified are clam, green mussel, oyster, cockle, karotal, laza, kostura, kata shamuk and kori. The mollusc shells collected in the coastal areas are used in many different purposes, like, making poultry and fish feed, lime production, ornamental usage, paint making etc. People from Rakhaing and some other tribes of the coast traditionally have long been harvesting green mussel, clam and oyster for their household consumption. In addition, mollusc meat is used in the coastal shrimp and prawn hatcheries as feed for mother shrimp/prawn.

Mollusc harvesters are mainly the coastal poor community and they harvest by hand and nets from coastal channels and muddy soil. Small but long established market chains have been found in Moheshkhali, Chaufaldandi, Ramu, Borobazar and Burmese Market Para in Cox's Bazar, Patia in Chittagonj, Sarnkhola and Morelgonj in Bagerhat, Paikgachha, Chandkhali and Koira in Khulna, and Munshigonj, Shyamnagar and Kaligonj in Satkhira district. The main harvest season for mollusc is winter and early summer (November –March). The main profession of many of the Rakhaing households in Cox's Bazar and Rajbangshi of Satkhira is mollusc collection. It was found that the bulk of natural harvest of mollusc shell go to the fish and poultry feed industries, the second important market is lime preparation industry followed by ornamental and decorative usages. The shells are also found to be used for making paint. The people in Rakhaing use meat for their daily consumption as well as sell to the community. The main dishes prepared from mollusc meat are *chartni*, curry, *bhuna*, light fry and chop. The quality of meat remain acceptable to the consumers for 2 days without any freezing and preservation then started to deteriorate and could be detected by bad smell. The price fluctuates based on the supply, demand and harvesting season. The stakeholders in the mollusc market chain identified are mollusc harvesters/collectors, wholesalers, retailers and consumers. No well organized market structure and practices were found for marine mollusc. The study identified the different distribution channels and value addition in each of the channels. The shell goes distance places by truck and boat. Variations were found in the distribution channels and prices in the study areas. Based on the interview, FGD and market visit with different stakeholders involved in mollusc industry, the total usage is estimated to be 1,130 MT per year. The study reveals that the market margin and value addition of mollusc muscle at different stages of marketing chain are 38.57% and 100% (Harvesting stage), 326.49% and 534.86% (Assembling stage) 26.58% and 40% (Hatchery Market), 28.76% and 50% (Tribal Market area) 48.14% and 120% (Chinese restaurant and Star hotel) respectively.

Most Bangladeshis are still unfamiliar with the nutritional benefit and flavor of fresh Mollusc. As such promotional programs may be taken to increase awareness among the community people

as well as to create demand and to improve sales prospects for farmers and harvesters of Mollusc in Bangladesh in general and in study areas in particular. In addition, this study also suggests that mollusc fishery could be a livelihood option for the coastal poor fishers.

Background of the Research

Molluscs (sometimes alternatively spelt mollusks) are the second largest phylum of animals, next to the arthropods (Oliver, 1989). They also show a great range of physiological, behavioural and ecological adaptations. The great majority of molluscs are marine, although many also occupy freshwater and terrestrial environments (Wye, 1989). They are extremely diverse in their food habits, ranging from grazers and browsers on many different biotic substrates to suspension feeders, predators, and parasites. Many are economically important as food, cultural objects, hosts for human parasites, or pests. Molluscs are among the best-studied animal groups in almost all aspects, including taxonomy, anatomy, development, ecology, biology and physiology.

There are at least 200,000 living species of which about 75,000 living and 35,000 fossils have been named making them one of the better known invertebrate groups. Numbers of living species may be even greater than current estimates. There are three major classes of living mollusks which include Gastropoda (snails, whelks, slugs, limpets); Bivalvia (scallops, clams, oysters, mussels); and Cephalopoda (squid, cuttlefish, octopuses, nautilus). There are also three or four minor classes which include Aplacophora (spicule worms) – which are often divided into two separate classes; Polyplacophora (chitons or coat of mail shells); Scaphopoda (tusk shells); and Monoplacophora.

Bangladesh is endowed with unique aquatic resources for aquaculture development. The fisheries resources of Bangladesh are highly diversified in terms of types, resources and types of the commodities produced. The fisheries of Bangladesh are very diverse and are comprised of inland open water capture fisheries, inland and coastal aquaculture and marine fisheries. The coastal water is one of the most productive zone in the world and rich in fish and shellfish. Most of our marine fishery resources are still unexploited, with a considerable size (301 species) of shellfish, which has economic importance as food (Ahmed, 1990). The following table shows the aquatic and semi-aquatic animal species in Bangladesh.

Table 1 Diversity of aquatic and semi-aquatic animal species. (Ahmed, 1990)

Animal Groups	Habitat	Species Number
Shrimp	Freshwater and marine	56
Crabs	Marine	11
	Freshwater	4
Lobsters	Marine	3
Molluscs	Freshwater	26
	Marine	301

The molluscs constitute a significant part of the world fishery today. In some developed and developing countries like Japan, USA, Canada, United Kingdom, China, Korea, the Philippines and India large quantities of edible oyster are exploited and harvested from natural beds. In some countries these are also cultured. The edible oyster contain glycogen, lipids, protein, vitamins specially A, B and D and several essential minerals. Some coastal dwellers use oyster as food and fish bait. The shells are also used to make lime. The clams are highly valued as food. Mussels and clams represent an important food source in many parts of the world, including Europe, South America, and the Far East, and they have considerable potential as a valuable protein source for many developing countries.

In our coastal area we have suitable molluscan habitats like sandy, muddy and rocky grounds, mangrove areas and coral reefs. Very little is known about the molluscan taxa of our Bay, although the study of marine molluscs began over a century ago. From our bay of Bengal Commans (1940), first reported some molluscs from the St. Martins's Islands. Later Ali and Aziz (1976) described 33 species under three classes from the same island. It has been found that there are 327 species (marine 301 and freshwater 26) of molluscs available in Bangladesh. There are three species of mollusc that occur naturally in the coastal waters of Bangladesh, namely, green mussel, clam and oyster.The true edible oysters (*Ostrea edulis* and *Crassostrea virginica*) occur in appreciable numbers along the coast of the Bay of Bengal and its adjacent estuaries. Recently, SUFER funded project by Wahab *et al*. (2004) and Salam *et al*. (2004)found that about 700 tons of oyster (with meat and shells) are annually collected from the Sundarbans in Satkhira region.

Among the coastal tribes like Mahato, Mundra, Chakma, Marma, Pundra Khatrio, Hajong and Rakhain, many are involved in mollusc collection for their livelihood. Many of the non tribal Muslim and Hindu are also involved in the same activities. People from Rakhain and some other tribes of the coast traditionally harvest oyster, green mussels and clams for their household consumption and sell the shells to prepare poultry meal. The collected mollusc species are untouched to non tribal general people because they, for cultural rather than religious reasons, are not considered suitable for eating. However, they are popular food items in many other developed as well as developing neighboring countries. In our country, only coastal tribes consume mollusk. In addition they make different value added products and different dishes from mollusk. The shells of the collected mollusks are used for making poultry and fish feed and for lime making. Shells of these bivalves are also being used for preparing decoration pieces and ornamentation.

Potential local markets have been identified for these mollusks by Sahadat (2004) and Ghose (2004) among the people of Rakhaing community at Cox's Bazar and tribal people in Hill Tracts regions. Prospective export markets also exist in Japan, Thailand, Malaysia, Cambodia and China where these species are widely eaten. In spite of the availability of the mollusks resources in Bangladesh coast, very little attention has been paid to exploit these available resources.

The majority of poor fisher folk in coastal communities do not own or have access to land or water resources. Many are engaged in the fishing industry as temporary laborers or are involved in PL

collection. Their livelihood options are precarious and some are currently being threatened with recommended bans on PL collection and fishing with bag nets. Alternative income generating activities are very limited. The exploitation of the mollusks resources could have a direct benefit to the poor as well as the national economy. Identification of economically viable populations, i.e. standing crop of these molluscs around the coast of Bangladesh is an important first step. The seasonal dynamics of the abundance, size distribution and percentage of marketable size, present level of exploitation and use if there be any, are essential prerequisite for establishment of a sustainable mollusc fishery for export market. However, it is equally important to identify the communities who are suitably responsive to the ideas of exploitation and culture of a previously unconsidered natural resource.

Bangladesh has an abundant resource of marine bivalves. The major bivalve groups in order of abundance are clams, edible oysters, windowpane oysters and mussels. These are mainly distributed in the South Eastern coastal region of Bangladesh, more specifically in the Cox's Bazar coastal area. The present exploitation is far below the level of natural production and confined to wild stocks; bivalve culture is not commercially practiced.

Few Bangladeshi tribal people traditionally consume shellfish as part of their diet. The bivalves, mostly clams and oysters, are gathered from their natural habitats as no culture system has yet been introduced. At the moment bivalves collected from natural fisheries are not depurated using standard techniques, although prior to their consumption they are held in clean seawater for 24 hours. Post harvest operations are carried out manually, and bivalves are sold to the local markets in fresh form soon after collection.

The major species of bivalves found in the coastal waters of Bangladesh and the location of the natural beds are described below

Edible oysters: These are sedentary organisms that grow attached to rocks, gravel, tree roots or any hard object in the intertidal zone. During low tide they are exposed to air and therefore become inactive, however the gills are kept moist by the water retained in the mantle cavity. Most species of oysters can tolerate low salinities and are therefore found in brackishwaters in estuaries and marshes. In the Bagkkhali estuary they are commonly attached to boulders, concrete posts and sluice gates of shrimp ponds. In Moheshkhali and Teknaf oysters are abundantly found on rocks, bricks, sluice gates, bridge posts and mangrove roots. In St. Martins they abound on coral rocks around the entire island. Four species of edible oysters have been identified from various natural beds. They are: *Crassostrea gryphoides*, *C. madrasensis, C. belcheri* and *Saccostrea cucullata*. Up to the 1940's large oyster beds existed in the Bagkkhali river, however after the war their number declined partly due to the removal of boulders on which the oyster settled, the rapid siltation of the river bed, and also indiscriminate harvesting. It has been estimated that over 900 hectares are available for culturing oysters which could produce 100 MT per hectare. The succulent oyster meat should be promoted locally as human food and could also be exported if the sanitation standards required are met by the industry. Oyster shells, which are the only by-product, could be used for lime production or as an additive to poultry feed.

Windowpane oysters: Only one species (*Placuna placenta*) of this oyster has been identified in the waters around Cox's Bazar, Gotibhanga (Moheshkhali) and Teknaf. Adult specimens are found at depths of 0.5–10 m preferably covered by a thin layer of mud. The white pearls produced by this species have a commercial value. Wild specimens of windowpane oysters are collected by local people for the pearls and for the shells which are used in the handicraft industry. There is a bright prospect for culturing it, and extensive culture areas have been identified in canals located between Moheshkhali, Sonadia and Futkhali near Sahpuridwip.

Clams: Two species of cockles have been identified in Bangladesh. They are the blood cockle *Anadara granosa* and *A. rhombea*. Relatively large natural beds have been found along the Banckkhali, Gotibanga, Chakaria and Teknaf estuaries. These species of clams typically live in muddy bottoms composed mostly of clay (65%) and silt (25%) usually 5–10 cm into the mud. The recorded values for salinity and temperature in natural beds have been in the range of 0–30 ppt and 20–30 °C respectively. Cockles are usually harvested at a premature size for the preparation of lime, while the flesh is totally discarded. The thick shell clam *Meretrix* sp. Is also found and could be cultured in numerous areas along the Moheshkhali and Teknaf estuaries.

Mussels: *Mytilus edulis* has been identified in the estuary of the Naf river and in St. Martins. They are firmly attached to hard substratums with the aid of their byssus. This mussel species requires full strength seawater for culture and therefore raft culture could be introduced in the Teknaf and St. Martins estuaries.

Objectives of the Research

Bangladesh has rich natural shellfish resource which are randomly exploited by coastal communities. Present level of demand is rather low and no sign of stock depletion is yet visible. However, due to the sedentary life style of these organisms, stock depletion can easily be caused if harvesting pressure increases. It is therefore recommended that strategies be developed for the judicious exploitation and utilization of this marine resource. The Bay of Bengal coastline of Bangladesh has not reached any serious level of pollution and therefore local people tend to consume shellfish with minimum concern to sanitation measures. No significant sickness from shellfish poisoning has so far been recorded in the country.

Little is known about mollusc marketing system, chain and infrastructures in Bangladesh. The objective of the present study were therefore,

- To examine the abundance and marketing system of mollusc in relation to its distribution, consumption and other uses
- To identify the stakeholder in the mollusc marketing chain
- To know the current health and hygiene related to mollusc consumption

Materials and methods

Location of study area

The survey was carried out in the following areas of Bangladesh coast (Fig. 1).

- Cox's Bazar: Sadar, Maheshkhali, Ramu, Teknaf and Shahporir dip.
- Chillagong: Patiya Sadar
- Khulna: Koyra, Chandkhal, Paikgacha
- Satkhira: Shamnagar, Kaligonj, Munshigonj
- Bagerhat: sadar, Moralgang, Sahrankhola

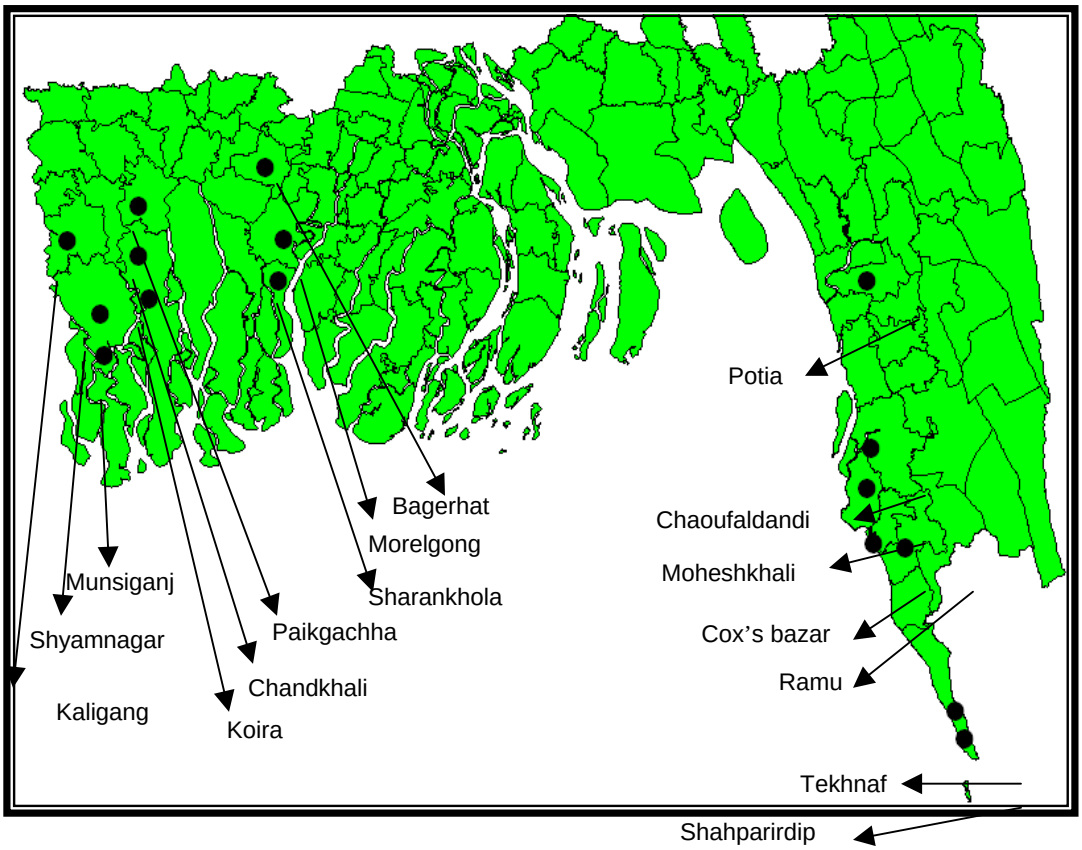


Fig. 1 Study areas for mollusc marketing servay

Data collection method

Data was collected through participatory rural appraisal (PRA) and questionnaire interview with mollusk harvester, whole seller, lime produces, fish and poultry feed producer, ornament maker crushing mill owner and meat consumer (Table 2). PRA tools including focus group discussion (FGD), transect walk, daily activity and seasonally were conducted with target people. Several FGD sessions were conducted where each group size was between 6 and 12 farmers. Cross check interviews were conducted with key informants. Several case studies were also made with different stakeholders. Samples were also collected for histopathological analyses.

Table 2 Sample size of the survey

Target group	Specific location of the survey	Sample size
Collector	Chaifaldandi, Cox's Bazar	20
	Ghotivanga, Moheskhali	20
	Shahporir dwip	20
	Kaligang, Shatkhira	20
Wholesaler	Barabazar, Cox's Bazar	10
	Chaufaldandi	5
	Sharankhola	10
Lime producer	Cox's Bazar	20
	Khulna	20
Meat consumer	Chaufaldandi	20
	Borobazar	20
	Ramu	20
Feed processor	Patiya	10
	Khulna	10
Ornament maker	Cox's Bazar	20

Target people

Mollusc harvester/collector : Harvesters are those who collect different types of molluscs from sea water. The function of the harvester is to procure supplies and display them in forms, and at times convenient for consumers and businessmen. Most of them collect molluscs in traditional method i.e. by hand and sometimes they usually do this sinking in the water.

Wholesaler : Wholesaler are the professional trader. They usually buy mollusks from collectors and sell in the wholesale market. They earn profit through buying and selling.

Consumer : Consumer are those who use molluscs as food like soup, curry, etc as a delicious food. They buy molluscs from bazaar, from collector or harvester.

Lime producer : Line producer are those who produce lime from moluscs shell. They collect shells of molluscs from the wholesaler.

Feed processor : Feed processor are those who produce fish, shrimp and poultry feed by crushing mollusc shells in crushing mill.

Ornament maker: They make different types of ornaments, bangle, showpieces etc.

Experimental Results and Discussion

Abundance of mollusc over the Bangladesh Coast

There are 30 mollusc species found during our survey among them 24 species are very common (Fig. 2).

Green mussel

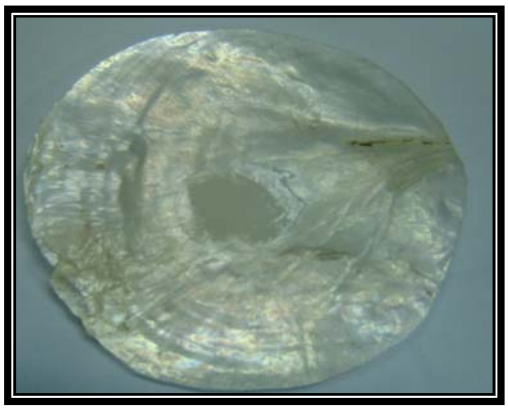
Clams

Oyster

Taltela jhinuk

Laza

Dant Jhinuk



Korta

Kata Shamuk

Ful kori

Angti Kori

Bang kori

Kala kori

Boro lal shangkho

Bhua shamuk

Kalo book chira shamuk

Sada net

Taj jhinuk

Bhuttar Dana

Sabuj Shamuk

Jinjira Jhinuk

Mutra Laza

Sada Kori

Kura

Lal Boro Laza

Fig. 2. Twenty four commonly available mollusk species.

Among the available species, 6 species are consumed by the coastal Rakhaing people - green mussel, clams, oyster, laza and dant jhinuk. The usage of different molluscs are given in Table 3.

Table 3 Major uses of different mollusk species by coastal people

Name of the species	Human consumption and meat used in shrimp gher	Shell use in fish, shrimp and poultry feed	Shell for lime preparation	Shell as Ornament and home decoration
Green mussel	√	√	√	
Oyster	√	√	√	
Clam	√	√	√	
Taltela jhinuk	√	√	√	
Laza	√	√	√	
Dant jhinuk	√	√	√	√
Kortal				√
Kata shamuk				√
Ful Kori				√
Angti kori				√
Bang Kori				√
Kala kori				√
Boro Lal Shamuk				√
Bhua Shamuk				√
Kalo buk chira shamuk				√
Sada net				√
Taj jhinuk				√
Bhuttar dana				√
Sabuj Shamuk			√	√
Jinjira Jhinuk				√
Mutra Laza			√	√
Kura			√	√
Lal boro laza			√	√
Sada kori				√

The people involved in different activities of mollusc

Although many of the coastal communities earn their livelihood from the mollusc sector, there are a few communities choose mollusk collection as their main profession like Rakahaing in Cox's Bazar and Rajbanshi of Satkhira. In addition around one thousand households in Cox's Bazar coast mainly muslims are involved in ornament making and retailing in commercial scale. In Chandkhali, Khulana and Sarankhola, Bagerhat, there are around 100 families who are involved in lime making from mollusc shell (Table 4).

From Satkhira to Teknaf, over the entire coast, around 10,000 households both tribal and non-tribal are involved in mollusc marketing chain either as collectors or wholesalers, ornament makers, meat suppliers for human consumption and to the shrimp hatcheries, lime makers, shell suppliers to the coastal districts and distant places for the preparation poultry and fish feed and paint.

Table 4a Mollusc harvesting and trading as main profession for coastal community

Name of the communities	Number of households involved	Area	Mollusc related activities
Muslim	125	Shahparirdip	• Shell collection • Wholesaling
Rakhaing	60	Tekhnaf	• Collection and meat consumption
Rakhaing	200	Cox's bazar	• Collection and meat consumption • Wholesale and meat supply
Muslim	1000		• Wholesaling and Ornament making • Poultry and fish feed making
Muslim	235	Moheshkhali	• Collection and wholesaling • Pearl collection from kortal
Rakhaing	50	Chaoufaldandi	• Collection, meat consumption • Shell wholesaling
Rakhaing	35	Ramu	• Collection and meat consumption • Meat saling • Lime making
Muslim	20	Potia	• Shell crusing and lime making
Hindu and Muslim	20	Moralgang and Sahrankhola	• Collection and lime making • Lime wholesaling
Muslim	15	Koyra	• Collection and lime making and wholesaling
Muslim	10	Chandkhali	• Shell collection, wholesaling, lime preparation and selling
Rajbangshi	150	Shamnagar and Kaligonj	• Shell Collection and selling
Muslim	30		• Shell wholesaling

Since mollusc culture is not started yet in Bangladesh all harvest come from wild sources (Fig. 3). In Cox's Bazar area mollusc collectors can be categorized into two groups: those who collect mollusc for shell and flesh/meat and those who collect mollusc only for shell. First group are ethnic Rakhaing people who collect mollusc for consuming meat and selling shell. To them mollusc meat is one of the delicious food items and cheap source of protein. Later group are Muslim people who collect and procure mollusc and sell these for poultry industry as well as ornament making industry. In Khulna region, mollusc collectors are mainly Hindu Rajbonshi women and they collect mollusc for shell. The Hindu collector does not eat mollusc meat. There are also some shell wholesalers who send harvesters deep into the *Sunderban* for mollusc collection. They pay to forest officer to get pass to harvest certain amount like Tk 1,500 for 5,000 *mound*. Usually the 5-6 harvesters go there by boat for a couple of weeks. If they fail to come back in time they must pay penalty @ Tk125/day to the forest office. Each boat contains about 150 *mond* of mollsc shell. Harvesters get Tk. 45-110/*mound* depending on species from wholesaler while the wholesaler sell about Tk. 60-130/mond to lime producer. Mollusc are collected mainly by hand and sometimes by special type of drag net from sea shore channel and muddy soil. They were attached to hard substrate, trunk of trees, roots or even on old oyster shells and around the channel and cluster as a pile and also in the sluice gates, bridges. Peak harvesting season is winter to early summer. It is one of the seasonal activities. A very few people collect mollusc around the year.

Table 4b Socio-economic Characteristics of Sample Respondents

Variables	Structures	Indicators/Levels
Gender	Male	75%
	Female	25%
Age group	10-20Years	14%
	20-30 Years	22%
	30-40 Years	44%
	40-50 Years	11%
	Above 50	9%
Education	No schooling	25.77%
	1-5 year schooling	60.23%
	6-10 years schooling	12.67%
	Above 10 years schooling	1.33%
Marital status	Married	45%
	Unmarried	25%
	Widow	17%
	Divorced	13%

Table 4b Socio-economic Characteristics of Sample Respondents (contd.)		
Variables	Structures	Indicators/Levels
Asset	Store	10%
	Boat	13%
	Net	15%
	Gold/silver	21%,23%
	Tv/Radio	33%,41%
Land	0-2decimal	31.33%
	3-5decimal	49.34%
	6-10 decimal	19.33%
Monthly income	500-1000 Tk	9.66%
	1000-1500Tk	30.33%
	1500-2000 Tk	40.00%
	2000-2500 Tk	7.00%
	2500-3000 Tk	5.66%
	Above 3000 Tk	4.00%
House structure	No house	4%
	Katcha	66%
	Semi-building	23%
	Building	7%

Different uses of mollusk

Human consumption of mollusk meat

People from Rakhaing and some other tribes of the coast traditionally have long been eating green mussel, clam and oyster meat (Fig. 4). After harvesting the Rakhaing people take the shell out using a hammer type special device, use some meat for their household consumption and rest of the meat they sell to the community. There are daily mollusc meat markets in the Borobazar and Ramu, Cox's bazaar. On average the daily sale of mollusk meat in Borobazar and Ramu market are 5 kg and 8 kg, respectively. The meats are always sold fresh. The quality of meat remain acceptable to the consumers for 2 days without any freezing and preservation, then started to deteriorate and could be detected by bad smell. The main dishes they prepare from mollusc meat are *chatni*, curry, *bhuna*, light fry and chop.

In the coastal cities – (Khulna, Chittagong and Cox's Bazar), no hotel/restaurants were found selling mollusc dish. The hotel and restaurant selling mollusc dishes in Dhaka are given in Table 5.

Table 5 Mollusc meat consumption in different restaurants of Dhaka

Name of the hotels	Meat needed kg year^{-1}
Purbani	10-15
Sheraton	15-20
Sonargaon	10-15
La Vinchi, Kawran bazer	5
Crystal garden, Gulshan-2	5
Abakash, Mohakhali	5

Mollusc meat sold by NEOSI Sale Center

Presently, the molluscs (mussel, clam and oyster) are not very well sold item in Dhaka. A few years ago, the Center used to sell 5-10 kg mollusc meat per day to each of the several restaurant/hotels. However, in recent days the demand decreased. Nonetheless, at present some Chinese Hotel and some guest houses purchase mollusc meat from this Center. It sells 25-30 kg meat of mussel, clam and oyster per month. The price is between Tk. 400-500 kg^{-1}. The foreigners living in different parts of Dhaka, purchase molluscs from NEOSI on average 10-15 kg month^{-1}. NEOSI collects mollusc meat through the suppliers from Satkhira, Khulna and Cox's Bazar.

Health and hygiene related to mollusc consumption

According to the mollusc harvesters and meat consumers, they did not find any diseases in molluscs. Their ability to identify diseased animal was very poor. However, few external lesions and presence of fouling organisms were found common in the harvested molluscs. Gaping and accumulation of sands and debris in the mantle and on the gills were occasionally found. Injury and shell damage during harvesting were also reported. This study also tried to understand the status of health and disease of mollusk meat consumers. In general, the consumers do not feel any problem due to eating meat rather they think that they are healthy due to consume mollusc meat. However, the mollusc collection, cleaning, processing and cooking are not hygienic among Rakhaing community. Clean water is not used during mollusc cleaning. Shell removing is done on the earthen floor and no icing or freezing is followed for short preservation and transportation. Since there is no icing, bad smell comes from the meat in the market. In addition lots of flies on the mollusc meat are common during selling in the market.

Meat used in shrimp hatcheries

Mollusc meat is fed to mother shrimp in different coastal shrimp hatcheries. Most of the hatchery owners prefer to feed fresh mollusc meat to the mother shrimp. There are several mollusc meat

wholesalers in Cox's Bazar Sadar. They collect mollusc from the harvesters and remove the shell. Shrimp hatchery operators place the order (the quantity and the time of supply) over cell phone to the whole sellers. The wholesalers supply the meat accordingly. The price of mollusc meat fluctuates based on seasonal supply and demand.

Use of shell in poultry and fish feed industries

The mollusc shell has huge demand in the poultry and fish feed industry as an essential source of calcium in the feed. The present supply of mollusc shell can not meet the high demand of this sector. In general the poultry and fish feed industry use 1-2% crushed shell in the feed preparation. The feed industries collect shell powder from crushing mils located in the coastal areas mainly from Patia, Chittagonj and Khulna region. There are about 8 crushing mills in Chittagong Cox's Bazar area. In Khulna region, 9 mills were found active to crush mollusc shells. Each mill can produce 10 mt dry shell powder/month. After crushing 40 kg mollusk shell, 36 kg small particle and 2 kg powder are obtained. Small particles are used in fish and poultry feed industries and the price is around Tk 160/*mound*. The powder is used in shrimp gher at a price of Tk 200/*mound*.

Lime making

Second important use of mollusc shell is making lime. In Cox's Bazar region there are about 20 lime producing factories using around 8 MT dry shells per month. While in Khulna region about 30 lime factories were found to use around 12 MT shells per month. Price of lime for human consumption (chewed with betel leaves) is about Tk 8-10/kg in lime producing areas while the price is about Tk 40-45/kg in urban areas.

Ornamental and decorative uses

There is a high demand of mollusc shell for the use in ornamental and decorative purposes especially in the Cox's Bazar area. There are several Jhinuk Markets in Cox's Bazar where mollusc collectors sell their shell. In addition many of the shops also sell different decorative and ornamental items made from mollusc shell. A large number of people are engaged in collecting, cleaning, processing of shell and preparation of various types of ornaments, showpieces and home decorating items from the shells. Usually the tourists from all over the country and overseas buy these items. The Cox's Bazar jhinuk markets also supply these items to the different parts of the country. The middlemen from different city markets come to Cox's Bazar and buy the ornaments and decorative items and sell to markets of Dhaka, Chittagong, Khulna and other major cities. One of the several leaders of the Shell Ornament Cooperative Society – Hajera Khatun, Signboard of a Shell Ornament Cooperative Society, Newpaper cutting on Hajera Khatun and Signboard of one of the many Jhinuk Markets in Cox's Bazar

There are some cooperative societies in Cox's Bazar formed by the ornament makes. The societies run by few successful women (wholesaler) who lend money to the collector of Teknaf, and Cox's Bazar. In return the collectors sell the collected shells to the money lenders. Most of

the members in the cooperative societies are women. They buy the shell from the wholesalers and after preparing the ornament and showpieces, sell to the wholesalers. The wholesales sell these items to the different shops in Cox's bazaar and other parts of the country. Although the amount of shell used in the ornament industry varies from year to year, on average every year 250 MT shells are used in this industry.

Paint making/shining

There are several factories in Cox's Bazar and Bagerhat areas where a number of households are involved in making paint and shining materials (special kinds of lime) from mollusc shell. The paints are used in painting walls, floor, flower vase and other items. The shining materials people generally use after painting the walls.

Mollusc marketing in Bangladesh coast

Consumption markets

Consumption markets of mollusc meats are found mainly in Cox's Bazaar sadar, Choufaldandi, Ramu and Teknaf areas. The consumers for these markets are limited in these areas only. After collection, the Rakhaing people both man and woman process the meat in their households. Generally before selling to the wholesalers or taking to the markets, they keep some meat for the household consumption. Both male and female retailers are found in the market. There are some households who buy the meat as wholesalers. People from different areas come to these wholesalers and buy mollusc meat for household consumption. The price of mollusc meat at different stages of market chain is given inTable 6.

Table 6 Average meat price (Tk per kg) in different stages in different areas

Species	Ramu			Cox's Bazar			Choufaldandi			Teknaf		
	HW	FW	RM	HW	F W	RM	HW	F W	RM	HW	F W	RM
Green muscle	25	35	40	40	50	50	15	25	30	40	50	50
Oyster	60	80	100	50	70	70	80	90	100	60	80	80
Calm	20	30	30	25	30	30	15	20	20	15	20	20
Laza	80	100	125	80	100	130	70	90	100	70	80	100

HW – Harvesters to Whosalers, FW – From Wholesalers and RM – Retail Markets

Among the four mollusc meat markets Borobazar in Cox's Bazar Sadar and Choufaldandi market is relative bigger that other two markets. Monthly mollusc sales are on average 150 kg, 250 kg, 300 kg and 100 kg in Ramu, Cox's Bazar, Choufaldandi and Teknaf, respectively. If the hotel and

restaurants in Dhaka are considered, the total annual mollusc meat consumption in Bangladesh stands 10, 240 kg (gross equivalent to 70 MT of mollusc with shell) per year.

Meat market in shrimp hatcheries

There are ten mollusc meat suppliers who supply mollusc meat in to shrimp hatcheries of Cox's Bazar area. In this sector average supply of mollusc meat is 650 kg per month (annual supply 8 MT equivalent to 60 MT of mollusc with shell). The hatchery owner use the meat from the same species as Rakhaing people consume. The hatchery owners call the meat supplier beforehand with the amount needed. There is no market place for this type of trading. The suppliers themselves send the mollusc meat to the hatcheries. The price is almost same sold for human consumption.

Mollusc shell market

Poultry and fish feed industry

In general the crushing factories buy the whole mollusc shell from the wholesalers and individual harvesters. The feed factories buy the crushed shell from the crushing factories. In a few cases the feed manufacturers purchase the whole mollusc shell and crush by themselves before adding with feed mixtures. About 20 crushing mills located in Cox's Bazar, Chittagong and Khulna regions supply the mollusc shell to the feed factories. The total crushed molluck shell the crushing factories supply to the poultry and fish feed manufacturer is estimated to be 450 MT annually. The main buyers (i.e., the feed manufacturers) of the crushed shells are given in the Table 7.

Tabler 7 Location and number of the crushing mill and the destination of crushed products

Location and number of the crushing mill	Crushed shell go to
Potia (8)	Chittagong, Chandpur, Comilla, Dhaka, Gazipur, Savar, Mymensingh and Bogra
Teknaf (2)	Teknaf and Cox's Bazar
Khulna (9)	Khulna, Barisal, Jhalokathi, Dhaka, Mymnsingh and Bogra
Cox's Bazar (1)	Cox's Bazaar, Chittagong, Gazipur

Lime preparation

In Cox's Bazar region there are about 20 lime producing factories are found and in Khulana the number was 30. The total mollusc shell used by these lime making factories is around 20 MT. In addition there are individual scattered households that also make lime in the backyard furnace. Approximate amount of shell these households use is 5 MT per month. The annual requirement

of mollusc shell in lime industry is around 300 MT. Price of lime for human consumption (chewed with betel leaves) is Tk 10/kg in lime producing areas while the price is about Tk 40/kg in urban areas. The cost of making 100 kg lime is approximately Tk 310 which include price of mollusk shell, wood and labour (shell Tk. 120 + wood Tk.140+ labour Tk. 50) (Table 8).The selling price of 100 kg lime is Tk. 800. Therefore, net profit is Tk 490 and it takes one week to do that.

Table 8 Cost-benefit of 100 kg lime production

Item	Amount needed kg	Cost (Tk)
Mollusc Shell	80	120
Fuel wood	100	140
Labour	2 man days	100
Total cost		360
Production cost	@ Tk. 3.60/kg	360
Selling price	@ Tk. 8.00/kg	800
Net Profit	@ Tk. 4.40/kg	440

Ornament market

Ornament markets are mainly based on Cox's bazaar. However, the raw materials come from different coastal regions and end products go to different parts of the country. Around 1,000 households in Cox's Bazar earn their livelihood from ornament marketing chain. In the bottom of the chain – the shell collectors from Teknaf, Shahporir Dip, Choufaldandi, Moheshkhali, Kutubdia, Ramu and other coastal areas, who collect mollusc shell from the shore, mangrove areas, coastal channel and streams. The *foria* or middlemen buy the shells from the harvesters and supply to the ornament wholesalers. The ornament wholesalers sometimes buy shell directly from the collectors. The ornament makers under different cooperative societies (controlled by the ornament wholesalers) take the shells as loan from the wholesalers. They clean, process and make different types of ornament and decorative pieces as the wholesalers desire. In return the ornament makers sell the ornament to the wholesalers keeping a minimum profit. The wholesalers supply those ornament to the different shops and market in Cox's Bazar and to other big cities. Although the amount of shell used in the ornament industry varies from year to year, on average every year 250 MT shells are used in this industry.

Table 9a The price wholesalers pay to buy mollusc shell from the harvesters and forias in Cox's bazaar for ornament and decorative piece making

Species	Price of shells from *foria* or collectors to wholesaler (Tk/kg)
Boro Jhinuk	1.50
Kostura	1.00
Calm	3.00
Choto shamuk	2.00
Choto Jhinuk	2.00
Boro chilon	5.00
Fulkuri	15.00
Kalakori	3.00
Kalo shamuk	20.00
Teltela jhinuk	10.00
Kalobukchira shamuk	30.00
Angty kori	20.00
Bhua shamuk	30.00
Boro lal shamuk	30.00
Shutra leza	30.00
Boro lal leza	25.00
Lal choto kori	20.00
Bang kori	25.00
Bhuttar Dana	30.00
Shabuz shamuk	30.00

On average each wholesalers buys 25 MT mollusc shell annually at a price of Tk. 400,000. The wholesaler pays a production cost of around Tk. 250,000 to the ornament makers (Tk. 10 per kg shell). Though the price of finished ornament varies a lot, depending upon the season, number of tourist and many other factors, a wholesaler can sell 1 MT ornament at a price Tk. 40,000.

Table 9b Cost-benefit analyses of ornament trading by an ornament wholesaler (total amount 25 MT per year)

Item	Price (Tk/kg)	Total amount (Tk)
Mollusc Shell	16.00	400,000
Labour	10.00	250,000
Production cost	26.00	650,000
Selling Price	40.00	1,000,000
Net profit	14.00	350,000

Table 9c Yearly income from mollusc ornamental and decorative market

Season	Shop type	Number	Monthly sell (Tk/months)	Total in season (Million/5 months)
Peak (Nov-Mar)	Permanent	50	6,000-10,000	1.5-2.5
	Floating	150	4,000-6,000	3.0-4.5
	Barmiz	200	1,500-2,000	1.5-2.0
Sub total				6.0-9.0
Season	Shop type	Number	Monthly sell (Tk/months)	Total in season (Million/7 months)
Off peak (Apr-Oct)	Permanent	50	4,000-6,000	1.40-2.10
	Floating	150	1,500-2,500	1.58-2.63
	Barmiz	200	1,000-1,500	1.40-2.10
Sub total				4.38-6.83
Grand Total (Million/Yr)				10.38-15.83

Estimated total annual usage of mollusc in major sectors of Bangladesh

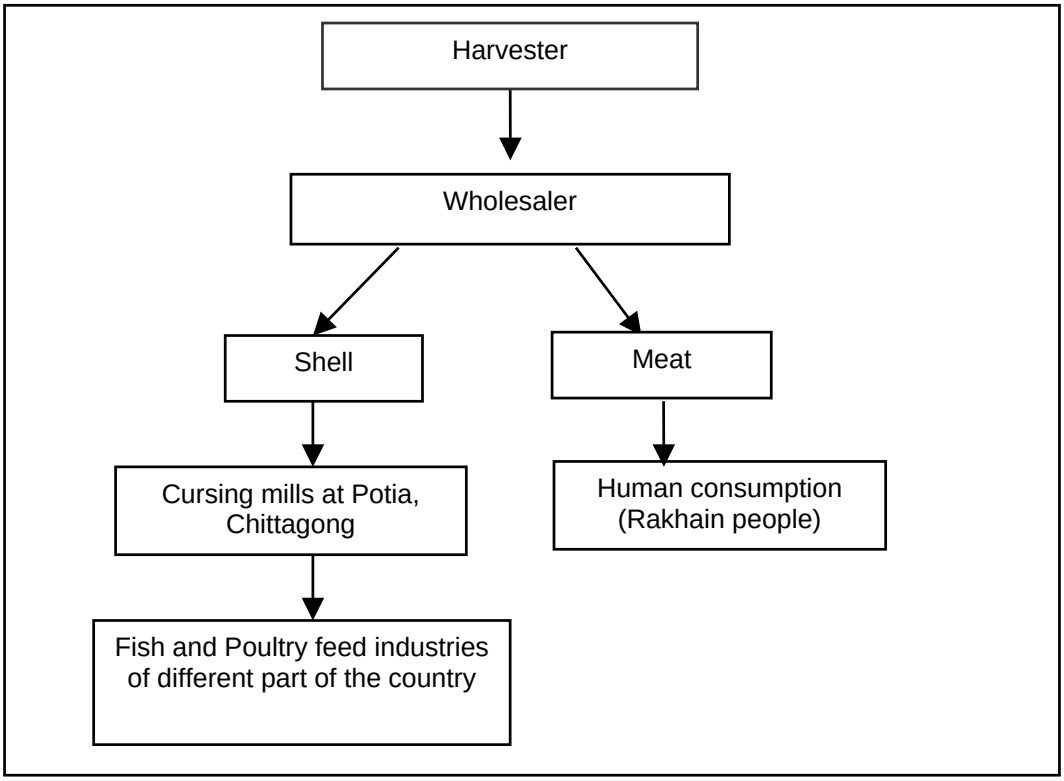
Based on the interview, FGD and market visit with different stakeholders involved in mollusc industry, the total usage is estimated. In the major sectors namely – meat consumption and shell used in animal feed industries, lime making and ornamental usage more than 1,000 MT molluscs are used in Bangladesh.

Table 10 Mollusc use in Bangladesh

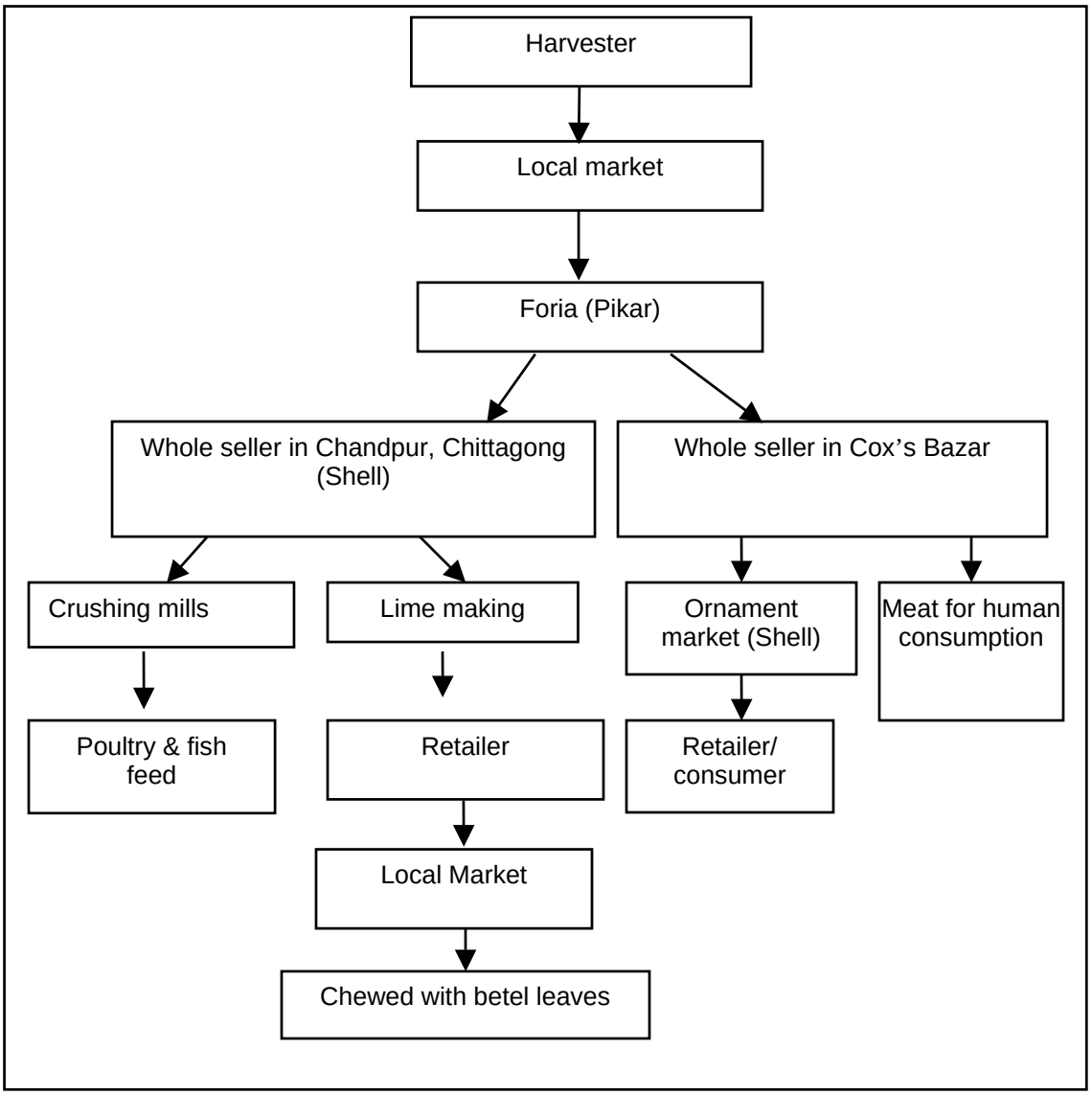
Name of the sectors		Estimated amount (MT)
Meat	Human consumption	70
	Shrimp hatcheries	60
Shell	Poultry and fish feed industries	450
	Lime making	300
	Ornament and decoration	250
	Total	1,130

Mollusc distribution channel

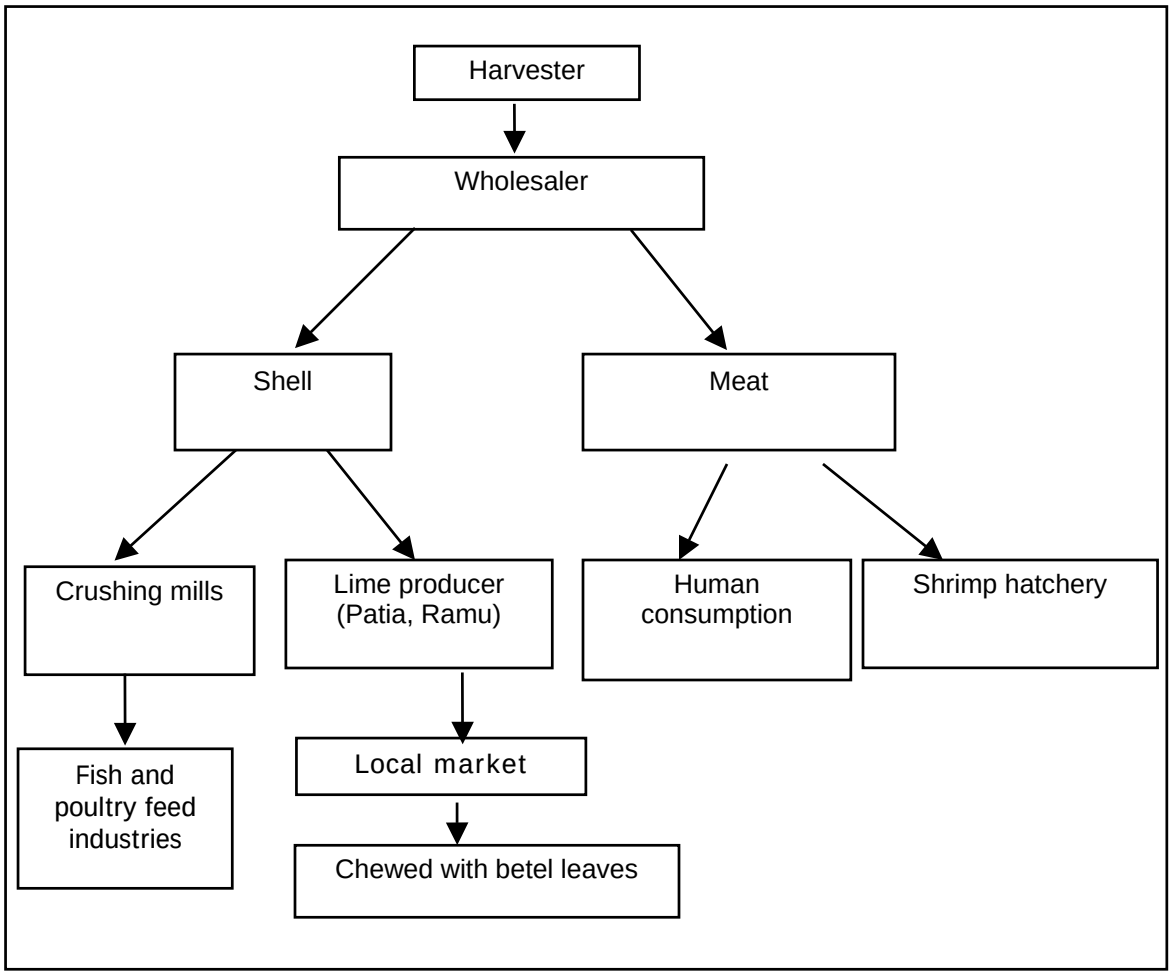
There are high demand for mollusc across the country but due to the inefficient marketing system such as lack of market place, marketing knowledge, packaging, promotion, transportation, information about market and distribution outlay, distribution of meat is confined within the community and nearby areas. No consumption market was found in Khulna region. However, distribution network of mollusc shell was found throughout the country. The distribution channel in major study areas are given below-



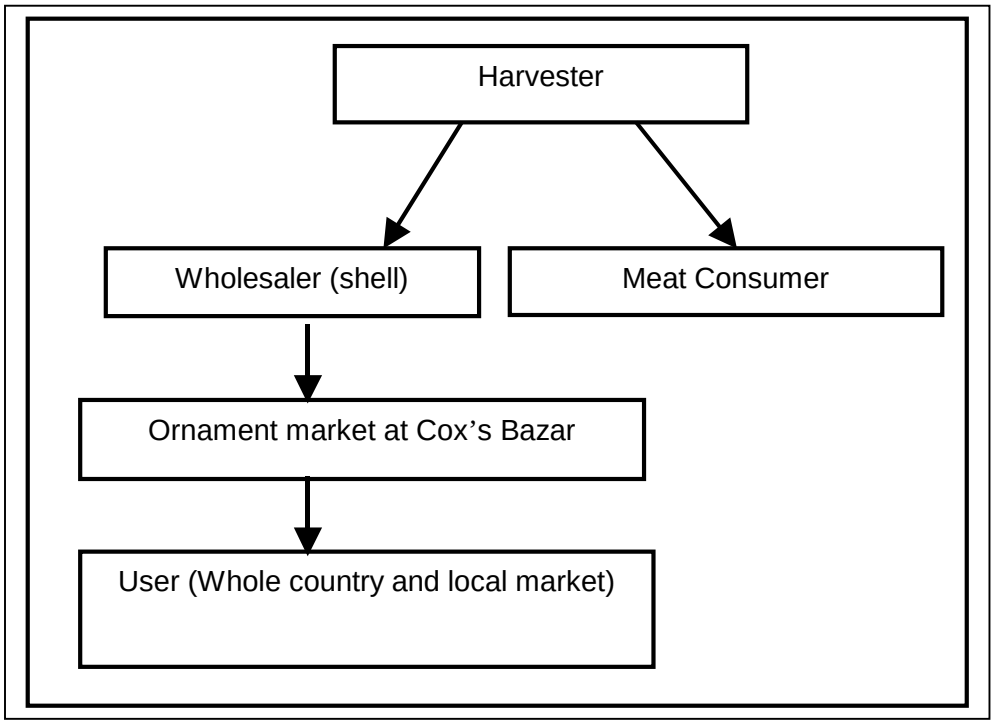
Distribution Channel of mollusk in Chaufaldandi, Cox's Bazar



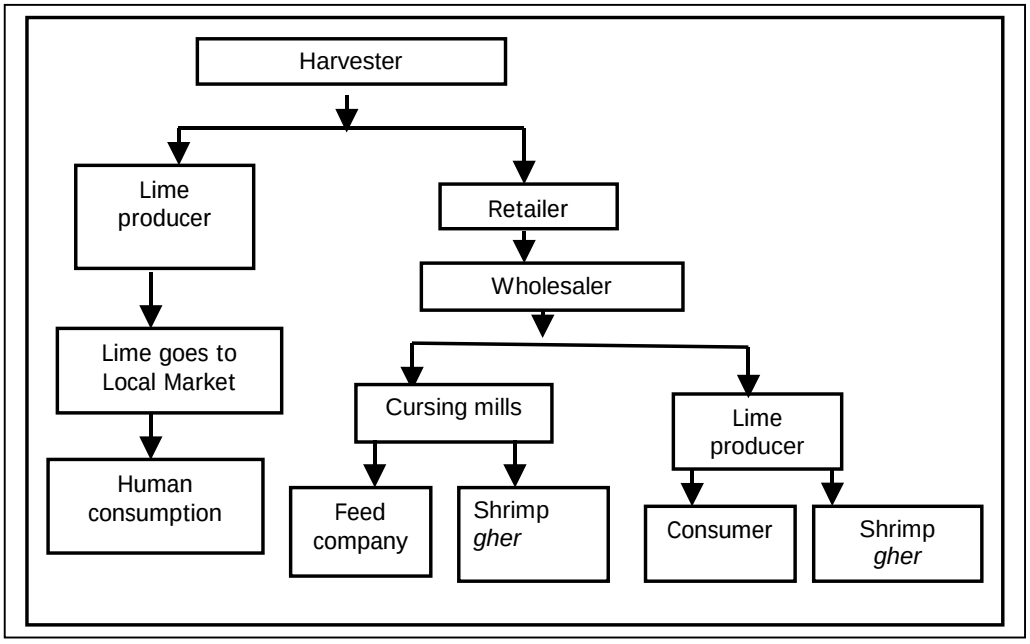
Distribution Channel of mollusk in Mohaskhali, Cox's Bazar



Distribution Channel of mollusk in Cox's Bazar Sadar



Distribution Channel of mollusk in Teknaf



Distribution Channel of mollusk in Khulna region

Table 11 Market margin and Value addition of Mollusc mussel

Stages	MM (Tk/Kg)	MM (%)	VA (Tk/kg)	VA (%)
Harvesting stage	1.35	38.57	1.75	100
Assembling/processing stage	17.07	326.49	18.72	534.86
Hatchery	14.70	26.58	20.00	40.00
Tribal area	16.75	28.76	25.00	50.00
Chinese restaurant and star hotel	35.75	48.14	60.00	120.00

Table 11elucidates that at processing and marketing in Chinese restaurant & star hotel value addition rate is high. The reason behind high value addition at processing stage is many activities like sorting, cutting, washing, storage, packaging grading, standardization are performed during assembling/processing stage. Again value addition in Chinese restaurant & star hotel marked a high degree. The art of serving, cooling and demonstration in a convenient environment helps attaining high value of Mollusc products.

Table 12 Market margin and Value addition of Mollusc Shell

Stages	MM (Tk/Kg)	MM (%)	VA (Tk/kg)	VA (%)
Harvesting stage	1.35	38.57	1.75	100
Assembling/processing stage	17.01	326.49	18.72	534.86
Industrial market	0.65	15.85	1.05	28.37
Wholesale market	0.45	9.09	0.65	13.68
Market Retail	0.33	6.00	0.05	9.25

Table 12 depicts a picture of value addition & market margin in Mollusc shell marketing. Here it is also observed that 534.86% value is added in assembling stage and market margin is 326.49% in this stage. As before separation of Mollusc muscle from shell by cutting, both of shell & muscle follows common process. Table 5 further reveals that market margin and value addition decreases gradually up to delivering shell made products to ultimate customers.

Contribution of Mollusc in value creation

There is a greater economic utility of Mollusc Muscle and shell for its contribution in the growth, nutrition, and egg spawning in poultry & duck industry and in shrimp hatchery. it is also a nutritious food for human being. Considering these factors we asked questions from the sample respondents in study areas according to their information we obtained following result as shown by table 6

Table 13 Contribution in value addition

Contribution in value creation	**Frequency**	**%**
Growth of poultry pro	128	42.67
Fattening of duck	154	51.33
Increasing rate of spawning	96	32
Nutrition value for good health	163	54.33

Table 13 reveals that 54.33% respondents opined about contribution of Mollusc muscle as nutritional value for good health while 51.33% told about fattening of duck and 42.67%, 32% for growth of poultry products and increasing rate of spawning respectively.

Conclusion and recommendation

The molluscs harvested in the coastal areas of Bangladesh by tribal and non-tribal people are used in many different ways. The major commercial sectors are poultry and fish feed, lime production, ornamental usage and human consumption. Among the thirty commonly available mollusc species, ten are commercially very important, namely clam, green mussel, oyster, cockle, karotal, laza, kostura, kata shamuk, kori and dant jhinuk..

Mollusc harvesters are mainly the coastal poor people from Moheshkhali, Chaufaldandi, Ramu, Borobazar and Burmese Market Para in Cox's Bazar, Patia in Chittagong, Sarnkhola and Morelgonj in Bagerhat, Paikgachha, Chandkhali and Koira in Khulna, and Munshigonj, Shyamnagar and Kaligonj in Satkhira district. The primary occupation for many of the households in these areas is mollusc collection. Both men and women collect mollusc by hand and nets from shoreline, small streams, and coastal channels. In general, only tribal people consume 6 species of mollusc – green mussel, clam, kostura, oyster, laza and dant jhinuk. A considerable amount of mollusc meat is also used in the coastal shrimp hatcheries. The spreading of mollusc market is not only limited to the coastal districts, it extends to distant places like Comilla, Dhaka, Mymensingh, Gazipur, Bogra and other districts as well. The peak harvesting season for mollusc is November –March.

The price of both mollusc meat and shell fluctuate based on the supply, demand and harvesting season. The target people/households in the mollusc market chain identified are mollusk harvester/collector, wholesalers, retailers and consumers. No well organized market structure and marketing practices were found in marine mollusc sector. The study identified the different distribution channels and value addition in each of the channels. The problems identified in mollusc marketing sector are -lack of physical market facilities, difficulty in getting pass to enter the Sundarban and other areas for mollusc collection, attack by Royal Bengal Tiger, frequent robbery and illegal toll collection, harassment by law enforcement agencies, lack of finance, fluctuating supply of mollusc, unwillingness of not tribal people to consume mollusc meat and poor economic status of the stakeholder in the bottom of the marketing chain (harvesters/collectors). Finally, data on stock and its' changing trend, trained personnel, market demand and sanitary regulation are limited, if they exist at all.

Recommendation

From this study, it became apparent that there was a need to improve the marketing systems of the present production of mollusc and to expand and create markets for future production at the domestic and regional levels. To this effect, the uses of mollusc for food, animal feed and non-food applications should be considered. It was also considered necessary to analyze marketing arrangements, identify and correct market imperfections, improve marketing information, study

price formation processes and distribution of bargaining power. Furthermore, it was considered important to make efforts for product development and diversification and to produce value-added products. These actions should be directed to improve the image of mollusc products with consumers and to be facilitated by promotional and informational campaigns. Possibilities for technical cooperation among stakeholders should be identified and use for technology transfer and training. Financing of the programme should be sought from donors both national and international, GOs and NGOs. .

Information exchange and interaction between scientists and stakeholders involved in mollusc sectors (collection, consumption, value addition, product development and marketing) in the region should be encouraged. It is necessary to provide organizational and government support for establishing landing center and market infrastructure for mollusc especially near the major harvesting sites. GOs and NGOs should kindle the demand by promoting molluscs as nutritious and palatable food to the both tribal and non-tribal community. Local people should be trained in the fields of mollusc biology, culture, processing, sanitation, health and hygiene and enhance extension activities. Trained local personnel from both tribal and non-tribal community should come forward for small-scale and commercial mollusc culture in the costal belt of Bangladesh. To do this efficiently, policies on marine fisheries should be developed to adequately focus on mollusc aquaculture. Access to the potential resources should be ensured. Target species, clear procedural details, institutional support and environmental concerns should be addressed properly. Constant supply of mollusc spats and marketing needs are also of prime concern in this regard. Above all, collection and dissemination of information on uses of mollusc as human food, animal feed (fish and poultry), ornamental crafts, medicine, fertilizer and building materials should be carried out involving all stakeholder, policy maker and donors.

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