

# SOFT-SHELL CRAB PRODUCTION IN COASTAL BANGLADESH: PROSPECTS, CHALLENGES AND SUSTAINABILITY

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Crab fisheries, aquaculture and trade have appeared as an opulent commercial venture, with global crab production of almost 1.3 million tons in 2015 (Hungria *et al.* 2017). Recently, soft-shell crab is one of the most desired forms for marketing because consumers consider the product to be a gastronomic delicacy (Perry *et al.* 2010, He 2015). The term *soft-shell crab* does not refer specifically to any particular crab species, but to the physiological state of any crab that has just undergone molting to replace their old hard exoskeleton with a new, slightly larger, hydrated and decalcified soft exoskeleton (Freeman and Perry 1985). During this short transitional stage, normally within the first hour, the term *soft-shell crab* is applicable (Freeman *et al.* 1987) and such crabs command value-added prices.

They are considered a culinary delicacy with high market value, often ranging up to seven times the price of comparable hard-shell crabs (Wickins and Lee 2002, Cap Log Group 2012). The demand and price of soft-shell crabs are increasing in international markets (Tavares *et al.* 2017). Based on abundance and available technology, *Scylla* spp. are among only a few swimming crab species (Shelley and Lovatelli 2011) that are cultured and marketed internationally as soft-shell crabs (Kennedy and Cronin 2007). The production of soft-shell mud crabs (mostly *S. serrata*) in coastal Bangladesh is a new addition to established fattening practices for hard-shell crab production (Rahman *et al.* 2017). The potential for soft-shell crab production and business development in Bangladesh is strong (Fig. 1). This article presents an overview of the current status of soft-shell crab culture in the country.

## PRESENT STATUS OF SOFT-SHELL CRAB CULTURE IN BANGLADESH

The brackishwater and marine coastlines of Bangladesh are well suited for soft-shell crab production. The production of soft-shell crab

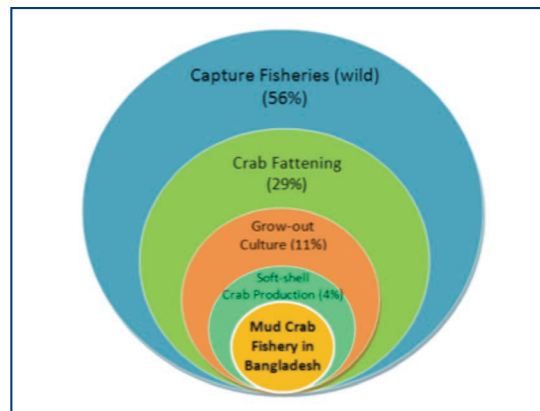


FIGURE 1. Contribution of different sources (approx. percent) to total crab exports from Bangladesh.



FIGURE 2. The largest land-based soft-shell crab farm in Shyamnagar, Satkhira, Bangladesh (Photo: Md. Mojibar Rahman).

was initiated in Cox's Bazar in 2010 and then gradually expanded into the Satkhira region on a limited scale (Islam *et al.* 2015). Approximately 39 farms are currently in operation in coastal areas in the Satkhira district. The farms operate soft-shell crab production systems in which crabs are stocked individually in small perforated plastic boxes (Shelley and Lovatelli 2011). Depending on production capacity, 30 farms can be categorized as small, eight as medium and one as a large farm (Fig. 2), holding approximately 2,000-14,000, 33,000-200,000, and 600,000 plastic boxes, respectively, covering approximately 70-80 ha of coastal water bodies that were formerly used for shrimp farming. Most of these farms are owned by non-local affluent business people and lands are leased for at least five years tenure and jointly operated because substantial investment and large-scale management are required (Rahman *et al.* 2017). The main water sources for the farms are seawater

canals and rainfall. There are well-facilitated water inlet and outlet systems on soft-shell crab farms.

A limited number of potential species are suitable for coastal crab aquaculture in Bangladesh. Presently the mud crab (*Scylla* spp.) is recognized as a prime candidate species to replace black tiger shrimp (*Penaeus monodon*) for farming in coastal water bodies. These conditions suggest very strong potential for semi-intensive mud crab aquaculture development. Soft-shell crab production is widely envisioned as having excellent prospects to contribute to livelihoods of coastal community members by providing income from lucrative foreign markets.

**On-farm production process.** Soft-shell crab farms are situated near sources of seed and other facilities, with affordable land, serviceable roads and communication services, and available labor. Farms typically purchase seed crabs from nearby depots

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or markets. Seed crabs are harvested from natural sources of mainly Sundarbans mangrove forests and associated tidal rivers, estuaries and canals. The individual size of seed crabs for stocking varies from 40-200 g but 120-150 g is in greatest demand (Fig. 3), generally at premium prices (Shelley and Lovatelli 2011).

Farmers typically stock juvenile crabs in floating boxes at the water surface between 0600 and 2200 h, after their arrival from depots. Most farmers use minced tilapia and/or snail meat as feed for production of soft-shell crabs, often feeding at 5-10 percent body weight daily on an as-needed basis. Fresh tilapia are available in coastal areas and are an acceptable source of protein for crabs. Pre-contracted suppliers provide tilapia to soft-shell crab farms at approximately US\$0.50/kg (45 BDT/kg). Small farms can purchase fish from local markets at lower prices. The conventional feeding schedule is once every 2-3 days in summer and a maximum of every 5-7 days in winter, with minced fish given while checking for molting. Pond water is exchanged up to 50 percent weekly during high tides. Soft-shell production ponds are also treated with lime during production at about 0.5 kilogram/decimal (1 decimal = 40.5 m<sup>2</sup>) twice monthly to maintain water quality, stabilize pH and avoid disease outbreaks.

After stocking one small crab per individual box, crabs are checked at 4-h intervals to monitor molting status. Laborers typically remain seated on a platform situated in the middle of the pond, accessing a row of containers using a rope under the platform to observe each crab for indications of molting (Fig. 4). Leftover food materials are simultaneously removed and new crabs stocked into boxes as they come available. Regular monitoring for molting is the most labor-intensive activity, leading to the instant harvesting of molted crabs (Tavares *et al.* 2017). Molted soft-shell crabs are collected from boxes and held in oxygenated freshwater for 45 minutes to clean and flush intestinal residues from the body, and retained in the soft-shell state followed by grading, weighing, chilling, packaging and storage for shipment (Rahman *et al.* 2017). Each crop cycle of soft-shell crab production requires an average of 25-45 days (Freeman *et al.* 1987, Shelley and Lovatelli 2011). Production calculations for soft-shell crabs are complicated because harvesting and stocking are ongoing continuous operations with variable rates and somewhat unpredictable timing.

**Marketing systems and export earnings.** Strong overseas markets for Bangladeshi soft-shell crabs have developed in Australia, Thailand, Singapore, Netherlands, Germany, USA and UK. Among these, the USA, UK and Australia import 80 percent of total production. Buyers' requirements or pre-contract conditions vary by country with regard to processing, freezing, packaging, wrapping, labeling, and shipment. Mean prices offered by buyers range from US\$ 10-15/kg. Soft-shell crab markets are not open to all farms; only experienced, larger-scale producers with export licenses are viewed as acceptable by buyers in the international export market for soft-shell crabs. This marketing system excludes many smaller producers from access to the limited number of buyers. Exporting soft-shell crab to foreign markets is relatively new and therefore no data on earnings of foreign currency are available. In 2015, Bangladesh government reported earnings of foreign currency of about US\$ 26 million from exporting 12,558 t live hard-shell crabs (FRSS 2017).

**Potential for areal expansion.** Bangladesh has 710 km of coastline, with the world's largest mangrove forest (the Sunderbans),



FIGURE 3. Stockable small-size crabs for soft-shell crab production (Photo: Md. Mojibar Rahman).



FIGURE 4. Women monitoring the molting status of crabs in cellular box soft-shell crab farm (Photo: Md. Mojibar Rahman).

which is a richly biodiverse aquatic ecosystem (Rahman *et al.* 2017). Land in the coastal region is 28 percent very suitable, 62 percent moderately suitable and only about 10 percent marginally suitable for crab farming (Salam *et al.* 2012). There are about 275,509 ha of shrimp and prawn *ghers* (modified ricefields) in the coastal zone (FRSS 2017). Many of these water bodies are improperly used for aquaculture, as impacted by shrimp farming, leading to the propagation of pathogens and to environmental degradation (Karim and Stellwagen 1998). The intensification and exploration of crab aquaculture for fattening and soft-shell crab production can potentially make more sustainable use of these water resources.

**Employment generation.** Development of commercial aquaculture creates layers of employment opportunities for landless laborers as they become involved in various parts of associated value chains (Belton *et al.* 2012). In coastal areas, commercial soft-shell crab farms thus create significant employment generation opportunity for vulnerable households, and especially for women (Fig. 5). Soft-shell crab farms are labor-intensive, hiring local men and women on a monthly or daily basis. Soft-shell crab farms presently support approximately 600 employees in coastal Bangladesh, the largest of which has approximately 300 employees (79 percent men and 21 percent women). Medium-sized farms employ more women, with an average of 22 employees, consisting of 60 percent men and 40 percent women (Fig. 6). Smaller production units employed an average of 3-6 workers, and also include family labor in the production system.





FIGURE 5. Women mince fish for feed in a soft-shell crab farm in Shyamnagor, Satkhira, Bangladesh (Photo: Md. Mojibar Rahman).

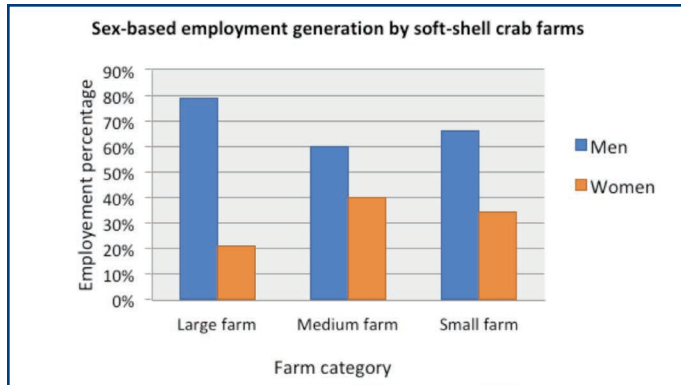


FIGURE 6. Percentage of men and women employed by soft-shell crab farms of various sizes in coastal Bangladesh.

Female employees are generally from impoverished households, and a majority are divorced, widowed or separated from their families. The mud crab fishery is considered the second highest employment generation sector in the region after black tiger shrimp farming (Salam *et al.* 2003, Jahan and Islam 2016). Soft-shell crab farming is viewed as one of the best and most resilient income opportunities for people in natural disaster-susceptible coastal Bangladesh.

**Hatchery development and scaling up.** Sustainability of the crab seed supply is the most critically important limiting factor for industrial development of soft-shell crabs. Globally, the large majority of soft-shell crab farm operations are based on supplies of wild stock (Hungria *et al.* 2017). The soft-shell crab farms in Bangladesh require a daunting number of crab juveniles for continuous production. Presently, depending on farm size, 1-5 t of small seed crabs are needed daily for stocking. The supply of natural mud crab seeds is not sufficient to meet the steady demand by soft-shell crab farms, causing some loss of production and limiting industry development.

Therefore, mud crab hatchery establishment (Fig. 7) and technological development for hatchery raised crablet production are urgently needed (Islam *et al.* 2015). Successful hatchery production can support a regular supply of seed crabs for grow-out culture systems to produce adequate numbers of properly-sized juveniles after the nursery phase. A sustainable and reliable supply of stockable crabs for soft-shell farms would thus reduce pressure on wild stocks



FIGURE 7. Mud crab hatchery and technology development in Shyamnagor, Satkhira (Photo: Md. Mojibar Rahman).



FIGURE 8. Plenty of wasted crab shells produced in soft-shell crab farms in Shyamnagor, Satkhira (Photo: Md. Mojibar Rahman).

(Perry *et al.* 2010). In this way, soft-shell crab production offers considerable potential for expansion and development in the scaling up of grow-out crab farming.

Expansion of crab culture consequently has the potential to benefit marginalized coastal farmers by building farm capacity, thereby generating economic improvement (Huq *et al.* 2015). Ancillary operational facilities including communication systems, electricity, processing plants, stocking materials such plastic boxes, PVC pipes, feeds, commercial hatchery seed production, packaging materials, and shipments or transportation services are also need and will contribute to regional employment and economic benefits of continued industry development.

**Feasible use of wasted crab shell.** A large quantity of hard-shell crabs are generated in soft-shell crab production, and at present these are discarded in landfills, without any economic use (Fig. 8). An estimated 6-8 million t of waste shells of crab, shrimp and lobster are generated globally each year (Yan and Chen 2015). Crustacean shells contain 20-50 percent calcium carbonate, 20-40 percent protein, and 15-40 percent chitin that could potentially be used for pharmaceuticals, paper industries, cosmetics, textiles, water treatment as well as fertilizers and animal feed production. The development of new uses for this byproduct could have added economic and environmental value.

**Potential for co-culture with fish.** Because soft-shell crab production is practiced in boxes occupying the surface level of ponds, there is a potential for integration with fish culture under the caged crabs in the same pond. For co-culture farming, bottom-dwelling species can be stocked to enhance farm production and income. Also, fish can serve as aerators that improve water quality and can graze phytoplankton, filamentous algae, and macrophytes in ponds as well as attached pe-

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riphyton on crab boxes, thereby serving to clean boxes biologically and reducing farming costs. In crab fattening systems, tilapia, mullet, milkfish and pearlspot are among the most compatible fish species for polyculture (Sathiadhas and Najmudeen 2004). In Bangladesh, research efforts are needed for species selection and the development of culture techniques under crab cages.

## CHALLENGES TO SOFT-SHELL CRAB PRODUCTION IN BANGLADESH

Mud-crab aquaculture remains in its infancy (Paterson and Mann 2011, Azra and Ikhwanuddin 2015). Soft-shell crab farming is a recent commercial aquaculture activity in coastal Bangladesh and operates at a very low scale compared to the heavy market demand. Some of the shortcomings/limitations on this type of business include:

**Lack of infrastructure.** The primary sites for producing soft-shell crabs are in close proximity to the Bay of Bengal, within comparatively disadvantaged coastal sub-districts. Natural disasters have had a significant negative impact on transportation and communication systems in this area. An irregular electricity supply requires farmers to use backup generators, increasing the cost of farming soft-shell crabs. Problems with access to information (limited telephone and internet access) and poor contact with buyers and other business connections result from insufficient coverage by cellular telephone networks. The poor availability and high price of production materials are barriers for the smooth functioning of soft-shell crab production. Many farms lack access to good-quality saline water for farming and fresh water for cleaning crabs and human use. Regulatory policies also make it difficult to obtain required permits for establishing farms and exporting products.

**Lack of technical knowledge.** The production technique for soft-shell crabs can be challenging. The process of obtaining soft crabs has a very technical focus and requires skill and considerable patience. Many biological and environmental factors are involved in molting and maintaining optimal environmental and nutritional conditions during the process contributes to greater production. Poor quality of stocked crabs and pond water conditions can delay molting. Additionally, the ability to critically observe and monitor molting status during premolt stages to forecast the timing of molting and to enable immediate harvest of newly molted crabs can directly influence production rates of soft-shell crabs (Ostrensky *et al.* 2015). Poor knowledge of crab fatteners about farming was documented in previous studies (Ferdoushi and Xiang-Guo 2013, Amutha 2016).

**Limited supply of seeds and high price of inputs.** The daily demand for juvenile crabs for stocking is a critically important issue for this sector. As a result of the gradual expansion of soft-shell crab farms and increases in the capacity of existing production units, the requirement for seed has grown substantially. Additionally, irrespective of sizes collected for soft-shell crab farming, there is a sharp demand for the same inputs as the traditional production and marketing of hard-shell crabs, most of which are exported live. The intensive collection of juvenile mud crabs has had a negative impact on the status of wild populations.

Secondly, the augmented demand for trash fish as crab feed is also generating environmental pressures in coastal areas. The price of these inputs is generally rising and at times supplies are unpredictable. These factors have contributed to a lack of business security and in some cases the failure of small-scale producers. For



FIGURE 9. Soft-shell crabs from small farms ready for transport to a processing plant in Shyamnagar, Satkhira (Photo: Md. Mojibar Rahman).

these reasons, a steady supply of seed is indispensable for the strength and sustainability of this emerging sector (Quinitio *et al.* 2015).

**Lack of marketing access for small-scale farmers.** In Bangladesh, access to export markets for soft-shell crabs is limited. External buyers of soft-shell crabs prefer larger-scale suppliers, favoring bulk purchases and shipments. Consequently, small-scale producers of soft-shell crabs sell their production to larger-scale producers with processing facilities and shipment capacity. These pooled supplies are then exported in the absence of market competitors, in a somewhat monopolized business environment. For these reasons, smaller operators and investors in soft-shell crab production may be restricted to marginal profit levels.

**Quality assurance and quality control.** The maintenance of proper product quality of soft-shell crabs for export is crucial. Many soft-shell farms have facilities for freezing and storage but smaller farms send their products to nearby processing plants that can compromise product quality during handling and transportation (Fig. 9).

**International market competition.** Commercial exploitation and marketing systems for crabs in Bangladesh are entirely export based, with limited demand in domestic markets (Chandra *et al.* 2012, Ferdoushi and Xiang-Guo 2013). Requirements for development of adequate and equitable connections with international export and domestic markets present significant challenges for the Bangladesh crab sector. Apart from these, other crab-producing countries may have competitive advantages with the advancement of technological innovation in the production and processing of value-added products to meet consumer preferences.

## CONCLUSION

Recent increases in the production of cultured mud crabs, accompanied by advancing technology and encouraging prospects in coastal Bangladesh, suggest that the mud crab industry will continue to develop in that area. Economic and market incentives are strong and soft-shell crab production has compelling potential in terms of profitability and sustainability. The future of the soft-shell crab industry hinges largely on the continued development of reliable sources of juveniles. Improved hatchery methods are the subject of a focused effort in Bangladesh and elsewhere. Hatchery technology, coupled with more effective conservation management of wild stocks, should contribute to the emergence of an economically and environmentally sound industry. As availability of crablets increases,



the pressure to harvest diminishing wild stocks will be relieved to some extent and soft-shell crab production is likely to emerge among the most profitable of aquaculture enterprises in Bangladesh.

## Notes

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