

The Footprint on Fragile Ecosystem

Sustainability of Mud Crab Production Practices in Coastal Bangladesh

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Participation of women in crab marketing positively improves their decision-making capabilities. (Photo: Z. Ferdoushi, 2015).

As an export commodity and luxury seafood, there has been increasing interest in crab harvest and crab farming in Bangladesh. The mud crab farming and fishing sector are playing a significant role in the national economy of Bangladesh through foreign exchange earning, increasing employment opportunities, and by improving the livelihood of the rural communities in the coastal region. While crab farming systems are often considered more resilient to environmental stressors and disease than shrimp farming, crab farming in Bangladesh is underdeveloped. Given that the farming depends on the wild seed stock, the existing crab stock in the wild (i.e., in the Sundarbans mangrove areas) is already at risk and over-exploited. Depletion of wild mud crab stock could lead to ecosystem imbalances. Further, low socio-economic capitals are observed in the crab fishing and farmer communities. Any disruption in international markets creates tremendous negative impacts on the income of marginal crab fishers and farmers, as evident in the COVID-19 situation. Therefore, the sectors warrant appropriate planning and policy supports for sustainable development. Considering its strong potential aspect in the international market, suitable environmental conditions in the southwest part of the country, and cheap labor cost, a short-term technology like crab fattening could be developed more through proper management.

Introduction

Seafood is considered the most traded food commodity globally (Watson et al., 2017), of which crab products occupy an important position. According to FAO (2016), the world crab fishery production (primarily comprised of *Scylla serrate* (Forsskål, 1775), *Scylla olivacea* (Herbst, 1796), *Portunus pelagicus* (Linnaeus, 1758), and *Callinectes sapidus* (Rathbun, 1896)) has increased from 343 thousand t in 1990, to more than 951,000 t in 2015. Crab is a member of phylum Arthropoda, belonging to the suborder Brachyura of order Decapoda under the class of Crustacea with broad carapace, living in marine, brackish, or freshwaters. They differ from species to species in size, shape, color and structure (Penn et al., 2018). Among them, Indo-pacific mud crab, swimming crab, Chinese mitten crab, King crab, and spider crab have

become an important source of income for export and local consumption in many countries. Several species of *Scylla* are collectively known as mud crab, indo-pacific swamp crab, or mangrove crab. Keenan et al. (1998) identified four distinct species of *Scylla*; *S. serrata*, *S. tranquebarica*, *S. olivacea* and *S. paramamosain*. It inhabits muddy bottoms, mangrove marshes, and river mouths in estuarine environments (Motoh, 1979), and occurs widely throughout the Indo-West Pacific Ocean and Australia, as well as in Japan, the Philippines, Indonesia, East and South Africa, and the Red Sea (Eldredge & Smith, 2001). There is an increasing trend in the production of mud crab in many Asian regions, propelled by faster growth rate. Wider distribution and high fecundity are other characteristics that are likely to contribute to the positive trend.

Crab aquaculture was firstly developed in China about 100 years ago. Now China, USA, Japan, Korea, and Thailand are ranked as the top five biggest crab consumers (Breinl & Miles, 1994). China, USA and Canada together contribute to 70 percent of the world's crab production. Gravid female crabs play an important role in marketing, particularly in Asian countries; Japan, Taiwan, Hong Kong, and Singapore (Agbayani, 2001). In Bangladesh, mud crab is the second most important seafood after shrimp and prawn in export earnings (Rahman et al., 2017). Compared to other aquaculture practices, crab fattening requires less space and time, with higher profitability that plays an important role in the recent expansion of this practice (Ferdousi, 2013). Thus, wild-caught mud crab and fattening practice of juvenile mud crab are now playing a significant role in the local and national economy through local employment and foreign exchanged earning. These practices are also improving the livelihood of the rural communities by creating alternative livelihood opportunities in the coastal region of Bangladesh. This chapter discusses sustainability issues related to mud crab fattening practices in the coastal area of Bangladesh.

History of crab farming practice

For the last few decades, shrimp farming is one of the most important economic activities in coastal Bangladesh. However, shrimp farming faces serious challenges such as converting mangroves into shrimp farms, destroying other biodiversity during wild seed collection, releasing pollutants into aquatic environments, etc. Again, with the continued expansion of shrimp culture worldwide, market prices have dropped, profit margins have been squeezed, and there has been an outbreak of viral diseases that affected shrimp farming in Bangladesh. In Bangladesh, traditional shrimp culture is done simply by “trapping, holding and growing” the wild shrimp fry gathered from tidal waters. During this type of traditional shrimp farming, mud crab larvae also enter the ponds and the tidal waters. However, the farmers consider these species a nuisance and do not take any special care of them. There are complaints that crabs make holes in the dykes, which drains out the water.

Using the experience of shrimp culture, some professional crab catchers became interested in crab culture. Juvenile mud crabs are released into the pond, and trash fish is used as supplementary feed. After 4-5 months of culture, the first crop is harvested and the next crop is started. This type of grow-out culture practice of crab at first started in the south east and south west part of Bangladesh. The mud crab fattening system was introduced in Bangladesh in the early 1990s. Adult female crabs are reared for gonadal development for 2–3 weeks in earthen ponds or bamboo-made cages (Hasanuzzaman et al., 2014). Both grow-out and fattening culture systems depend entirely on wild-caught of sub-adult or juvenile crab from natural sources. After harvesting crab from the wild, the small-scale fishers sell the crabs to depots where crabs (gravid female and male crabs with all appendages) are packed live for international markets. Damaged and weak crabs are sold on local markets. Healthy, non-gravid and juvenile crabs are stocked in grow-out and fattening systems. In the absence of any hatcheries, small-scale fishers are the only supplier of crablings to the grow-out and fattening culture systems. The southeast part of Bangladesh can establish

hatcheries to provide a continuous supply of seed (Salam & Ross, 2000). There are two seasons for crab fattening in Bangladesh: the dry or peak season (October to May), and the lean or wet season (June to September). According to one estimate, about half a million people in Bangladesh are involved in crab production, and a million others are involved across the carb industry. The export value of crab products was 7.6 million USD in 2015, which skyrocketed to nearly 43 million USD in 2018-19 (Savage, 2021). About 90 percent of crab exports are destined to China.

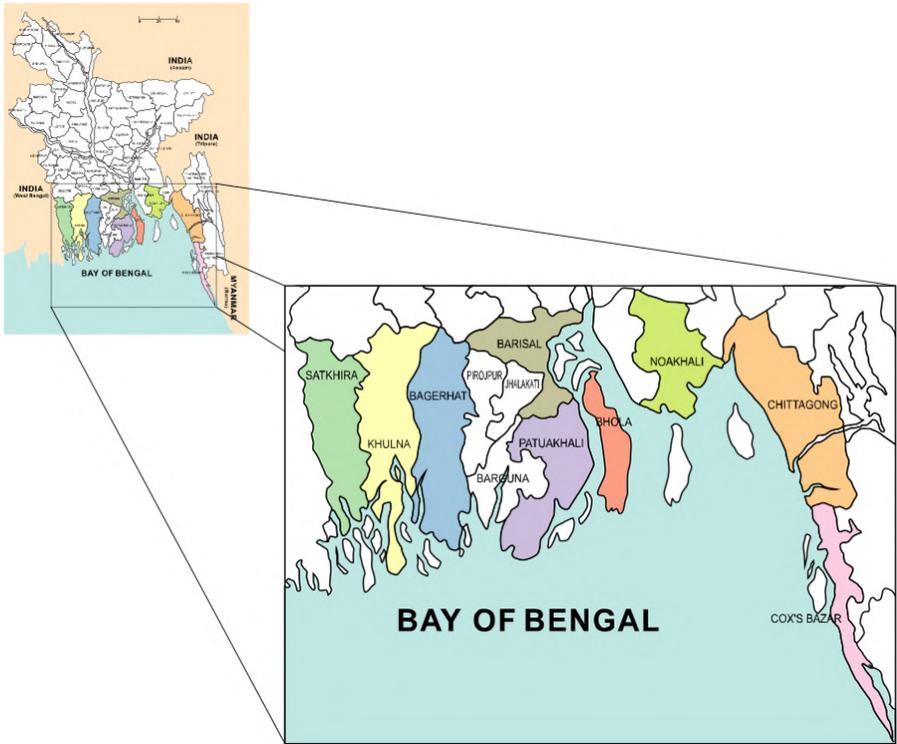


Figure 1. Crab farming and fishing area in Bangladesh.

Sustainability of mud crab production

FAO (1995) defined sustainability as the management and conservation of the natural resource base, and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development that conserves land, water, plants, and animal genetic resources is environmentally non-degradable, technically appropriate, economically viable, and socially acceptable. According to Tisdell (1999), aquaculture development should regard its environmental consequences and the sustainability of aquaculture. Production technology, social and economic aspects, and environmental aspects — these three interrelated aspects are the main flow of sustainability (Figure 2).

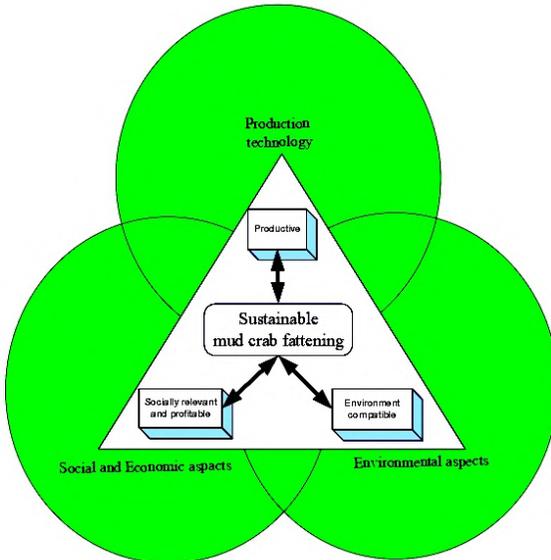


Figure 2. The three inter-related aspects of the sustainability of mud crab fattening in Bangladesh (Adapted from Edwards 1998).

Production aspects

Culture species, culture facility, and husbandry, are the three main aspects of production technology (Edwards, 1998). Culture species influences husbandry during various stages of production. Culture facilities should be diverse as static or running water ponds, cages, and pens. At the same time, husbandry may involve various stock management methods, use of different feeds, management of substrate, water quality management, disease prevention, and therapy (Edwards, 1998). The mud crab fattening in Bangladesh has great potential. Farming in pens and cages in mangrove swamps could be successfully established as an alternative livelihood for the people in the coastal region in Bangladesh (Zafar & Hossain, 2009). While grow-out and fattening systems are practiced more widely, soft-shell farming is also introduced in Bangladesh. While crab farming systems are often considered more resilient to environmental factors and disease than shrimp farming, crab farming in Bangladesh has also experienced a boom-and-bust cycle. The capture mud crab fisheries are a year-round coastal fishery, particularly in the mangrove habitats of Bangladesh. The harvesters use a variety of fishing methods that include long metal hooks, split bamboo trap, rope line, cast net, setbag net, or even fish by hand. In the Sundarbans mangrove forest, non-mechanized country boats are used to operate these gears, which are controlled by one to three fishers, often by family members, including women and children. The crab farmers usually buy juvenile crab from the small-scale fishers at Tk 10 per species, which are then reared in pond and gher (enclosure) for three months. It is estimated that after spending BDT 45 per crab, the farmer can sell it at Tk 250 (BBS, 2020). Earlier fishers were able to collect 4-5 kg crabs; after five years, the amount lowered to 2-3 kg. The size of crabs has also reduced from 250-350 g to 100-150 g. For better catch, crab fishers must roam a longer distance in the forest (Rahman et al., 2017). Over-exploitation, harvesting small and brood crabs, destruction of breeding and nursery habitats, environmental pollution, have all led to a decline of natural stocks of crab fishery (Rahman et al., 2017).

Environmental aspects

The external environment includes the natural resources used for aquaculture development such as land, water, nutrients, and biological diversity. The internal environment of the aquaculture system is considered as husbandry part of the production technology (Edwards, 1998). However, like any other aquaculture practice, brackish water mud crab fattening can also negatively impact the environment. The most important one is the overexploitation of crab in the mangrove region, increased soil salinity that could raise the social conflict between agriculture and fisheries. Moreover, unplanned construction of ponds or other structures would also reduce biodiversity. The farming depends on the wild seed stock. The harvesting pressure could decrease the wild stock, and the uncontrolled fishing of brood may threaten the natural populations, ultimately affecting fishers' livelihoods. Despite all negative impacts, mud crab farming in pens in mangrove swamps can enhance the soil quality by increasing the organic carbon (Zafar & Hossian, 2009). In addition, the practice has offered an opportunity for increasing farmer's incomes. However, the overall balance between resource use and impact needs to be more widely assessed.

Unfortunately, crab farming resulted in several adverse environmental effects on estuarine ecosystems. Figure 3 is showing the direct and indirect environmental impacts of crab farming. Coastal farming could directly or indirectly alter the aquatic and terrestrial environment and bring changes in the physical environment through its negative environmental impacts. All of those changes can ultimately destruct the local ecosystem, including the livelihood of the coastal people (Figure 3).



Figure 3. Direct and indirect environmental impact of mud crab fattening.

There is a number of drivers behind the recent expansion of mud crab fattening in Bangladesh. The species has a high tolerance to environmental stress and disease occurrence. It has a shorter crop cycle; thus, the economic return is high; culture systems are diverse with low to moderate to high inputs, and the culture technique is simple. Therefore, this activity became a viable alternative livelihood option. Plus, the species has a lucrative international market. All these factors make crab fattening a popular farming practice (Rahman et al., 2020). However, this practice has a footprint on the coastal ecosystem, particularly on the Sundarbans mangrove ecosystem. Due to the unavailability of hatchery-produced crab seeds, the farmer is dependent on wild-caught juveniles (Ferdoushi & Xiang-Guo, 2013) for the fattening practices. Again, wild sources also serve as the source of mature crab. The harvesting of wild stock seems unsustainable as berried crab is often harvested during breeding, bypassing the annual banned period in January-February. Unfortunately, it has been speculated that the existing crab stock in the wild, primarily in the Sundarbans mangrove areas, is already at risk

and possibly over-exploited (Chantarasri, 1994). Indiscriminate harvesting, harvesting freely during the breeding season, and destruction of natural habitats, including breeding, feeding, and crab nursery grounds, have been reported more recently (Rahman et al., 2017). Depleting wild mud crab stock may lead to ecosystem imbalances resulting in ecological deterioration of water and soil, along with loss of biodiversity in the Sundarbans mangrove forests and other areas experiencing high fishing pressure (Rahman et al., 2020).

Socio-economic aspects

The social and economic aspects are getting attention nowadays and there is a significant concern for livelihoods of connected communities (Ruddle, 1993; Edward, 1998). In the coastal region of Bangladesh, particularly in the southeast and southwest part, mud crab fattening is widely practiced and socially accepted due to its greater contribution to the livelihood of the coastal people. The practice could be varied in regions with different social characteristics like age, religion, family size, and production, and total income from fattening. In the rural area, the farmer's access to vital social services like education and training is poor (personal communication). While some commercial enterprises are involved in crab farming, most of the farmers and all harvesters are small-scale. The industry employs nearly 500,000 farmers, most of them with very small landholdings who are living below the poverty line (Roy, 2020). A survey of the farmers involved in mud crab fattening shows that the majority of farmers involved in mud crab fattening are between 26-35 years of age. Very few farmers (only 5 percent) had more than a secondary school certificate education. About 36 percent of the total farmers have a household with 5 to 6 people. The larger size of the family may make it difficult to invest in farming due to financial constraints. It is revealed that 63 percent of interviewed farmers took on crab fattening as their primary occupation (Ferdousi, 2013). There is a low adoption rate of this improved technology because of the incremental cost implications, which the farmers cannot afford and because of inappropriate extension methods

and unfavorable weather conditions during the wet season. Moreover, lack of training programs could be another barrier in this sector.

Similar low socio-economic capitals are also observed in the small-scale fishing communities that collect crabs from the Sundarbans. Besides traditional fishers, many poor people who lost other livelihood options on land, as well as deserted or widowed women are also involved in crab harvest. As the crab market is export-oriented with very low local demand, any disruption in international markets creates tremendous negative impacts on the income of marginal fishers and farmers. Particularly, closures of global markets during COVID-19 created a dire situation characterized by huge income loss, food insecurity, and poverty.

Conclusion

The above discussion reveals that the introduction of crab fattening in Bangladesh can bring substantial social and economic benefits to marginal segments of society. However, the insufficient resources, poor institutional support, lack of extension services, vulnerability to interruption of global markets can be considered as the major constraints for long-term sustainability and sustainable livelihoods for crab farmers. However, unlike shrimp and prawn, crab farming in Bangladesh has not developed as fast as expected. It is still in the primitive stage, constrained by inadequate research focus with respect to both the mud crab fishery and species biology. Therefore, the industry warrants appropriate planning and policy support for sustainable development. The income of crab farmers could be significantly higher if culture methods were intensified. Considering its strong potential aspect in international market and suitable environmental conditions in the southwest part of the country, cheap labor cost and short-term technology like fattening could be better developed through proper management. Both the private and public sectors can play a significant role in developing this export-oriented species. Proper institutional and administrative support and extension services like training, providing precise message during the needed time would positively affect the livelihoods of the poor. It also

observed that the participation of women in crab fattening could positively improve their decision-making capabilities. However, it is urgently needed to have more support from national and international organizations. More research and knowledge, and extension services are needed for sustainable livelihoods through crab farming. Overexploitation of wild crab fishery is another major concern. Therefore, it is essential to immediately improve the technology and management with proper stocking density assessment, and establish a resilient environment by reducing stress through sustainable water management practices. The government should take necessary steps to stop the current rate of mangrove habitat destruction to allow suitable living conditions for the restocked mud crab larvae into the mangrove region. Government should also pay attention to the alternative income-generating option for poor fishers in the mangrove region during the closed season.

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Zannatul Ferdoushi is currently serving as a professor in the Department of Fisheries Management, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh. Her PhD research focused on crab fishing and fattening practice in Bangladesh. At present, her research emphasizes interdisciplinary approaches related to fisheries resource management through environmental sustainability and biological production assessments.