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Mud crab farming: An alternative livelihood in the Indian Sundarban

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Mud crab grow-out pond.

Mud crab is one of the most valuable crustaceans in both domestic and export markets. They are hardy and can survive out of water for extended periods at lower temperatures making them ideal species for live export to other countries and the domestic market. There are four commercially important species of mud crab, *Scylla serrata*, *S. tranquebarica*, *S. olivacea* and *S. paramamosain* and they are the focus of commercial fisheries and aquaculture production throughout their distribution (Keenan et al., 1998, Shelly and Lovatelli, 2011). Molecular studies conducted in India suggested that *S. serrata* (Forsk.) is the most abundant mud crab species in India followed by *S. olivacea* (Balasubramanian et al., 2016).

S. serrata are the largest species, commonly known as green crab whereas *S. olivacea* has orange to reddish colouration in claws and carapace. *S. serrata* can grow to a size of over 1.5 to 2 kg while *S. olivacea* reported to have a maximum weight of 1.2 kg. Mud crab has huge demand in export and domestic market fetching a price from 8 to 25 USD depending on size and season. This report is prepared to familiarize the farmers, researchers and entrepreneurs about the current practices adopted by mud crab farmers in India with special reference to the Indian Sundarban where mud crab capture and farming constitute an important livelihood among the small holder farmers.

Wild seed collection and traditional farming

Mud crab fattening predominates farming practices in Sundarban as opposed to grow-out culture. Locally, mud crab fattening is known as *chamber chas* and has been practiced since the late 1990s (Nandi et al., 2016) although the contribution of mud crab to fisheries is an age old practice in Sundarban. In West Bengal, three districts, namely North 24 Pargana, South 24 Pargana and Purba Midnapur have brackishwater areas (Mahapatra et al., 2014), some of which is utilised for mud crab culture and fattening. Smaller sized mud crabs from capture fisheries contribute to the domestic market whereas crab fattening or grow out systems aim for the export market.

Juvenile mud crab are generally purchased by the farmer from wild seed collectors (0.10-0.15 USD/ 20 g size). Mud crab fattening is carried out by feeding trash fish or farm-made feed at the rate of 5-8% body weight either directly in pond, pen or cage systems for a period of 20-30 days or until the gonad-developed animal fetches a good price in the domestic and export markets. Different types of low-cost by-catch, trash fish and molluscan meat are fed to animals of different sizes depending on season and availability. Bombay duck (*Harpodon nehereus*), goat fish (*Upeneus* sp.), threadfin



Above, below: Trash fish (raw and sun-dried).





Preparation of farm-made mud crab feed.

bream (*Nemipterus* sp.) and grenadier anchovies (*Coila* sp.) are among the commonly available trash fish in West Bengal. Molluscan species such as *Telescopium* sp. and *Bellamya bengalensis* which are available in ponds and canals as pests are often caught and utilised as feed in nursery rearing of mud crab. The ease of farming and lower investment required in crab culture along with good return attracts small farmers to this venture.

Improved culture practices

In an effort to circumvent the long culture period and optimise the economy, ICAR-CIBA developed a three tier modular farming system of mud crab which can readily be adopted by farmers of the Sundarbans. The long culture period of 6-8 months hinders the production efficiency, survival rate and economics resulting in farmers' reluctance towards adopting the farming practices.

Nursery culture in hapa system

Nursery rearing is carried out using hatchery produced mud crab instar of *S. serrata*. In this system, a 20 micron mesh nylon net hapa of described dimension (eg. 3 m X 3 m X 3 m, 5 m X 5 m X 3 m) is suspended equidistantly between rows of catwalk using rope. The pre-stocking pond preparations include drying, ploughing, filling, disinfection with bleaching powder (30 ppm), liming (200kg/ha) and fertilisation using probiotics and minerals to initiate algal productivity. Hides made of shredded plastics or ropes are sufficiently placed inside the hapa to facilitate shelter and reduce cannibalism. Mud crab instars of 5-6 mm are stocked @ 90-100 / m³ in a hapa. Molluscan meat, chopped to a size suitable for the crab, are fed ad libitum twice daily by lowering a feeding tray inside the hapa. Feeding trays are exclusively employed in order to avoid wastage of feed and to check contamination of water. Grading of animals is carried out 15 days after stocking and continued till harvest i.e. 25 days of culture (DOC). After 25 days, an average survival of 80-90% is achieved and the crablets are stocked in nursery ponds.

Nursery rearing in pond system

The harvested crablets of 2.5-4 cm from hapas are stocked into nursery ponds at the rate of 3-4 individuals/m². Pond preparation includes crab fencing, disinfection, liming and fertilisation using minerals and probiotics. A specially



Farm made pellet feed.



Hapa nurseries for rearing of mud crab instar.

designed feeding tray that leaves a space between the bottom soil and tray while submerged is employed to avoid crushing of crablets present in the bottom sand while lowering the tray. The animals are fed with chopped molluscan meat ad libitum twice daily. To provide shelter and to avoid cannibalism, a large number of hides made of pipes and tiles are provided. Grading and culling of animals are carried out by carefully picking up the hideout pipes and collecting shooters of 80-100 g among the smaller size crabs (10-40 g) which were then stocked to grow-out ponds. Final harvest after completion of second tier is carried out after 45 days with an average harvest size of 80g (40-120 g) and average survival of 50%.

Grow-out system in pond

The harvested crabs of 70-80 g size are stocked in grow-out culture ponds at a rate of 0.5-0.7 m² and cultured for a period of 6 months. Paddle wheel aerators (2 HP) are operated in grow-out ponds for two hours daily to improve circulation of water in order to disperse the pheromones released during moulting which attract other crabs. The animals are fed with chopped trash fish or wet feed prepared by mixing trash fish with fish oil, flour, probiotics and yeast. After six months culture, the male *S. serrata* attain an average weight of 900-1000 g while females attain 600-700 g with an average survival of 60%. Partial harvest is carried out by the bamboo-line method while final harvest is done by completely draining

of pond and hand-picking crabs from the bottom of the pond. In the bamboo-line method, capture of culture mud crab is usually done using a line where a rope is attached to a wood or bamboo stick, at the end of which is a weight and bait is tied to assist in sinking and luring the mud crab. Several such lines may be placed on the dyke of the water body and the catch can be made using a circular net when the line stretch indicates a pull by mud crab.

Polyculture

In an on-station experiment, polyculture of mud crab was carried out along with different finfish and shellfish species such as milkfish (*Chanos chanos*), mullets (*Mugil cephalus*, *Liza tade*, *Liza parsia*), shrimp (*Penaeus indicus*). The combination of mud crabs (*S. serrata*) and milkfish and mud crabs and mullets at 0.5:0.5:0.5 ratio indicated a benefit-cost ratio (BCR) between 1.57 and 1.73 respectively. Growth parameters of mud crabs were similar in both (407.64 ± 105.78 g and 418.89 ± 105.24 g respectively), with no significant differences after 210 days trial (Anand et al., 2018). In another experiment, crab monoculture was compared with polyculture with *Penaeus indicus* (2/m²) and *Mugil cephalus* (0.5/m²). Mud crab (59.47 ± 1.77 g) stocked in all ponds at the rate of 0.5/m² uniformly, recorded no significant difference between the polyculture and monoculture ponds. These results show that there is no negative interaction between



Crab hide used in nursery.



Hapa-reared crablets.

the mud crab and other animals stocked in the polyculture pond which indicated that polyculture provide an efficient and sustainable utilisation of resources.

Box culture

In recent years, a capital-intensive box culture method of crab growout has gained popularity among mud crab farmers. In box cage systems, fattening is largely carried out although grow-out is also done in a lesser scale. In case of grow-out culture, the nursery reared crabs are stocked in boxes at the rate of one crab per box and cultured for 4-6 months attaining 200-400 g for *S. olivacea* and 300-900 g for *S. serrata*. Box culture systems have both advantages and disadvantages. The pros of the system include lower maintenance, predictability, easy assessment etc. It can also be employed in and indoor system where there is scarcity of land and water using flow-through or recirculatory aquaculture systems (RAS). A high capital investment on boxes and related equipment is one of the drawbacks of box-culture system. The lower activity of crabs is also believed to lower the metabolism of the animals and subsequent feed intake. Therefore, the animals in boxes are fed only once daily with trash fish compared to two times in open pond culture systems. Very low activity of the animal inside the box-cage, coupled with constant exposure to sunlight, as the boxes remain at the surface, result in infestation by algae and difficulties with molting can constitute a problem during culture.

Crab fattening involves rearing of soft-shelled or immature crabs in individual boxes wherein the animals are fed until the shell is hardened or up to the development of gonads. Gravid females with full orange-red eggs fetch a high price both in domestic and export markets. A 200 g animal after 1 month gain 25-50 g and the fattening may continue for 9-10 months in a year with one fattening cycle duration of 20-30 days.



Nursery rearing of mud crab in ponds.



Nursery-reared crabs.



Feeding tray.



Mud crab harvest using farm-made circular net.

Submersible box system

The high temperature during summer induces stress to the cultured mud crab in boxes which remain afloat at the pond surface throughout the day. Besides the stress caused by the heat, the constant exposure to sun may cause algal growth and fouling on the exoskeleton. These factors may lower the market value of the animal, hinder molting and cause death due to high temperature. A practical and innovative thinking is imperative in solving a problem faced in the farm, and has been one of the significant factors in improving the culture system. Keeping in mind these factors which adversely affect the box farming, the submersible box system was developed. This submersible box system is engineered and designed based on the function of a water pump. In this system, the PVC pipe which help float the box are interconnected and a pump is attached in one corner of the pipe. The system functions by pumping in or flushing out water from the pipe which in turn submerged or make the structure afloat. Using this technique, the cages can be submerged underwater during the hot days.



Above, below: Box culture of mud crab.

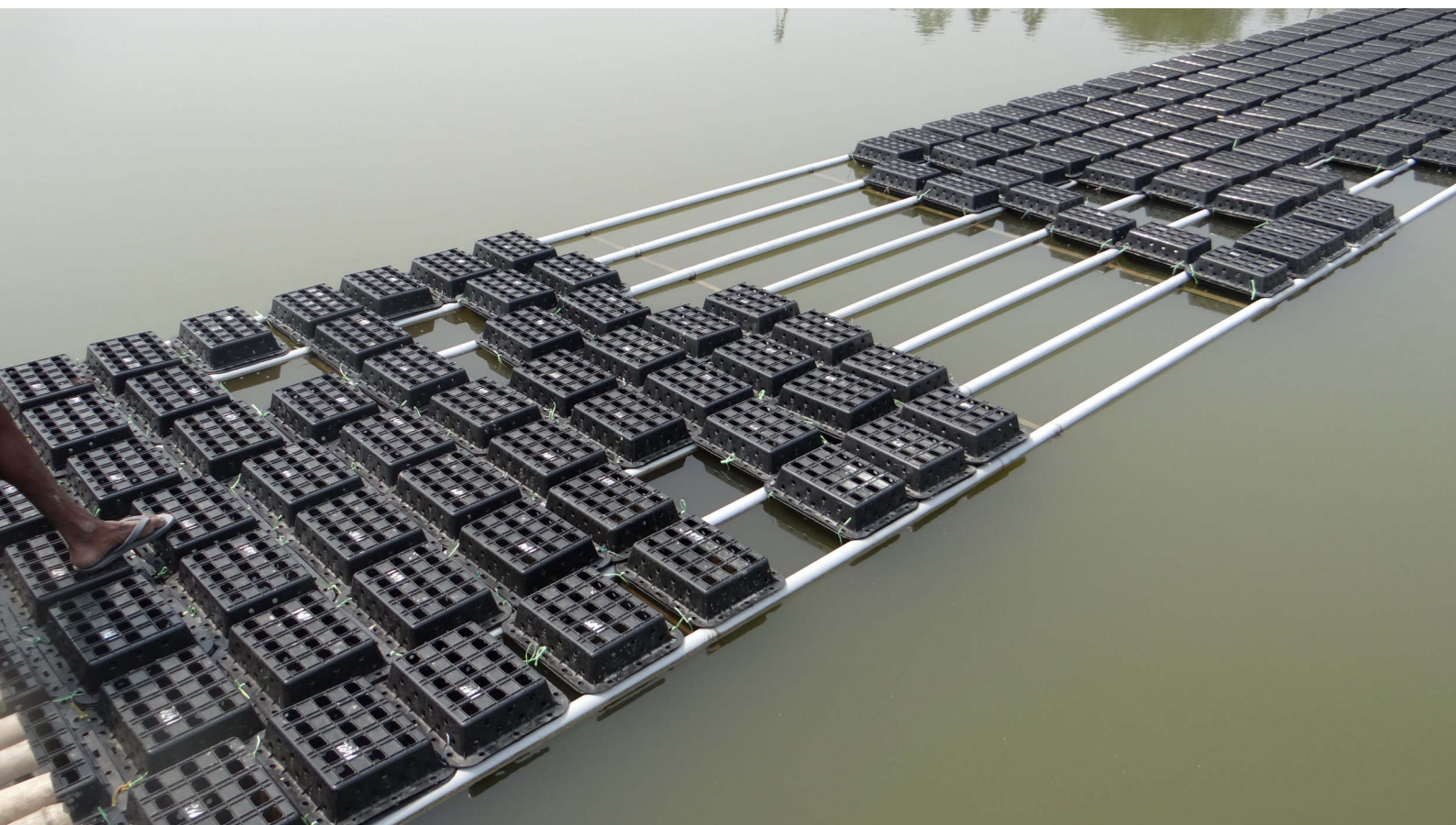
Vertical RAS system

Another emerging technology that has entered the market in recent years is the vertical RAS which is designed principally for indoor environments. This system incorporates a sand-filter, bio-filters and U.V. filters, which are all interconnected with a specially designed and vertically stacked mud crab box. Although it is a sophisticated system with the ability to control water quality requirements and facilitate observation of the culture crabs, it may not be suitable for farmers of low means due to its high initial investment. On the other hand,





Above, below: Rafts for box culture of mud crab.





Above, below: Different styles of boxes for crab growout.



Interconnecting pipes for support and floatation of box cages.

vertically stacked mud crab boxes which can be installed in pond system with a lifting and sinking mechanism can be an innovative and less expensive alternative for farmers.

Market

The mud crab produced through culture and fattening is generally aimed for export market. Most of the farmers directly sell their product to exporters but in some cases may also involve middlemen. The different grades of mud crab (*S. serrata* and *S. olivacea*) fetch different prices which are fixed by the exporter depending on prevailing export market. Mud crabs that have lost a claw or are in sub-optimal condition are often blatantly rejected by the exporter. Male mud crabs of more than 1 kg and berried females of >900 g fetch 22-24

USD kg⁻¹. Mud crabs of size > 700 g, >500 g, >400 g and >300 g fetch 17-18 USD, 13-14 USD, 11-12 USD and 8-9 USD respectively. Mud crab (*S. olivacea*) of size ranging from 20 g to 150 g is commonly available in the local market fetching a price of 3-6 USD.

Constraints in mud crab farming

The mud crab farming in India overwhelmingly depends on collection of wild seed posing a threat to the wild population. Hatchery technology, although available, has limitations owing to the poor survival of larvae. Development and dissemination of mud crab hatchery technology is desirable to resolve the problems of the farmers. The lack of commercial feed mill and manufacture of dedicated mud crab feeds compel farmers to use low-cost fresh feed. Low priced feed such as trash fish and molluscs remain the major feed fed to culture mud crab. The problem with these feeds is fast spoilage and the requirement of storage facilities.

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1.5 HP pump for suction and delivery of water into the box cage pipe, controlling floatation and submersion.



Several units are interconnected using the main pipe from the pump.



A single farm-made submersible cage.