Mud Crab (*Scylla* spp.) Aquaculture in the South-West Sundarbans Region of Bangladesh

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Abstract

Mud crab (*Scylla* spp.) aquaculture has become an important livelihood option for the coastal fisher-folks in Bangladesh. Mud crabs harvested from wild sources are traditionally fattened in pens installed in tidal rivers, *ghers*, and earthen ponds in Bangladesh. The study was aimed at understanding the practice and production economics of mud crab farming in the South-West Sundarbans region of Bangladesh, and was conducted in the areas namely Bagerhat, Satkhira and Khulna districts where mud crab fattening are predominately ventured. Most of the farmers fatten both male (lean) and female (gonadally immature) crabs of 100 - 180 g. The crabs are stocked at varying rate (12 - 641 g/m^2), and fed at the rate of 8-10% of body weight with trash live fishes, dried fishes, snails, mollusks, and cattle viscera. The fattening for a mean cycle of 22 ± 14.34 days has the survival rate of 55 - 90%, and has the production of 0.065 ± 0.26, 0.084 ± 1.33, and 0.17 ± 3.76 kg/m^2 in Bagerhat, Satkhira, and Khulna, respectively. After harvesting (mostly partial), crabs are sold at average price rate of 4.35 ± 0.45 US$/kg. The lowest production cost (3.14 US$/kg) and the better economic return (US$ 147.77) per cycle was recorded in the district of Satkhira. The mud crab fattening has hitherto

been evaluated economically feasible in and around the Sundarbans region, but the production and economic efficiency can be scaled up adopting scientifically demonstrated regime of stocking, feeding, and health management. The development of crab seed hatchery, artificial feed for crab, and strongest marketing network are addressed as crux issues for the sustainability of mud crab aquaculture in Bangladesh.

Keywords: Mud crab; Fattening; Pen Aquaculture; Socio-economic; The Sundarbans

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Introduction

Mud Crabs (*Scylla* spp.) with their increased global acceptance as high quality seafood as well as their substantial socio-economic role in artisanal coastal fisheries in many tropical and subtropical Asian countries become one of the commercially important aquaculture species. These mud crab species are widely distributed in Indo-West Pacific region (from East and South Africa to Southeast and East Asia), Northeast Australia, the Marianas, Fiji, and the Samoa Island. Given aquaculture potentiality, *Scylla serrata*, *S. tranquebarica*, *S. paramamosain* and *S. olivacea* are the most commercially farmed mud crab species (Shelley and Lovatelli, 2011). These mangrove swamp dwelling species are predominantly cultured in China, Philippines, Thailand, Vietnam, Malaysia, Indonesia, India, Sri Lanka, and Bangladesh. Since dating back to the mud crab culture in Guangdong, China in 1890

(Shen and Lai, 1994); the farming of mud crabs (based on wild crab stock) has been practised in the three basic types of grow-out from crablet (small crab) to consumption size, fattening of empty/lean/soft-shell crabs and rearing berried crabs in earthen ponds, pens, cages, tanks, and integrated silviculture in coastal waters and mangrove forests.

Historically the mud crab aquaculture was developed by the low-income fisher-folks (Overton and Macintosh, 1997) and later it became popular among the shrimp farmers as an alternative to shrimp industry, which was affected severely by white spot disease in 1990s. The characteristics of mud crab species (e.g. wide environmental range adaptation, disease resistance, easy live transportation) as well as their feasibility to low-input farming technology make these species suitable candidate for aquaculture industry.

In Bangladesh, mud crab aquaculture took its root along the coastal belts in late 1980s (*personal Communication*), and was developed

in the form of fattening wild lean crab harvested from the forests and rivers around the Sundarbans and the Chakaria Sundarban in Bangladesh. The potentiality of mud crab aquaculture is reported in various articles (Ahmed, 1992; Kamal, 2002; Zafar, 2004; Zafar and Hossain, 2008). Over the last few years, mud crabs have become luxury export commodity, and are exported from Bangladesh to Taiwan, China, Hong Kong, Malaysia, Thailand, Korea, Singapore, Japan, USA and EU. The export value

of mud crab in 2009-10 was estimated at more than US$ 4637681.16 (BEPB, 2010).

As mud crab aquaculture is not historically well developed in Bangladesh, a number of scientific studies were conducted focusing on fattening techniques in earthen ponds, cages and bamboo pens (Kamal, 2002; Kamal and Uddin, 2004; Zafar, 2004; Zafar and Hossain, 2008; Khatun *et al.* 2009), and pond fertilization, effect of salinity and stocking density (Saha *et al.*, 1999, 2000; Mia *et al.*, 2007; Mia and Shah, 2010) to improve the farming technology. Nevertheless, the mud crab farming is hitherto practised in a traditional approach by the coastal poor fisher-folks. The present study was thus aimed at understanding the practice and production economics of mud crab farming systems in and around the Sundarbans regions. This paper also addresses the key issues of sustainable mud crab aquaculture in Bangladesh considering international market, socio-economic and environmental challenges.

Materials and methods

The study was carried out in three districts namely Satkhira, Khulna and Bagerhat of Bangladesh (Fig. 1) with recognizing the fisher-folks in these areas as the pioneer of fattening mud crabs in Bangladesh.

The study acquired primary data from direct field survey following questionnaire interview, focus group discussion (FGD), and cross-check interviews. Initially a pilot survey was done with

draft questionnaire to obtain base line information on mud crab farming. Attention was paid to incorporate any new information that had not been written in the draft schedule. Based on the experience and information acquired from the pilot survey, draft questionnaire was then necessarily modified and updated into structured questionnaire. The set questionnaire was then filled up by interviewing farmers involved in crab farming in the study areas. The interviews dealt with mud crab fattening system, production costs and returns, socio-economic status of fatteners, and prospects as well as constraints of mud crab farming in Bangladesh.

FGD with fatteners, fishermen, collectors, depot owners, and exporters was conducted to determine issues pertinent to sustainable production technology, socio-economic benefits and environmental impacts of mud crab aquaculture. Each group had a size of 8 to 12 individuals, and the FGD sessions were held at fattening farms, fatteners' house, and local markets.

The information collected was validated through cross-check interview with Upazilla fisheries officers, relevant non-government organization (NGO) workers, local researchers and leaders.

As the farmers do not practise book keeping, it is very difficult to collect data. Considering their memory, data collection is often questioning. However, the economic analysis and performance indicators were determined according to Shang (1990). In the data analysis, mean values, percentage and ratios are considered, and the economic performance was estimated per cycle of fattening. All

data collected from questionnaire were compiled using Microsoft Excel software-2007, and rearranged, tabulated and presented as descriptive statistics using Software SPSS 15.

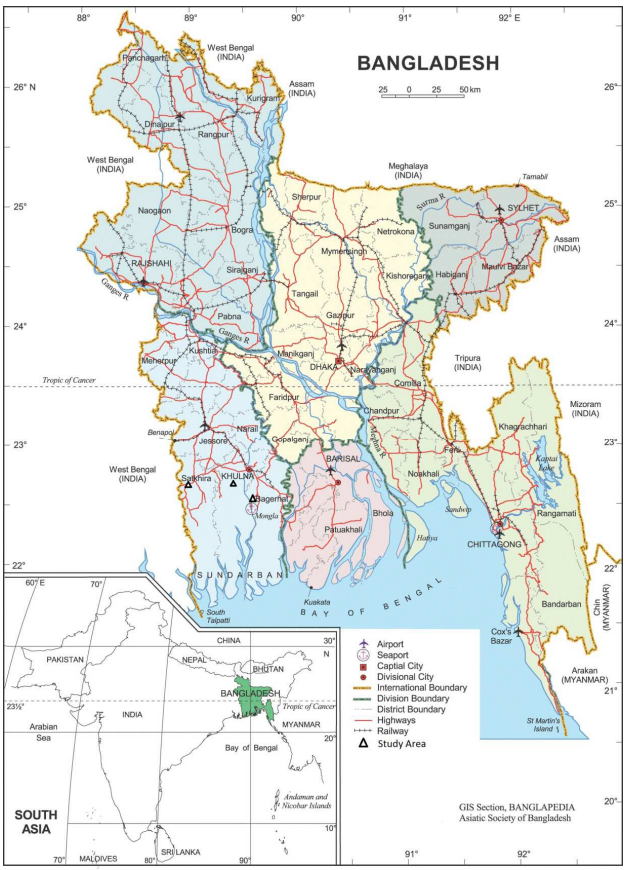

Fig. (1): The Map showing the study area

Results and discussion

Pattern of mud crab farming

Traditionally, the mud crab aquaculture in and around the Sundarbans region deals with *Scylla* spp., which is not well defined in Bangladesh whilst *Scylla serrata* and *S. olivacea* are much more

confusingly interpreted in literatures (BOBP, 1992; Saha *et al.*, 2000; Kamal, 2002; Kamal and Uddin, 2004; Zafar, 2004; Zafar and Hossain, 2008). However, the mud crab species are predominantly cultivated in the form of fattening lean (locally called as water) and/or empty (egg-less/incomplete egg) crabs of low market value for a short period of time (12-30 days) to increase their meat and egg content with supplementary feeding.

In the study areas, the artisanal fisher-folks involved in crab trading (catching and selling) in Paikgachha under Khulna district are reported as the pioneer of introducing such fattening of mud crabs inhabiting abundantly in the Sundarbans, mangrove tidal rivers and coastal waters. Later on, the mud crab fattening became profitably popular among the fisher-folks, and got extended in other south-western districts, noticeably in Satkhira and Bagerhat districts. At present, the practice of mud crab fattening in the south-west Sundarbans region is reported by about 37%, 35% and 28% in Bagerhat, Satkhira and Khulna, respectively.

The fattening of mud crabs are adopted (Table 1) in pens (made of bamboo, bamboo-fence, betel-nut tree-split, rope and nylon net) installed in earthen ponds (Fig. 2), *Ghers* (inundated and enclosed coastal low-lying fields; Fig. 3) and in tidal rivers in the study areas. Most (90.20%) of the pens are put into practice in *Gher* while 8.50% and 1.30% are in tidal river-pens and earthen ponds, respectively. The size of the pen was found highly variable with ranging from 80 to 24960 m^2, and the mean size was recorded as 6933.20 ± 157.39, 1667.20 ± 34.99 and 1555.60 ± 22.86 m^2 in Bagerhat, Satkhira and Khulna, respectively.

Keenan and Blackshaw (1999) reported the fattening in pond of 8000 m^2 in Southeast Asia. However, the size recorded in the present study is found larger compared to the fattening ponds of 200-500 m^2 and enclosures of 100-300 m^2 in Vietnam (Duc Dat, 1999). Cholik (1999) also reported fattening in ponds of 500-800 m^2 in Thailand and of 1000 m^2 in Indonesia.

Table (1): A brief features of mud crab fattening system adopted in the South-West Sundarbans region of Bangladesh

Parameter	**Location**		
	Bagerhat	Satkhira	Khulna
Size of pen (m^2)	1040 – 24960	80 - 5200	208 - 3848
Size of water/empty cab stocked (g)	100 - >180	80 - >180	100 ->180
Stocking density (g/m^2)	28.75 -77.00	12.00 – 192.25	72.00 – 641.00
Feeding rate (% of body weight)	8 – 10	8 - 10	8 – 10
Fattening period (days)	15 – 75	12 - 15	15 – 30
Survival (%)	70 – 95	60 - 90	45 – 80
Production (kg/m^2)	0.045 – 0.077	0.021 – 0.119	0.062 – 0.432

Fig. (2): Mud crab fattening in earthen pond

Fig. (3): Mud crab fattening in *gher*

Most of the crab farmers (about 77%) do fatten only mixed sex crabs in their pens and others cultivate fishes (e.g. *Oreochromis* sp., *Pangasius* sp., *Setipinn*a sp., *Lates calcarifer, Liza parsia,*

Rhinomugil sp.) and tiger shrimp (*Penaeus monodon*) with mud crabs (mixed sex) in the fattening pens. Before stocking, most of the mud crab farmers (about 66%) do not dry pens but about 27% and 7% of farmers do practise incomplete drying and complete drying, respectively.

The farmers collect lean and/or empty crabs of 100 - >180 g from different sources such as crab depot (about 88%), river+*Gher* (about 5%), forest+river (1%), agent (1%), agent+depot (about 1.5%), and *Gher*+depot (about 1.5%), and stock them at spatially varying stocking density (SD) as of 48.50 ± 0.47 g/m^2, 66.0 ± 2.13 g/m^2 and 250.25 ± 5.24 g/m^2 in Bagerhat, Satkhira and Khulna, respectively.

The SD is found relatively lower than that of 500 – 1000 g/m^2 in Vietnam (Duc Dat, 1999), and of 408.84 g/m^2 (experimentally) in Bangladesh (Begum *et al.*, 2009). According to Shelley and Lovatelli (2011), mud crabs can be stocked at the rate of 500 -900 g/m^2 in fattening system.

None of the farmers fertilize their pens. But, about 74% farmers use lime before stocking as well as in the course of fattening, especially when water fall significantly, water becomes red with bad odour, and moribund and dead fishes and crabs are found in *ghers*. The application dose (4.161 ± 84.76 g/m^2) is not as scientific rate of 25 g/m^2 in mud crab culture as reported by Begum *et al.* (2009). However, the application of cow manure of 750 kg/ha, urea of 20 kg/ha and TSP of 25 kg/ha may increase the production and profitability of the crab fattening system according

to Begum *et al.* (2009). Saha *et al.* (1999) also recommends the use of cow manure at the rate of 500 kg/ha per two weeks in addition to supplementary feed.

The crabs are fed with a different kinds of fishes such as *Oreochromis* sp., *Pseudapocryptes elongates* (locally called as *Chewa* fish), *chela* sp., *Salmostoma* sp. (locally as *Chela*), *Puntius* sp.,*Glossogobius* sp., *Monopterus cuchia,* small lower-priced mixed trash fishes (locally called as *Amadi*), eel fish, drying fish, snail, and cattle viscera. The farmers buy these food staff mostly (69%) from market, and also collect from river, collectors, fishermen, depots, and agents. The fishes and other food are first chopped, then washed and finally spread over the water surface at the feeding ration of 8-10% body weight which is in the range of daily feeding level reported by Shelley and Lovatelli (2011); Khatun *et al.* (2009); Begum *et al.* (2009); Agbayani (2001) and Duc Dat (1999). About 54% farmers feed crabs traditionally in the morning every day. However, some farmers feed in both morning and evening, some at evening or at afternoon, and even at anytime. It is noticeably reported that farmers feed crabs once at interval of one day while they use snail and the price of food is high. Most of the farmers try to monitor the feeding of crabs checking by hand, eye or if feed is floated.

Most of the farmers (about 74%) monitor the water quality but not in scientific way; only perceiving water colour and odour. They apply lime at the rate of 4.161 ± 84.76 g/m^2 and potassium permanganate, $KMnO_4$ of 0.11 ± 0.61 g/m^2 when water deteriorates

and mortality of crabs and fishes occur. However, the optimal range of dissolved oxygen (> 5 ppm), pH (7.5 – 8.5), salinity (>10 ppt) and temperature (25 – 35 ^{o}C) should at least be monitored as suggested by Shelley and Lovatelli (2011) to increase the survival and minimise the risk of diseases.

The fattening per cycle in the south-west regions of Bangladesh has a wide duration of 12 – 75 days. The mean cycle is reported as 32 ± 19.19, 14.31 ± 1.26, and 18.91 ± 6.73 days in Bagerhat, Satkhira, and Khulna districts, respectively. It is also notably reported that farmers often prefer crabs, locally called as *virgin* (not mated; not well distinguished sexual characteristics) because such *virgin* crabs are found to grow faster. However, the average duration of fattening cycle lie in the typical range of 14 – 60 days reported by Shelley and Lovatelli (2011); Agbayani (2001) and Keenan (1999).

Most of the farmers (about 98%) practice partial harvesting during high tide, which is found substantially related to muscle flesh fullness and shell hardening of crabs, as well as gonad maturity of female crabs for which crabs fetch higher price in both national and international markets. The crabs reaching at market size are harvested with bait sticks, iron hook, rope lining with bait (*thopa*), bamboo trap (*atol*), lift net (*hecha*), scoop net (*jalty*), net, jute-sack, and also by hand. The farmers harvest their crabs in the morning preferably; sometimes in the afternoon, or at any convenient time.

The survival rate of the present practice of fattening system in and around the south-west Sundarbans region of Bangladesh was recorded in the wide range of 55 - 90% which is almost similar to the survival rate of 86% reported by Begum *et al.* (2009), 85% by Zafar (2003) and of 70 - 90% by Keenan (1999). But, the survival range is found higher than that of 46.7 - 52.2% in bamboo pen in the tidal flats of mangrove forest for 100 days (Khatun *et al.* 2009). Such differences are likely to be associated with fattening duration, specific environment (tidal flooded open field vs mangrove tidal flats), cannibalism, and partial harvesting. The mean weight gained was estimated in the range of 16.19 - 26.62 g, and the mean production was recorded as 0.065 ± 0.26, 0.084 ± 1.33, and 0.17 ± 3.76 kg/m^2 in Bagerhat, Satkhira, and Khulna, respectively. The production rate in the present fattening system is yet relatively lower than the production reported as 0.37 kg/m^2 (Begum *et al.* 2009), which may be contributed from higher stocking density, initial size during stocking, culture period, species, and scientific regime of feeding, water quality and health management.

Marketing

The fattened crabs, after harvesting, are mostly sold at the local depots, and some of them at retail market as well. The depots are not so far away from the fattening places (locally called as *points* or *hatchery*); usually the mean distance ranges from 0.67 to 1.66 km. The crab are carried in sack made of jute or plastic, basket lined with straw and jute-mat during winter but basket and

polythene are used in rainy season and only basket are used in summer.

The fattened crabs are sold at prices varied significantly in relation to the grading system (Table 2), and seasonal demand (i.e. higher in winter season). The average price of crabs was estimated at 4.35 ± 0.45 US$/kg.

Table (2): Grading and Price (* US$) of hard shell mud crab (Local Market)

Grading System		Range	Mean ±SD
F1	>180 g; Full gonad	4.94 – 7.42	5.63 ± 1.38
F2	>180 g; Full gonad	3.26 – 4.82	3.84 ± 0.87
F3	>100g; Full gonad	1.95 – 3.52	2.87 ± 0.69
XXL	>500 g; Full meat	5.21 – 7.16	6.24 ± 1.27
XL	>400 g; Full meat	3.91 – 5.86	4.97 ± 1.12
L	>300 g; Full meat	2.60 – 4.59	3.70 ± 0.99
M	>250 g; Full meat	1.30 – 3.26	2.43 ± 0.89
SM	>150 g; Full meat	1.04 – 2.60	1.44 ± 0.52

* US$ 1.00 = 76.78 Bangladesh Taka (BDT)

Finance and economics of production

About 30% of the fatteners run their fattening business with their own money while 28%, 21%, 6%, 5%, 5%, 4% and 1% are financed by schemes of NGOs, depot-owners, NGO+own, money lenders, only cooperatives, cooperatives+own, and own+depot-owner, correspondingly. The loan is paid through different mode

of payments such as *dadon*, full payment, installment, and crab-exchange. In *dadon* system, the money is given in advance with high interest rate (more than 16 %) and/or other sort of agreements by which crabs must be sold to the *dadon* provider. Full payment and installments system has an interest rate of 10 - 15%. In crab-exchange system, crabs are sold directly to the money lenders but at a price deducted by 12% from the current market price.

There is land leasing system in which *ghers* and ponds are leased mostly for one year at a varying rate reported as 0.07 ± 0.04, 0.04 ± 0.02, and 0.06 ± 0.01 US$/m^2/year in Bagerhat, Satkhira, and Khulna, respectively. The payment is paid on either single or installment basis.

The economic analysis (Table 3) summarize that the net return was higher in Satkhira (US$ 147.77) while US$ 118.32 in Bagerhat and US$ 75.14 in Khulna. The benefit cost ratio (BCR) was estimated at 1.07, 1.34 and 1.06 in Bagerhat, Satkhira and Khulna, respectively. Begum *et al.* (2009) reported BCR of 1.22 for earthen-pen fattening and Khatun *et al.* (2009) estimated at 1.77 for mixed-sex mud crab culture in bamboo pens installed in mangrove tidal flats. These ratios are not absolutely different from the BCRs of the present study. However, the pay break period of 0.88, 0.64 and 0.86 years in Bagerhat, Satkhira and Khulna, respectively was considerably lower than 2.90 years reported by Khatun *et al.* (2009).

Table 3 Cost, return and economic indicators per cycle of fattening system adopted in the South-West Sundarbans region of Bangladesh

	Items	**Bagerhat**			**Satkhira**			**Khulna**		
		Quantity	Unit Value (US$)	Total Value (US$)	Quantity	Unit Value (US$)	Total Value (US$)	Quantity	Unit Value (US$)	Total Value (US$)
Return	Crab (/kg)	450.66 ±42.59	4.03 ±0.45	1816.15 ± 823.04	140.04 ±55.47	4.20 ±0.18	588.19 ± 38.27	264.45 ±155.55	4.82 ±0.10	1274.66 ±79.86
	Gross Return			**1816.15**			**588.19**			**1274.66**
Annual Capital Cost	Land leasing (/m²)	6933.20 ±157.39	0.07 ±0.04	485.32 ±279.48	1667.20 ±34.99	0.04 ±0.02	66.69 ±0.09	1555.60 ±22.86	0.06 ±0.01	93.34 ±17.09
	Pen making (/m²)	6933.20 ±157.39	0.06 ±0.04	424.16 ±247.84	1667.20 ±34.99	0.12 ±0.10	198.42 ±74.24	1555.60 ±22.86	0.23 ±0.15	363.55 ±234.16
	Total Capital Cost			**909.48**			**265.11**			**456.89**
Operating Cost	**Fixed Cost Cycle⁻¹**									
	*Depreciation (%)	11.11		100.04	6.00		15.91	7.00		31.98

Economic Indicators	Interest (%)	14.17 ± 1.27		209.64	11.24 ±3.25		44.43	14.17 ±1.76		148.68
	Total Fixed Cost			**309.68**			**60.34**			**180.66**
	Variable Cost Cycle^{-1}									
	Gher or pond preparation (/m^2)	6933.20 ±157.39		31.79 ±13.90	1667.20 ± 34.99		11.00 ± 8.91	1555.60 ± 22.86		15.86 ± 7.00
	Water or empty crab (/kg)	336.26 ±305.33	2.56 ± 0.65	860.83 ±219.31	110.04 ± 92.38	2.69 ±0.17	296.01 ± 18.59	389.29 ± 228.98	2.19 ± 0.53	852.55 ± 207.54
	Feed (/Day)	32 ± 19.19	15.03 ±41.81	481.02 ±1338.06	14.31 ± 1.26	4.81 ± 2.78	68.83 ± 39.75	18.91 ± 6.73	7.65 ± 6.28	144.66 ± 118.73
	Trap (pieces)	3.73 ± 1.96	2.41 ± 1.19	8.99 ± 6.87	1.24 ± 1.15	0.62 ± 0.69	0.77 ± 2.01	2.17 ± 1.30	0.75 ± 0.45	1.63 ± 1.33
	Labour during harvest (individual)	2.57 ± 1.41	1.01 ± 0.78	2.60 ± 1.47	1.66 ± 0.61	1.22 ± 0.53	2.02 ± 0.40	1.87 ± 0.75	1.89 ± 0.81	3.54 ± 1.09
	Marketing cost			1.16			0.53			0.06

				± 0.76			± 0.18			± 0.26
	Miscellaneous			1.76 ± 1.11			0.92 ± 0.18			0.57 ± 0.26
	Total Variable Cost			1388.15			380.08			1018.86
	Grand Total Cost			1697.83			440.42			1199.52
Eckonomic Indicators	Net Return			118.32			147.77			75.14
	Benefit Cost Ratio			1.07			1.34			1.06
	Production Cost (US$/kg)			3.77			3.14			4.54
	Return on Operating Cost (%)			6.97			33.55			6.26
	Pay Back Period (year)			0.88			0.64			0.86

* Depreciation is estimated with considering both land leasing and pen making cost for 9 cycles in Bagerhat, 18 cycles in Satkhira, and 14 cycles in Khulan in a year.

Mud crab aquaculture and people in and around the Sundarbans

While more than 0.35 to 0.4 million people are involved in crab fishery in and around the Sundarbans region of Bangladesh; a significant portion (more than 0.1 million) adopt mud crab fattening as their livelihood. Most of the farmers aged between 17 and 60 years are male (more than 90%), and *Hindu* (78%) in religion. About 71% of farmers are in nuclear family and 29% are in Joint family. The mean family members are recorded as 5.09 with range of 2 to 12 individuals. Wife, children, brother, and parents also take part in making pen, collecting lean crab, stocking, feeding, harvesting, and marketing of fattened crabs. The levels of their educations are reported as about 44.0% with primary, 38% with high school, 12% with secondary school certificate (SSC), 1% with above SSC, and only 5% are illiterate.

The fatteners in Bagerhat, Satkhira, and Khulna are reported to have average experience in crab fattening of 13.40 ± 8.34, 11.2 ± 4.38 and 17.7 ± 3.84 years, correspondingly. In addition to crab fattening, the farmers are also engaged in other livelihood options such as agriculture, day labour, fish culture, fish trading, fishing, crab depot business, shop keeping, and even some are in teaching profession. The mean earning member of the family are 1.24 ± 0.67 individuals, and the monthly income of the fatteners' family in Bagerhat, Satkhira, and Khulna was estimated at US$ 142.70 ± 407.95, US$ 155.42 ± 610.19 and US$ 95.88 ± 257.37, respectively.

Apart from fatteners, the poor jobless and day-labour people living in and around the Sundarbans region of Bangladesh are substantially dependent on wild mud crab population for their livelihood. They have become predominant stakeholders of mud crab supply chain through their active involvement in harvesting wild crab stock, supplying them to fatteners, and trading mud crabs at local market.

There are other people such as depot-owners and money lenders and some NGOs and cooperatives take part in crab fattening through providing credit and thus make money from interests and commissions. Some land owners lease their lands, and earn money through full payment or half payment system.

Environmental issues

While the fisheries to the Sundarbans are severely vulnerable to sea level rise and salinity intrusion (Hasanuzzaman *et al.*, 2010), the potentiality of mud crab aquaculture is likely to be scaled up as the mud crab species have a wide range of salinity tolerance. Mud crabs can be farmed and fattened in pens/ cages in inundated coastal swamps, *ghers*, and tidal rivers whilst these pen and cage cultures are deemed as environment friendly aquaculture technology.

However, the expansion of mud crab aquaculture in and around the Sundarbans, which is solely dependent on wild stock, may be limited as the wild stock is highly exposed to increasing fishing pressure by the poor coastal people. Another limitation for mud crab aquaculture is feed; at present the fatteners are wholly

dependent on live food (trash fishes, eel fishes, snails, mollusks etc) collected from wild and fish farms. Moreover, the use of such food staffs for crab aquaculture conflict with the nutritional need of human population, especially poor people community in the coastal regions. Such negative impacts of mud crab aquaculture may be curbed by reducing extraction of wild stock all the way through developing hatchery seed and artificial feed for mud crab species.

Conclusions

Mud crab farming in the South-West Sundarbans of Bangladesh is fattening type, and lean and empty crabs (*Scylla* sp.) are fattened in pens installed in tidal rivers, inundated coastal *ghers* and earthen ponds. Though the fatteners do not adopt scientific management, the present practice of mud crab fattening is found somewhat economically cost-effective. However, the economic profitability can be augmented and sustainable if stocking rate, water quality and feeding management are adopted scientifically. Ancillary, survival rate may be increased if escaping of crabs is prevented using well-built net, and cannibalism is reduced adopting mono-sex fattening and uniform sized crabs, essentially produced from hatchery. Comprehensive training for trainers as well as farmers is needed to support coherent expansion of mud crab aquaculture along the coastal areas of Bangladesh.

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الاستزراع المائي لسرطان الطين (*Scylla* spp.) في جنوب غرب منطقة السونداربـاس في بنكلادش

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الخلاصة

أضحى استزراع السرطان الطيني (Scylla spp.) مصدر رزق مهم للصيادين على سواحل بنكلادش المدية. عادةً ما يتم حصادها من البيئة الطبيعية في أقفاص وأحواض ترابية في الانهار المدية، تهدف الدراسة الى فهم هذه الممارسة واقتصاديات الانتاج لاستزراع سرطان الطين في جنوب غرب سوندرابانس في بنغلادش، وقد تمت الدراسة في في مناطق باكيرهات، ساتكيرا ومقاطعة خولنا حيث تتم في الغالب عمليات التسمين. معظم المزارعين يستخدمون كل من الذكور(النحيفة) والاناث (ذات المبايض غير الناضجة) باوزان 100-180 غم. توضع االسرطانات في الأقفاص بمعدلات تتراوح بين (12- 641 غم/ م^3)، وتغذى باستخدام الاسماك الحية غير الاقتصادية، الاسماك المجففة، القواقع، المحار واحشاء المواشي بمعدل 8-10 % من وزن الجسم. بلغ معدل دورة التسمين 22 ± 14.34 يوم ومعدل بقاء 55-90% ومعدل انتاجية 0.065 ±0.26 ، 0.084 ± 1.33 و 0.97 ± 3.76 كغم/ م^3 في باكيرهات، ساتكيرا وخولنا على التوالي. بعد الحصاد الجزئي يتم بيع السرطانات بمعدل سعر 0.45 ± 4.35 دولار امريكي /كغم. بلغت أوطأ كلفة انتاج (3.14 دولار امريكي) وسجل أفضل عائد اقتصادي في مقاطعة ساتكيرا حيث بلغ (174.77 دولار). كان لتسمين سرطان الطين جدوى اقتصادية في مقاطعة سونداربانس والمناطق المجاورة لها، لكن الانتاج والكفاءة الاقتصادية يمكن زيادتها باعتماد انظمة تستند على اسس علمية في التغذية والادارة الصحية لمناطق التربية، كما تناولت الدراسة اهم القضايا الجوهرية لاستدامة مزارع سرطان الطين في بنكلادش.