TRADITIONAL PRACTICE OF MUD CRAB (Scylla olivacea) FATTENING IN THE SOUTH WEST REGION OF BANGLADESH

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Abstract: The state of art of traditional practice of mud crab fattening was evaluated in terms of technical and economic aspects from 30 randomly selected fattening farms at Paikgacha, Khulna during April to December 2001. Farmers fattened only lean (empty egg and/or hepatopancreas) females, of 170-200 g individual biomass that were rejected during grading at local crab landing centers, for 1-3 weeks using low cost tilapia and/or trash fish at a rate of 5-8% day\(^{-1}\) of stock biomass. Continuous stocking and harvesting of lean and ripe females respectively was a function of availability and prices of lean individuals. Thus, maintaining a fixed stocking density was not observed. The survival and production rates were recorded at 80±14\% (range: 60-100\%) and 1.46±0.48 Kg m\(^{-2}\) (range: 0.71-2.10) respectively. The net income of a farm with an average size of 122±22 (range 90-150) m\(^{2}\) was recorded at Tk. 23,221±8,490 \(\text{yr}^{-1}\).

Key words: Mud crab, Scylla olivacea, fattening, survival, production, cost-benefit

Introduction
Mud crab is one of the most potential exportable aqua-resources of Bangladesh (Ahmed, 1992; Khan and Alam, 1992). Continued increase in export of live mud crab plays an important role to the foreign exchange earnings of Bangladesh (Azam et al., 1998). Fattening of mud crab has become a new agro-business across the coastal zone of Bangladesh (Kamal, 2002, Kamal et al., 2003; Zafar, 2003, 2004) in recent years like other Southeast Asian countries (Patterson and Samuel, 2005; Williams and Primavera, 2001; Triño and Rodriguez, 2001; Anon, 2003; Agbayani, 2001; Kuntiyo, 1992; Ladra, 1992; Williams and Primavera, 2001; Triño and Rodriguez, 2001; Agbayani, 2001; Kuntiyo, 1992; Ladra, 1992; Williams and Primavera, 2001). Fattening of mud crab is a holding operation of lean female or soft male crabs for a short period of time to harvest fully ripe females or hard shelled males using low cost feeds in small enclosures (Triño and Rodriguez, 2001). A number of crab fattening methods have so far been developed in the Indo-Pacific region namely, pond culture, cage culture, pen culture, polyculture with fish, shrimp and algae, etc. (Patterson and Samuel, 2005; Triño and Rodriguez, 2001;...
Marichamy and Rajapackiam, 2001; Marichamy 1996; Babu and Monjulatha, 1995; Chong, 1995; Felix et al., 1995; Kathirvel 1993; Liong, 1992).

The fattening of mud crab is growing rapidly as a new economic activity in the coastal region of Bangladesh due to high demand of large egg bearing females (body weight ≥180 g) and hard shelled males (body weight ≥400 g) and particularly due to comparatively good returns on investment in a short time period. However, the present practice of mud crab fattening is said to be traditional in nature and is mainly carried out by poor coastal communities without financial assistance from formal agencies (personal communication).

In Bangladesh, crab fattening in ponds was started in the early 1990’s (Kamal, 2002), while fattening and culture of mud crab in bamboo cages, pens and pots only at experimental level were started in the early 2000’s (Obayed, 1998; Kamal, 2002, 2004; Kamal and Uddin, 2004; Zafar, 2003, 2004; Khatun, 2007). Salam et al. (2003), using GIS tools, identified the lower South-western region as the most suitable for developing mud crab culture in Bangladesh.

Mud crab fattening and culture have been reported as sustainable and promising for the poor coastal communities from many other countries (Patterson and Samuel, 2005; Anon, 2003; Mwaluma, 2002; Trino and Rodriguez, 2002; Williams and Primavera, 2001; Ikhwanuddin and Oakley, 1999; Liong, 1993; Kuntiyo, 1992; Ladra, 1992; Liong, 1992). Unfortunately, about 30-45% (Kamal et al., 2003; Khan and Alam, 1992) of the harvested crabs do not reach to the consumers table due to transport mortality and rejection at various stages of handling prior to export (Kamal et al., 2003; Ladra and Lin, 1992). Sustainable development of mud crab fattening could reduce the current loss of rejected but valuable crab resource and could provide alternate livelihood to the millions of coastal poor especially shrimp fry collectors or forest byproduct harvesters.

In view of the above, the present study was made to assess the distribution of crab fattening farms and the state of art of traditional mud crab fattening practiced by local farmers in terms of technical and economic aspects from the South-western Paikgacha Upazila under Khulna district of Bangladesh.

Materials and Methods

Study area: Several field visits were made in three coastal districts, namely Bagerhat, Khulna and Satkhira (Fig. 1) to assess the distribution of mud crab fattening farms. The technical (farm size and design, pond management, species, stocking, fattening period, food and feeding, method of harvesting, survival rate, production rate) and economic (various costs and benefits) aspects of mud crab fattening by the local farmers were evaluated. For this data were collected through a prescribed questionnaire from randomly selected 30 fattening farmers from three different locations of Paikgacha Upazila, namely- Shibsha River Ghat, Kapilmuni and Shamukpota, between April and December, 2001. The species used in fattening in the area was identified as Scylla olivacea following Kennan et al. (1998) and Keenan (1999).

The survival and production rate of fattened crabs were calculated following Rattanachote and Dangwatanakul (1991):

\[
\text{Survival rate (\%)} = \frac{\text{No. of crab caught}}{\text{No. of crab stocked}} \times 100.
\]
Production rate (Kg m\(^{-2}\)) = Weight harvested / Pond size (m\(^2\));
Production rate (%) = (Weight harvested / Weight stocked) \times 100.
Economic analyses: Different types of costs and returns were analysed through standard production economics on mean values of 30 crab fattening farms following Shang (1990).

Statistical analysis: All the statistics (mean, SD, correlation coefficients, and regression) among different variables were analysed and graphically presented by using the Microsoft Excel Software.

Results

Distribution of crab fattening farms: The location, number of mud crab fattening farms and manpower involved are shown in Fig. 1 and 2. The maximum and the minimum fattening farms and manpower involved were found in Khulna and Satkhira district respectively (Fig. 2). Again in Khulna district, the maximum number of farms (614 no) and manpower (1597 person) were recorded in the Paikgacha Upazila and the minimum number of farms (125 no) and manpower (325 person) were found in the Dacop Upazila (Fig. 3). Most of the fattening farms are established near the bank of a river or a canal where brackishwater was available throughout the year (Photo 1). Most of the family members work in their farms beside their regular economic activities.

Farm size and design: The size of mud crab fattening ponds varied between 90 and 150 m² with a mean size of 122.22±21.81 m². Almost all the ponds were found rectangular in shape with a common inlet and outlet made of PVC pipes. In most of the farms (>95%) water was exchanged twice a month, during the new and full moon spring tides. Usually a single pond was divided into 3-4 components (Photo 1) or more (Photo 2) by using bamboo fences (bana) of 1-2 m high (Photo 3). The pond depth varied from 1 to 1.5 m with the depth of water in the pond between 0.5 and 1.0 m. Some fatteners used fine nylon mosquito net (locally called 'Moshari jal') or medium mesh nylon nets (Photo 1, 2) around the bamboo fencing in order to prevent escaping stocked crabs from the pond. Each fattening farm has small hut (Photo 4) made of dried Nypa leaf and bamboo used to stay night guard and to keep relevant materials (bamboo pens, bamboo baskets, ladder, scoop net and feed, etc.).

Farm management: Most of the fattening farms (90%) did not follow any post-stocking management except the water exchange through natural tidal flow twice a month and daily application of fresh trash or Tilapia fish as feeds. Some fatteners (20%) did exchange old water only before stocking new batch of crabs or when water quality...
became severely polluted due to uneaten food materials. Farmers did not use any kind of fertilizer or lime in their ponds before or after stocking.

**Species and sex:** Almost all the farmers fatten only a single species available in the region, i.e. red mud crab (*Scylla olivacea*). All the farmers were found to fatten only female mud crab.
**Stocking**: Most of the farmers stocked their ponds with rejected grade (lean or empty, body weight 170-200 g) female crabs, locally called ‘khosha’. Farmers mainly collected these rejected crabs from crab trading depots and from nearby shrimp ponds (*gher*). Stocking was done during early morning or late evening. However, there was peak and lean season in mud crab fattening—the peak season was winter and the lean was summer. However, a few (20%) farmers continued crab fattening throughout the year. Most of the farmers stocked and harvested their ponds simultaneously.

**Stocking density**: Fatteners did not maintain any stocking density during stocking seed crabs. However, stocking density varied from <1 to >3 (0.72-3.50) individual m\(^{-2}\) with a mean density of 1.97±0.96 individual m\(^{-2}\) (Table 1).

**Fattening period**: The period of fattening varied from one to three weeks depending on the stage of maturity of the gonad and/or hepatopancreas and prices of fattened crabs in the depots. Some farmers (~15%), however, kept fattened animals in their ponds for extended period of time, usually additional 1-2 weeks, in order to get good prices.

**Harvesting method**: Only fattened individuals, i.e. carapace is full with hepatopancreas and/or gonad, were harvested regularly. Harvestable crabs were checked by light

| Parameters                      | Mean±SD       | Range       |
|---------------------------------|---------------|-------------|
| Pond size (m\(^{2}\))          | 122±22        | 90-150      |
| Fattening period (days)         | 12±5          | 7-21        |
| Crab stocked (no)               | 241±119       | 65-450      |
| Crab stocked (Kg)               | 45±20         | 15-80       |
| Stock size (g)                  | 192±11        | 170-200     |
| Stocking density (indv. m\(^{-2}\)) | 1.97±0.96 | 0.72-3.5  |
| Crab harvested (no)             | 180±67        | 65-293      |
| Crab harvested (Kg)             | 37±12         | 15-56       |
| Survival rate (%)               | 80±14         | 60-100      |
| Production rate (%)             | 87±15         | 63.64-100   |
| Production rate (kg m\(^{-2}\)) | 1.46±0.48    | 0.72-2.10   |

Table 2. The regression equation parameters (a, b) and correlation coefficients among stocking density, survival rate and production rate in mud crab fattening practice.

| Relationships                          | Regression parameters | r\(^2\) | n  |
|---------------------------------------|-----------------------|--------|----|
| Production rate vs. stocking density  | a = -13.802           | b = 110.64 | 0.8608 | 30 |
| Survival rate vs. stocking density    | a = 60.08158          | b = 7.344114 | 0.47   | 30 |
| Survival rate and production rate     | a = -0.54757          | b = 0.011354 | 0.619  | 30 |

\[a=\text{intercept} ; \quad b=\text{slope} ; \quad r^2=\text{correlation coefficient} ; \quad n=\text{sample size.}\]
examination at the anterolateral sides of carapace of the animals (Photo 5). Fattened crabs showed no light penetration through the carapace. Unfattened individuals were returned to the pond. Farmers usually check their stock daily and fattened ones are harvested. A continuous selective harvesting regime with baited traps and/or small scoop net was common practice (Photo 6-7). The fattened crabs were taken out from the pond by using a small push net. A few fatteners, however, found to use bare hands for harvesting fattened individuals. Total harvesting was done at the end of fattening season by hand after dewatering the pond. Each harvested crab was tied with nylon threads, kept in bamboo basket (Photo 8) and transported immediately to the nearby crab landing center by tricycle van.

**Survival rate**: The mean survival rate of fattened crab in traditional method was estimated at 80±14% with a range from 60 to 100%. The survival rate showed a significant negative correlation with the stocking density (r²=0.7, p<0.05).

**Production**: The estimated production parameters are shown in Table 2. The production rate was found to vary from 0.72 to 2.1 Kg m⁻² with a mean production rate of 1.46±0.48 Kg m⁻² (Table 2). The relationship among the production rate,
survival rate and stocking density in the investigated farms are given in Table 3. The relationship between production rate and stocking density was found to be positive and significant ($r^2=0.86$, $p<0.05$). Similar relationship was noticed between production rate and survival rate ($r^2=0.619$, $p<0.05$). However, a significant inverse relationship was found between survival rate and stocking density ($r^2=0.7$, $p<0.05$).

**Cost benefit analysis:** The cost-benefit analyses of 30 traditional mud crab fattening farms was performed on the mean values on a single cycle and are shown in Table 3. The mean net income from a farm with an average size of 122±22 m$^2$ was Tk. 23,221±8,490 from 10 crops in a year on average. The mean benefit cost ratio per farm was estimated for a cycle at 1.514077±0.254793 (range 1.15-1.93).

Among variable costs, the major cost involvement was the price for seed crab, which varied from Tk. 1,350 to 6,000 with a mean value of Tk. 3,569±1,370 crop$^{-1}$. The minimum variable costs involved was the cost for tying harvested crab using nylon threads (Tk. 36±13 crop$^{-1}$). Among different fixed costs (lease, labor and construction materials), the land lease cost was found to be the highest (Tk. 179±61 crop$^{-1}$) followed by bamboo pen (Tk. 84±32 crop$^{-1}$), nylon netting (Tk. 48±16 crop$^{-1}$), guard room (Tk. 14±5 crop$^{-1}$) and scoop net, ladder, basket etc. (Tk. 12±4 crop$^{-1}$). The average gross and net profit per crop from a traditional mud crab farm with an average size of 122±22 m$^2$ was estimated at Tk. 2,528±800 and 2,190±744 respectively (Table 3).

**Discussion**

**Distribution of crab fattening farms:** Most of the crab fattening farms are around the crab landing centers, within the impact zone of the Sundarbans (20 km around the reserved forest), mainly due to the availability of seed crabs, low cost trash fish, and ready market to sell out fattened crabs. Large number of fattening farms in Paikgacha and Rampal Upazila could be due to the presence good communication facilities to both the Sundarbans and traditional shrimp gher, the major sources of wild crab harvesting, by water ways and to the export point in the capital city, Dhaka by road. Sometimes, a considerable volume of (5-20% of harvested crabs) rejected crabs are returned from Dhaka during export grading to these landing centers to sell out to the fatteners at lower prices. However, the quality of these rejected crabs become poor due to double transport stress.

**Species and sex:** Of the four mud crab species available in the Indo-Pacific region (Kennan et al., 1998) only the red mud crab (*Scylla olivacea*) is being fattened in the SE region of Bangladesh (Ahmed et al., 2005). What Zafar (2003, 2004) reported from the east coast of Bangladesh as *S. serrata* would be *S. olivacea* (Ahmed et al., 2005). The other three species, namely, *S. serrata*, *S. tranquibarica* and *S. paramamosain* are being fattened in other Asian countries (Patterson and Samuel, 2005; Triño and Rodriguez, 2001; Kenan, 1997; Rattanachote and Dangwatanakul, 1992; Ladra, 1992; Liong, 1992). Only female crabs were found to fatten in the study region because its price was 2-3 times higher than that of male crabs against the same fattening period and feed costs. By 2004, however, local fatteners became familiar with the fattening of soft-shelled male mud crabs mainly due growing demand and corresponding price hike for male crabs in the international
markets. Zafar (2004) and Khatun (2007) studied on both male and female crabs in their experimental studies.

**Pond size and design:** Small bamboo pens installed in earthen ponds was found as the single means of crab fattening in this study. Single celled cage, net cage, floating net cages, popular in many SE Asian countries (Rattanachote and Dangwatanakul, 1992; Liong, 1992; Kennan, 1997) were not found in the study area. The cemented tank has reported not to be suitable at all for fattening mud crab (Bede and de Silva, 1992). Salam and Hasan (2004) and Kamal (2002) have reported fattening practice of mud crab in small bamboo pens installed in earthen ponds. The average size of mud crab fattening ponds in Surat Thani province of Thailand was around 270 m² (Rattanachote and Dangwatanakul, 1992). The pens observed in the present investigation were comparatively smaller in size than that of other SE Asian countries (Table 4). The reason for the smaller pen size is they are mostly managed by the family members. However, in an experiment, Obayed (1998) used 600 m² pens in earthen pond for fattening mud crab at Mongla, Bagerhat, Bangladesh. In another experiment, Zafar (2004) conducted comparative fattening study of *S. serrata* in single-celled bamboo cage (30 cells cage⁻¹, 1.5 ft long and 8 inch wide) and bamboo pens (30x30 m) installed in earthen ponds in the Chakaria Sundarbans of Bangladesh.

**Food and feeding:** Low cost trash fish was found as the main food used in mud crab fattening both in home (Obayed, 1998; Kamal, 2002; Salam and Hasan, 2004) and abroad (Rattanachote and Dangwatanakul, 1992; Nazar, 2003). However, coastal crab fatteners in Bangladesh were found to use shrimp head, mussel meat and tilapia (Salam and Hasan, 2004), low cost fresh and salted eels (*Anguilla* sp.; Zafar, 2004), mixture of different locally available ingredients e.g., trash fish, soft–shelled snails, bivalve meat, mussel or clam meat, crustaceans, animal entrails etc. (Nazar, 2003). The traditional mud crab fatteners used trash fish and horse mussel to feed their stock (Hanvivatanaki, 1990). Most of the research workers used 5% feed to biomass of the stocked animals applied once or twice a day (Zafar, 2004; Obayed, 1998; Nazar, 2003). The crabs were fed with fresh trash fish at the rate of 10-15% of body weight per day and mortality during fattening varied from 10-15% (Cholic and Hanafi, 1992). In Taiwan fatteners fed larger size stock (8-12 cm carapace width with stocking density of 2-4 m⁻²) once a day at rate of 200 g trash fish per crab and live snail at 100 m⁻² (Sivasubramaniam and Angel, 1992). Obayed (1998) found FRC at 1.8 with trashfish.

**Stocking and stocking density:** The stocking practice was found to be fully dependent on the supply of rejected grade crabs from local crab landing centers (depot) and the price. The variation in stocking density among the farms was mainly due to availability of lean crabs from various sources. Obayed (1998) used a stocking density of 0.8 crab m⁻² for fattening. Zafar (2004) stocked 120 crabs (60 male and 60 female) in open cage (without chamber) system and 60 crabs in 60 celled cage, one male (160-180 g) or female (140-160 g) in every compartment (1x60). Keenan (1997) practiced crab fattening in pond at a stocking rate of 10 individual m⁻² for 30 days. A stocking density of 2 individual m⁻² in pen system was used in Indonesia (Cholik and Hanafi, 1992). The Taiwanese traditional mud crab fatteners used a stocking density 2-4 individual m⁻² (females of 8-12 cm
carapace width) which was reduced to 1 individual m\(^{-2}\) during the summer (Sivasubramaniam and Angell, 1992).

**Fattening period:** Fatteners usually identify a fully ripe female by examining the anterolateral sides of the carapace using torch-light or against sunlight. No light passes through carapace in females with fully mature ovary and/or hepatopancreas. In Bangladesh, Salam and Hasan (2004) reported 12-15 days fattening period for female crabs in bamboo pens. Zafar (2004) harvested berried females from pot culture after 14 days of stocking. Zafar (2004) fattened *S. serrata* in 14-15 days in bamboo cell cage (30 cells cage\(^{-1}\)) and earthen ponds. The fattening period in the present investigation was 7-21 days, which is comparatively shorter than that in SE Asian countries (15-35 days) (Triño and Rodriguez, 2001; Keenan, 1997; Liong 1993; Macintosh *et al.*, 1993; Cholik and Hanafi 1992; Ladra 1992; Rattanachote and Dangwatanakul, 1992; Sivasubramaniam and Angell 1992).

**Survival rate:** The survival rate (80±14%, range 60-100%) found in the present study is closer to that (85.20%) reported for *S. serrata* from traditional fattening farms in Surat Thani, Thailand (Rattanachote and Dangwatanakul, 1992); 80-100% for *S. serrata* fattening in earthen pond in the Philippines (Kuntiyo, 1992); 80-85% for *S. serrata* with a stocking density of 10 individuals m\(^{-2}\) from Australia (Keenan, 1997). Obayed (1998) reported a poor survival rate (55%) in a mixed sex (male and female) fattening experiment at Mongla, Khulna due to aggressive behaviour of males over females. The lower survival rate (80±14%) observed in the present study in comparison with 88-100% of Zafar (2004), 88.33% of Kamal (2004) and 90% of Saha and Ahmed (1999) from Bangladesh could be due to higher stocking densities used by the traditional farmers. Therefore, an inverse relationship was found between the stocking density and survival rate. Gunarto and Cholik (1990) reported the survival rate of 77.05%, 49.17% and 32.06% at stocking density of 1, 3 and 5 crab m\(^{-2}\) respectively. Zafar (2004) also observed 91.90%, 64.13% and 42.16% survival with stocking densities 1, 2 and 4 crabs m\(^{-2}\) respectively from SE coast of Bangladesh.

Mortality of crab due to cannibalism has widely been documented as a serious problem in crab fattening (Triño and Rodriguez, 2001; Bede and De Silva, 1992). Kuntiyo (1992) suggested to use several small compartments or cubicles to accommodate a single crab per compartment or a net cage battery to overcome this problem. Zafar (2004) achieved 100% survival when used single celled bamboo cage in mud crab fattening. Higher survival rate has been reported as the function of lower stocking density in mud crab fattening and culture by many workers (Trino *et al.*, 1999; Gunarto and Cholik, 1990; Baliao *et al.*, 1981).

However, Triño and Rodriguez (2001) attributed sex (male) as the factor for lower rate of survival (86.9±1.88) in mixed sex fattening than in mono-sex fattening due to aggressive behaviour of male crabs over the females. Cholik and Hanafi (1992) suggested that mixed sex culture enhances cannibalism. Zafar (2004) observed culture system as a factor affecting mortality, being no mortality of females and only 3.33% mortality of males in cage system and 3-12% mortality in pond system. Zafar (2004) reported seasonal variation (salinity and temperature) as the key factors for the variation in growth and mortality in both the fattening systems (cage and pond). A higher mortality has been
attributed to transportation stress as Liong (1991) observed that the survival rate of local crabs was higher (>90%) than that of imported crabs (60-80%).

**Growth and production:** Zafar (2004) observed comparatively higher growth rate in male crabs than that of females. Zafar (2004) obtained mean growth of female crabs at 16.00±4.68 g in 15 days in bamboo pots and 0.34 g crab⁻¹ day⁻¹ in earthen ponds. Zafar (2004) observed comparatively higher average daily growth in cage system (1.12 g indiv⁻¹ day⁻¹) than the earthen pond (0.51 g indiv⁻¹ day⁻¹). In general, the juvenile crabs showed an increase of 60-120% of its body weight at each moult (Nazar, 2003). Obyed (1998) found the specific growth rate (SGR) of mud crab in fattening pond at 2% day⁻¹. Rattanachote and Dangwatana (1992) reported a weight increase of 40.92-69.58 g and 118.36-144.27 g for female and male crabs respectively in 30 days with 500 m² pond with a stocking density of 3-5 crabs m⁻². Tríño and Rodriguez (2001) observed a production rate of fattened mud crab in 20-30 days for monosex male, female and mixed sex at 17.9±44.3, 15.9±39.3 and 14.2±30.4 Kg per 150 m² pond respectively. A comparison of pond size, stocking density, survival rate and production rate in traditional fattening practice of mud crab from different sources is given in Table 4.

**Cost benefit analysis:** Liong (1992) attributed mud crab fattening as lucrative and it possess large turnover rate. Similar trend was seen in the present investigation in Bangladesh as the net profit margin of Tk. 228±126 (range 43-410) per crop per square meter pen area is quite satisfactory for poor landless coastal people of Bangladesh in comparison with any other available businesses in the region. Zafar (2004) attributed that mud crab fattening in bamboo cell-cage was sustainable and economically viable as higher gross profit (Tk. 350 cage⁻¹ in 15 days) was obtained with bamboo cell-cage than the earthen pond (Tk. 224 pond⁻¹ in 15 days). Liong (1992) reported that the purchase of stockable crab and trash fish constitutes the major operating expense. Liong (1992) mentioned the high profit rate in pond system mainly due to low operating cost. However, the scale of operation is much smaller, and, hence, total returns or net income, may not be too impressive (Liong, 1992). The similar trend was also noticed in the SW region of Bangladesh.

Mud crab in live condition is being exported mainly to SE Asian countries (Azam et al, 1998) and the price of mud crab is usually higher than that of fish and mollusks in those countries (Agbayani, 2001) which is expected to increase in the world market in future. However, the increasing prices for large sized seed crabs set the main constraints in mud crab fattening by the resource-poor fatteners in the study area. Agbayani et al. (1997) reported that the demand for mud crab is price-elastic in Bangladesh, India, Sri Lanka, Indonesia, and the Philippines. Demand increases as the price decreases.

**Problems:** The key problems in mud crab fattening in the study area include- i) insufficient supply of the post-moult lean crab for fattening; ii) high investment cost for making bamboo pen; iii) inconsistent supply and higher price of trash fish; iv) inconsistent prices of seed and fattened crabs at local markets; and, v) poor credit facilities to the poorest group.
Table 4. A comparison of production parameters for different types of crab fattening methods in South and SE Asia.

| Source                        | Method | Location                  | Species                  | Sex            | Fattening period (days) | Pond/Encloser size (m²) | Stocking density (Indv. m⁻²) | Seed size (g) | Feeding rate (% stock biomass) | Harvesting method | Harvesting size (g) | Food items                                                                 |
|-------------------------------|--------|---------------------------|--------------------------|----------------|-------------------------|-------------------------|-------------------------------|----------------|--------------------------------|-------------------|---------------------|---------------------------------------------------------------------------|
| Tritto and Rodriguez, 2001    | Pond   | Sarawak                   | Scylla olivacea           | M, F           | 20-30                   | 150                     | 0.25-0.5 indv. m⁻²            | 250            | 10                             | Partial with baits              | M: 496-520          | Mussel+25% fish bycatch                                                  |
| Keenan, 1997                  | Pond   | Semarang                  | Scylla paramamosain      | M+F            | 30                      | 8000                    | 10 indv. m⁻²                  | 350            | 2.5%                          | Selective, daily            | M: >400              | Fresh eel+Tilapia                                                        |
| Keenan, 1997                  | Fence  | Aklan, Philippines        | Scylla olivacea           | M, F           | 20                      | 9                       | 10 indv. m⁻²                  | 85             | 5%                            | Complete, hand picking        | F: 163-204           | Trash fish                                                   |
| Keenan, 1997                  | Pond   | Surat-thani, Thailand     | Scylla tranquebarica     | M+F            | 120                     | 200                     | 3 indv. m⁻²                   | 150            | 5%                            | Partial with scoop net        | M: 160-180           | Trash fish+Tilapia                                                        |
| Ladda, 1992                  | Cage   | West coast of Malaysia    | Scylla olivacea           | M+F            | 20                      | 500-800                 | 3-5 indv. m⁻²                 | 200            | 5%                            | Complete, hand picking        | F: >180              | Trash fish+Tilapia                                                        |
| Rattanachote and DangwatanaKul, 1992 | Pond   | NE coast, Sri SE coast, Bangladesh | Scylla olivacea | M+F | 35                      | 20-30                   | 30-80 kg cage              | 400            | 5%                            | Partial                        | M: 163-204           | Trash fish                                                   |
| Ligan, 1992                  | Cage   | SW Bangladesh            | Scylla olivacea           | F             | 21                      | 30                      | 0.5, 0.33, 0.5                | 0.5            | 5%                            | Partial                        | M: 163-204           | Trash fish+Tilapia                                                        |
| Bede and Silva, 1992          | Pen    | SW Bangladesh            | Scylla olivacea           | F             | 30                      | 122±22 (7-21)           | 0.25-1                        | 2.12±0.903   | 7%                            | Partial                        | M: 163-204           | Trash fish+Tilapia                                                        |
| Zafar, 2004                   | Pond   | SW Bangladesh            | Scylla olivacea           | --             | 7-21                    | 100                     | 0.5, 0.33, 0.5                | 2.12±0.903   | 7%                            | Partial                        | M: 163-204           | Trash fish+Tilapia                                                        |
| Kamal, 2004                   | Cage   | SW Bangladesh            | Scylla olivacea           | --             | 122±22 (7-21)          | 100                     | 0.5, 0.33, 0.5                | 2.12±0.903   | 7%                            | Partial                        | M: 163-204           | Trash fish+Tilapia                                                        |

**Source**: The source of the data is given for each method and location.

**Location**: The location where the fattening methods were used.

**Species**: The species of crab used for fattening.

**Sex**: The sex of the crabs used for fattening.

**Fattening period (days)**: The duration of the fattening period for each method.

**Pond/Encloser size (m²)**: The size of the ponds or enclosures used for fattening.

**Stocking density (Indv. m⁻²)**: The density of crabs stocked in each pond or enclosure.

**Seed size (g)**: The size of the seed crabs used for fattening.

**Feeding rate (% stock biomass)**: The feeding rate used for each method.

**Harvesting method**: The method used for harvesting the crabs.

**Harvesting size (g)**: The size of the harvested crabs for each method.

**Food items**: The food items provided to the crabs during the fattening period.

**VCR**: The vertical cover ratio used for each method.

**Cover/Encloser**: The type of cover or encloser used for each method.

**Survival rate (%)**: The survival rate of the crabs during the fattening period.

**Production rate (%): Wt. harvested/Wt. stocked (kg) x 100**: The production rate for each method.
Conclusion

Mud crab fattening in bamboo pens in earthen ponds has been found economically viable for the resource-poor coastal people. Future expansion of crab fattening would reduce considerable loss (>30%) of harvested crabs during grading for export. Considering the constraints mentioned above, measures are to be taken to enhance supply of seed crabs, to develop low cost supplementary feeds and to provide micro-credit to the poorest part of the coastal population in order to ensure continued growth in mud crab fattening business across the coastline of Bangladesh.

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