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# SPECIES AVAILABILITY, CULTURE TECHNIQUE, REPRODUCTION OF PRAWN AND SHRIMP IN BANGLADESH: A REVIEW

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## ABSTRACT

Bangladesh is considered one of the most suitable countries in the world for freshwater prawn farming because of its favorable agro climatic condition. The expansion of shrimp farming is triggered by the increased international market demand, seed production and intensive shrimp culture. Shrimp farming is having a positive impact on the livelihoods of many people in Bangladesh, especially the poorer farmers. Prawn and shrimp farming offer a reliable source of revenue that is often more profitable than other kinds of farming, or other non-farming employment. The objective of this paper was to review species availability, culture technique and artificial breeding of prawn and shrimp in Bangladesh.

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## INTRODUCTION

The freshwater ecosystems of Bangladesh provide a unique environment for enormous prawn production potential because of the favorable climate and availability of wild seed stock. Moreover, the populace of this country has close ties with the wetland systems including rivers, deltas, rice paddies and fish ponds making them naturally prepared to exploit the full potential of the freshwater prawn fisheries. The latest estimate of the area of land under shrimp cultivation has jumped from 64,000 *ha* in 1983 to 275,000 *ha* in 2012 (FRSS, 2013) in Bangladesh. In the coastal area of the greater Khulna region having a tropical climate, productive and unpolluted estuarine areas is considered to be a suitable natural habitat for penaeid shrimp culture. The culture of prawn and shrimp in Bangladesh has been drawing greater attention by fish farmers, particularly in brackish waters.

## RESEARCH METHODOLOGY

This review collected information from different research articles and from places where prawn and shrimp cultures are abundant for example Khulna, Bagherhat, Jessore, Paikgacha, Koyra, Batiaghata, Dumuria, Rupsha, Terokhada, Digholia, and Fultala.

## RESULTS

**Species availability**

There are 24 species of freshwater prawns including 10 species of *Macrobrachium* in Bangladesh. Among these species, only *Macrobrachium rosenbergii* is commercially cultured. There is a high prospect of *M. malcolmsonii* culture in Bangladesh since larval production and culture is similar to that of *M. rosenbergii*, which has been farmed successfully in the India. The available *Macrobrachium* and *penaeus* species in Bangladesh are shown in the following table:

**Table 1.** The available *Macrobrachium* species in Bangladesh (Ahmed et al., 2008; Ahamed et al., 2014)

| Scientific name | English name | Local name |
|---|---|---|
| *Macrobrachium birmanicus* | Freshwater prawn | Thenguaicha |
| *Macrobrachium dayanus* | Freshwater prawn | Kairaicha |
| *Macrobrachium dolichodactylus* | Freshwater prawn | Icha |
| *Macrobrachium lamarrei* | Freshwater prawn | Icha |
| *Macrobrachium malcolmsonii* | Monsoon river prawn | Chotkaicha |
| *Macrobrachium mirabilis* | Freshwater prawn | Lutiaicha |
| *Macrobrachium nipponense* | Oriental river prawn | Icha/chingri |
| *Macrobrachium rosenbergii* | Giant freshwater prawn | Golda chingri |
| *Macrobrachium rude* | Freshwater prawn | Godaicha |
| *Macrobrachium villosimanus* | Freshwater prawn | Dimuaicha |
| *Penaeus monodon* | Giant tiger shrimp | Bagda chingri |
| *Penaeus semisulcatus* | Indian white shrimp | Sada icha |
| *Penaeus indicus* | Indian white shrimp | Sada icha |
| *Penaeus japonicas* | Kuruma prawn | Dora kata / Japani chingri |
| *Penaeus merguiensis* | Banana shrimp | Bagda chama |
| *Penaeus penicillatus* | Red tail prawn | Chama icha |
| *Penaeus orientalis* | White prawn | Boro chama |

## DISTRIBUTION

The giant tiger prawn is broadly distributed throughout the greater part of the Indo-Pacific region, extending from the northward to Japan and Taiwan, eastward to Tahiti, southward to Australia, and westward to Africa (Motoh, 1985). The species *Penaeus monodon* occurs mainly in Southeast Asian waters and it is widely distributed from 30°E to 155°E longitude and 35°N to 35°S latitude. In broadly, the *Penaeus monodon* is a widely distributed penaeid shrimp species which is native to the Indo-West Pacific with a range comprising southern Japan, China, Taiwan, Vietnam, Korea, the Philippines, Cambodia, Malaysia, Singapore, Australia, Thailand, Indonesia, Papua New Guinea, Myanmar, Bangladesh, Pakistan, India, Sri Lanka, Tanzania, Madagascar, and South Africa and the Red Sea off Yemen (FAO, 2012). Their main fishing grounds are located in the tropical states, predominantly in Malaysia, Indonesia and the Philippines. The peneideans are mainly abused in tropical, subtropical, and warm temperate waters, and distributed at all depths and in almost all environmental conditions. The fry, juveniles and adolescents inhabit surface waters such as in shallow water and mangrove estuaries, while most of the adults inhabit deeper waters down to almost 160 m.

**Current status of prawn and shrimp farming**

Production of shrimp and prawn was estimated from the Khulna district of Bangladesh, from the shrimp depots of Paikgacha, Dacope, Koyra, Batiaghata, Dumuria, Rupsha, Terokhada, Digholia, Fultala, and Metro Upazila in Khulna district. The total harvest of shrimp and prawn and observed production in shrimp depots in Khulna district was 21611 and 18620 ton respectively where the total area of shrimp farming is 58472 hector. The annual total harvest of shrimp was 5873, 4388, 1636, 2145, 5416, 616, 582, 569, 345 and 41 ton at Paikgacha, Dacope, Koyra, Batiaghata, Dumuria, Rupsha, Terokhada, Digholia, Fultala, and Metro Upazila in Khulna district respectively. The annual total shrimp production in depots was 4833, 3675, 1408, 1992, 4694, 602, 529, 537, 311 and 39 ton at Paikgacha, Dacope, Koyra, Batiaghata, Dumuria, Rupsha, Terokhada, Digholia, Fultala, and Metro Upazila in Khulna district respectively. Where the total shrimp farming area are 17276, 12680, 4530, 6253, 13284, 1178, 1102, 1070, 987 and 112 hector at Paikgacha, Dacope, Koyra, Batiaghata, Dumuria, Rupsha, Terokhada, Digholia, Fultala, and Metro Upazila in Khulna district respectively.

**Production and its contribution to the economy of Bangladesh**

The firstly records of Bangladesh's export of freshwater prawns dates back to the 1960's and was mainly from the capture fishery to markets in the USA, UK, France, Italy and Belgium (Ahamed et al., 2014). In the early 1990s, prawn farming had developed well especially in the southwestern Bangladesh; over 90% of the prawn exports came from the capture fisheries to confirm the importance of this subsector in the freshwater prawn fisheries of Bangladesh. The export of prawn and shrimp and foreign earning during 1999/2000 to 2011/2012 are presented in Figure 1.

**Reproduction**

Wild males produce spermatozoa from around 35 g BW and females becomes gravid from 70 g. Mating (Figure 2) occurs at night, shortly after moulting, while the cuticle is still soft, and sperm are subsequently kept in a spermatophore (sac) inserted inside the closed thelycum of the female. Females of *P. monodon* are highly fecund, Spawning occurs at night and fertilization is external, with females releasing sperm from the thelycum as eggs are released in offshore waters. Nauplii hatch 12–15 h after fertilization. Females spawn 4 times during their lifespan at carapace length of 50,62,66, and 72 mm. but it is unknown how many times males mate. This species breeds year-round. The range of the number of offspring is 248,000 to 810,000. The gestation period is 12 to 15 hours (Knott, et al., 2011; Vainio and Lagerspetz, 2006).

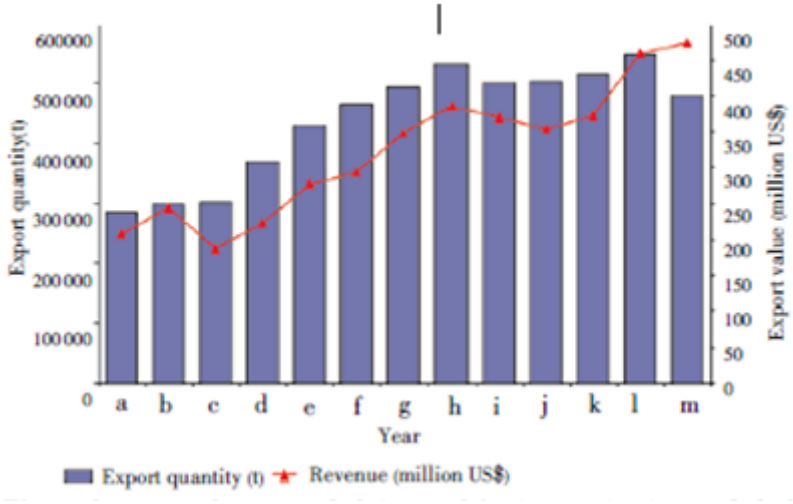


**Figure 1.** Export of prawn and shrimp and foreign earning in Bangladesh during 1999/2000-2011/12 (source: DoF, 2013). a: 1999-2000; b: 2000-2001; c: 2001-2002, d: 2002-2003; e: 2003-2004; f: 2004-2005; g: 2005-2006; h: 2006-2007; i: 2007-2008; j: 2008-2009; k: 2009-2010; l: 2010-2011; m: 2011-2012 (adopted from Ahamed et al., 2014).

**Courtship and mating behavior of *Penaeus monodon***

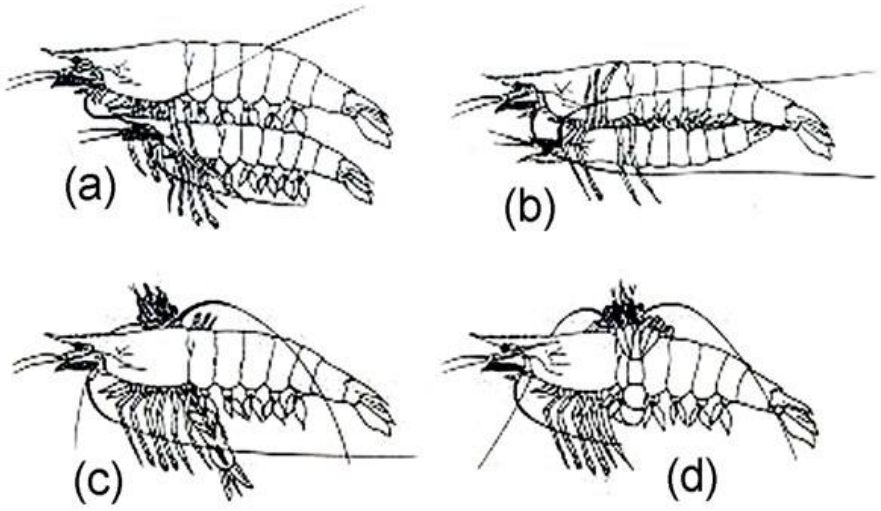


**Figure 2.** Courtship and mating behavior of *Penaeus monodon*

(Phase 1): A; Female above-male below in parallel swimming, (phase 2): B; Male turns ventral side up and attaches to female, (phase 3a): C; Male turns perpendicular to female (phase 3b): D; Male curves body around female and flicks head and tail simultaneously (Primavera, 1979).

**Ovarian maturation**

The maturation of the ovary has been categorized into five stages, the classification of which is based on ovum size, gonad expansion, and coloration.

**Stage I and V (undeveloped and spent stages)**

Ovaries are thin, transparent, and not visible through the dorsal exoskeleton. Stage I is known as the perinuclear stage composed of perinuclear oocytes (46-72 microns). Oocytes bigger than 55 microns are enveloped by a single layer of follicle cells. Similar features are observed in the spent stage (stag v) which also contains some yolky oocytes, thicker follicle layer, or irregularly shaped perinucleolar oocytes.

**Stage II (developing stage)**

The ovaries are white to olive green in color, and discernible as a linear band through the exoskeleton. The developing ova averaging 177 microns in diameter have yolk granules and cells believed to be nutritive bodies. The cells referred by as cystoplasmic inclusions are composed of small granules of glycoproteins, medium-sized globules of lipoglycoproteins, and few large lipid droplets.

**Stage III (nearly ripe stage)**

The anterior portion of ovaries is thick and expanded. They are very visible through the exoskeleton, particularly at the first abdominal segment, when viewed against the light. The ova average 215 microns in diameter.

**Stage IV (ripe stage)**

The ovary classified as ripe (mature) stage is diamond-shaped, expanding through the exoskeleton of the first abdominal segment. The isolated ovary appears dark olive green, filling up all the available space in the body cavity. There is the presence of a characteristic margin of peripheral rod-like bodies, the apexes of which radiate from the center of the egg. The ova average 235 microns in diameter (Akand et al., 1990).

**Life cycle**

Shrimp mature and breed only in a marine habitat. The females lay 100,000 to 500,000 eggs, which hatch after some 24 hours into tiny nauplii. These nauplii feed on yolk reserves within their bodies, and then metamorphose into zoeae. Shrimp in this second larval stage feed in the wild on algae, and after a few days, morph again into myses. The myses look akin to tiny shrimp, and feed on algae and zooplankton. After another three to four days, they metamorphose a final time into postlarvae: young shrimp that have adult characteristics. The whole process takes about 12 days from hatching. In the wild, post-larvae then migrate into estuaries, which are rich in nutrients and low in salinity. They migrate back into open waters when they mature.

**Development of prawn farming**

Around three-quarters of prawn farms are located in the southwest part of Bangladesh which has been identified as the most important and promising area for prawn culture, because of the availability of wild postlarvae, favorable resources and climatic conditions, such as the availability of ponds, low lying agricultural land, warm climate, fertile soil, and cheap and abundant labor (Ahmed 2001). In 2002, there were an estimated 105000 prawn farms in Bangladesh, of which 75000 (71%) were located in the southwest (Muir 2003). At that time, there were 30 000 ha of land under prawn farming (Williams 2003); this compares with 3500 ha in the mid 1980s (Muir 2003a). At present, the prawn culture area has increased to an estimated 50 000 ha (Khondaker 2007). The freshwater prawnfarming starts in Bangladesh dates back to the early 1970s in the Satkhira district (Ahmed et al. 2013). Early 1990s, the culture of these freshwater resources spread to the southwest Bagerhat district and further to other neighboring districts including Khulna and Jessore day by day. The areas ofshrimp farm were mostly concentrated in few upazila of the districts Khulna, Bagerhat, Satkhira and Cox's Bazar in early 70's. The area of shrimp farm increased very rapidly during 1980 – '90. In 1982-83, the area was around 39,496 ha, while now it is around 115,088 ha which is 3.43 times more than the past (DoF, 2007).Therefore, the beginning of the last decade has also witnessed the development of prawn farming to other parts of Bangladesh including the Noakhali, Patuakhali and Mymensingh districts. A recent study shows that around 75% of the prawn farms are still located in the southwest part of Bangladesh

**Culture technique**

There have three types of culture system in Bangladesh. In extensive culture system, the shrimps are fully dependent on the availability of natural food in the pond. The amount of natural food organisms becomes insufficient as the shrimps grow. When natural food diminishes the growth of shrimps slow down. This usually occurs towards the second month of the culture period depending on the stocking density and fertility of the pond. Additional feeds should be given in the form of supplemental feeds throughout the culture period to maintain the optimum growth rate. Pond fertilization is done when the natural food in the pond is diminishing. Transferring of stock to a new pond with luxuriant growth of natural food has been found to be maximum growth of shrimp but mortality during transfer is unavoidable especially when the shrimp have newly molted. The characteristic features of improved extensive system includes low stocking density, irregular fertilizing and feeding while in semi intensive system, medium stocking density, regular fertilizer and handmade feed (sometime commercial feed ) are used , water exchange are performed when need.

**Pond preparation**

The bottom soil plays a major role in any earthen pond culture system. Natural food organisms are one of the most important food sources in ponds. It is rich in protein, vitamins, minerals and other essential growth elements that simple supplementary feed cannot complete (Hussain and Uddin 1995). The drying of the pond bottom is the most cheap and effective method of eliminating undesirable species in pond prior to the culture period. Drying facilitates mineralization of organic matter and oxidizes harmful chemical substances. The chemicals used for liming of soils are Calcium oxide, Calcium hydroxide, Calcium $CaCo_3$ and mixed calcium-magnesium carbonate. About 69.92% farmers used lime at different doses in Bagerhat region of Bangladesh (Ahmed et al., 2008).

**Stocking density**

The highest stocking density of bagda PL was found in Mongla (40.95 thousand/ha) whereas lowest in Mollahat (8.08 thousand/ha) Thana. Stocking density of 15 and 22 pcs/m2 exhibited the highest production of 4635.1±128 kg/ha/crop and 4328.7±138.2 kg/ha/crop respectively (Saifullah et al., 2005). Stocking density between 10-20 pcs/m2 is ideal for successful shrimp farms and for the nursery of shrimp the stocking density of 100pcs/m2 is given better production. The fry should be stocked in the early morning (7 to 10 am) or late in the evening (9 to 11pm) when the pond water temperature is low.

**Seasons of fry availability**

Marketing of prawn seed starts in the month of March- April and the peak season of fry marketing is May to July. The maximum harvest from nature occurs in this time. Hatchery produced seeds are available between March to September (Saifullah et al., 2005).

**Nursing of fry**

Many farms use nursery ponds, tanks, cages where the post-larval shrimp are grown into juveniles for three weeks. The tanks are first filled with filtered aerated sea water. Stocking density is about 5000 fry/$m^3$ of water for *P. monodon*, 10,000/$m^3$ for *P. indicus* and *P. merguiensis*. The fry are fed with finely chopped mussel or cockle meat. Artemia nauplii are also used to minimize cannibalism. 50% of the water is changed daily. The size of nursery pond ranges from 500 to 2,000 $m^2$ and water depth is 40–70 cm .It is provided with at least one gate with a fine screen (1 mm mesh size) to prevent undesirable organism .Stocking density in nursery pond is about 50–150 fry/$m^3$ depending on the size of the fry. The nursery pond should be prepared properly. The pond is completely drained of water and dried until bottom soil cracks. Derris root at 4 g/$m^3$ can be applied when the pond cannot be completely drained. Lime at 500 to 2,000 kg/ha, chicken manure at 500 to 2,000 kg and inorganic fertilizer (16–20-0) at 25 to 100 kg/ha are then applied. About 30% of the water is changed daily. Chopped mussel, cockled meats are fed to the larvae at the rate of 20% total biomass. The nursing period is 30–45 days when the larvae reached 0.2–1.0 g body weight.

**Nursery cages**

Synthetic net cages (0.5–1.0 mm mesh size) with bamboo or wooden frames are kept afloat by bamboo raft or synthetic floats. The cages can be used to nurse shrimp larvae. Nursery cages are placed in calm water such as river, lagoon or fishpond. The cage (3 $m^3$) is usually stocked at 1000–2000 fry/$m^3$ of water.

**Grow-out pond**

In the grow-out phase, the shrimp are grown to maturity. The post-larvae are transferred to ponds where they are fed until they reach marketable size, which takes about three to six months.

**Food and feeding habit**

The food of *Penaeus monodon* consisted mainly of Crustacea (small crabs and shrimps) and mollusks, making up around 85% of ingested food. The remaining 15% consisted of fish, fish larvae and scales, polychaetes, ophiuroids, debris, sand, and silt. The foods contents of *P. monodon* are divided into four broad categories (Marte, 1980) .These are digested material and detritus, vegetable substance, crustaceans and non-crustaceans and food pellets. In Zoeal stage, they are herbivorous. At this stage they prefer phytoplankton such as Chaetocerosand Skeletonema. In Mysis stage (5-7 days after hatching), they become carnivorous. Their preferences shifting from phytoplankton to zooplanktons such as the Brachionus, the brine shrimp, Artemia and other zooplanktons. In postlarval stage, they started to ingest small crustaceans like crabs and shrimps, mollusks, fish, ophiuroids, polychaetes and even debris, sand and silt. They eat both plants and animals but when starved they eat any food offered to them. The staple food of *Penaeus monodon* is crustaceans though mollusks are also eaten in large amounts. In the wild environment, they prefer small shrimps and fishes. They feed on mollusks and fish for their gonad development and to attain sexual maturity (Pascual, 1989). They are opportunistic in feeding behavior. The feeding activity of female prawns is significantly higher than that of the males having same age. The adult is act as a predator especially for the slow-moving benthic macro-invertebrates (Motoh et al., 1985). They are slow eaters. They take food with their pincers then bring this to their mouth, and finally chew on the food slowly. In case of small size of the food they throw the whole piece into the mouth. Though they have been found to eat almost allthe day, they seem to eat more at night than at daytime. Before low tidethey proliferatetheir feeding activity. When the food is of poor quality and become insufficient they become cannibalistic in nature. There is also evidence that the healthy prawns attack the weak ones or those that have just molted to feed on (Ramanathan et al., 2005).

**Supplemental feeds**

Supplemental feeds provide nutrition in case of insufficient natural food for increased growth. Different artificial feeds consisting of cooked rice, fishmeal, oil cake, kura, chira, snail muscle etc have been used in shrimp farm. Boonyaratpalm and New (1993) obtained better production by using soybean meal, cornmeal, broken rice and rice bran. William *et al*. (1995) reported a production of 1,024 - 1,662 kg/ha of prawn fed with formulated diet. Tidwell *et al*. (1993) got suitable production using fishmeal, oilcake and rice bran (Tidwell et al., 1993). The types of feed used are: Moist/wet feeds - These are prepared using locally available ingredients. The feeds should be given fresh immediately after preparation. The commonly used feeds include the following: rice bran with trash fish, house discards, chopped toads and frogs, snails' shells crushed, mussel and clam meat, snails. The other one is dry pelleted feeds - Pelleted feeds are commercially used supplementary feeds of shrimps. The feeds should have also a longer shelf – life. Supplemental feeds may be given by broadcasting, through feeding tray or automatic machine feeder.

**Feeding rate and frequency**

Feeding rate and frequency are essential in maximizing conversion rate of feed to shrimp. The feed is given at 5–10% of the estimated shrimp biomass per day.The common feeding frequency adopted is 2–5 times a day. Apportioning daily feed ration several times a day improve feed conversion efficiency because it reduces feed wastage, ensures feed quality. If the stocks are to be fed 5 times a day, two should be given in daytime and 3 at night as the shrimps are more active when dark.

Recommended nutrient levels for prawn and shrimp feed on percentage fed basis

| Shrimp size (gm) | Protein (%) | Fat (%) | Fiber (%) | Ash (%) | Moisture (%) | Calcium (%) | Phosphorus (%) |
|---|---|---|---|---|---|---|---|
| 0.0-0.5 | 45 | 7.5 | Max.4 | Max.15 | Max.12 | Max.2.3 | Min. 1.5 |
| 0.5-3.0 | 40 | 6.7 | Max.4 | Max.15 | Max.12 | Max.2.3 | Min. 1.5 |
| 3.0-15.0 | 38 | 6.3 | Max.4 | Max.15 | Max.12 | Max.2.3 | Min. 1.5 |
| 15.0-40.0 | 36 | 6.0 | Max.4 | Max.15 | Max.12 | Max.2.3 | Min. 1.5 |

(Source : Lin, 1994)

**Aeration and water exchange**

Four aerators are needed for a 0.5-1.0 ha pond. These are installed at the corners of the pond, usually 3-5 m from the bottom of the dike. The type of aerator to be used depends on the depth of the water. One horsepower paddle wheel aerators should be used in ponds of less than 1.2 m water depth and the 2 HP paddle wheel aerators should be used in ponds deeper than 1.2 m. The most popular type of aerator is the long arm paddle wheel aerator. Change of pond water is important to maintain water quality. The process also helps to introduce new food organisms into the pond and stimulate molting of shrimp. The water in the pond can be changed through tidal flows or by means of a mechanical pump. Tidal exchange of pond water is practiced in traditional culture. Water in the pond is drained to one half of the pond level during low tide and is replenished during rising tide. Water pumps of various capacities are used to replenish pond water in semi-intensive and intensive culture operation.

**Harvesting**

Shrimp can be harvested in good condition within a short period of time. The harvesting should be done carefully so that it does not damage or contaminate shrimp. Rapid harvesting will reduce the risk of bacterial contamination. Complete harvesting is done by draining the pond water through. The average culture period required is around 120-150 days during which time the prawns will grow to 20-30 gm size (depending on the species). It is possible to get two crops in a year. Harvested shrimps can be kept between layers of crushed ice before transporting.

**Prawn productivity**

The average annual yield of head-on prawns in Bangladesh was reported to be 336 kg/ha (Muir 2003). The average productivity of prawn has increased in recent years, probably as farmers have become more confident to increase stocking densities and feeding levels. In the early1990s, the average yield of prawn was only168 kg ha-1, which was low due to the traditional farming method and the relatively low level of inputs (Rahman 1994). However, in the late 1990s, reported yields had increased, with a typical yield of 200-250 kg/ha being obtained (Rahman 1999), while Hoq, Islam and Hossain (1996) reported that prawn production when reared together with fish, varied from 162 to 428 kg ha-1. Nevertheless, most of the prawns are cultivated using extensive methods in Bangladesh and productivity is low compared with other countries. The quantity of total prawn production in Bangladesh remains rather uncertain because production statistics often do not distinguish between prawn and shrimp.

## CONCLUSION

Freshwater prawn farming plays an important role in the economy of Bangladesh, earning valuable foreign exchange and contributing to increased food production, diversifying the economy and increased employment opportunities. In spite of several problems, the practice of prawn farming has offered an opportunity to increase incomes for farmers and associated groups. Shrimp farming offers significant employment opportunities, which may help alleviate the poverty of the local coastal populations in many areas, if it is properly managed. Estimates of the labor intensity of shrimp farms range from about one-third to three times more than when the same area

was used for rice paddies, with much regional variation and depending on the type of farms surveyed. Despite the great potential of shrimp culture in this country, successful commercial farming is facing a number of challenges, including lack of quality seed, poor quality feed, lower production, inadequate food safety and quality control and marketing constraints. So, it is necessary to overcome these challenges with the help of institutional and organizational support, technical assistance, improved government facilities and infrastructure, extension services and training programmes.

## CONFLICT OF INTEREST

The authors declare that they have no competing interests.

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