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## An overview of freshwater prawn fishery in Bangladesh: present status and future prospect

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### PEER REVIEW

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#### Comments

This paper is presented well and presented very good data of available *Macrobrachium* species in Bangladesh, and their production since last 14 years, which would be very effective for further sustainable management of this shrimp fishery in Bangladesh as well as neighboring countries.  
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### ABSTRACT

The freshwater prawn fishery plays an important role in the economy of Bangladesh. The fishery is mainly based on the culture of *Macrobrachium rosenbergii*. The culture fishery has been growing rapidly, thus, masking the dwindling capture fishery which is faced with serious environmental issues augmented by deleterious fishing methods. Despite the high prospects of the freshwater prawn aquaculture in Bangladesh, a lot of research is needed to ensure the sustainable development of the capture fishery which forms a key source of prawn aquaculture seed as well as provide a baseline for future appraisals. Freshwater prawn aquaculture in Bangladesh is based on traditional methods with continuous adaptations by the rural fishers. However, numerous constraints to its full development are evident at all stages of its production. Lack of quality brood stock, seed, feeds and poor technical knowledge at farmers level are but some of the impediments challenging the sustainability of this industry. This paper reviews the freshwater prawn fishery of Bangladesh over the last few decades and outlines approaches for the development of an ecosystem-based management of both the culture and capture sectors of this important fishery.

### KEYWORDS

Freshwater prawn fishery, Aquaculture, Economy, Sustainable management, Bangladesh

## 1. Introduction

Prawns/shrimps are decapod crustaceans comprising about 33 genera with over 2500 species identified worldwide, of which less than 300 species are of economic interest<sup>[1]</sup>. Most of these species belong to five Penaeid families: Solenoceridae, Aristidae, Penaeidae, Sicyoniidae and Sergestidae, and three Caridean families: Pandalidae,

Crangonidae, and Palaemonidae which includes two subfamilies, namely Palaemoniinae inhabit inland water bodies, from brackish waters to mountain streams and occasionally, marine, and Pontoniinae which is exclusively marine<sup>[2]</sup>. As many as 21 valid genera and around 300 species from different parts of world have been reported under Palaemoniinae with some large species of great potential for aquaculture<sup>[2]</sup>.

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The words ‘prawn’ and ‘shrimp’ are frequently used synonymously. However, there is still an international debate on the clear definition of shrimp and/or prawn. In some countries, the bigger penaeid species are referred to as ‘prawn’ while the smaller carideans are referred to as ‘shrimp’ and *vice versa* in some other parts of the world. In some regions they are also classified depending on the habitat. For example, freshwater crustaceans are called prawn, while saltwater crustaceans are called shrimp or *vice versa*. Consequently, the terms “shrimp” and “prawn” appear to be defined along numerous lines. However, in the present study the term ‘prawn’ is used to refer to the freshwater crustaceans commonly referred to as freshwater prawn. To date, the freshwater prawn fisheries in the world are mainly dominated by the genus *Macrobrachium* which is comprised of over 200 species<sup>[3–6]</sup>. The most common species include the giant river prawn *Macrobrachium rosenbergii* (*M. rosenbergii*), the oriental river prawn *Macrobrachium nipponense*, and the monsoon river prawn *Macrobrachium malcolmsonii* (*M. malcolmsonii*) with a few other minor species.

Bangladesh has a vast network of freshwater ecosystems covering an estimated 4699345 ha<sup>[7]</sup>. These ecosystems fall under two basic types; (i) natural and manmade closed water bodies for the culture-based freshwater fisheries including pond, lake and prawn farms and, (ii) natural and manmade open water bodies such as rivers, low laying rice fields and flood plains for the capture based freshwater prawn fisheries. The former cover about 774055 ha while the latter cover 3925290 ha including some 300 rivers.

These freshwater ecosystems of Bangladesh provide a unique environment for enormous prawn production potential because of the favorable climate and availability of wild seed stock<sup>[8–10]</sup>. 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. There are 24 species of freshwater prawns including 10 species of *Macrobrachium* in Bangladesh (Table 1)<sup>[8,11–13]</sup>. Among these species, four, including *M. rosenbergii*, *M. malcolmsonii*, *Macrobrachium villosimanus* (*M. villosimanus*) and *Macrobrachium lamarii* (*M. lamarii*) are of commercial importance with the latter three being key revenue earners for the national economy of Bangladesh<sup>[14]</sup>. However, the farming systems of these species have not developed yet in the country due to unavailability of seeds and the absence of a viable culture technology. Nevertheless, there is a high prospect of *M. malcolmsonii* culture in Bangladesh since larval production and culture is similar to that of *M. rosenbergii*<sup>[15]</sup>, which has been farmed

successfully in the India. The neighboring Pakistan has also put enormous resources towards establishment of freshwater farming system in the country. Additional attributes of *M. rosenbergii*, including a fine delicate flavor and good market prices both in national and international market, and the fact that it’s commercial culture has been tested in Bangladesh, give the species a most significant potential for the development of the freshwater prawn fisheries in Bangladesh<sup>[10,16–19]</sup>.

**Table 1**

Available *Macrobrachium* species in Bangladesh<sup>[8,11–13]</sup>.

Scientific name	English name	Local name
<i>Macrobrachium birmanicus</i>	Freshwater prawn	Thengua icha
<i>Macrobrachium dayanus</i>	Freshwater prawn	Kaira icha
<i>Macrobrachium dolichodactylus</i>	Freshwater prawn	Icha
<i>M. lamarrei</i>	Freshwater prawn	Icha
<i>M. malcolmsonii</i>	Monsoon river prawn	Chotka icha
<i>Macrobrachium mirabilis</i>	Freshwater prawn	Lutia icha
<i>Macrobrachium nipponense</i>	Oriental river prawn	Icha/chingri
<i>M. rosenbergii</i>	Giant freshwater prawn	Golda chingri
<i>Macrobrachium rude</i>	Freshwater prawn	Goda icha
<i>M. villosimanus</i>	Freshwater prawn	Dimua icha

Freshwater prawn fishery is currently one of the most important sectors of the national economy of Bangladesh. The existing freshwater prawn fishery of Bangladesh is mostly based on the aquaculture of the giant freshwater prawn, *M. rosenbergii*. Generally, the fisheries sector has attracted considerable attention because of its huge export potential. Unfortunately, the freshwater prawn fishery statistics remain intermittent, incomplete and in many cases inaccurate, since the fisheries sector surveys do not distinguish between prawns and shrimps<sup>[8]</sup>. Fish and fisheries products comprise the second largest export industry in Bangladesh contributing 2.46% of to the total export earnings and 4.39% to gross domestic product in 2011–2012 fiscal year<sup>[7]</sup>. Prawn and shrimp sector as a whole contribute 54.32% of the total export earnings from fisheries products<sup>[7]</sup>. Prawn and shrimp production sector provided direct and indirect employment opportunity for around 1.5 million people<sup>[8]</sup>.

Despite the enormous potential of the freshwater prawn fisheries of Bangladesh, it has been faced with numerous huddles including poor production technology, socio-economic and environmental issues and inadequate biological information on the commercial species, factors which remain an obstacle for the definition of sound development programs for this important prawn fishery. This paper assesses the present status of freshwater prawn fishery in Bangladesh with regards to existing resources, current exploitation levels, impacts to the environment and the current development levels and management systems

in the country. Further, the study evaluated the unexploited potential of the freshwater prawn fishery in Bangladesh and its future prospects, while highlighting key areas that require urgent extensive research in order to provide a solid base for the sustainable development of this important fishery.

## 2. History

The inland freshwaters of Bangladesh held very rich stocks of prawns and other fisheries resources, with majority of the locally consumed and exported prawns coming from the capture fisheries before the advent of prawn farming in the 1970s<sup>[20]</sup>. Bangladesh started to export some freshwater prawn from capture fisheries to USA, UK, France, Italy and Belgium in the 1960s. However, starting prawn farming in the early 1970s<sup>[21]</sup> substantially increased the total production of freshwater prawn along with capture fishery and the amount of export of freshwater prawn increased significantly as a non-traditional item. Towards the 1990s, catches from capture fisheries started to decline due to construction of embankments for dams, irrigation, flood control and water flow regulators all over the country resulting blockage of the migratory routes of many freshwater species<sup>[22]</sup>. Thus, the breeding and spawning grounds of many species were cut off from the main habitat areas resulting in serious impacts on recruitment and proliferation of the wild stocks. Moreover, the continued harvesting of large quantities of prawn postlarvae and juveniles for stocking of the culture facilities further impacted the declining wild stocks and capture fisheries<sup>[23]</sup>. All these factors augmented the already deteriorating condition of the freshwater prawn capture fishery in Bangladesh. On the other hand, many rice farmers and some capture fishermen started switching to prawn farming, which increased rapidly due to the high demand both in national and international markets<sup>[10,18–20,24]</sup>.

## 3. Present status

By 1998, about 46% production of *M. rosenbergii* still came from the capture fisheries with 84% production of the overall production of the *Macrobrachium* species including *M. malcolmsonii*, *M. villosimanus* and *M. lamarii* coming from this fishery<sup>[22]</sup>. However, the present form of freshwater prawn fishery is mainly based on the aquaculture of the giant freshwater prawn, *M. rosenbergii*. A recent statistics in 2011–2012, indicated that 70% of the total production of freshwater prawn was from aquaculture while only 30% was from capture fishery<sup>[7]</sup>.

### 3.1. Development of prawn farming

The farming of the freshwater prawns starts in Bangladesh dates back to the early 1970s in the Satkhira district<sup>[25]</sup>. In the early 1990s, the cultivation of these freshwater resources gradually spread to the southwest Bagerhat district and further to other neighboring districts including Khulna and Jessore<sup>[10,18,19]</sup>. By the late 1990s, prawn farming became one of the most lucrative industries for investment owing to increasing demand and value of freshwater prawns in the international market. Consequently, the start of the last decade has further witnessed the expansion of prawn farming to other parts of Bangladesh including the Noakhali, Patuakhali and Mymensingh districts<sup>[26]</sup>. A recent study shows that around 75% of the prawn farms are still located in the southwest part of Bangladesh<sup>[19]</sup>, making the area most invested region for freshwater prawn farming in the country. Furthermore, the southwest areas have also been identified as the most promising for prawn culture because of the wide availability of wild seed and optimal climatic conditions with numerous existing facilities such as ponds, low lying agricultural land, as well as demographic factors relating to cheap and abundant manpower. According to a recent statistics<sup>[7]</sup>, the freshwater prawn farms are covering a total area of 275 232 ha. Further, the farming of the freshwater prawn continued to expanding substantially over the recent years at an average rate of 10% annually<sup>[19]</sup>.

#### 3.1.1. Culture techniques

The culture of the freshwater prawns in Bangladesh is conducted in both ponds and low lying rice fields locally referred to as gher. An estimated 71% of prawn farmers engage in gher systems with the remaining percentage concentrated in pond culture systems<sup>[17]</sup>. To date, traditional, extensive, improved extensive and semi-intensive culture systems have been successfully practiced in Bangladesh. These culture systems are categorized based on the stocking density of postlarvae and the management techniques of the culture system. Traditional prawn culture usually involves trapping tidal waters (and therein, wild seed) in the nearby coastal enclosures, usually the gher systems, and the cultured species are left to grow with no feeding or application of fertilizers and other inputs. On the other hand, the extensive culture systems present slightly modified versions of the traditional methods. These extensive systems are therefore also commonly referred to as low-input systems where stocking densities vary between 10 000 and 18 000 post larvae per ha per year. Like the traditional systems, the extensive systems also heavily dependent on the natural productivity of the

gher/pond which is boosted by application of organic and, occasionally, more expensive inorganic fertilizers to enhance the development of plankton food items in the ponds. Thirdly, the extensive culture systems may be improved generally by use supplementary feeding for the cultured species. These supplementary feeds mainly consist of a mixture of locally available feed ingredients including rice and wheat bran, oil cake and fish meal. Therefore, the improved extensive systems are slightly more productive than the extensive systems. Lastly, semi-intensive culture systems encompass intermediate levels of stocking averaging at 18 000–30 000 post larvae per ha per year and rely on commercially manufactured feeds. With increased demand for freshwater prawns in both national and international markets, many farmers continue to switch over from the tradition and extensive systems to the more productive improved extensive and semi-intensive systems. Currently, the number of farmers engaged in semi-intensive culture systems is estimated at slightly over 20%<sup>[8]</sup>. These numbers are expected to increase as the demand for the freshwater prawns continues to increase especially of the supply of wild seed continues to remain stable and adequate to sustain the growth in this industry.

In pond systems, the farmers usually stock hatchery-produced post larvae at the densities above 10 000 post larvae/ha, mostly in polyculture with Indian and Chinese carps. Due to the dependence of these systems on the weather, the stocking seasons usually run from April through May period. The prawns are fed using either locally formulated feeds or commercial feeds depending on the financial status of the farmers and the scales of investment. In the case of formulated feeds, the farmers use about 50 g of wheat flour per 1 000 post larvae in the first week of stocking and the feeding rate is doubled in the second week<sup>[8]</sup>. Various carp species are integrated in the freshwater prawn culture systems at a stocking densities ranging between 2 500 to 3 000 fingerlings/ha<sup>[27]</sup>. In these systems farmers also use formulated feeds comprising a mixture of fish meal, rice bran, mustard oil cake, molasses and wheat flour. However, farmers who are financially unable to afford these formulated feeds and mixtures simply feed the cultured prawns using boiled wheat or cooked rice<sup>[28]</sup>. In some cases, some farmers use commercial fish feeds to boost the prawn production, especially during the fattening in the latter stages of culture. In the use of commercial feeds, various feeding regimes are employed with three different rates as follows: during the 0–4th week culture, the prawns are fed at the rate of 6% of body weight followed by 4% body in the 5th–16th week and down to 3% body weight in the last 17th–32nd week<sup>[29]</sup>. The harvesting of the cultured prawns is usually

done in stages between the 6th–8th months after stocking mostly from October to December in annual ponds. However, in perennial ponds, the culture duration is often extended running into May–June of the following year when the final harvesting is completed. The average sizes of prawns at harvest ranges anywhere from 60–150 g with annualized yields ranging from 175 to 200 kg/ha under the home-made feeds culture systems<sup>[27]</sup>. In the culture systems employing commercial feeds yields as high as 400 kg/ha have been documented<sup>[26]</sup>.

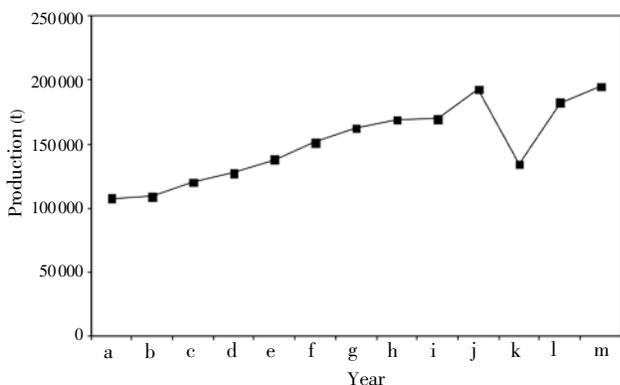
The cultivation of the freshwater prawns in modified rice fields or ‘gher’ in Bangladesh<sup>[30]</sup> usually involves strengthening the walls of the existing rice paddies through building higher and stronger dikes with inclusion of a deeper canal along the sides maintain a deeper refuge area for the cultured prawns especially during the dry season when water levels drop drastically<sup>[31]</sup>. Gher farming is an indigenous technological revolution which has proved suitable for the integrated cultivation of the freshwater prawns, fish and rice<sup>[32]</sup>. During the rainy season, the water bodies are used for the cultivation of prawns and fish. However, in the dry season, the deeper refuge areas on the sides are used for prawn and fish culture while rice is planted in the less flooded central parts of the gher or paddy. The gher systems are generally situated in low lying areas of the floodplain and the water sources are mainly rainfall, extracted ground water and/or river water supplied through canals and diversions of the flow channels.

Freshwater prawn culture in gher systems usually runs from May to June when the abundance of wild post larvae is highest, and the farmers can stock the gher systems with minimal labor requirements. The stocking densities ranging from 10 000 to 30 000 post larvae/ha<sup>[17,33]</sup>. Majority of the farmers still prefer wild postlarvae to hatchery produced fry because the production of the hatchery postlarvae is limited, and the survival rate of wild post larvae is much higher than that of the hatchery produced fry<sup>[34–36]</sup>. Different carp species including catla (*Catla catla*), rohu (*Labeo rohita*), mrigal (*Cirrhinus mrigala*), silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngodon idella*) and common carp (*Cyprinus carpio*) are also cultured in integrated systems with the freshwater prawns. The carps are generally stocked at low densities ranging from 2 000 to 5 000 fingerlings/ha<sup>[16]</sup>. A variety of supplementary feeds are used by the gher system farmers, with many farmers utilizing the locally available freshwater snail *Pila globosa* muscle to feed the ponds and gher systems at the rate of 66.5 kg/(ha·day)<sup>[16]</sup>. However, the supply of the snail meat is not regular and therefore farmers also use their own formulated feeds including mixtures of cooked rice, rice bran, oil cake and

fish meal as well as commercial pellets. In all cases, the farmers apply both organic manure (cow dung) and inorganic fertilizers such as urea and triple super phosphate–TSP to enhance the production of natural food in the ponds. The fertilization rates are normally about 1500 kg/(ha·year) of cow dung, 400 kg/(ha·year) of urea and 200 kg/(ha·year) of TSP at varying frequency[16]. The harvesting season mainly runs from November to January. Several studies have shown that the integrated prawn–rice culture systems were very ecologically sound[37,38], since the shrimps also enhance the productivity of the rice paddies by predated insects which often cause enormous losses to many farmers in the country. Moreover, the burrowing behavior of the crustaceans has been shown to improve the overall soil fertility thus boosting the productivity of the gher systems and paddy systems.

### 3.1.2. Production and its contribution to the economy of Bangladesh

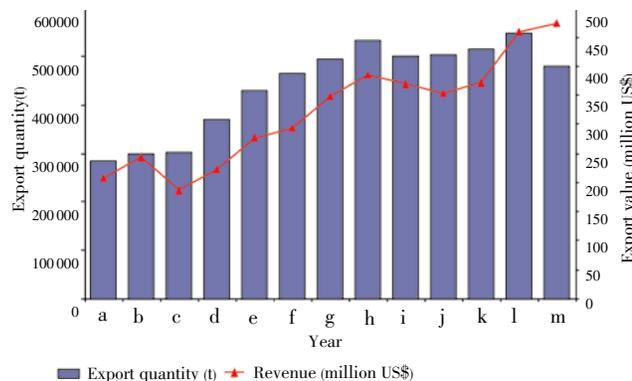
The total production of freshwater prawn during 1999/2000 to 2011/2012 fiscal year is presented in Figure 1. The average annual growth during this period was 6.51%.



**Figure 1.** Freshwater prawn production 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.

The early 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[20]. However, documented records for substantial freshwater prawn exports only date back to the in the 1970s. During this period, the culture of several species also started to increase substantially although the vast quantities of the freshwater prawn exports still came from the capture fisheries. Furthermore, even in the early 1990s when prawn farming had developed well especially in the southwestern Bangladesh, over 90% of the prawn exports still came from the capture fisheries confirming the importance of this sub-sector in the freshwater prawn fisheries of Bangladesh[39]. However, with the growing demand of freshwater prawns in world market supported by high prices, rice farmers in the

southwest areas of Bangladesh rapidly switched to prawn farming[24]. The export quantity of prawn and shrimp and foreign earning during 1999/2000 to 2011/2012 are presented in Figure 2. Today, shrimps and/or prawn are likened to gold, and the term “white gold” is often used in Bangladesh to refer to these valuable resources.



**Figure 2.** 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.

### 3.2. Problems facing the freshwater prawn fisheries in Bangladesh

The problems facing the freshwater prawn fisheries of Bangladesh may be outlined as: large scale water abstraction for irrigation, construction of embankments for flood control, siltation, soil erosion due to deforestation in the catchments water, pollution from industrial, agriculture and municipal waste, high production costs, insufficient supply of postlarvae, poor quality of feed, disease and flood. However, the disease outbreaks associated with poor management and husbandry, poor and/or lack of technical knowledge among the farmers, and most importantly, the lack of continuous research and monitoring within this important industry. A wide variety of diseases are occur in the freshwater prawns culture systems every year, including the white spot disease, soft shell, black spot and gill disease[39]. Black spot, the most widespread disease of prawn from postlarvae to harvest size, is caused by bacteria, and often followed by fungal and viral attacks[40] causing mass mortalities and losses in the aquaculture industry. In cases where the mortalities are checked by fast prophylaxis, the recovered harvests command a substantially lower market value due to defacement of the prawns. Secondly, the lacks of technical knowledge among the farmers reduce the productivity of the shrimp production. They have no knowledge about the modern method of shrimp farming that reduce the productivity. Lastly, the lack and/or continuous research and monitoring to support the fast growing freshwater prawn

culture fisheries means that poor seed continues to be used for stocking, little effort in development of proper feeds for the culture species, little effort to evaluate the economics of the prawn, fish and/or prawn–fish integrated culture systems to advice farmers on the best farming practices including optimal stocking densities, fertilization rates, improvement of husbandry the culture systems.

The environmental and ecological impacts of the freshwater prawn fisheries of Bangladesh have remained at low scales compared to the sister industry of brackish water shrimp farming<sup>[41,42]</sup>. However, with the rapid increase of prawn farming concentrated mostly in southwest areas of the country, the growing concerns of the impacts of this fishery on the environment as well as on other types of fisheries cannot be ignored<sup>[43]</sup>. Environmental and ecological impacts associated with the gher construction and expansion into virgin wetland ecosystems, collection of wild postlarvae for stocking of the aquaculture industry, and snail harvesting for feed materials in the freshwater prawn culture systems are but some of the noticeable activities of concern in this industry. In the prawn farming region, large areas of wetland have been converted to gher and pond systems which has negative impacted the environment with decline in rice production as well as wetland biodiversity<sup>[44,45]</sup>. Moreover, the gher systems block fish migration routes and hamper the normal life cycles of some indigenous species. Consequently, many fish species have been rendered extinct while many others have been endangered<sup>[46,47]</sup>. Moreover, the decline in rice production due to conversion of rice paddies to gher systems and aquaculture ponds has serious socio-economic implication for many rural folks whose staple food is rice and other cereals associated with the paddy systems.

Secondly, the collection of wild postlarvae for stocking of the gher ponds is another concern for negative environmental and ecological impacts of the freshwater prawn fisheries<sup>[23,43,48]</sup>. The unchecked harvesting of the postlarvae has substantially reduced the wild production of freshwater prawns, and may further threaten the natural populations of these species. Moreover, a large number of juveniles of other fish species are also caught and discarded during the collection of postlarvae and this is likely to have severe long-term impacts on overall biodiversity in the coastal and wetland ecosystems<sup>[23]</sup>. It is with these concerns in mind that the DoF banned the harvesting wild postlarvae in 2001 although this has not been strictly implemented due to the limited availability of hatchery seed and lack of alternative livelihoods for poor people engaged in postlarvae catching<sup>[36,49]</sup>. However, the ban triggered an expansion on the number and sizes of prawn hatcheries, from only 16 hatcheries with a total production of 10 million post larvae a year in 2000, to a total of 81 hatcheries recorded in 2007.

However, majority of these hatcheries continued to operate sub-optimally due to lack and/or inadequate technological knowledge, skilled manpower and supply of wild brood stock. During the same year, the production of post larvae from the hatcheries reached about 100 million but only enough to cater for 20% of total demand in the freshwater prawn culture sector<sup>[50]</sup>.

Lastly, the freshwater prawn culture system is heavily depended on locally available materials including the mud snail *Pila globosa* for muscle and cereal brans including rice, wheat and maize, as well as their ground flours, fish meals, etc. The increased harvesting of the mud snail *Pila globosa* for feed production in the industry has shown some negative ecological and human health impacts. For example during the monsoon season, there is severe shortage of supply of this snail in the prawn farming area and therefore, many farmers import from it from other districts and neighboring water bodies as far as India. Williams and Khan reported that many of the fishers involved in the crushing of these snails in the feed preparation process complain of skin irritation and respiratory problems<sup>[51]</sup>. In addition, the farmers often dump the shells of the mud snail in nearby canals thereby create environmental pollution and blockage of the natural drainage systems.

The dependence of the freshwater prawn fisheries on local cereals and brans including rice, wheat and maize, as well as their ground flours, fish meals, has serious socio-economic impacts on the food security of the rural poor.

#### 4. Conclusion

The freshwater prawn fishery plays an important role in the economy of Bangladesh through foreign exchange earning and its contribution to the overall food production. The sector is also an important employer of many rural fishers and farmers thus supporting the rural economies immensely. Despite the few environmental and ecological problems associated with this industry, the fishery provides an opportunity to increase incomes for farmers and associated groups. The recent records of production and export value from this sector demonstrate bright future prospect of this sector in the country. However, the current freshwater prawn fishery is mostly based on culture of *M. rosenbergii* and therefore, the development of the capture fishery has largely been neglected leading to stagnation in its growth. Although the freshwater prawn culture of *M. rosenbergii* contributes a lot to the national economy of Bangladesh, the contribution from the fishery can be greatly improved by development of proper culture technology and management systems for commercialization of this species. At the beginning, the freshwater capture prawn fishery of

Bangladesh was very rich and was sufficient to adequately supply the country with enough harvests but at present, the natural stocks are greatly reduced not to mention the rapid increase in the population. The condition is aggravated by radical man-made changes in the environment with pollutant discharge from the urban centers or from established industries, and building of multi-purpose dams in river systems as well as silting. To alleviate these negative impacts, several approaches are recommended: first, by preserving and maintaining environmental quality and designating sanctuary areas as conservation measures for the natural prawn fishery. Further, by promoting the culture of other commercial species such as *M. malcolmsonii*, *M. villosimanus* and *M. lamarii*. The *M. malcolmsonii* has a tremendous potential for culture in Bangladesh due to its fast growth, good taste and high prices in international markets similar to *M. rosenbergii*. Thirdly, there is a need for continuous monitoring, research and development into sustaining the excellence of this sub-sector. Some studies have been conducted on the culture and marketing system of *M. rosenbergii*. However, comprehensive studies on the biological aspects of the freshwater prawns including reproduction, growth, and stock assessment of these commercially important prawns of Bangladesh are still lacking, thus hampering their sustainable management. Research on different biological aspects of these freshwater prawn species is therefore key to the sustainable management of this fishery.

### Conflict of interest statement

We declare that we have no conflict of interest.

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### Comments

#### Background

The freshwater prawn fishery plays an important role in the economy of Bangladesh. The fishery is mainly based on the culture of *M. rosenbergii*. The culture fishery has been growing rapidly thus, masking the dwindling capture fishery which is faced with serious environmental issues augmented by deleterious fishing methods. Despite the high prospects

of the freshwater prawn aquaculture in Bangladesh, a lot of research is needed to ensure the sustainable development of the capture fishery which forms a key source of prawn aquaculture seed as well as provide a baseline for future appraisals. Freshwater prawn aquaculture in Bangladesh is based on traditional methods with continuous adaptations by the rural fishers. The neighboring Pakistan has also put enormous resources towards establishment of freshwater farming system in the country. Additional attributes of *M. rosenbergii*, including a fine delicate flavor and good market prices both in national and international market, and the fact that its commercial culture has been tested in Bangladesh, give the species a most significant potential for the development of the freshwater prawn fisheries in Bangladesh.

#### Research frontiers

Numerous constraints to its full development are evident at all stages of its production of prawn. Lack of quality brood stock, seed, feeds and poor technical knowledge at farmers level are the impediments challenging of the sustainability of this industry.

#### Related reports

The farming of the freshwater prawns starts in Bangladesh dates back to the early 1970s in the Satkhira district. In the early 1990s, the cultivation of these freshwater resources gradually spread to the southwest Bagerhat district and further to other neighboring districts including Khulna and Jessore. By the late 1990s, prawn farming became one of the most lucrative industries for investment owing to increasing demand and value of freshwater prawns in the international market. Consequently, the start of the last decade has further witnessed the expansion of prawn farming to other parts of Bangladesh including the Noakhali, Patuakhali and Mymensingh districts.

#### Innovations and breakthroughs

A recent study shows that around 75% of the prawn farms are still located in the southwest part of Bangladesh<sup>[19]</sup>, making the area most invested region for freshwater prawn farming in the country. Furthermore, the southwest areas have also been identified as the most promising for prawn culture because of the wide availability of wild seed and optimal climatic conditions with numerous existing facilities such as ponds, low lying agricultural land, as well as demographic factors relating to cheap and abundant manpower. According to a recent statistics, the freshwater prawn farms are covering a total area of 275 232 ha. Further, the farming of the freshwater prawn continued to expanding substantially over the recent years at an average rate of 10% annually.

### Applications

This paper reviews the freshwater prawn fishery of Bangladesh over the last few decades and outlines approaches for the development of an ecosystem-based management of both the culture and capture sectors of this important fishery.

### Peer review

This paper is presented well and presented very good data of available *Macrobrachium* species in Bangladesh, and their production since last 14 years, which would be very effective for further sustainable management of this shrimp fishery in Bangladesh as well as neighboring countries.

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