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*Review Article*

# Scope, Prospects and Constraints of Freshwater Prawn (*Macrobrachiumrosenbergii*, De Man) Culture and Management Practices in Punjab (India)

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**Abstract**

Variety of freshwater prawns (about 100 species) found all over the world of which 25 have inhabited the Indian waters. Among these, *Macrobrachium rosenbergii* (giant freshwater prawn is a crustacean species belonging to the family Palaemonidae) possessing high potential and great commercial importance in India and abroad. It is a hardy species by virtue of its ability to adapt to various types of fresh and brackish-water conditions. It is omnivorous, bottom dwelling animal, accepts pelleted feed and eat greedily. The giant freshwater prawn is suitable for cultivation in many natural freshwater bodies as well as low saline brackish water ecosystem in tropical and subtropical climates all over the world. Within recent years controlled hatching and grow out culture of marketable forms of this species have been tried in lentic water bodies in India and is still growing. Several culture management techniques have been adopted by various workers and found that the average production rate of freshwater prawn in India is 1-2 tonnes/ha/yr. Israel has reported 3,000 to 4,000 kg fish and 1,500-2,000 kg/ha prawns within a culture period of 7-8 months under polyculture operation. In India prawn culture with carps under polyculture practices has reported production levels of 600-1640 kg/ha/yr. However, prawns require optimum physico-chemical characteristics in water and rearing of prawn larva up to marketable size is a system specific. Presently, culture of *M. rosenbergii* is being done in most of the coastal states of the country. Inland states have also initiated prawn culture which may take time to standardize the production under different agro-climatic conditions. The assessment revealed that the growth and production of giant freshwater prawn is highly dependent on the suitable environmental conditions for commercial as well as greater management orientation. Therefore, the farming community and entrepreneurs must understand the scope, prospects, situation, features, impact and constraints of *Macrobrachium rosenbergii* culture, hatchery operation and its management practices on scientific basis.

**Key words:** Giant Freshwater prawn farming, scope, prospects, constraints, management practices

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## Introduction

Aquaculture in India has a long history; there are references to fish culture in Kautilya's *Arthashastra* (321–300 B.C.) and King Someswara's *Manasoltara* (1127 A.D.). The traditional practice of fish culture in small ponds in eastern India is known to have existed for hundreds of years; significant advances were made in the state of West Bengal in the early nineteenth century with the controlled breeding of carp in *bundhs* (tanks or impoundments where river conditions are simulated). Fish culture received notable attention in Tamil Nadu as early as 1911, subsequently, states such as Bengal, Punjab, Uttar Pradesh, Baroda, Mysore and Hyderabad initiated fish culture through the establishment of Fisheries Departments. Indian aquaculture has been evolving from the level of subsistence activity to that of an industry. This transformation has been made

possible with the development and standardization of many new productions and associated techniques of input and output subsystems. The total inland fish production in the country registered growth from 1.2 tons in 1986 to 3.5 million tons in 2004-05, in which the contribution of freshwater aquaculture was way ahead of either brackish water aquaculture or capture fisheries sector on a constant basis. India is third largest producer of fish in the world with annual production of 6.4 million metric tons and second largest producer of inland fish, with annual growth rate of over 6%. The freshwater aquaculture at present accounts over 70% to total inland fish production. Carps, both Indian and exotic, contribute to over 90% of the total freshwater aquaculture production. This sector alone is contributing about one third of the total fish production in the country. The average production rate of freshwater prawn in India is 1-2 tons/ha/yr. Among the landlocked states, Punjab holds 5$^{th}$ position with highest fish productivity (6.09t/ha/yr) in the country, which is more than double the National average productivity (2.60t/ha/yr). In Punjab the area nearly about 9890 ha is under aquaculture. This state also has a vast network of water resources including 17,543 Km of rivers and canals, 5804 ha of reservoirs and wetlands and 8000 ha of village ponds, 1.65 lakh ha of barren/ waste land and 1.72 saline affected areas having immense potential for fishery development. Punjab produced 86000 tons of fish in 2005-2006 and >65 % production was contributed by the culture sector. Fish and prawn production can be enhanced through development of improved technology as well as suitable scientific management.

Prawn fishery of India with an annual catch of over 100,000 tons is second only to the United States and accounts for 18% of the world's production. Flourishing trade of exporting 'Prawn-pulp' to Burma and Malaya from earlier times and 'Frozen and canned' prawns to USA and Japan in recent years has made Indian Prawns a major foreign exchange earner. Export earnings from them have shown a steady increase in the last decade from Rs 115 million in 1961 to Rs 330 million in 1970. A part from being a delicacy, prawns is a rich source of proteins and vitamin A and D, most wanted to support the underfed human populations of the world. They contain considerable quantities of glycogen and free amino acids in their muscle which make their flesh so sweet and tasty. As they contain very little fat, they have become a favorite protein food for the weight conscious aristocracy.

In the tropical countries of Asia, the long legged giant prawn *(Macrobrachium rosenbergii)* has been known as food item for the people since long years ago. The prawn can attain big size which makes its capture wherever it occurs become an item for commercial venture. *Macrobrachium rosenbergii* is one of the freshwater species possessing high potential and good market demand. There are a number of species of freshwater prawns in India of which few are of commercial importance *(M. rosenbergii, M. malcolmsonii, M. villosimanus, M. birmanicum Choprai, M. mirabile, M. rude, M. idea, M. idella,* and *M. equidens)*the first two are larger in size and are more desired. Most of these prawns are crustaceans belonging to the family Palaemonidae. The now famous giant freshwater prawn, *Macrobrachium rosenbergii*, is a good example of this group. It composes an important fishery in many natural freshwater bodies in several tropical and sub-tropical countries all over the world. Within recent years controlled hatching and grow out culture of marketable forms of this species have rapidly expanded in many countries and is still growing. This species has a fine delicate flavour and commands good market price in local markets as well as in foreign trade in both developing and developed countries.

The average production rate of freshwater prawn in India is 1-2 tonnes/ha/yr. India accounts annual production (1979) amounted to about 350mt for *M. rosenbergii,* 4mt for *M. malcolmsonii*, 20 mt for *M. villosimanus;* and 125mt for *M. mirabile.* Although hatcheries and grow out culture are on trial, there is no information on production from this source. As per the available report, a maximum production of 4.2 tonnes/ha/yr has been achieved in Brazil, 2.5-3 tons/ha/yr in Taiwan and 280-4,000 kg/ha/yr in Veitnam, USA, Thailand, Porto Rico, France, Polynesia, Martinique, Dominican Republic and south African countries. Israel has reported 3,000 to 4,000 kg fish and 1,500-2,000 kg/ha prawns within a culture period of 7-8 months under poly-culture operation. In India prawn culture with carps under polyculture practices has reported production levels of 600-1640 kg/ha/yr. At present, culture of *M. rosenbergii* is being done in most of the coastal states of the country. Inland states Madhya Pradesh, Haryana, Punjab, Bihar, Tripura, Chhattisgarh etc. have also initiated prawn culture which may take time to standardize the production under different agroclimatic conditions.

**Situation of prawn culture in Punjab and Haryana**

Prawn farming was implemented in Haryana with an area of 70.06 hectares brought under fresh water

prawn farming. The state government has fixed a target of undertaking prawn farming in 100 hectares of fresh water area. At least, 119 farmers had been given subsidy and imparted technical know-how to take up prawn culture during the year 2004. The project of fresh water prawn farming was initiated in 12 districts–Yamunanagar, Karnal, Sonepat, Faridabad, Gurgaon, Jhajjar, Rohtak, Bhiwani, Fatehabad, Sirsa, Hisar and Jind. The department not only provided technical know-how to the fish farmers for undertaking prawn farming in fresh water but also took them to a study tour to Andhra Pradesh so as to acquaint them with the latest practices being adopted there.

Two other projects to develop water-logged areas into aquaculture estates and utilization of saline water for fish and prawn culture were also being implemented with 100 per cent assistance from the Union Ministry of Agriculture. Under the project, 18.7 hectares of area was brought under fresh water prawn culture by imparting training and technical know-how to the farmers in the districts of Gurgaon, Rohtak, Jhajjar and Sirsa. Under the project for utilization of saline water, 23.2 hectares of water area was brought under fish or prawn culture by providing benefit to the farmers in the districts of Gurgaon, Jhajjar, Rohtak and Sirsa. Under both these projects, 100 per cent assistance was provided to the farmers at a rate of Rs 2.30 lakh per hectare, which included Rs 2 lakh for development of area and Rs 30,000 for inputs.

As it was a new technology, the scientists identified the sites and the experts analyzed soil and water before using them for prawn culture. The seeds of prawn were procured from Andhra Pradesh and Tamil Nadu. Both these projects were being implemented since 2002-03. As per the figures of the Fisheries Department, a total area of 8,760 hectares was under fish culture as on March 2004. At least, 39,133 tons of fish was produced in the state during that period. As many as 8,120 fish farmers were benefited by the training and incentives providing by the department. At least, 17,660 farmers in the state were presently engaged in fish farming. An additional area of 663.25 hectares was brought under fish culture during the last financial year.

Seven villages in Punjab took up prawn farming in the year 2003 alone. These are Badshapur, Kapurpind, Kah Kalan and Barra Pind in Jalandhar district, Dogawalli village in Kapurthala district, Punnia village in Sangrur district and Kishanpur in Ropar district. Mr Nirmal Singh was also adopted prawn culture in Jalandhar but could not continue. The trial on prawn farming was also conducted by CIFA scientist at Ludhiana without any success story. Mr. Rajwinder Singh is also importing prawn from other state for the local consumer in Ludhiana. Recently, a farmer Mr Ajitender Pal Singh Cheema has commercialized prawn farming after stocking 14000 seeds in 0.28 ha area by using Godrej Agrovet Scampi feed and blower/ aerator at Rasulpur village Distt-Barnala and earned Rs 57,000/- per crop in 7 months (April to October). Mr Cheema is doing freshwater prawn farming in a very amicable and eco-friendly way. At present, Mr Cheema is the only farmer in Punjab who is involved in prawn farming. He is now planning to increase prawn culture area for *Macrobrachium rosenbergii* to fulfill the need of the consumer as well as to gain maximum output.

*Special Features of Freshwater Prawn Species in Aquaculture*

Freshwater prawn culture has now a day gained much commercial importance for its rising internal market demand and export potentialities. More than forty species of *Macrobrachium* commonly occur in Indian waters, but only a few like, *M. rosenbergii, M. malcolmsonii, M. birmanicum Choprai, M. villosimanus, M. rudae, M. idea, M. idella,* and *M. equidens.* Among these *M. rosenbergii* are most suitable and potential species for freshwater prawn farming in the state of Punjab because it grow fast and large size compare to other species. The other two species, *M. malcolmsonii* and *M. birmanicum choprai* is also in order of merit for culture in our freshwater. It can be a good diversification option for agriculture farmers besides generating employment and providing nutritious food to the consumers.

The natural distribution of these species as original habitat in river has immensely accepted for their culture by fisher folk in different parts of our country. Availability of *M. rosenbergii* in the river systems is limited to estuarine zone with a maximum of about 100 kms from the sea shore while *M. malcolmsonii* is available throughout the length of river system starting from its point of origin to the point of joining the sea making it easy for culture throughout the country. On the contrary, *M. birmanicum choprai* is found to be available in the middle stretch of Gangetic system only, limiting its culture area accordingly in North India. The other common medium and small sized *Macrobrachium* sp. *M. lamarrei* and *M. idea* are available throughout the river stretch and connected lakes and canals where as *M. scabriculum, M. equidens, M. idella, M. villosimanus,and M. rudae*are limited to coastal areas and deltaic regions.

1. *Macrobrachium rosenbergii De Man,* (Giant River Prawn) is the largest freshwater prawn in the world. It is mostly distributed in the estuarine and freshwater zones of river mouth and backwaters (salinity range 0–20 ppt) in the tropical and sub-tropical areas of Indo-Pacific region. Recent developments in hatchery seeds production techniques, have transformed *Macrobrachium rosenbergii* farming as a major profitable aquaculture activity in countries like Thailand, Taiwan, Hawaii and Mexico. It is introduced into several countries in Africa, Europe, America, Asia and in New Zealand where suitable temperatures (14–34 $^{o}$C) for its culture and obtainable naturally or optimum water conditions 25–30 $^{o}$C are created. Male attains length 34 cm where as female 26 cm.

   *M. rosenbergii* is elongated sharply upturned rostrum with an elevated crest reaching beyond antennular peduncle having rostral formula 13-14/11-13. Rostrum is as long as or longer than carapace. Horizontal black or brown dotted lines are on the carapace ranging from one in number in the smallest to eight on the bigger specimen which disappear in bigger specimen. Tip of the rostrum red; black or yellow dots on each abdominal segment on each abdominal segment on both sides. Having longer and slender body juvenile moves faster than other species who have more bulky and broader body shape; second cheliped is much longer than the total body length more so in male which is stouter.

2. *Macrobrachium malcolmsonii* (Monsoon River Prawn or Indian River Prawn) is available in the rivers of Indian sub-continent. In India it is very common in peninsular rivers that drain into Bay of Bengal. This species is in the habit of crawling out of ponds in the grassy bunds during drizzling heights and hence protective devices to prevent their escape are to be installed. Maleattains length 23 cm where as female 20 cm. The hatchery technology of this species has been achieved in 1991.

   Rostrum of *M. malcolmsonii* is shorter than carapace having conspicuous convex proximal upper margin. Dorsal teeth unevenly spaced with noticeable irregularity in serration in the distal half which is without teeth. It has more than 9 dorsal teeth on the rostrum. Rostral formula 12-13/4-7. Tip of the rostrum red. Horizontal black or brown dotted or discontinuous lines on the carapace may be one to four in numbers. Which disappear in bigger specimen; black or golden yellow dots on each abdominal segment on either side. Having longer and slender body juveniles move faster than other species who have more bulky and broader body shape; Second cheliped is much longer than the total body length more so in male which s stouter.

3. *Macrobrachium birmanicum Chopra*i or *M. Gangeticum* (Ganges River Prawn) looks similar in appearance and size as *Macrobrachium malcolmsonii* and often confused for the others. Available in Ganga river system and suitable for culture in Gangetic plains. It attains length 190 mm. The hatchery technology of this species has been achieved recently in the year 2000. Rostrum short with conspicuous elongated proximal crest with 9 to 10 teeth and distal end with only 1 to 2; ventral teeth 3 to 4 rarely 5 to 6.

4. *Macrobrachium villosimanus* is available in the Hooghly River system. It attains length 14 cm. Rostrum more strongly upturned distally with less elevated crest. Rostral formula 12-14, 7-10. Dorsal teeth larger and uniformly arranged, longitudinal dotted lines on carapace.

5. *Macrobrachium rudae* is distributed from South African continent to Burma. In India form good fishery in rivers of the east coast (Bengal, Orissa, Andhra Pradesh in particular). It attains length 13 cm. Rostrum more blunt and shorter. Its dorsal margin slightly convex with 12 or more teeth continuously arranged. Presence of 3 or 4 characteristics transverse lines or dark bands on carapace.

6. *Macrobrachium idea* is distributed from East African coast to Phillipines in rivers and estuaries, seems a rare species in Kerala.Male attains length 11 cm where asfemale 9 cm.

   Rostrum without an elevated rostral crest and not reaching beyond tip of antennular peduncle. Dorsal margin of rostrum straight with less than 12 teeth.

7. *Macrobrachium idella* found in the Rivers and estuaries of south west coast of India.It attains length14 cm.

8. *Macrobrachium equidens* found in East and West coast in fresh and brackish waters but small numbers. It attains length 10 cm.

9. *Macrobrachium josephi* is another Indian freshwater prawn species which is larger in size and recorded maximum about 185 mm total length from VeliLake and Kulathoor Rivulet in Trivandrum.

***10.*** *M. scabriculum* attains average length about 6 cm and found in West Bengal, Orissa, tamil Nadu, Andhra Pradesh and Kerala.

***11.*** *M. lamarrei lamarei* attains average length about 6 cm and found in all states.

## Prospect of Freshwater Prawn Farming (*Macrobrachium rosenbergii* De Man)

Although India has vast freshwater resources they are not fully exploited except for carp culture in limited scale. Fresh water fish culture employing composite fish culture technology has become popular for use in large number of tanks and ponds in the country. To meet the raw material required by the processing units for export demand there is urgent need to expand our production base. In addition it is always stressed that there is a need to utilize our natural resources productively to ensure required food security.

The freshwater giant prawn has been known as quick growing and is a superior animal for culture. Experimentations to grow *Macrobrachium rosenbergii* have been tried by several workers since before 1960. Workers in Thailand started growing prawn in earthen ponds in 1956 with juveniles collected from the open waters. From the experiments, it shows that *Macrobrachium* could well be used for pond culture. Young prawns are able to survive well in varied types of freshwater, provided that the water contains enough amount of dissolved oxygen. The rearing of larvae to juveniles and from juveniles to grown adults of marketable size, growing prawn in ponds has evolved. The giant freshwater prawn can even be cultivated in irrigated paddy-fields that are able to retain water depth not less than 15 cm. At present, information available does not identify any other species with greater potential than *Macrobrachium rosenbergii*. The technological development of *Macrobrachium rosenbergii* in the form of captive breeding and post larval production, the species is recognized as one of the major commercial aquacrop species in countries like Malaysia, China, Vietnam, Thailand, India, Bangladesh, Pakistan, Korea, Japan etc. Freshwater prawn has become suitable commercial species to be cultured along with other species in different culture practices (Kurup *et al*., 2002; Kutty 2005, Kunda *et al.,* 2008; Asaduzzaman *et al*., 2009). The culture technique of growing prawn is relatively simple due to the resistance of the animal to changes of environmental conditions such as temperature and salinity and it is omnivorous in nature. Production cost is low and the product is highly valued in the market. The demand of prawn is getting progressively greater; hence efforts for increased production are necessary. The freshwater giant prawn has now become a subject of efforts to cultivation.

### Scope

Considering the high export potential, the giant fresh water prawn, *Macrobrachium rosenbergii,* the scampi, enjoys immense potential for culture in India. About 4 million ha of impounded freshwater bodies in the various states of India, offer great potential for fresh water prawn culture. Scampi can be cultivated for export through monoculture in existing as well as new ponds or with compatible freshwater fishes in existing ponds. It is exported to Europe and USA. Since the world market for scampi is expanding with attractive prices, there is great scope for scampi production and export.

Prawn farming *(Macrobrachium* sp.) picks up in the states of Punjab and Haryana. Farmers in Punjab produce 5.4 tons per hectare, those in Haryana 4.5 tons per hectare. In Haryana, 40,000 families depend on prawn farming for their livelihoods, and 10,000 ponds have been constructed, 80 percent of them operational. About 700 hectares of prawn farms exist in Punjab. Haryana and Punjab has a marketing advantage due to close to Delhi, where it sells 90% of its production. Farmers in the two states are also doing polyculture fish in their prawn ponds and to follow the April to October prawn season with a crop of fish. As per the state Govt. record, "The state had 5,726 units at present covering a total area of 7,327 hectare under fish culture. Out of this 2,686 units had been set up by farmers on their own land covering an area of 3,084 hectare. The remaining 3,037 are panchayat village ponds covering 4,243 hectare. The total fish production in the state from all sources has touched 6,580 metric tons." It is thought that as many as 2,113 people received training in aquaculture in 2002-03. A farmer could earn about Rs 60,000/- per hectare per year from prawn farming, compared to Rs 20,000/- per hectare from wheat or rice. The quality seeds of prawn for stocking of pond can be procured from Andhra Pradesh, Tamil Nadu, Bhubaneshwar (Orissa), Kolkata (West Bengal) and Raipur (Chhattisgarh).

#### *Impact*

In general at present, there is significant decline of catch from natural stocks almost everywhere in countries in the region. Harvest has diminished

owing to indiscriminate fishing which causes the stock decrease soon. The reduction of stock is also due to the destruction of habitat by human being. Construction of dams, roads and factories in the lower reaches of the river systems leads to the reduction of the dispersal area of the prawns including the spawning and feeding grounds. Water pollution is another factor which is positively deplete on the growth and abundance of the stocks. The development of the technique to hatch *Macrobrachium rosenbergii* under controlled conditions as well as the nursery rearing of the larvae and post-larval stages of this species has greatly stimulated the expansion of the culture of this species of prawns. However, recent introduction of *Macrobrachium rosenbergii* in India has lead to the development of giant prawn culture of commercial scale. Prawn and fish farming can be expanded in Punjab because it is less risk and ease of marketing over traditional agriculture activities and, of course, greater returns. The farmers can turn from paddy-wheat rotation towards alternative agricultural production i.e. fish and prawn farming in the state of Punjab. It will usher in the utilization of water resources and side by side economic development of the Punjab farmers.

*Possibility*

Prawn production requires careful management and is hindered by a general lack of technical information, particularly the proper use of chemicals for water quality control and weed control. The evaluation of prawn production in Punjab should be expanded in saline water zone. Variable juvenile

**Initial Requirement for the Culture of *Macrobrachium rosenbergii* (Capital Cost)**

| | | | |
|---|---|---|---|
| 1. | Location of pond | : | Good location, available electricity, water and transport facility |
| 2. | Farm Size (Area of Pond) (Construction of pond including digging, bundh Rs 50,000/- construction and compaction and consolidation) | : | (0.5 ha) |
| 3. | Pond Depth | : | 5 to 6 feet |
| 4. | Culture Period | : | 6-8 months (April to November) Only one crop of 6-8 months culture period will be considered. |
| 5. | Mustard Oil Cake | : | Rs 1700/- (cost for 200 kg) |
| 6. | Lime | : | Rs 1500/- (cost for 500 kg) |
| 7. | Air Blower/Aerator | : | Rs 30,000/- |
| 8. | Generator | : | Rs 1,00,000/- |
| 9. | Refrigerator | : | Rs 15,000/- |
| 10. | Shallow tubewell and water pumpset 5 HP | : | Rs 50,000/- |
| 11. | Inlet/Outlet Sluices | : | Rs 10,000/- |
| 12. | Pump house cum store room-AC roof | : | Rs 20,000/- |
| 13. | Cost of Prawn seed | : | Rs 15,000/- (@ Rs 1 per pc) |
| 14. | No. of Seed to be Stocked | : | 15,000 nos. (stocking density@30000 per ha expected Survival rate 60 to 70% of stocking |
| 15. | Godrej Agrovet Feed (Scampi feed/ Pelleted feed) | : | Rs 28,000/- (1000 kg @ Rs 28 per kg) |
| 16. | Nets and other implements(Cast/Seine net) | : | Rs 10,000/- |
| 17. | Labor for crop harvesting | : | Rs 2,500/- |
| 18. | Ice for crop transportation | : | Rs 500/- |
| 19. | Diesel to pump out water | : | Rs 1500/- |
| 20. | Pumping and Aeration charges | : | Rs 5000/- |
| 21. | Transportation of seed from Delhi (Bhuwaneshwar/Raipur/Andhra) to Ludhiana | : | Rs 1500/- |
| 22. | Vehicle charges for prawn sale | : | Rs 4000/- |
| 23. | Watchman-cum-Labor charges | : | Rs 12,000/- |
| 24. | Ice box | : | Rs 2000/- |

size and quality, variable food supply, and pH control may be most important in determining prawn yields. The state of Punjab has vast freshwater resources and optimum weather condition, the state has a great potential for prawn culture with a little bit of support from the government like timely availability of seeds through establishment of prawn hatchery, feed and marketing of the produce. There is a lot of possibility to bring wasteland, waterlogged area and area with saline culture under prawn farming with concept of sequential culture, i.e. prawn during summers and fish during winters for gaining maximum output. The proper utilization of available non-productive resources (viz., 1.65 lakh ha of barren/waste land and 1.72 lakh ha saline affected areas) for aquaculture will immensely enhance the rate of fish as well as prawn production in the state.

*Technical Parameters for the culture of freshwater prawn*

The giant freshwater prawn is suitable for cultivation in tropical and subtropical climates. It is a hardy species by virtue of its ability to adapt to various types of fresh and brackish-water conditions. It accepts pelleted feed and has omnivorous feeding habit. In the natural environment, lower reaches of rivers, tidal inlets, where water is directly or indirectly connected with sea are their preferred habitat specially during spawning. The breeding takes place in low saline waters which is also needed for larval and post larval development after incubation. Breeding of *M. rosenbergii* takes place in estuaries. Though seed may be available in natural sources to a limited extent, for large scale culture there is a need to ensure regular supply of seed. For ensuring availability of quality seed in predictable quantity freshwater prawn hatcheries should be encouraged, technology for which is already developed. Freshwater prawn hatcheries are coming up in many states.

*Pond Construction and Water Supply*

The site selection plays an important role as the entire management aspect of the farm ultimately depends on specific conditions of the site. The aspects to be considered are topography of the area, soil type, availability of quality water etc. The area should be free from pollution and flooding. Other considerations like approach roads etc. have also to be taken into account. Rectangular ponds are suitable mainly from the harvesting point of view. A convenient width is 30-50 m, whereas length of the pond depends on site, topography and farm layout. Normally a size of 0.5 to 1.5 ha is found suitable. The average depth of the ponds should be 0.9m with a minimum of 0.75m and a maximum of 1.2m deep clear water with sandy-loam soil bottom for freshwater prawn culture. Hard water is found to be better for prawn growth where as in muddy or turbid water growth is not good. Dike and pond slope may be kept at 2:1. Bund must have a freeboard of at least 60 cm above the highest water level in the pond. Designing and layout of the farms may be done keeping in view the water intake and water outlet facilities. The drainage system should be designed carefully to prevent mixing of outlet water with incoming water. Appropriate water supply and drainage systems have to be designed keeping in view the water source and topography of the area. Tubewell and pumping system may be considered if required for water intake/exchange. Water exchange on weekly or fortnightly basis as required is desirable and provisions are to be made accordingly.

*Farm Management*

The type of pond preparation to be adopted before stocking is based on the type of culture and its intensity and nature of the culture pond. Before stocking of the seeds, liming of the pond (@ 250 kg/ ha) assumes great importance here than in the case of freshwater fish culture. The application of fertilizers is restricted in case palletized feed is used. However, occasionally raw cow dung, single super phosphate; urea etc. can be applied on assessing the productivity. Mohua oil cake can be applied @ 2500 kg/ha to kill the unwanted fishes. After 8 days of liming raw cow dung applied in case of pond not treated with Mohua Oil Cake. Poultry manure @ 1000kg/ha can also be used in place of raw cow dung. After a week of organic manure treatment inorganic fertilizer (NPK) @ 20 kg/ha as basal dose should be applied before stocking of pond. If water quality found conducive stocking of freshwater prawn seeds may be done. The post stocking management also needs to fertilize the pond till the end of culture period. Each month one tenth of the basal dose of raw cow dung and inorganic fertilizer (NPK) @ 10 kg/ha is to be applied to the pond under culture with a gap of 7 to 10 days between organic and inorganic manuring. Besides this liming @ 125 to 250 kg/ha may be done for better growth of prawns as their calcium requirement is much more during moulting. Such management is required both in polyculture and monoculture of prawn. Alternatively combination of urea at 100kg and bleaching powder at 200 kg/ha can also be applied, with urea applied 18 hr before the bleaching powder application. In a newly excavated pond 5-7 tons cow dung or pig

manure and 200-500 kg lime/ha should be applied. To maintain the planktonic population in the pond, organic and inorganic fertilizers like poultry droppings, pig and cow/buffalo manure, biogas slurry etc may be applied after stocking of juveniles at periodical intervals. Urea and super phosphate should be applied in desired quantity depending on the soil and water quality of the pond. Dissolved calcium in water helps in moulting process. Therefore, after a heavy shower, Ca level in the water may decrease which is signaled by lowering of water pH. If pH decreases below 6.5, the molting process is arrested and chances of pathogen infection increased. So, it is very important to maintain Ca balance in water. For this purpose, 50 kg lime/week or 100 kg lime/fortnightly should be applied.

The stocking density normally varies from 4000 to 50000 nos. of post larvae per ha depending on the type and intensity of the management practices but it should be kept between 30,000 to 50,000 post larvae (PL)/ha under monoculture operation. But in case of juveniles (35 to 45mm) are stocked it should be @ 20,000 to 25,000/ha. If the facilities for aeration and water exchange are available, the stocking density may be increased up to 1.5 lakh/ha. The culture system may be monoculture or polyculture with carps. In case of polyculture with carps the more pond depth is preferred at 4-5 feet. In case of polyculture the stocking density of prawn may vary from 2500-20000 post larvae. The carp fingerlings may be of the order of 5000 - 2500 Nos. Prawn being detritus feeder, feeding at the bottom level on decaying matters, stocking of bottom feeder fishes such as Mrigal and Common carp may be avoided or minimized to 7% to get better prawn production. Nursery may be incorporated where the post larvae obtained from hatcheries could be reared for a period of 4-5 weeks (or 30 days) till they attain 40-50 mm or 1-3 gram.

In order to get desired production, feeding, aeration, water exchange, periodic monitoring should be continued. The quality and type of feed is based on culture system. *Macrobrachium* with its omnivorous feeding habits can make use of a variety of feeds from common wet feed made from rice bran and oil cake to scientifically formulated pelleted feed. Prawn fed with protein and calcium rich feeds grow fast and better. Crushed snails, trash fish, poultry viscera and notonectids serve as good food for them. The rate of feeding is determined by the stage of growth of prawn, water quality, density of stock and other manuring practices. Generally the feeding rate may be 5% of the body weight. Feed is given @ 10% of the total body weight of the prawns initially and reduced to 3% gradually. Feeding should be given in adequate quantity to avoid cannibalism among the prawns and thus increase their survival rate and production. Morning inspection of the culture pond should be observed everyday to assess the feed consumption and any crawling of prawn. Immediately check pH and dissolved oxygen content of water it should be optimum as mentioned below. Every month netting of prawn should be done to know the growth rate of prawn for increasing better production. Periodic harvesting of prawn should be done if prawn attains minimum 60 gms. However, desired marketable size prawn is 70 gms and above. The males grow faster and bigger than the females within the same time. There will be also differential growth of prawns which necessitates periodic harvesting to increase prawn production.

The duration of culture varies from 6 to 12 months depending on the type of culture practice. Generally in monoculture the culture period may be 6-8 months under monoculture and 8-12 months under polyculture. The average growth of prawn may range from 50g to 200g depending on the duration, density, water quality, feeding etc. The survival rate may range 50% to 70% depending on the type of management practices.

*Biology*

The freshwater giant prawn *Macrobrachium rosenbergii* is the most hardy and resistant species within the genera of *Macrobrachium.* It can easily tolerate different salinities of water from fresh to saltwater; therefore, this species is considered euryhaline. It lives in turbid freshwater but the larval stage requires brackishwater to survive. The animal is known for its rapid growth, with the males growing faster compared to the females. The adults are omnivorous, eat greedily and frequently on both plant and animal materials. Pieces of worms molluscs, crustaceans, cut up flesh and internal organs of fish and other animals, grains of rice, wheat, peas, beans, ground nuts, coconuts, fruits, pellets of poultry feed, etc. are items that are readily consumed. Tender stems and leaves of aquatic plants, such as *Ipomoea reptans* are also eaten when no other better food is available. When sufficiently hungry, it may even become cannibalistic. Males can reach a body size of 32 cm, females grow to 25 cm. In mating the male deposits spermatophores on the underside of the female's thorax, between the walking legs. The female then extrudes eggs, which pass through the spermatophores. The female carries the fertilized eggs with her until they hatch; the time may vary, but is generally less than 3 weeks. A large female may lay

up to 1000,000 eggs. From these eggs hatch zoeae, the first larval stage of crustaceans. They go through the eleven larval stages before metamorphosing into post larvae, at which stage they are about 8 mm long and have all the characteristics of adults. This metamorphosis usually takes place about 32 to 35 days after hatching. These post larvae then migrate back to freshwater. There are 3 different morphotypes of males. The first stage is called "small male" (SM); this smallest stage has short, nearly transluscent claws. If conditions allow, small males grow and metamorphose into "orange claws" (OC), which have large orange claws on their second chelipeds, which may have a length of 0.8 to 1.4 their body size. OC males later may transform into the third and final stage, the "blue claw" (BC) males. These have blue claws, and their second chelipeds may become twice as long as their body. Male rosenbergii have a strict hierarchy: the territorial BC males dominate the OCs, which in turn dominate the SMs. The presence of BC males inhibits the growth of SMs and delays the metamorphosis of OCs into BCs; an OC will keep growing until it is larger than the largest BC male in its neighbourhood before transforming. All three male stages are sexually active though, and females who have undergone their premating moult will cooperate with any male to reproduce. BC males protect the female until their shell has hardened, OCs and SMs show no such behaviour.

Food materials are located mainly by the sense of smell and touch. When searching for food the first and second pair of the thoracic legs which are chelate sweep about actively. The prawn is usually quiet during day time and stays at the bottom of waters without much active locomotion and tends to avoid strong illumination. They are active at night time, searching for food. When mature, male prawns are considerably larger than females. The second thoracic legs are extremely long and rather thick, the head is big, the abdomen compact with very little space between the pleura, and the genital pores are at the base of the fifth thoracic legs. Females are generally smaller than the males, the second thoracic legs are shorter and more slender and the head is smaller. There is a spacious brood chamber below the abdomen, formed by the downward prolongation of abdominal pleura, and genital pores are at the bases of the third thoracic legs. The ripe ovaries can be seen through the carapace as large orange coloured masses occupying a large portion of the dorsal and lateral parts of the cephalothorax. Sexually mature males are able to mate at any time, while the females are ready to respond only after completing their premating moult.

The moulting that takes place shortly before mating or spawning is called premating or prespawning moult, to differentiate from the ordinary moulting. The frequency of moulting depends on the age, availability of food, quality of food, and also is affected by the water quality. Young specimens moult more frequent than old ones. Animals obtaining enough and good quality of food moult sooner than those taking less or poorer food. Females with actively developing gonads getting ready for spawning, take longer period to moult. Ordinarily the interval between two moults is 20–40 days. Newly moulted specimens are weak and vulnerable to predation. It takes 2–6 hours for the new shell to become sufficiently hardened.

A large number of species of *Macrobrachium* which includes *M. rosenbergii* is known that they reach sexual maturity long before attaining their maximum size. Under tropical conditions, mating occurs throughout the year within 6–20 hours after mating the eggs are laid; and unmated ripe females may lay eggs within 24 hours but the eggs are not fertilized and drop off in two or three days. The laying of one whole batch of eggs is usually completed within 20 minutes where the eggs are extruded through the female genital pores into the brood chambers. Fertilized eggs will hatch in approximately 18–21 days during incubation period. The number of eggs produced by each individual female depends upon the size of the specimen. Some workers estimated the number of eggs varies from 800–1000 per 1 gram of body weight. But practices show it is easier to estimate the number of newly hatched larvae rather than the number of eggs. From the time of hatching to the juvenile stage, the development of larvae takes 30–45 days through a series of metamorphosis (stages), all larval stages require brackishwater to grow which corresponds to at least 5% seawater. Specimens which live in pure freshwater and fail to reach brackishwater within 4–5 days would not be able to survive. They are planktonic in habit and are active swimmers whereas during the early stages, they tend to move around close together in large groups, usually close to the surface of the water. This milling together disappears in about 10 days. Their swimming position is peculiar, tail first, ventral side up with the head lower than the tail.

The larvae are attracted by light, but direct sunlight and other strong lights are avoided, and through the whole larval stages they eat continuously as long as food is available in the form of living food and suspended particles of suitable sizes. As soon as the larvae metamorphose from the last larval stage, they

**Fig. 1:** Diagrammatic view of the external features ofGiant FreshwaterPrawn (*M. rosenbergii*)

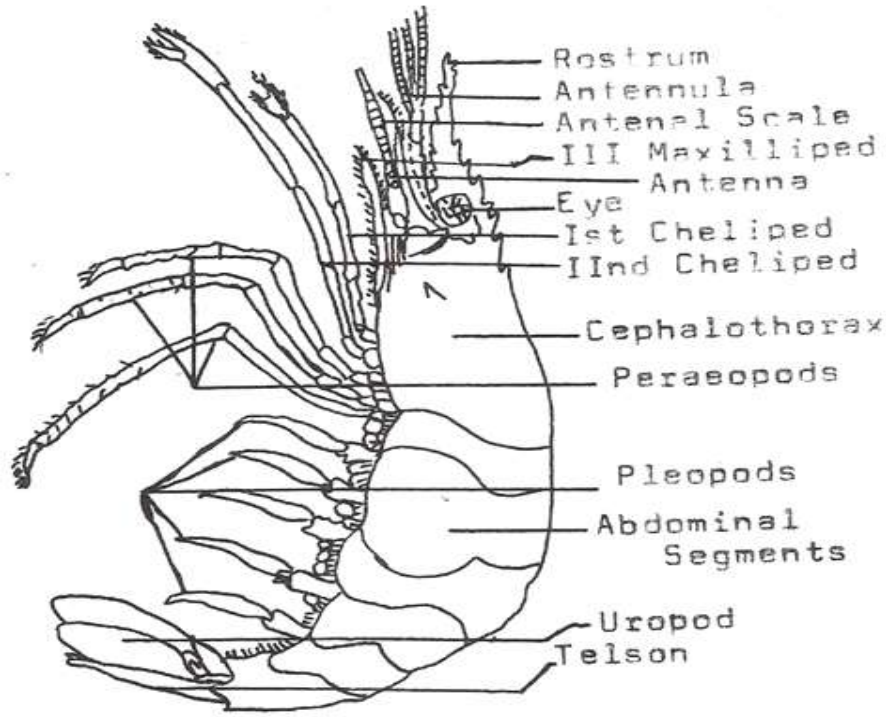


**Fig. 3:** Harvesting of Freshwater prawn (*M. rosenbergii*) from farmer's fish pond in Punjab

cease to be planktonic or pelagic. They settle to the bottom as crawlers or attach themselves to vegetation and submerged objects as juveniles. Under natural conditions, these newly transformed juveniles still remain in brackishwater for several weeks before starting the migration upstream towards freshwater for their wide dispersion. They feed on tiny worms, small crustaceans, insect larvae and a variety of organic materials. In good environmental conditions, they can attain about 5 cm in two months and can survive wide temperature ranges.

*Characteristic of Adults*

Among adults the male prawn is much bigger than the female. Males can reach a body size of 32 cm, females grow to 25 cm. It is differentiated by a pair of long and rather thick second thoracic legs which is the pincer. It has a very prominent head and compact abdomen with very little space between its pleura. A genital pore is present at the base of its fifth thoracic legs. A female is comparatively smaller than a male with shorter and slender second thoracic legs, a medium head and a spacious brood chamber. The genital pores are located at the base of its third thoracic legs. When the female is sexually ripe the fully developed ovaries can be seen through the carapace. It is a large orange mass occupying a large portion of the dorsal and lateral parts of the cephalothorax. The swimmerets become slightly distended and arched outward to form a large "brood chamber" to accommodate the enormous number of eggs to be laid. The basal segments of the pleopods, particularly those of the first three pairs are elongated and are equipped with much branched setae on their inner margins which are developed during spawning to accommodate the eggs which are attached in bundles to this setae through an adhesive substance as the eggs are extruded.

*Growth and Moulting*

The entire body of the prawn is covered by hard chitinous shell that is periodically shed out during metamorphosis, which is called moulting. Metamorphosis occurs at each stage of larval development. During metamorphosis from zoea I to post larvae the process of moulting occurs 10 times or more in all the 3 large size freshwater prawn. Generally among arthropods, the body is usually covered with hard chitinous coating known as the exoskeleton. This hardened integument is a good protection of the body of the animal. However, like other crustaceans it prevents the expansion of the body. Hence, the shedding of the exoskeleton or moulting becomes a necessity in order to institute growth. As a natural process when the animal has accumulated enough body tissues, body expansion becomes inevitable. At this process, a new thin, soft and elastic sheet is developed gradually but steadily immediately underneath the old hard exoskeleton. When the new coating is fully developed, the animal becomes quiet and tries to separate and seclude itself from the others to shed off the old hard shell. As soon as the old shell is shedded, the new shell which is soft and elastic expand due to pressure emanating from the accumulated mass of body tissue. This body expansion is actually the unit of growth which periodically has to take place in the animal in the process of growing. Just after the old shell is shaken off, the animal is very soft. It takes hours before it is hard enough for the prawn to resume its normal active life. During the time that the shell is soft, the animal is immobile and helpless when attacked by predators. This is probably the reason why the animal secludes itself during moulting.

The casting off the old shell is rapidly accomplished in a matter of minutes. The prawn try to bend its body to exert strong internal pressure until a dorsal transverse split occur in the membranous part between the cephalothorax and the abdomen. Then the animal bend its abdomen ventrally forming an inverted "U" shape arc dorsally, until a portion of the body is out through the split dorsal opening. As the abdomen gets rid of its cast, it bends anteriorly to facilitate the release of the exuvium of the cephalothorax. In the process, it is possible that a longitudinal split along the sides of some segments of the large thoracic appendages also occur to ease the withdrawal of the new limbs. The frequency of moulting depends largely on the quality and quantity of food taken. And like any other organism, growth rate is faster at younger stages and gradually slows down as the animal gets older. Hence, moulting is more frequent when the prawns are young.

*Breeding Behaviour*

Mature male prawns are always ready for copulation. They can perform intercourse whenever the female is ready. On the other hand, the female have to be in a certain stage/condition in order to be able to mate.Mating cannot be performed if the exoskeleton of the female is hard. Therefore, to consumate the act the female have to undergo a premating moulting. It will take only a few hours before the new shell hardens, hence, it is necessary that mating should take place at certain precise state of the shell. It should not be too soft nor too hard.

When it is too soft, the male is liable to devour the female. If the shell becomes fully hardened, mating may not be effectively performed or no mating occurs.In other words, the female has to prepare itself for a "love" affair every time she is ready to spawn in order to fertilize the eggs and young ones are borned.

How does the male know that the female is undergoing a premating moulting as differentiated from ordinary growth moulting? The female releases certain kind of substance to attract the male during premating moulting. When the male notices this, then it immediately starts courting the female instead of devouring it. It will display its masculine grace and strength by lifting its head, raising its body, waving its feelers and raising and extending its long and powerful thoracic legs in an embracing manner with intermittent jerking movements until the females favour is won.

Upon agreement the male holds the female between its pair of long thoracic legs at the same time cleaning the ventral portion of her shells in the thoracic region with its other legs. This is followed immediately by the actual copulation which takes only a few seconds like a lightning. The sperm is deposited in one mass on the ventral thoracic region between her thoracic legs. The sperm is coated with thin layer of gelatinous substance for protection and to keep them intact.

*Egg-laying (Spawning)*

Whether the female is mated or not, it will lay eggs in about 24 hours following the premating moulting. During the ejaculation of the eggs, the mother prawn bends its abdomen forward as far as it could reach to touch the ventral thoracic region. The eggs which are extruded through the genital pores are directed into the "brood chamber". They are held together by some extremely thin and membranous substance and are deposited first on one side, starting on the chamber between the fourth pair of pleopods and so on to the third, second, and finally to the first. The eggs are held in bundle tightly to the fine ovigarous setae of the first four pairs of pleopods and look like bunch of grapes. The female carries these eggs till they hatch out and such egg bearing females are called "berried". The number of eggs carried by the female is based on its size and weight, which ranged between 8,000 to 1,50,000. A mature female will breed and spawn 3-4 times in a year under natural freshwater environment.

*Incubation and Embryonic Development*

The eggs, like bunches of berries in the brood chamber are carried by the brood during the whole incubation period which lasts approximately 18–21 days, depending on temperature of 26 to 31 C. During the incubation period, the mother prawn moves the pleopods back and forth intermittently to provide sufficient aeration to the eggs. In the meantime, the first pair of the thoracic legs is busy cleaning the eggs of any foreign matter.

Embryonic development immediately starts as soon as the eggs are extruded. The first nuclear division will be observed about 4 hours after fertilization. The cleavage is completed in about 24 hours. Rudiments of the body region of the embryo will be visible on the third day and appendages will be formed on the fourth day. The eye pigment starts appearing at the end of the eight day. The heart is formed and start beating on the tenth day. The embryo is actually formed on the twelfth day which is subsequently followed by the larvae development on the seventeenth day. Midway of the embryonic development period, the egg orange pigmentation turns light gray to dark gray as the embryo is further developed until it hatches.

*Hatching Process*

The breaking of the eggs is accomplished by a slow but continuous vibration of the mouthparts of the larvae, coupled with the stretching of the rolled up body forcing the eggs to elongate gradually. As these mouthparts vibration and body stretching increase its force, these are reinforced by the intermittent vigorous vibration of the thoracic appendages for about 10 minutes with increasing intensity. This continuing and increasing force is soon accompanied by the stretching of the telson outward until the egg shell breaks up and the telson thrushes out first followed by the head and with strong body bending and stretching the larva springs out of the egg case.

*Larvae and Juveniles*

The newly hatched larvae which are devoid of many segments and appendages of the adult start swimming in about 5 minutes after coming out of the egg shell. At this point in time, the water must be brackish. The minute and fragile larvae have no semblance to their parents. While they are attracted

by light, they avoid strong illumination and direct sunlight. During the entire larval stages, they remain pelagic and actively swim around upside down grasping their food as they come across. They are voracious feeder and will eat continuously as long as food is available. The food consists of zooplankton such as copepods, minute protozoans, rotifers, cyclops and pieces of animal flesh, food grains, fruits, etc. The food is grasp by their thoracic legs as they swim. There are about 13 larval stages. These development stages from hatching up to final metamorphosis is completed in about 45 days. Obviously growth rate is influenced by water temperature and quality of food. You may observe that fast growing individual larvae may complete metamorphosis in less than 25 days.

As soon as the larvae metamorphose, they lose their pelagic characteristics and become bottom crawlers or cling to submerged objects such as leaves, roots, stems and branches of aquatic and semi-aquatic vegetation. This time they feed greedily on aquatic worms, bottom insects and larvae, fish eggs, tiny fry or other aquatic animals, algae, and particles of organic materials including some epiphytes.The larval transformation to post larval stage marks also the end of their life in brackishwater. From this stage on, they start their positive rheotrophic migration. They swim against swift currents by tightly crawling on the bottom. They can migrate up to inland lakes and dams passing along sides/edges/embankments of streams. During flood seasons, they further move upward to rice fields, small lagoons and freshwater ponds which are not accessible during dry season. From the beginning of their upstream migration up to their adulthood, the prawns stay in the freshwater as their permanent abode.

*Sexual Maturity*

The female prawn attained its first sexual maturity on the tenth month when they are about 12 cm or more in length. A sexually matured female will develop the gonads and will lay eggs whether it is mated or not. However, the eggs of unmated female will fall off in a few days as such eggs would not hatch. Some females were observed to spawn twice in four months under controlled condition. The number of spawning per female per year in the natural habitat is yet to be further observed. It can be assumed under natural conditions that as the female develop its gonad it starts its negative rheotrophic migration. Somewhere along the way, it undergoes premating moulting and gets mated. At this point, it should reach tidal lagoons or mouths of tidal rivers where water remain brackish all the time for the hatching of the eggs and subsequent development of the larvae. If the mother prawn fails to reach the brackishwater area in this journey the young larvae will die within three to four days after hatching.Some studies on the fecundity of the giant prawn showed that they have quite high reproductive capacity. A female of about 17.2 cm long weighing about 65 g can produce about 90 000 eggs. Large females are assumed to be able to produce a lot more. Brown (1991) reported fecundity can be as high as 80,000 to 1,00,000 eggs in mature females while first broodstock may be around 5,000 to 20,000 eggs. Ratnayake*et al.,* (2001) revealed fecundity ranging from 24171 to 34294 in *M. rosenbergii* reared under varied sex ratio in Sri Lanka. Fujimura, preliminary established a weight/number relationship in estimating the fecundity of female prawn. The total number of eggs is estimated by multiplying the total weight of the spawner in grams by 750.

*Migration*

Movement of the prawn chiefly migration, like any other aquatic fauna is influenced by many factors mainly physical, chemical and biological stimuli. While the positive and negative rheotrophic migration of the prawn to complete its life cycle may be a natural instinct, it is quite obvious that it may be associated with chemical stimulus. The desire to hatch and grow the young larvae in a brackishwater to perpetuate its kind requires the prawn to perform the journey. Perhaps temperature also plays an important role since the water is warmer in the coastal areas than upstream.

*Food and Feeding Habit*

The giant prawn is an omnivore, bottom dwelling animal and feed greedily. In nature, they feed upon young molluscs, crustaceans, small worms, decomposed plant and animals, flesh of both aquatic and terrestrial animals, grains, nuts, beans, coconut meat, pieces of some fruits, etc. Actually they are also cannibalistic since they devour their own kind when they encounter soft shelled individual except perhaps when they are in a premating moulting when the female is guarded by the male. They continue to crawl on the bottom in search for food or cling on submerged vegetation including those along embankments of rivers or lakes or impoundment or among hanging roots of floating aquatic plants such as the water hyacinth. They can be observed also nibbling epiphytes among submerged twigs and branches. Unlike fishes, they do not take feed directly into the mouth; rather, they break the feed into small

pieces with the help of mandibles and then take into the mouth. Since they are cannibalistic in nature, under starved condition, they attack the newly molted and weak members of their own species or other animals and feed on them.

*Feeding Practices*

The production capacity of culture pond largely depends on quality of feed provided. The grow out feed should contain 30-40% crude protein, out of which 50% should be from animal origin. The different feed ingredients are mixed in desired proportion and prepared as pellet, and provided to the prawns to avoid the wastage of feed. Locally available feed ingredients like rice bran, mustard oil cake, groundnut oil cake, coconut oil cake, soyabean meal, maize, sorghum, barley and other ingredients obtain from plant are used. Besides fish meal, the other ingredients of animal origin evaluated for incorporation in the feed are poultry viscera, slaughter house waste, small prawns, fishes, mussel or snail meat etc. Along with these feed materials, vitamin and mineral mixture in desired quantity are added to help the prawn to overcome environmental stress. Now a day farmer's are using pelleted scampi feed of Godrej Agrovet Ltd and chicken viscera for feeding prawn and getting desired result.

For grow out culture of prawns feed are initially given at 5-8% of the body weight/day. The feeding rates decline as the animals grow and reach about 1.5 – 2% bwd when the animals are about 20 g in size. Broodstock are fed with balanced artificial formulated pelleted feed at 3-5% of the body weight twice daily during morning and evening. Farmers generally feed the cultured prawn twice daily with feeds that contain protein levels ranging from 20 to 35%. However the species grows well even with 15% protein feeds in ponds with sufficient natural food (Mitra *et al* 2005).

| Nutrients | Growth stages | Requirements |
|---|---|---|
| Protein (%) | Broodstock | 38-40 |
| | Juveniles ($2^{nd}$ $4^{th}$ month) | 35-37 |
| | Adult ($5^{th}$ $6^{th}$ month) | 28-30 |
| Carbohydrate (%) | For all stages | 25-35 |
| Lipid including phospholipids (%) | For all stages | 3-7 |
| High unsaturated fatty acids (%) | | >0.08 |
| Cholesterol (%) | For all stages | 0.5-0.6 |
| Vitamin –C (mg/kg diet) | Grow out | 100 |
| Calcium/Phosphorus | | 1.5-2.0:1 |
| Zn (mg/kg diet) | | 90 |
| Other minerals | | Quantitative requirements not yet known |
| Energy | Broodstock | 3.7- 4.0 kcal/g feed |
| | Other stages | 2.9- 3.2 kcal/g feed |

The summary of nutrient requirements of freshwater prawn, *M. rosenbergii* based on laboratory trials are depicted in following table (Mitra *et al* 2005).

*General conditions of soil and water quality for culture*

The ideal soil for *Macrobrachium* culture should be clay silt mixture or sandy loam (Sandy-clay, Sandy–loam, Silty-clay or Silty-loam) comprising of 60% sand and 40% silt with good water retention capacity. Soil should be alkaline and fused lime can be applied to make the soil fertile before stocking of prawn. Lime should be applied @ 2-4 tonnes/ha. Acidic soils (pH = 4.5 or less) with high concentration of iron, Manganese, Aluminium are to be avoided. There should be availability of abundant and good quality water. The water should be free from any kind of pollution. The pH should be maintained at 7 to 8.5. The temperature should range from 18 $^{o}$C to 34 $^{o}$C with an optimum range of 26 $^{o}$C to 32 $^{o}$C. Dissolved oxygen content in water should not be less than 2.5 ppm. The concentration of dissolved oxygen in water can be raised by provision of aerator. To maintain $O_2$ level in water, water depth in pond should be maintained and aquatic plant should be kept within certain limit. Water exchange may be done periodically to remove the excretory products from the pond. Water quality parameters should be analyzed periodically and if required lime treatment should be done.

| | | |
|---|---|---|
| Water Temperature | : | 26 $^{o}$C to 32 $^{o}$C |
| pH | : | 7.0 to 8.5 |
| Dissolved Oxygen | : | > 2.5 mg/l |
| Total Hardness | : | 100 to 150 mg/l |
| $NH_4^+$ –N | : | 0.02 to 0.20 mg/l |
| Calcium | : | 30 to 80 mg/l |
| Phosphorus | : | 0.01 to 0.9 mg/l |
| Nitrogen | : | 0.05 to 0.5 mg/l |

**Marketing**

There is good demand for fresh water prawn in local, national and international markets; as such there may not be any problem in marketing the same because it is used to maintain fairly stable market price. It has been stimulated by the increasing market demand and high economic return in production. Fresh water prawns can be sold directly by the farmers either in the market or to exporters for processing before export. Weight of *M. rosenbergii* up to 50 g can fetch Rs 300/- per kg whereas more than 100g cost Rs 400/- to 600/- per kg during harvesting season. Marketing of freshwater prawn in Punjab have many options such as selling to wholesaler, market to local consumer, hotels, restaurant, pizza hut or become a processor so that extended marketing time avail. Selling to wholesaler is easy but when low production noticed, a considerable profit may not be felt. Local marketing requires expenditure in advertisement and the timing of harvest to selling is critical, because freshwater prawns are very sensitive perishable items. To ensure the compliance with government regulations processing of freshwater prawns and processors requires obtaining training and certification in hazard analysis critical control point (HACCP). Cultured freshwater prawn production in Punjab still accounts for a small proportion of the total freshwater aquaculture production in India. However, the rapid growth in production caused by the expansion of culture has significant impacts on the marketing and economic return of the industry.

*Hatchery Management*

Hatchery should be located in such a place where pollution free freshwater, sea water, healthy and disease free brood prawns, feed ingredients for supplementary food, uninterrupted power supply, hatchery workers, road for transport, required environmental condition etc are available. It is essential to have a detailed plan for establishment of a hatchery, which would largely depend upon the production target. Accordingly, different capacity of larval rearing tanks and water filtration tanks, rooms for laboratory, food preparation, Artemia hatching, storeroom etc are provided.

*Following points should be thoroughly studied before starting hatchery management*

- Freshwater and seawater requirement with desired characteristics
- Broodstock management
- Larval rearing
- Airlift biofilter recirculatory system
- Water quality management
- Larval feed
- Hatching of Artemia cysts
- Supplementary feeding
- Moulting and growth
- Disease diagnosis and control
- Harvesting of post larvae
- Rearing of post larvae in nursery
- Seed transportation
- Grow-out culture

*Constraints and Problems*

- Fish farming being an alternative enterprise, the farmers of Punjab have not lagged in adopting fish culture where the area under fish farming increased ten folds compare to the past. In spite of this the various groups are facing some constraints in the production and marketing of fish/prawn.
- Prawn farming in Punjab is economically feasible but the major constraints for the development of prawn farming is the lack of hatchery seed and the need to disseminate the necessary technology to the private sector. The establishment of a small government hatchery, together with facilities to rear post larval prawns (PL/juveniles) to a suitable stocking size, and the ability to demonstrate grow-out technology, is critical to the development of commercial prawn culture in the state.
- The commercial rate of electricity charges is a major constraint in aquaculture development in the state. Fish farmers need to be provided free electricity like agriculture farmers. Inadequate and untimely supply of credit, lack of proper technical guidance on prawn farming and lack of proper marketing and storage facilities is problem for middle level fish farmer.
- The growth and development of freshwater prawn is temperature dependent so only one crop (April to October) can be harvested in Punjab which impediments in the adoption of prawn farming. The farming solution throughout the year may be chalked out and suggested.

- Unavailability of good quality freshwater prawn seeds and monosex seed (male) lowering the seed survival rate in the pond.
- The cost of freshwater prawn seed and its import is very costly. Govt. owned/ private Prawn hatchery could not established in Punjab.
- Farmers are facing the problems of theft and poaching. High price and ready market attract the poachers easily. Prawn has resistant to diseases, but a heavy stocking density, over manuring, non-maintenance of clean environment, accumulation of organic matter at the bottom of the pond cause many hazards to the health of the species. These hazards include retarded growth injuries, diseases and parasitic infections that adversely affect the production.
- During the course of culture operations a few insect and pest are encountered which sometimes cause heavy mortality to the young stock. These insect and pest include aquatic insects, predatory and weed fishes, frogs etc which reduce the fish production to a large extent.
- One of the major problems in fish ponds was found to be the control of excessive growth of aquatic weeds. Though the presence of some plants to a limited extent is desirable, yet their excessive growth affects the prawn productivity per unit of the area stocked.
- Being an outdoor enterprise it is prone to damages by animals like snakes, tortoises and flooding during the rainy season.
- Operation of cast net is not effective to catch all the prawns, also cast net needs multiple operation and more effort, because prawn lives in bottom of the pond, so the pond should be drained out to harvest prawn crop and dispose immediately to middlemen or market consumer.
- The problems in the disposal of prawn/fish and delayed payment of the crops were also reported by the farmers and the middlemen. The time lag between the delivery of prawn and payment was reported to be sometimes more than two months. No compensation for the delayed period noticed.
- Prawn/fish producer and middlemen faced lower price for their crop. They are being forced to sale the produce at lower prices due to lack of steady marketing outlets. Also, there are very few buyers in Chandigarh so the producer forced to spend time in searching prawn consumer to sale the catch and even some of the buyer asked to provide headless prawn.
- Punjab farmers engaged himself in fish culture in a more amicable and eco-friendly way compare to other states of India, but majority of the people in Punjab are not in fond of eating fish as well as prawn due to spine and unusual looks.
- The lack of an efficient storage, insulated/ thermostat van, packing and transportation facilities, quickness in the decomposition of the produce resulting into increased losses.
- The middlemen are forced to dispose of produce quickly otherwise decaying of the prawn/fish starts which in turn lower the price of the crop.
- Prawn/fish marketing is not controlled by the Govt. agency, therefore the malpractices such as lower price during the increased volume or market arrivals.
- Major problem in the sale of prawn/fish is the peculiar odours after death of prawn which affects the demand in local markets.

The aforesaid problem clearly exhibits that prawn farming is affected on various accounts, which ultimately affects the production levels. Under these situations, there is a need to formulate basic guidelines to make prawn farming/enterprise commercially viable in Punjab.

*Management and Precaution for successful freshwater prawn farming*

- Prawn production is increased by obtaining juveniles of nearly the same size. If widely different sized juveniles are obtained, survival in the early days after stocking into ponds may be low since larger prawns will eat the smaller ones and smaller prawns may be nutritionally challenged and less able to survive.
- Separate size groups into different ponds as variability of more than 0.5" between the large and small juveniles in this trial caused low survival due to cannibalism.
- Zooplanktons provide the best food source for small prawns. The pond should be conditioned with inorganic and organic fertilizer until a bloom of zooplankton and phytoplankton develops.
- No prawns should be stocked if the pond water is clear.
- The timing of prawn stocking should be carefully managed so that the pond does not remain filled for more than two weeks prior to stocking.

- A food supply will develop as the fertilizer stimulates phytoplankton and zooplankton growth. With an adequate food supply, the prawns are expected to grow fast enough to be safe from all but the largest predators.
- Prawns do not really like light and will inhabit the deeper portions of the pond. If weeds and filamentous algae become established, chemical treatment should be avoided. If weeds are allowed to grow, prawn production will be lower than expected and harvest will be difficult.
- Aquashade and other water soluble dyes may reduce the amount of primary productivity in ponds and therefore reduce prawn production by reducing the amount of natural food organisms. Grass carp may eat some of the young prawns so that prawn survival may be less when the generally herbivorous fish is stocked with prawns. Culture systems using catfish and prawns or carps and prawn have been proposed but in all cases of polyculture, the prawn production is reduced from that obtainable in monoculture.
- During the time between stocking juveniles and the time that feed is first offered to the prawns, ponds are managed to produce zooplankton that will serve as the food for the young prawns. Organic fertilizer added at the rate of about 50 kg/ha/wk can produce abundant zooplankton populations. Inorganic fertilizers that have nitrogen and phosphorus should be added until a phytoplankton bloom develops in the water. The visibility into the water column should be less than 18 inch in a properly fertilized pond. Add 3.5 to 5 kg/ha/wk of phosphorus in order to maintain a good bloom.
- The lime requirement for the pond must have been considered before the pond was filled with water in order for a fertilization program to be effective. The optimum growth of prawn depends upon the pond soil, which should be alkaline. Fused lime can be applied to make the soil fertile. The agriculture grade lime should be applied @ 2-4 tonnes/ha in properly ploughed pond bottom before stocking of prawn.
- Phytoplankton and zooplankton blooms can be started rapidly when water from a reservoir or adjacent pond is used to fill the prawn pond. Addition of fertilizer to pond water that already contains relatively large quantities of microorganisms causes rapid increases in numbers. This practice should be encouraged in prawn culture in order to assure an abundant food supply for the young prawns and shade for the pond bottom to discourage aquatic weed growth. All incoming water should pass through a screen that is small enough to retain fish eggs, small fish, and insects. Ponds should be stocked with the prawns between one to two weeks after the pond is filled.
- The concentration of dissolved oxygen in water should not be less than 2.5 ppm. Uniform dissolved oxygen of the pond water can be raised by the application of aerator using blower, pipe and pierced stone.
- The concentration of ammonia and production of $H_2S$ may increase due to decomposition of organic matter. Necessary liming and water exchange may be done to keep their conc. within critical limit.
- Feeds and feeding gradually change from a fertilization schedule to feeding a slow sink pellet. Common agricultural byproducts such as cottonseed meal and distillers grains may be utilized to feed the prawns during the first two months of grow-out. However, during the last 30 to 60 days of production, a pellet may be utilized. Scatter the feed as evenly over the pond bottom as possible. Narrow pond designs are common in prawn culture in order to allow easy feed application. Prawns use natural food to supplement the diet provided, so a very complete diet must be provided in plastic lined ponds or tanks. Godrej Agrovet has already prepared Scampi feed which can be utilized to feed prawn.
- Harvesting prawns can be similar to seining other aquatic animals but it is difficult to harvest prawn through simple drag net. A special net like seine with ½ inch mesh size using glass beads or iron weights at its bottom to make pockets can be utilized for harvesting prawn. Once the prawns were collected, the large prawns were sorted from the small ones with a bar grader and by hand picking. Small prawns (less than 45g) were returned to the pond for 30 days or more of additional growth. Removal of the large blue claw prawns allows other prawns to grow to a larger size. Prawns require oxygenated water to survive, so plenty of aeration should be utilized when harvesting. Provide a substrate in the holding tanks if you want to keep the harvested prawns alive. The substrate will allow prawns to seek refuge from their aggressive companions. Prawns jump considerable distances so that a cover should be placed over the holding tank

immediately after it is filled. To preserve the best appearance of the large blue claw males, close their claws with a small rubber band prior to holding in tanks. Water temperatures, 20 to 25 $^{o}$C, slow the prawns down so that they are less aggressive.

- The final harvest of prawns should occur before pond water temperatures fall below 22 $^{o}$C. The giant prawn is a tropical to sub-tropical animal and has slow growth at low temperatures. Little or no growth is expected when water temperature is less than 26 $^{o}$C. Indoor culture of the prawn is difficult and requires a great investment in tanks, filters, and electricity. Only the hatchery and nursery phases are practical for indoor culture of prawns.
- Monoculture of prawn can be done amicably from April to October where as polyculture of carp during rest of the months in order to utilize resources and time interval for gaining maximum output.
- Prawns after death deteriorates faster and gives bad odour compared to fish, so it is necessary to keep them in ice just after harvesting or quickly transport to processing plant.
- It is important that the government facilities should not be much larger than needed. The adequate demonstration of nursery and grow-out technology, for providing a small income to the farmers, and for producing post larvae and juveniles for supply to the private sector to stimulate the development of prawn farming.
- Good quality of freshwater prawn seeds (acclimatized seeds in nursery pond with good size) should made accessible for stocking in fish farmer's pond so that survival of the prawn seeds attains to be maximum.
- The cost of freshwater prawn seed (PL/juveniles) and its import should be available at cheaper rate. Govt. should provide prawn seed to farmers on subsidized rate and establish freshwater prawn hatchery in Punjab to fulfill the urgent need of the fish farmers.
- The facilities should therefore be designed to produce sufficient post larval prawns to stock nursery ponds for the production of enough juveniles to supply the requirements of private farmers wishing to stock up to 10 ha of ponds at 5 juveniles per m$^2$. The hatchery should also produce enough stock to provide service to the farmers, grow-out demonstration and training activities. The demonstration ponds should also produce marketable prawns annually.
- State Govt. should also try to motivate the riparian farmer's in adoption of freshwater prawn culture in unutilized saline affected water-logged areas (1.72 lakh ha) in south-west district of Punjab, for this it is necessary to provide incentives/subsidy for the utilization of resources and improving economic condition of the region.

**Conclusion**

Freshwater aquaculture over recent years has not only led to substantial socio-economic benefits such as increased nutritional levels, income, employment and foreign exchange but has also brought vast un-utilized and under-utilized land and water resources under culture. With freshwater aquaculture being compatible with other farming systems it is largely environmentally friendly and provides for recycling and utilization of several types of organic wastes. Over the years, however, culture practices have undergone considerable intensification and with the possibility of obtaining high productivity levels.

Prawn culture appears to be economically viable and has great potentiality in India. But technologies for semi-intensive culture of freshwater prawns are yet to be developed in Punjab. Initially extensive culture in a scientific line is required to be popularized to exploit the existing potential areas at an optimum level. It is also very important to aware the farmers about the source of seed supply for appropriate pond stocking. Therefore, before bankers consider financial support for any *Macrobrachium rosenbergii* culture operation, they should see that seed supply is assured and prawn hatchery establishment and feed development get priority over prawn farming. Prawn production requires careful management and is hindered by a general lack of technical information, particularly the proper use of chemicals for water quality control and weed control. The evaluation of prawn production in Punjab may continue for one more season to find out the percentage survival and adaptability of the species. Variable juvenile size and quality, variable food supply, and pH control may be most important in determining prawn yields. There is need to use quality seed, balanced feed and

scientific management practices for successful prawn farming.

In fact prawn farming is a profitable venture, a farmer can earn more than Rs 70,000/- per hectare per year from prawn farming, compared to Rs 25,000/- per hectare from wheat or rice. Now, there is a need to popularize the technology for adoption and diversification among farmers through mass awareness programme. The reasons for the adoption and expansion include less risk and ease of marketing over traditional agriculture activities and, of course, greater returns.

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