# Farming the freshwater prawn *Macrobrachium malcolmsonii*

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## Introduction

In India, the coastal shrimp farming industry has suffered serious losses due to outbreaks of viral diseases and its growth has also been limited through legal constraints, such as the introduction of legislation regulating development in the coastal zone. Recently, freshwater prawn culture has been recognized as an alternative, eco-friendly and sustainable system for prawn production. Freshwater prawn farming is popular in South East Asian countries but it has not gained much progress in India until recently, although freshwater prawns are a high priced product and have a high market demand in both domestic and export markets. In India the largest species that are of interest for aquaculture are *Macrobrachium rosenbergii*, *M. malcolmsonii* and *M. gangeticum* respectively. The latter two species are indigenous and can be farmed in monoculture[1,2,3,4] or in polyculture with compatible carps[2,4,5,6,7,8]. *M. rosenbergii* is the prawn preferred by farmers and is cultivated commercially in certain parts of the country. However, *M. malcolmsonii* is cultured traditionally and *M. gangeticum* experimentally; considering the culture potential of these species the Central Institute of Freshwater Aquaculture has made considerable efforts to develop culture technologies for commercial production, although concerted efforts on dissemination of appropriate technologies tailored to meet local conditions of farmers in different areas are required. This article describes farming technology for *M. malcolmsonii* under mono- and polyculture systems with fast growing compatible carps.

## Site selection and pond construction for freshwater prawn farming

*M. malcolmsonii* may be cultured in earthen ponds, concrete tanks, small reservoirs, cages, pens and paddy fields. Culture locations should be free from pollution. Sandy loam, clayey loam, loam with adequate water retention quality of the soil is preferred for construction of freshwater prawn farms. Ponds should be situated in areas not vulnerable to flooding or drought, with a supply of good quality freshwater, access to road and transport facilities, and electricity supplies.

Ponds should be constructed such that water can be drained via gravity to facilitate harvesting of the prawn crops. For ease of the management, medium sized rectangular ponds of 0.2 – 0.5 ha are most suitable; however for commercial production pond area may be increased to 1.0-1.5 ha. In tropical areas the average depth of water should be 1.0-1.5 m in grow out ponds. Pond bottoms should be smooth and gradually sloping from the water inlet towards the outlet end for easy draining. The slope towards the outlet should be around 1:500 (2%) in larger ponds and 1:200 (0.5%) in smaller ponds. The provision of marginal shallow trench can facilitate drain harvesting of prawns. The pond embankments should be at least 40-70 cm above the highest water level. Depending on the soil quality, the internal slope of the pond embankments should be from 1:2 to 1:4. Water inlets and outlets should be equipped with screens during embankment construction. Water supply, distribution, screening and treatment (oxygenation) systems need to be provided in the freshwater prawn farms. Embankments should be covered with vegetation such as fast growing grasses to reduce soil erosion and crops such as bananas, papaya and coconuts may also be planted for integrated farming. If required, the pond should be fenced with nylon nets to prevent overland entry of predators into the ponds.

## Pond management

### Eradication of aquatic vegetation, weed and predatory animals

In newly constructed ponds there will be no aquatic weeds to remove. However, from the old ponds aquatic vegetation should be removed. Weed fishes as well as predatory fishes can be eradicated by applying mahua oil cake at 2.5 tonnes/ha. 18-21 days after the mahua oil cake application the pond may be stocked with prawn seed. Alternatively, bleach powder can be applied at 300-350 kg/ha depending upon the pond conditions. A combination of urea and bleaching powder may also be used, for this, 100 kg/ha urea is applied on the first day and the next day a half dosage of bleach powder (150 kg/ha) is applied. The pond can be stocked with prawn seed 8-10 days after application of bleaching powder. Finally, ponds can be simply be fully dried to remove weed and predatory fishes.

### Liming and base manuring

To correct the pond pH lime is applied into the ponds. Depending upon soil pH, agricultural limestone is applied at 250-1000 kg/ha/year. The pond bottom can be treated to kill pathogens by applying burnt lime (calcium oxide) or hydrated lime (calcium hydroxide). In acidic soils a higher dosage of lime is applied to increase pH and to improve the total alkalinity to about 40 mg/l. If total alkalinity of the water remains above 60 mg/l, the pond should not be treated with lime. If ponds are prepared using bleach powder, lime need not be applied. Old ponds should also be de-silted to reduce sediment containing a heavy load of organic matter. During drying period of old ponds or newly constructed ponds, the bottom can be harrowed using a tractor to increase the oxygenation of the soil. In case of old ponds, the harrowed bottom can be treated with lime and should be exposed to sun for 10-15 days to remove toxic gases and kill pathogens. Ponds with high pH can be treated by adding calcium

sulphate (gypsum) to maintain total hardness at around 50-100 mg/l. About 2 mg/l gypsum is needed to increase total hardness by 1 mg/l.

To increase the fertility and productivity of the ponds, base manuring is used. Base manure may include both organic and inorganic fertilisers. Raw cow dung is applied at 2-3 tonnes/ha or poultry droppings at 0.5-1.5 tonnes/ha along with 100 kg/ha single super phosphate and 60 kg/ha urea in newly constructed ponds. In old freshwater prawn ponds the application of organic manure is discouraged. Chemical fertilisers are more dependable than organic manure. The limiting nutrients in prawn ponds are phosphorus and nitrogen, which need to be applied in a balanced form. The optimum ratio of nitrogen : phosphate in fertiliser needs to be about 2:3 in prawn ponds. During the culture period fertiliser can be applied at 4-8 kg nitrogen and 5-12 kg phosphate/ha at monthly intervals[9].

### Increasing surface area

Like many other crustaceans, *M. malcolmsonii* shows strong territorial defence and hiding behaviours. During moulting there is always the risk of predation by larger dominant prawns. Hence to reduce predation an increase in habitat surface area and hiding substrates are required in grow out ponds. Bushes, palm- and coconut-leaves, bamboo trees, tiers, tree branches etc are used indigenously to provide substrates for prawns to cling to and hide in. Alternatively 1,000-1,500 pipes/ha made from plastic, earthenware or concrete, around 40 cm long and 9 cm diameter, may be placed in the pond as prawn habitats, although this interferes in cull-harvesting. Nylon screens or stretch nylon nets can also be placed vertically or horizontally in ponds as substrates. Increasing the habitat surface area improves overall prawn recovery and growth rates, resulting in higher prawn yields.

## Stocking

After ponds have been prepared and the water conditioned to contain a supply of desirable natural food, the prawn seed may be stocked. However, it is impractical to stock 1-2 week old post larvae (PL) directly in grow out ponds as most of them are lost through predation. Therefore PL should be reared separately in nurseries for 1-2 months to become hardier juveniles of around 2-3 g before release into grow out ponds. Such juveniles are less vulnerable to predation and more tolerant of high pH and ammonia than PL. Although juveniles are more costly than PL, they have better survival and require a shorter time to reach marketable size. Grading juvenile prawns before stocking has significant advantages. It increases the average harvest size and total pond production. Size grading is a way of separating out the faster growing prawns. After grading, large and nearly equal sized prawn juveniles are stocked.

Sudden changes in temperature and pH may cause mortality at prawn seed stocking, hence before release into the pond prawn juveniles need to be gradually acclimatized with the pond water. Lower stocking densities tend to result in larger average size of prawns in relation to higher stocking densities. Higher stocking density can provide greater yields but smaller average size. Stocking density needs to be adjusted depending upon the pond productivity, the level of management and desired market size.

In monoculture *M. malcolmsonii* juveniles can be stocked at 30,000-50,000/ha whereas, in poly-culture with fast growing compatible carps such as catla *Catla catla*, silver carp *Hypophthalmichthys molitrix*, rohu *Labeo rohita*, or grass carp *Ctenopharyngodon idella*, they should be stocked at 15,000-20,000/ha. Healthy and disease free carp fingerlings or yearlings can be stocked at 2,500-3,000/ha. Stocking larger sized carp fingerlings of 5-10 g and stunted yearlings of 100-200g is recommended for prawn-carp polyculture. The stocking ratio of carps may be decided based on the management practices and availability of natural food in the ponds. The stocking ratio of *C. catla* or *H. molitrix*, *L. rohita* and *C. idella* is typically 5:4:1. Bottom feeding carps like mrigal *Cirrhinus mrigal* and common carp *Cyprinus carpio* are not recommended for prawn-carp polyculture.

## Feed and feeding

*M. malcolmsonii* is an omnivorous bottom dwelling prawn and naturally feeds on decomposing plants and animals, small worms, insects and their larvae. They are also cannibalistic in nature and may consume freshly moulted conspecifics in pond environments. At the beginning of stocking *M. malcolmsonii* juveniles rely on natural productivity of the ponds enhanced through the initial addition of inorganic fertilisers and/or organic base manures. In extensive farming, the prawn juveniles mostly rely on the availability of natural foods in the rearing ponds, which tends to lead to very poor prawn yields. However, successful semi-intensive *M. malcolmsonii* farming requires supplementary feeding. Providing feed from the beginning of the *M. malcolmsonii* rearing period improves performance and is cost-effective. Application of feed and fertilisers from the beginning of the *M. malcolmsonii* rearing not only increases the availability of natural food but also decreases the water transparency, therefore reducing the growth of weeds.

For grow out culture of *M. malcolmsonii* high protein diets of 50% plant origin and 50% animal origin are required. Locally available cheaper feed ingredients such as broken rice, rice bran, groundnut oilcake, mustard oilcake, soybean meal, sorghum, barley, maize etc. of plant origin and poultry viscera, wastes from abattoirs and processing plants, fishes, fish meal, snails or mussel meat etc. can be used in suitable combination for preparing farm made feeds for grow out[10]. The composition of formulated feed includes 15% fish meal, 15% soybean meal, 42% groundnut cake, 26% rice bran and 2% vitamin and mineral premix. In addition to above ingredients amino acid balance and essential fatty acids (highly unsaturated fatty acids (HUFA n-3) are also added in formulated feeds of prawns[11]. Supplementary feed is provided in the form of pellets. Juveniles are fed with formulated starter diet containing higher protein and lipid in crumble form. Size of the formulated feed should be 1.2 mm for starter-2, 2 x 4 mm for grower and 2 x 5 mm for booster. *M. malcolmsonii* feed should have 28-32% protein, 3-6% fats, 31-34% carbohydrates and 6-7% fibre during grow out for optimal growth and survival. As there is a lack of formulated feed in pellet form, *M. malcolmsonii* can be fed with a mixture of groundnut oil cake and rice polish in the ratio of 1:1. The feed mixture may be made into small balls applied after sun drying.

Prawns are nocturnal in habit and feed more actively at night. Hence, feeding is done mostly during late evening and early morning. Feeds are generally broadcast evenly along the marginal area of the pond. Feeding is also sometimes done via feeding trays or baskets placed in different locations in the pond, which is helpful in monitoring consumption and adjusting feeding rates. Pellet feeds are given at 3-15% of the body weight of prawn daily thrice (60-75% at late evening). Initially a higher percentage (15%) of feed is given and at final stage of culture it should be reduced to 3-4% of the body weight. Monthly sampling should be conducted to estimate the standing prawn biomass in pond, based on which feeding rate is decided for the coming month. In prawn-carp polyculture the formulated feed should contain ingredients accepted by both the prawns and carps. Grass carps are fed with aquatic weeds such as *Hydrilla* and tender terrestrial grasses or wastes of cabbage leaves on platforms. The faeces of grass carp accelerate plankton production and enrich the detritus food chain for other carps and prawns.

## Water quality management

In grow out ponds it is essential to maintain desirable water quality throughout the culture period. With continuous culture operations, there is gradual accumulation of organic matter and nutrients from feeds, fertilisers, dead organisms and the metabolites of culture organisms in the pond bed. This deposited sediment decomposes to release nutrients into water to stimulate phytoplankton production. However, excessive silt deposition impairs water quality of the pond leading to prawn stress, slow growth, susceptibility to disease, prawn mortality and possible failure of the crop. Therefore, to maintain suitable water quality periodical monitoring is done. The favourable range of water quality in *M. malcolmsonii* culture ponds is in the range: water temperature 26-32°C, water transparency 30-60 cm, pH 7.0–8.5, dissolved oxygen > 5 mg/l, free $CO_2$ < 8 mg/l, hardness 100-50 mg/l, total alkalinity 80–150 mg/l, $NH4^+$-N 0.02–0.20 mg/l, calcium 30–80 mg/l, phosphorus 0.01–0.90 mg/l and nitrogen 0.05–90.5 mg/l[12]. Freshwater prawn ponds should be free from hydrogen sulphide. Sub-lethal stress level of hydrogen sulphide in pond water occurs as low as 0.1-0.2 mg/l and prawns die instantly at 3 mg/l or greater level in pond[9]. To maintain good water quality, frequent exchange with pollution-free water and aeration is essential.

## Health management

Being an indigenous species *M. malcolmsonii* is more tolerant to environmental fluctuations and comparatively more resistant to pathogens. However, due to intensification of culture practices *M. malcolmsonii* may suffer from disease due to a combination of pathogenic, nutritional, physiological and environmental factors. These diseases may be viral, bacterial, fungal, nutritional and environmental in origin. Prawn disease can be prevented by maintaining scientific rearing practices, avoiding high stocking and over feeding, de-silting of pond bed followed by harrowing and exposure to sun-drying between the culture cycles, frequent water exchange of 30-50% and aeration etc.

In freshwater prawn juveniles the nodavirus pathogen (MrNV) (see Aquaculture Asia Vol. XIII, No. 4) causes whitish tail or milky white muscle leading to mass kills. This pathogen is transmitted from broodstock to larvae to PL to juveniles and adult prawns. Infectious hypodermal and haematopoietic necrosis virus (IHHNV) is also an emerging disease in PL and juveniles causing mass mortalities. Reddish discoloration of cuticles, muscular atrophy, growth retardation and deformities are main symptoms of this disease. *Macrobrachium* muscle virus (MMV) causes weakened swimming ability and inclination to stay on aquatic vegetation[13]. To prevent viral diseases in grow out ponds, infected or diseased juveniles should not be stocked.

Vibriosis bacterial diseases are prevalent in prawn eggs, larvae and PL. These luminescent bacteria can cause massive losses in prawn hatcheries. Water should be treated with 20-30 ppm chlorine or formalin to check bacterial diseases. Shell diseases are the most common bacterial disease in crustaceans causing white spot, black spot and rust disease. Prawns may also suffer fouling by microbial epibionts such as filamentous algae, bacteria or protozoans, which may affect the appearance and market value of prawns. Fouling is particularly common in larger prawns which moult less frequently. Treatment with 20-30 ppm formalin is effective and safe to control it. Fungal diseases may occur in ponds associated with accumulation of organic matter and eutrophication. Good environmental management can effectively control many diseases and external fouling; hence proper feeding, frequent water exchange, aeration etc are important considerations in health management.

Appendage deformity syndrome (ADS), slow growth syndrome (SGS) and branchiostegal blister disease (BBD) have also been reported in freshwater prawns in Andhra Pradesh. Idiopathic muscle necrosis (IMB) has been reported in *Macrobrachium* larvae, PL and sub adults. Black gill disease can be caused by melanisation of gills due to high concentrations of nitrite and nitrate in the pond environment. It can be prevented by appropriate feeding practices or increased exchange to maintain water quality in grow out ponds[13].

## Culture types

Based on the degree of farm management, the *M. malcolmsonii* monoculture can be categorised into extensive, semi-intensive and intensive culture systems. Extensive culture is typically carried out in large ponds and water impoundments such as reservoirs, irrigation ponds and rice fields. They are stocked naturally in ponds or fish farmers stock at very low stocking density with juveniles collected from wild sources. In this culture system water quality, prawn growth and health is generally not monitored. Supplementary feeding and organic fertilisers are rarely applied. Prawn production is limited to about 200-400 kg/ha/year[1].

In semi-intensive farming systems *M. malcolmsonii* ponds are made free from predators and competitors. Fertilisation is used and a balanced feed ration is supplied. Juveniles are stocked at 30,000-40,000/ha. Water quality, prawn health and growth rate are monitored. Prawn production for such systems is in the range of 500-1000 kg/ha/year[3,4,14,15]. This form of culture is the most common in tropical areas.

Intensive *M. malcolmsonii* culture can be done in small earthen or concrete ponds (0.05- 0.2 ha). Prawn juveniles are stocked at more than 40,000/ha under controlled conditions in

predator free ponds. There is strict control over all aspects of water quality and continuous aeration is provided. Pond water is exchanged frequently. Prawns are fed with nutritionally complete diet, as the system is unable to provide sufficient natural food to support the prawn biomass. A high degree of management is required to achieve higher production of 2,000-3,000 kg/ha/year. This form of culture is not common practice as it requires more research, particularly on quality management.

## Prawn harvesting management

*M. malcolmsonii* reaches a marketable size of 30 - 40 g after six to seven months of rearing. Prawns are typically harvested by reducing the water level and repeatedly seining the pond. Finally ponds are drained and the remaining prawn crop is harvested. On complete draining prawns accumulate in deeper zones or the marginal trench of the pond from where they are collected by hand.

*M. malcolmsonii* do not grow at same rate. Males grow bigger than females, and even in the same sex there exists heterogeneity in growth. Those that grow faster tend to become dominant, while others remain stunted. Such heterogeneous individual growth of prawn results in different market prices. To reduce heterogeneous individual growth problems, ponds are stocked only once and partial harvesting of large size prawns can be done continuously for sale, leaving smaller once to grow with less heterogeneous individual growth. Periodic harvesting is done using bag seine nets of suitable mesh size. After several partial harvests, ponds are drained to harvest all remaining prawns within 9-12 months. In tropical perennial ponds where temperature remains at optimum levels regular stocking of freshwater prawn juveniles and selective harvesting (culling) of marketable size prawns (multi-stocking and multi-harvesting) can be practiced. However, in cull harvesting it is not possible to harvest all the bigger size prawns available in pond. If large dominant prawns escape harvest they may cause negative impacts through predation on subsequently stocked juvenile prawns. For complete harvesting the ponds are completely drained occasionally.

## Polyculture

Prawn polyculture is practiced with fast growing compatible carps such as catla (surface feeder), rohu (column feeder) and grass carp (plant eater). If ponds are prone to phytoplankton abundance, silver carp can be incorporated in culture. Grass carp are stocked subject to availability of preferred aquatic weeds or terrestrial grasses for regular feeding. Bottom feeder carps such as mrigal and common carp are not used in prawn poly-culture. Prawn production in this kind of polyculture system varies according to level of management, but ranges from a few tens of kilos to > 700kg/ha/year[4,16,17]. In addition to the prawns, 3,000-4,000 kg/ha/year of various carp can be also produced under semi-intensive management practices. Better production can be obtained using stunted yearlings.

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