Aquaculture:

Definition of aquaculture= **Aquaculture**  also known as **aquafarming**, is the controlled cultivation of [aquatic organisms](https://en.wikipedia.org/wiki/Aquatic_organism) such as [fish](https://en.wikipedia.org/wiki/Fish), [crustaceans](https://en.wikipedia.org/wiki/Crustacean),  [algae](https://en.wikipedia.org/wiki/Algae) and other organisms of value such as [aquatic plants](https://en.wikipedia.org/wiki/Aquatic_plant) . Aquaculture involves cultivating [freshwater](https://en.wikipedia.org/wiki/Freshwater) and [saltwater](https://en.wikipedia.org/wiki/Saltwater) populations under controlled or semi-natural conditions, and can be contrasted with [commercial fishing](https://en.wikipedia.org/wiki/Commercial_fishing), which is the harvesting of [wild fish](https://en.wikipedia.org/wiki/Wild_fish).

Since seventy percent of the world’s surface is covered in water, humans have realized its importance as a resource. For this reason, one of the areas heavily exploited regarding the use of water as a resource is aquaculture, especially in the production of food as opposed to using the terrestrial land. It serves different purposes, including food production, restoration of threatened and [endangered species populations](https://www.conserve-energy-future.com/most-endangered-species-on-earth.php), wild stock population enhancement, the building of aquariums, and fish cultures and [habitat restoration](https://www.conserve-energy-future.com/causes-effects-solutions-for-habitat-loss-and-destruction.php).

Important types of aquaculture:

[Types of Aquaculture](https://www.conserve-energy-future.com/aquaculture-types-benefits-importance.php#Types_ofnbspAquaculture)

[1. Mariculture](https://www.conserve-energy-future.com/aquaculture-types-benefits-importance.php#1_Mariculture)

[2. Fish Farming](https://www.conserve-energy-future.com/aquaculture-types-benefits-importance.php#2_Fish_Farming)

[3. Algaculture](https://www.conserve-energy-future.com/aquaculture-types-benefits-importance.php#3_Algaculture)

[4. Integrated Multi-Trophic Aquaculture(IMTA)](https://www.conserve-energy-future.com/aquaculture-types-benefits-importance.php#4_Integrated_Multi-Trophic_AquacultureIMTA)

[5. Inland Pond Culture](https://www.conserve-energy-future.com/aquaculture-types-benefits-importance.php#5_Inland_Pond_Culture)

[6. Recirculating Systems](https://www.conserve-energy-future.com/aquaculture-types-benefits-importance.php#6_Recirculating_Systems)

[7. Open-net pen and Cage Systems](https://www.conserve-energy-future.com/aquaculture-types-benefits-importance.php#7_Open-net_pen_and_Cage_Systems)

[8. Flow-through / Raceway](https://www.conserve-energy-future.com/aquaculture-types-benefits-importance.php#8_Flow-through_Raceway)

Depending on Hydrobiological features,the Motive of farming

Special Operational Techniques, various types of cultural practices are carried out .

1. Mariculture

Mariculture is aquaculture that involves the use of seawater. It can either be done next to an ocean, with a sectioned off part of the ocean or in ponds separate from the ocean, but containing seawater all the same. The organisms bred here range from molluscs to seafood options like prawn and other shellfish, and even seaweed.

[Growing plants](https://www.conserve-energy-future.com/elephant-ear-plant.php) like seaweed are also part of mariculture. These sea plant and animal species find many uses in manufacturing industries such as in cosmetics and jewelry where collagen from seaweed is used to make facial creams. Pearls are picked from molluscs and made into fashion items.

2. Fish Farming

Fish farming is the most common type of aquaculture. It involves the selective breeding of fish, either in freshwater or seawater, with the purpose of producing a food source for consumption. [Fish farming](https://www.conserve-energy-future.com/causes-effects-solutions-of-overfishing.php) is highly exploited as it allows for the production of a cheap source of protein.

Furthermore, fish farming is easier to do than other kinds of farming as fish are not care-intensive, but only requiring food and proper water conditions as well as temperatures. The process is also less land-intensive as the size of ponds required to grow some fish species such as tilapia is much smaller than the space required to grow the same amount of protein from beef cattle.

3. Algaculture

Algaculture is a type of aquaculture involving the cultivation of algae. Algae are microbial organisms that share animal and plant characteristics. They are sometimes motile like other microbes, but they also contain chloroplasts that make them green and allow them to photosynthesize just like green plants.

However, for economic feasibility, they have to be grown and harvested in large numbers. Algae are finding many applications in today’s markets.

4. Integrated Multi-Trophic Aquaculture(IMTA)

IMTA is an advanced system of aquaculture where different trophic levels are mixed into the system to provide different nutritional needs for each other. Notably, it is an efficient system because it tries to emulate the ecological system that exists in the natural habitat.

The IMTA makes use of these intertropical transfer of resources to ensure maximum resource utilization by using the waste of larger organisms as food sources for the smaller ones. The practice ensures the nutrients are recycled, meaning the process is less wasteful and produces more products.

5. Inland Pond Culture

This usually involves inland artificial ponds of about 20 acres in size and about 6-8ft deep. It is common to see aeration systems connected to the pond, to introduce air into the ponds. This enhances the supply of oxygen and also reduces ice formation in the winter season.

6. Recirculating Systems

This involves a closed set of chambers (units) where fish is kept in one and water treatment kept in another. It is highly dependent on the power supply, as water has to be pumped constantly through the fish chambers. As water flows through the treatment chamber, particulate matter is filtered out and air introduced. This closed system controls the salinity, temperature, oxygen and anything that can cause harm to the fish.

It is an environmentally friendly system because very little new water is introduced to replace water that evaporated. The residue from the filters is also disposed of in a responsible manner.

7. Open-net pen and Cage Systems

Open-net pen and Cage systems are often found offshore and in freshwater lakes. Mesh cages of between 6 and 60 cubic feet (pens) are installed in the water with the fish inside it. With a high concentration of fish in the pens, waste, chemicals, parasites and diseases are often exchanged in the immediate water environments.

The fish also attract predatory animals (bigger fish), which are often entangled in the nets. This system uses public water; therefore, environmental regulation and some authorization protocols must be respected.

8. Flow-through / Raceway

This is a system made of long units stocked with fish. The units have feeding stations attached to them. Water is diverted from flowing water and fed into the raceway units flowing downstream. Down the end of the unit, waste is collected and disposed of. Raceways are common for culturing trout.



Fig:Mariculture.

Important fresh water fish groups in India

1. Labeo rohita (Rohu)
2. Labeo gonius (Rohu)
3. Catla catla (Bhakur)
4. Cirrhinus mrigala (Nain)
5. Wallago attu (Parhin)
6. Mystus seenghala (Dariai tengra)
7. Heteropneustes fossilis (Singhi)
8. Clarias batrachus (Mangur)
9. Channa punctatus (Gurrie)
10. Channa striatus (Sowra)
11. Channa marulius (saul)
12. Channa gachua (Sauri)
13. Anabas testudineus (Anabas)
14. Notopterus chitala (Chital)
15. Mugil cursula (Mullet)
16. Mastacembelus armatus (Baam)
17. Xenantodon cancila

Captive fisheries:

Captive fisheries is exploitation of aquatic organisms without stocking the seed. Recruitment of the species occurs naturally. This is carried out in the sea, rivers, reservoirs, etc. Fish yield decreases gradually in capture fisheries due to indiscriminate catching of fish including brooders and juveniles. Overfishing destroys the fish stocks. Pollution and environmental factors influence the fish yield. Captive Fishing and subsequent re-introduction of a threatened species is an important and in some cases very successful tool for species conservation.

Capture fisheries is intended for catching fishes and also prawns, lobsters, crabs, sea-cucumbers, whales, pearl oysters, edible bivalve and copious other organisms of other than fishes etc. Primitive human beings were acquainted with capture fishery centuries passed for him to observe and understand for the possibilities of culturing fish. Then also he depended mostly on the culture of fishes with parental care. Later, he tried to collect the fingerlings in canals, distribution canals. In the earlier days, the mixture of carnivore fish fingerlings and carp fish fingerlings were stocked together in tanks. Later, they were segregated and stocked selecting the required variety. Capture of fishes can be broadly divided in to two types; a) Capture by Human effort b) Capture by observing the behavioural pattern of Fishes.

Inland capture fishery of India has an important place; it contributes to about 30% of the total fish production. The large network of inland water masses will continue to provide great potential, for economic capture fishery which consequently will compete well with fast growing fish-culture practices. The freshwater inland water bodies fall into five major categories, distinguished as the Ganga, the Brahmaputra and the Indus system of the Northern India, and the East and the West coast river systems of the Southern (peninsular) India. These river systems have certain characteristics of their own with respect to their ecology, climatic conditions and fish populations of commercial food fishes. Besides, there are a number of land-locked lakes especially those situated at high altitudes which have started supporting cold water fisheries of both indigenous and exotic species. India is the third largest producer of fish and second largest producer of inland fish in the world. The fisheries sector provides employment to over 11 million people engaged fully, partially or in subsidiary activities pertaining to the sector, with an equally impressive segment of the population engaged in ancillary activities.

Culture fisheries:

Culture fisheries is the cultivation of selected fishes in confined areas with utmost care to get maximum yield.The seed is stocked,nursed and reared in confined water ,then the crop is harvested .Culture takes place in ponds,which are fertilised and supplementary feeds are provided to fish to get maximum yield.

Culture fisheries practices are usually applied in small water bodies such as village dams and irrigation reservoirs. Fish growth is driven by the natural productivity of the waters.

#### Economic Importance of Fish

**(i) Fish as food:**

The fish flesh is an excellent source of protein, has very little fat, carries a good amount of minerals and vitamins A and D and rich in iodine. Above all man can digest it easily. Some important edible fish of India are given in the Table 9.7 & 9.8.

**(ii) Fish for controlling diseases:**

Diseases like malaria, yellow fever and other dreadful diseases that are spread through mosquitoes can be controlled. Larvivorous fish eat larva of mosquito. The important larvivorous fish are Gambusia, Panchax, Haplochitus, Trichogaster, etc.

**(iii) Scientific value:**

Some fish like the lung fish are of zoological importance because of their discontinuous distribution and anatomical features.

**(iv) Aesthetic value:**

A large number of fish are cultured in aquarium for their beauty and graceful movements. The important aquarium fish are Macropodus, Trichogaster, Carassinus (gold fish) and Pterophyllum (angel fish).

**(v) Fishery Bye-products:**

**(a) Fish oil:**

It is extracted from the liver of the sharks, sawfishes, skates and rays and has medicinal value. These mainly include cod liver oil and shark liver oil.

**(b) Fish Manure:**

The fish waste after the extraction of oil, is used as fertilizers,

**(c) Fish Glue:**

It is a sticky product, obtained from the skin of the cod and is used as gum.

**(d) Isinglass:**

It is a gelatinous substance, obtained from the air bladder of perches, Indian Salmons and cat fish used in the preparation of special cement and in the clarification of wine and beer,

**(e) Shagreen:**

The skin of sharks and rays, which has pointed and sharp placoid scales are used in polishing the wood and other materials. It is also used for covering the jewellery boxes and swords,

**(f) Leather:**

A highly durable type of leather is prepared from the skin of sharks and rays,

**(g) Artificial pearls:**

The silvery boney scales of cypnmids (a type of fish) are used in the manufacture of artificial pearls especially in France.

**(vi) Employment:**

Development of fishing industry generates more employment opportu­nities.

**(vii) Source of Income:**

The fishing industry has brought a lot of income to the farmers in particular and the country in general. Now we can talk about “Blue Revolution” (fish production) on the same lines as ‘Green Revolution’ (for producing enough food for all).

Fresh water prawn culture:

The giant freshwater prawn is suitable for cultivation in tropical and subtropical climates. The most commonly cultured species in India is Macrobrachium rosenbergii. 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. 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.

*Macrobrachium rosenbergii*is found in inland freshwater areas including lakes, rivers, swamps, irrigation ditches, canals and ponds, as well as in estuarine areas. This species requires brackishwater in the initial stages of their life cycle (and therefore they are found in water that is directly or indirectly connected with the sea). Mature male prawns are considerably larger than the females and the second chelipeds are much larger and thicker. The head of the male is also proportionately larger, and the abdomen is narrower. The head of the mature female and its second walking legs are much smaller than the adult male. A ripe or ‘ovigerous' female can easily be detected because the ovaries can be seen as large orange-coloured masses occupying a large portion of the dorsal and lateral parts of the cephalothorax.

The life cycle of *M. rosenbergii*can be summarized as follows. The mating (copulation) of adults results in the deposition of a gelatinous mass of semen on the underside of the thoracic region of the female's body (between the walking legs). Successful mating can only take place between ripe females, which have just completed their pre-mating moult (usually at night) and are therefore soft-shelled, and hard-shelled males. In tropical areas these coincide with the onset of the rainy season. Within a few hours of copulation, eggs are extruded through the gonopores and guided by the ovipositing setae (stiff hairs), which are at the base of the walking legs, into the brood chamber. During this process the semen attached to the exterior of the female's body fertilizes the eggs. The eggs are held in the brood chamber and kept aerated by vigorous movements of the swimmerets.



The length of time that the eggs are carried by female freshwater prawns varies but is not normally longer than three weeks. The number of eggs that are laid also depends on the size of the female. Female prawns of *M. rosenbergii*are reported to lay from 80000 to 100000 eggs during one spawning when fully mature. Egg incubation time averaged 20 days at 28°C (range 18-23 days).

Freshwater prawn eggs of this species are slightly elliptical, with a long axis of 0.6-0.7 mm, and are bright orange in colour until 2-3 days before hatching when they become grey-black. This colour change occurs as the embryos utilize their food reserves. As the eggs hatch, rapid movements of the abdominal appendages of the parent disperse the larvae. Freshwater prawn larvae are planktonic and swim actively tail first, ventral side uppermost (i.e. upside down). *M. rosenbergii*larvae require brackishwater for survival. The larvae go through 11 distinct stages before metamorphosing into post larvae. Stage I larvae (zoeae) are just under 2 mm long (from the tip of the rostrum to the tip of the telson). Larvae swim upside down by using their thoracic appendages and are positively attracted to light. By stage XI they are about 7.7 mm long. Newly metamorphosed post larvae (PL) are also about 7.7 mm long and are characterized by the fact that they move and swim in the same way as adult prawns. They are generally translucent and have a light orange pink head area.

On completion of their larval life, freshwater prawns metamorphose into post larvae (PL). From this point onwards they resemble miniature adult prawns and become mainly crawling rather than free-swimming animals. When they do swim it is usually in a normal (dorsal side uppermost) way and in a forward direction. Rapid evasive movement is also achieved by contracting the abdominal muscles and rapid movement of the tail. Post larvae exhibit good tolerance to a wide range of salinities, which is a characteristic of freshwater prawns.

Post larvae begin to migrate upstream into freshwater conditions within one or two weeks after metamorphosis and are soon able to swim against rapidly flowing currents and to crawl over the stones at the shallow edges of rivers and in rapids. In addition to using the foods available to them as larvae, they now utilize larger pieces of organic material, both of animal and vegetable origin. Post larval freshwater prawns are omnivorous can also be cannibalistic.

The hatchery and nursery should be located inland where there is ample supply of good freshwater. Saline water required for larval development can be transported and mixed with freshwater to attain the desired salinity. The quality of intake water, whether it is saline or fresh, is of paramount importance for efficient hatchery operation. Water quality is thus a critical factor in site selection. Hatchery sites should preferably be far from cities, harbours and industrial centres, or other activities, which may pollute the water supply. In all cases, water supplies need careful analysis during site selection, to determine their physical, chemical, and biological characteristics, and the extent to which these may vary daily, seasonally, or through other cycles.

Special care is needed in hatcheries that are situated in or near areas where the use of pesticides, herbicides, and fertilizers is intensive. Ideally, freshwater should be obtained from underground sources. The brackishwater for use in *M. rosenbergii*hatcheries should be 12-16 ppt, should have a pH of 7.0 to 8.5, and contain a minimum dissolved oxygen level of 5 ppm. High levels of heavy metals, such as mercury (Hg), lead (Pb) and zinc (Zn), should also be avoided,

In addition to having sufficient supplies of good quality water, a good hatchery site should also have:

•  A secure power supply, which is not subject to lengthy power failures. An onsite emergency generator is essential.  
•  Have good all-weather road access for incoming materials and outgoing PL;  
•  Have access to food supplies for larvae;  
•  Employ a high level of technical and managerial skills;  
•  Have access to professional biological assistance from government or other sources;

It also important to consider other factors to ensure success, including the:

•  Suitability of the climatic conditions;  
•  Suitability of the topography;  
•  Availability of adequate supplies of good quality water;  
•  Availability of suitable soil for pond construction;  
•  Maximum protection from agricultural and industrial pollution;  
•  Availability of adequate physical access to the site for the provision of supplies and the movement of harvested animals;  
•  Availability of supplies of other necessary inputs, including postlarval and/or juvenile prawns, equipment, aquafeeds or feed ingredients, and power supplies;  
•  Availability of good skilled (managerial) and unskilled labour;

**Topography**

Farms must be close to their market so the road access must be good. Large farms will need to have local access for heavy trucks be able to reach the farm easily, for the delivery of supplies and the efficient collection of harvested prawns.

A survey is necessary, to assess the suitability of a site from a topographical point of view. It is important to minimize the quantities of earth to be shifted during pond construction. Flat or slightly sloping lands are the most satisfactory. The ideal site, which slopes close to 2% (2 m in 100 m), allows good savings on earth movement. Care should be taken to ensure that pond sizes and alignments allow efficient construction, and at the same time permit good access and effective water supply and drainage.

**Climate**

The meteorological records such as temperature, the amount and seasonality of rainfall, evaporation, sunlight, wind speed and direction, and relative humidity should be studied for site selection. Avoid highly unstable meteorological regions. Strong storms and winds increase the risks of flood and erosion damage, and may lead to problems with transport access and power supply.

Temperature is a key factor. Seasonal production is possible in semi-tropical zones where the monthly average air temperature remains above 20°C for at least seven months of the year. The optimum temperature range for year-round production is between 25 and 31°C, with the best results achievable if the water temperature is between 28 and 31°C. The temperature of the rearing water is governed not only by the air and ground temperature but also by solar warming and the cooling effects of wind and evaporation. The rate by which pond water is exchanged and the temperature of the incoming water are also important considerations.

Rainfall, evaporation rates, relative air humidity and wind speed and direction also need to be investigated. Ideally, evaporation losses should be equal to or slightly lower than rainfall input, to maintain an approximate water balance. Mild winds are useful to promote gas exchange (oxygenation) between water and the atmosphere. However, strong winds can increase water losses by evaporation and may also generate wave action, causing erosion of the pond banks. Avoid areas where it is constantly cloudy because this makes it hard to maintain a steady water temperature, as it interferes with solar penetration. Periods of cloud cover of several days' duration may also cause algal blooms to crash, which in turn lead to oxygen depletion.

**Nursery Phase**

The nursery can be either indoor or outdoor. The selection of sites for indoor nurseries should follow the same pattern as for hatcheries. Site selection for outdoor nursery facilities should be similar to that for grow-out ponds.

**Holding Tanks**

After rearing freshwater prawns in hatchery, hold them until ready for stocking in ponds. Concrete tanks of 50 m3 are convenient for holding postlarvae (PL) prior to transport for stocking in ponds. Use nets suspended from floats in the tanks to increase the surface area available to the PL but this may make the normal operations of feeding, cleaning etc. more difficult.

**Indoor Nursery Facilities**

Tanks for indoor freshwater prawn nurseries can be constructed from concrete or fibreglass. The use of asbestos cement tanks is not recommended. The shape of nursery tanks is not important and their size, usually from 10 to 50 m2 with a water depth of 1 m. The best stocking density for indoor nursery tanks depends on the length of time the animals will remain in the tanks before transfer to an outdoor nursery or grow-out facility. It is recommended not to exceed a stocking density of 1000 PL/m3 in tanks without substrates.

Artificial substrates of various designs and materials can be used to increase surface area; these provide shelter and increase survival rates. Layers of mesh can therefore be used to increase the amount of surface edges available to the prawns in both vertical and horizontal planes.

The water supplies for indoor nurseries can be flow-through or recirculating. For flow-through, water is allowed to continuously enter from above the tank and exit from the lowest part of the tank through a vertical standpipe. Standpipes are covered with a 1.0 mm mesh screen to prevent PL and juveniles from escaping. This drainage system draws water from the tank bottom where food waste and detritus settle.

**Outdoor Nursery Facilities**

Nursery ponds are similar to grow-out ponds in design and facility requirements. They usually vary in area from 300 to 2000 m2 . Artificial substrates can be used to increase the surface area available to the prawns. PL is retained in holding tanks for more than a week or two prior to stocking in nursery facilities, grow-out ponds.

Whilst the PL are in the holding tanks water is exchanged at a rate of 40-50% every 2-3 days and provide aeration.

PL is at densities of up to 5000 PL/m2 for one week, or up to 1500-2000 PL/m2 for one month under these conditions. If you need to hold them for one month, you could improve survival if you reduce the density to 1000/m2.



**Water quality and supply**

Freshwater is normally used for rearing freshwater prawns from post larvae to market size. Water of 3-4 ppt salinity may be acceptable for the culture of *M. rosenbergii*. The reliability of the quality and quantity of the water available at the site is a critical factor in site choice. However, as in the case of hatchery water supplies, the absolute ‘ideal' for rearing sites may be difficult to define; a range of water qualities may be generally suitable. As for hatchery water, the level of calcium in the freshwater seems to be important. Growth rate has been reported to be lower in hard than in soft water. It is recommended that freshwater prawn farming should not be attempted where the water supply has a total hardness of more than 150 mg/l (CaCO3).

**Greenwater System of Freshwater Prawn Culture**

A more common alternative to the ‘clearwater' system for flow-through hatcheries is known as the ‘greenwater' system. In the greenwater system, a mixed phytoplankton culture in which *Chlorella*spp. is dominant is maintained in separate tanks. Its cell density is about 750000-1500000 cells/ml. A fertilizer solution in tap water is added to the tanks at least once per week to maintain the culture. This solution provides a mixture of 4 parts of urea to 1 part of NPK (15:15:15) garden fertilizer, applied at the rate of 185 g per 10 m3 tanks. Tilapia (*Oreochromis mossambicus*) is held in the tanks at the rate of about 1 per 400 l to graze on and control filamentous algae. Copper sulphate, at the rate of 0.6 ppm is added to the greenwater tanks once per week to control rotifers. The tilapia also helped to fertilize the culture. The sodium salt of EDTA (ethylene diaminetetraacetic acid) is included in the greenwater culture at 10 ppm as a chelator. The greenwater is prepared at the same salinity as the larval rearing water. Greenwater does not thrive at more than 12 ppt salinity. The greenwater culture is never used for larvae if the culture is more than three days old. Part had to be discarded or used for filling larval tanks and the rest diluted regularly to avoid phytoplankton ‘crashes' occurring in the larval tanks. Although the greenwater system may have some advantages, it is difficult to manage successfully and adds more complications to the hatchery process. For this reason, most commercial freshwater prawn hatcheries now use clearwater systems of management, whether they are flow-through or recirculation.

**Harvest of post-larvae**

New post larvae (PL) are about 7-8 mm long. Although PL can withstand the physiological shock of sudden transfer from 12 ppt water into freshwater, it is not recommended to harvest them from the larval tanks and transfer them directly into holding tanks containing freshwater.

The animals are best acclimatized to freshwater in the larval tank. Once the majority of larvae have metamorphosed (at least by day 32-35) water level in reduced in flow-through system tanks to about 35 cm.

The PL can then be harvested and transferred, or the larval tanks refilled to 70 cm with freshwater and the animals temporarily held in them. If the latter is done, the PL should only remain in the larval tanks for a few more days, with frequent water exchange, before transfer to a larger holding tank.

The best way to harvest PL from the larval tanks is to reduce the water level and then remove them in dip nets. Most flow-through hatchery operators harvest their post larvae only once, at the end of the production cycle.

**Nursery pond management**

The preferred stocking density in the nursery pond is 20/m2. Post-larvae (8-10 mg) may be fed with pellet diet (crude protein 35%; lipid 8%) in crumble form @ 100% of the biomass during the first fortnight and further reduced to 50% in subsequent period. In the absence of pellet diet a mixture of groundnut oil cake (powdered) and rice bran may be given as feed. The feed should be broadcasted in the pond twice daily preferably in the morning and in the late evenings. In nursery ponds approximately 10% of the pond surface may be covered with floating weeds with dense root system such as *Eichhornia*sp. to improve the survival rate of post-larvae. The weeds should be kept inside a PVC or bamboo frame to avoid their spreading in the pond. Aeration is provided for ~8 h/day.

A fortnight after stocking sampling of post-larvae may be done to observe the growth using cast net or fry net. During nursery rearing water temperature may be checked twice daily. pH, dissolved oxygen, transparency and depth may be checked once every week and to be maintained in optimum ranges. Loss of water due to seepage and evaporation should be compensated by water addition at least once every fortnight. Nursery rearing may be done for 45-60 days. At the end of rearing period the juveniles (>1.0 g) are collected by dewatering the pond and transferred to grow-out ponds

Juvenile prawns can be harvested by seining your ponds two or three times with a 5 to 6 mm mesh seine, or by emptying them completely. Polypropylene boxes or tanks filled with water from the nursery pond and kept aerated, can be used to transport the juveniles to the grow-out ponds if they are close by. There are some advantages in grading the juveniles into two or three groups, depending on their average weight, before stocking them into separate grow-out facilities. This decreases competition in grow-out ponds by reducing Heterogeneous Individual Growth (HIG) and increases productivity.

Some mortality (10-20%) will occur soon after PL are stocked, even when the conditions are ideal. Total survival from stocking until removal from the nursery ponds should be at least 75%. The weight of the prawns at the end of the outdoor nursery period should be about 0.8-2.0 g, but the time taken to reach those sizes will depend on local conditions.

**Grow-out phase**

A freshwater prawn farm is very similar to a freshwater fish farm. Prior to initiation of culture the ponds should be well prepared. The pond bunds/dykes should be repaired and strengthened. Ponds should be drained and the pond bottom should be exposed to sun for a week to kill all predatory fishes. 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 1.2 m. 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.

Lime may be applied as per the requirement after testing the soil pH. It can be applied @ 200 kg/ha, if the soil pH is between 6.5-7.0. Higher dose will be required in case of soil with low pH values. Water should be let into the pond up to two feet using nylon mesh nets to prevent the entry of eggs and larvae of predatory fishes and competitors. Pond should be fertilized with raw cow dung/poultry manure and super phosphate as per the requirement. In general for a pond of medium nutrient contents the fertilizers may be applied at the rate of 5 tonnes raw cow dung, 200 kg urea and 300 kg/ha/crop super phosphate.

After a week of fertilization the pond should be filled up to 4 feet water level. Transparency of pond water should be checked after 2-3 days using a secchi disc. Ponds can be stocked with post-larvae in case of nursery pond and with juveniles in case of grow-out ponds once the transparency is 30-35 cm during early morning or late evening hours.

**Stocking**

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. Liming of the pond assumes great importance than in the case of freshwater fish culture.

The application of fertilisers is restricted in case pelletised feed is used.

However, occasionally cow dung, single super phosphate, urea etc. can be applied on assessing the productivity.

The stocking density normally varies from 4000 to 50000 PL/ha depending on the type and intensity of the management practices.

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 500-2500 nos.

Nursery may be incorporated where the post larvae obtained from hatcheries could be reared for a period of 4-5 weeks till they attain 40-50 mm or 1-3 gm.

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.

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 my be 5% of the body weight.

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 50 gms to 200 gms depending on the duration, density, water quality, feeding etc. The survival rate may range 50% to 70% depending on the type of management practices.

**Health, Predation and Disease**

Continuous exchange of a small proportion of the water is the normal way of maintaining good water quality. However, some farmers change water more suddenly every two weeks, and in much larger proportions, because this tends to make the prawns moult. The more that moult (and are therefore soft-shelled) at the same time, the less potential losses there may be due to cannibalism. Low dissolved oxygen should be suspected if prawns begin to crawl out of the ponds or congregate at the edges of the pond in daylight. If this problem occurs, flush the pond. Very high pH levels in freshwater prawn ponds can cause prawn mortalities, both because of the direct effect of the pH itself and because of the greater solubility of waste ammonia at high pH. High pH is often caused by dense phytoplankton blooms.

Major problems that may arise during culture are mortality of the stock due to low dissolved oxygen in the pond water. Heavy plankton bloom, very low water level and lack of water exchange leads to low dissolved oxygen levels. Continuous rainy/cloudy days precipitate this problem. Immediate water exchange or aeration of ponds during night hours prevents this problem. Development of bottom algae due to high transparency of water is another problem during monoculture of prawns. To avoid this problem always maintain transparency in 30-40 cm range by frequent fertilization. Predation is one of the greatest problems for any aquaculture enterprise, including freshwater prawn farming. Predation is caused mainly by other aquatic species, birds, snakes and humans. Normally, insects (mainly dragonfly nymphs), carnivorous fish and birds are the most serious predators in freshwater prawn farming.

**Post Harvest Handling**

In general, the value of harvested product depends on its quality. Speed during and after harvesting, getting the prawns on ice and out of the sun, and care in handling to prevent physical damage, will all reap valuable dividends.

**Handling prawns to be sold fresh**

If you intend to sell your prawns fresh (instead of selling them alive or frozen) you will need to keep them very cool. You should not place live prawns straight onto ice; this results in a slow decline in body temperature, causes stress, and accelerates the deterioration process, which occurs after death. To kill a batch of 50 kg of prawns, for example, immerse them in 50 l of water and 80 kg of ice for 30 minutes.

Finally, you should wash them in chlorinated water (5 ppm active chlorine). After killing, remove prawns from the cold water and immediately place them in isothermal boxes, with alternate layers of ice and prawns, placing ice in the first and last layers.

**Handling prawns to be sold frozen**

If prawns are to be sold within 5 days of harvest, which is considered to be their maximum practical refrigerated shelf life, freeze them immediately. Freezing at temperatures below -10°C is essential; storage at -20°C or below is recommended; storage at -30°C is ideal.

To avoid physical damage to the muscle structure of the prawns, it is recommended that the freezing temperature passes from -1°C to -5°C as rapidly as possible (not more than 2 hours). This decreases the production of ‘drip' (leak) at the moment of thawing, and keeps the prawns looking and tasting the same as before freezing.

If you freeze them more slowly, it will cause large ice crystals to form between the cells of the animals and increase ‘drip'. Keeping prawns frozen on-farm is generally not good practice, except on very large farms where specialist equipment has been installed.



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