HAND BOOK OF SHRIMP SEED PRODUCTION AND FARMING

भाकृअनुप
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PREFACE

Shrimp aquaculture from a traditional activity, followed since ages in the *Bheris* of West Bengal, *Gheris* of Orissa, *Pokkali* fields of Kerala, *Khar* lands of Karanataka and *Khazani* fields of Goa, has transformed into commercial activity following scientific inputs brought into this system by the research works of fisheries research institutions and promotional agencies under the central and state governments. Research on scientific shrimp farming commenced in India in the early seventies with the operation of All India Co-ordinated Research Project on Brackishwater Fish farming by Indian Council of Agricultural Research. Under the project, low cost and low-input technologies for shrimps and fishes were developed and tested. During this period successful breeding and seed production of almost all the commercial penaeid species was achieved under controlled conditions by government run hatcheries. Demonstration of semi-intensive shrimp culture technology coupled with the establishment of large-scale hatcheries in late eighties led to tremendous growth of shrimp farming.

India is bestowed with 1.2 million ha potential area for development of brackishwater aquaculture and only 16.3% of the area alone has so far been brought under culture. With a good number of candidate species of shrimps, crabs and finfishes available in the country, there is vast scope for development of brackishwater aquaculture. Shrimp aquaculture in India is synonym to culture of tiger shrimp, *Penaeus monodon* and over dependance on this species resulted in a number of problems in the farming sector. The year 1994-95 witnessed the widespread appearance of bacterial and viral diseases resulting in severe loss to farmers. The major reasons attributed for the disease outbreak are over crowding of farms, level of intensification and lack of awareness about environment safety among the shrimp farmers.

Good management practices, both at the seed production stage and farm are required to prevent and control the spreading of viral diseases. It is equally important to create awareness among the farmers about the necessity to follow eco-friendly management practices to prevent the occurrence of diseases as well as to avoid the various social and environmental impacts that are attributed to shrimp farming. I appreciate Dr.P.Ravichandran and Dr.S.M.Pillai, Principal Scientists in bringing out this comprehensive bulletin which I hope will be useful to the scientists, entrepreneurs, farmers and students.

18-2-2004
Chennai

Mathew Abraham
Director

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SHRIMP HATCHERY TECHNOLOGY

1. INTRODUCTION

The two major inputs for successful shrimp farming are seed and feed. The traditional culture systems were dependent on the seed that are present in the tidal water. During the initial stages of the scientific farming, seed collected from the wild were stocked in ponds. However, this was felt as a limiting factor for the expansion of scientific shrimp farming. Non-availability of seed was the major constraint for the development of scientific farming during the early 1980's. Though experimental shrimp hatcheries were in operation since late 1970's in Government Institutions, commercial hatcheries were set up only in the late 1980's commensurate with the development of shrimp aquaculture. Majority of the hatcheries were set up in the major shrimp production states like Andhra Pradesh, Tamil Nadu, Orissa etc. There are around 237 shrimp hatcheries in the country with a combined production capacity of 11-12 billion postlarvae per annum.

In the context of bacterial and viral disease outbreaks, the availability of healthy and disease free seed from hatcheries has become crucial for successful shrimp farming. This handbook details the technology for the production of healthy shrimp seed in hatcheries.

2. SITE SELECTION

Penaeid shrimps are marine in origin and the early larval forms are purely marine and need the marine environment for growth and survival. Hence, the hatchery technology should provide the larvae with the most conducive environment similar to that of sea. This involves proper site selection. The hatcheries are to be located close to clear and clean sea water source. The major criteria for selection of the hatchery site are discussed below.

2.1 Sea water quality

The foremost requirement of a hatchery is availability of clean seawater. The sea water should not be turbid and should be free from suspended solids. Heavy winds and wave action and inflow from rivers/creeks are the major causes for the turbidity in the nearshore areas. Ideal sites are those that are located near sheltered coastal areas away from any freshwater/brackishwater inflow.

Water temperature plays a very definite role in the growth of larvae. Sea water temperature between 28°C to 32°C are optimal for most of the tropical species of shrimp. Hence, the hatchery should not be located in areas where there is severe winter or summer.

Salinity of the water is one of the most important factor controlling the physiology of marine organisms. The optimal salinity for the growth and survival of shrimp is between 30 and 34 ppt, though the adults can tolerate wide range of salinity. Heavy rainfall and freshwater influx from rivers reduce the salinity of the sea water and make it unsuitable for use in hatchery. Hence, the hatchery should not be located near the river mouth or in areas that experience heavy rainfall.

Apart from these, other parameters that affect the growth and survival of the larvae and their optimal levels/ tolerable limits are presented herewith.

PARAMETERS	TOLERABLE LIMIT	OPTIMAL LEVELS
Temperature (°C)	18 - 36	28 - 32
Salinity (ppt)	26 - 34	30 - 34
pH	7.0 - 9.0	8.0 - 8.4
Dissolved oxygen (ppm)	Above 3	Above 4
Ammonia - N (ppm)	Upto 0.1	Less than 0.01
Nitrite - N (ppm)	Upto 0.1	Less than 0.01

While selecting the site, it should be seen that all the above parameters of sea water are within the tolerable levels. The most ideal site should have optimal levels of these parameters during the major part of the year.

Pollutants and contaminants have serious impacts on the survival of the delicate shrimp larvae. Hence the hatcheries should not be located in areas where there is a large number of industrial or agricultural run-off into the sea. Heavy metals and pesticides should be well within the "safe levels" to ensure proper running of the hatchery to produce healthy shrimp larvae.

2.2 Weather

The local weather conditions at the hatchery site exert a profound influence on the sea water quality. Heavy monsoon rains will seriously affect the salinity and turbitidy of the sea water, while severe summer or winter will lead to high or low temperature conditions. Similarly, cyclone prone areas should also be avoided, as it would cause severe damage to the hatchery installations.

2.3 Nearness to shrimp landing site

Hatcheries generally depend on the wild caught broodstock or spawners of shrimps. Hence, it is essential that the hatchery is located nearer to the shrimp landing centres so that long distance transportation of the broodstock/ spawners could be avoided. Transportation causes severe stress to mature shrimp, which can lead to the regression of the ovaries or death of the shrimps.

2.4 Infrastructure facilities

Availability of infrastructure facilities such as approach roads and electricity is one of the important considerations for selecting a site. The hatchery operation mainly depends on the electrically operated machineries such as water pumps and air blowers. However, complete dependence on the generator is not advisable, since the operational costs will be very high. Similarly, an approach road without and proper communication facilities, a hatchery may not be able to function, since all the material inputs have to be brought in from outside. Hence, a suitable site with proper road and communication facilities including state sponsored electric supply should be chosen.

3. HATCHERY DESIGN AND CONSTRUCTION

A basic prerequisite in the design and construction of a hatchery is an understanding of the biological requirements of the species and the concept of different systems involved in the hatchery.

A hatchery should have provisions for :

- Broodstock maintenance
- Induced maturation (shrimps)
- Spawning/ hatching
- Larval rearing
- Live-feed culture (phytoplankton/ zooplankton)
- Postlarval rearing

The maintenance of these biological materials require 4 major infrastructure systems :

- Seawater supply system
- Air- supply system
- Tanks
- Buildings

3.1 Seawater supply system

The most important design criteria in seawater - based hatcheries is the selection of suitable materials to be used in the hatchery. Materials like plastics, PVC, concrete and wood, which do not corrode in the saline environment are commonly used in these type of hatcheries.

3.2 Seawater intake

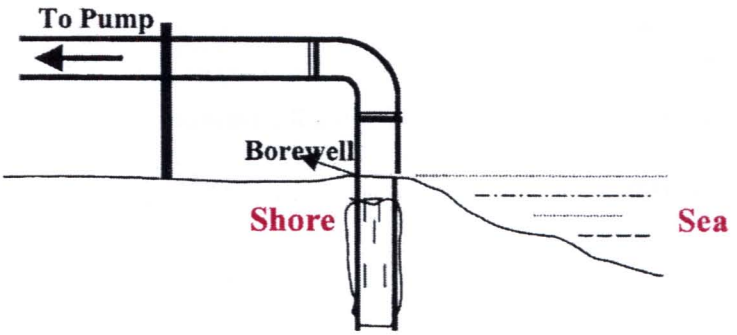
There are numerous designs now in use in the various sea water based hatcheries. These designs are dependent on specific site characteristics, topography, geology, climate etc.

The commonly used system of drawing water is through intertidal borewells or through inshore open wells. Low depth intertidal borewells are suitable in areas where the wave action is minimal. Inshore open wells could be used where the wave action is more in the intertidal zone and there is no freshwater aquifer in the shoreline. If the water from the inshore wells is low saline due to the water table, drawing of water directly from the open sea by constructing concrete jetties into the sea beyond the breaker zone is the best option.

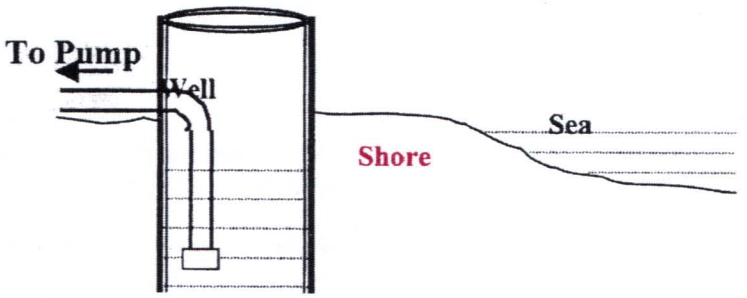
The sea water used inside a hatchery should be free from suspended solids, living organisms and chemical contamination. It is therefore essential to provide facility for water treatment in the hatchery depending on the quality of source water. Hatchery requires clean seawater. If the water is drawn from the open shore, it will contain suspended particles which are to be removed as a first step before any other treatment. Large suspended particles are easily removed by allowing the water to stand overnight in settling tank by the process of sedimentation. If the sea water is drawn from intertidal borewells or inshore wells, then the water will be free from suspended particles and no sedimentation will be necessary.

SEA WATER INTAKE

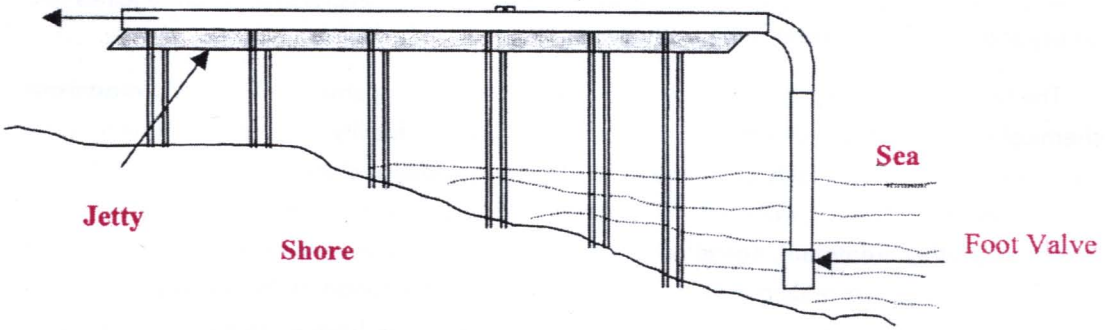
A) INTER-TIDAL BOREWELL



B) INSHORE WELL



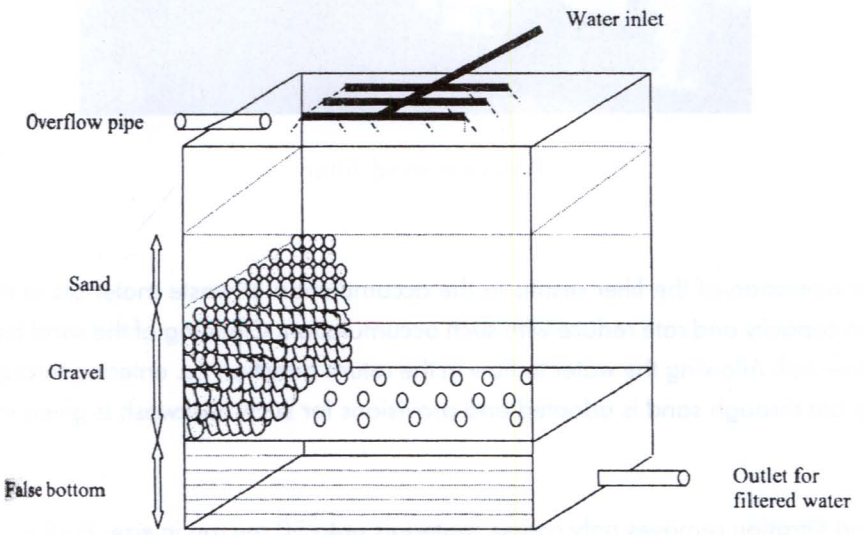
C) DIRECT PUMPING FROM OPEN SEA



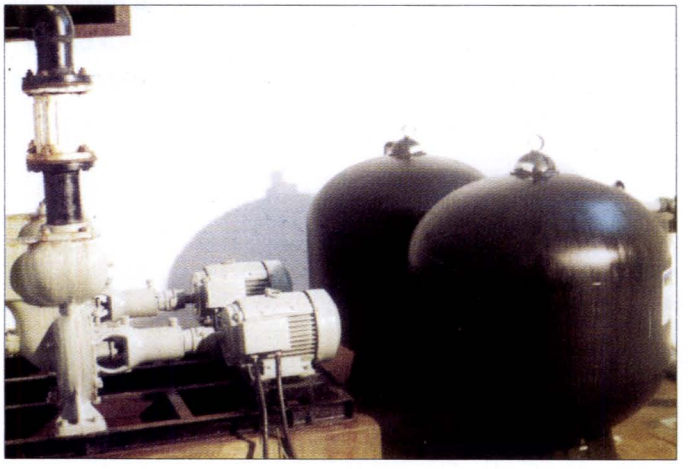
The next step in the treatment of sea water is the removal of unsettled suspended particles and other living organisms. This could be done by filtration. The filtration is done through sand-gravel filter which is a simple and most practical system. Two types of sand- gravel filters are generally used in the hatcheries, which work on a) filtration by gravity and b) filtration by pressure.

A simple gravity filter consists of a wooden or concrete tank with layers of gravel and sand. The gravel layer consists of larger gravels at the bottom with medium and smaller gravels above it. Similarly, three grades of sand, (coarse to fine) is used above the gravel layers. A perforated PVC pipe, embedded at the bottom of the gravel layer and extruding out of the tank acts as the outlet. The water is pumped into the filter at the top. The water flows through the sand and gravel-bed. The coarse suspended particles are trapped in the sand bed and the clean water is collected through the outlet at the bottom.

SAND-GRAVEL FILTER (By gravity)



Pressure/ rapid sand filters use the same principle as that of the gravity filters. The difference is that water passes through the sand and gravel bed under pressure. The filter-housing is made of FRP and is sealed air tight after arranging the sand and gravel in position. The delivery from a pump of required capacity is attached to the inlet of the filter and the filtered water flows out through the outlet at the same velocity as that of the pumped - in water. The filtering rate is very high and hence it is called as rapid sand filter.

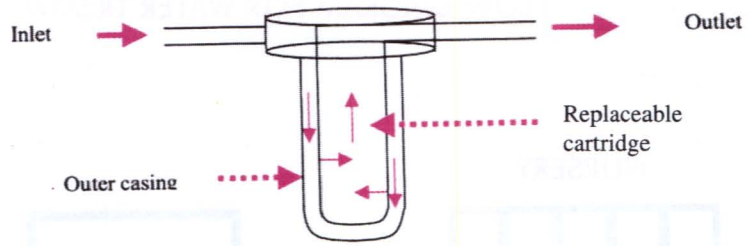


Pressure sand filter.

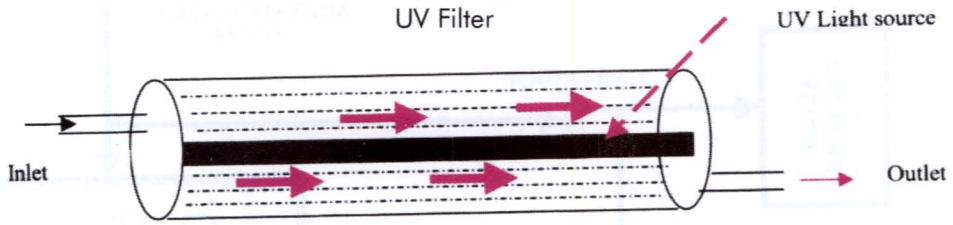
The operation of the filter results in the accumulation of waste materials in the sand bed. The filtration capacity and rate reduce with such accumulation. Cleaning of the sand bed, therefore, becomes essential. Allowing the water to flow in the return direction *i.e.* entering through the gravel and flowing out through sand is adopted and provisions for such backwash is given in all the sand filters.

Sand filtration removes only coarse materials upto 10 micron in size. Further, filtration can be done by using fibre based cartridge filter, which will remove suspended particles upto 1 micron in size. The fibre filter is enclosed in a non-corrosive housing. The water is pumped through the cartridge to the outlet. This could be easily fitted to the water lines.

On-line cartridge filter

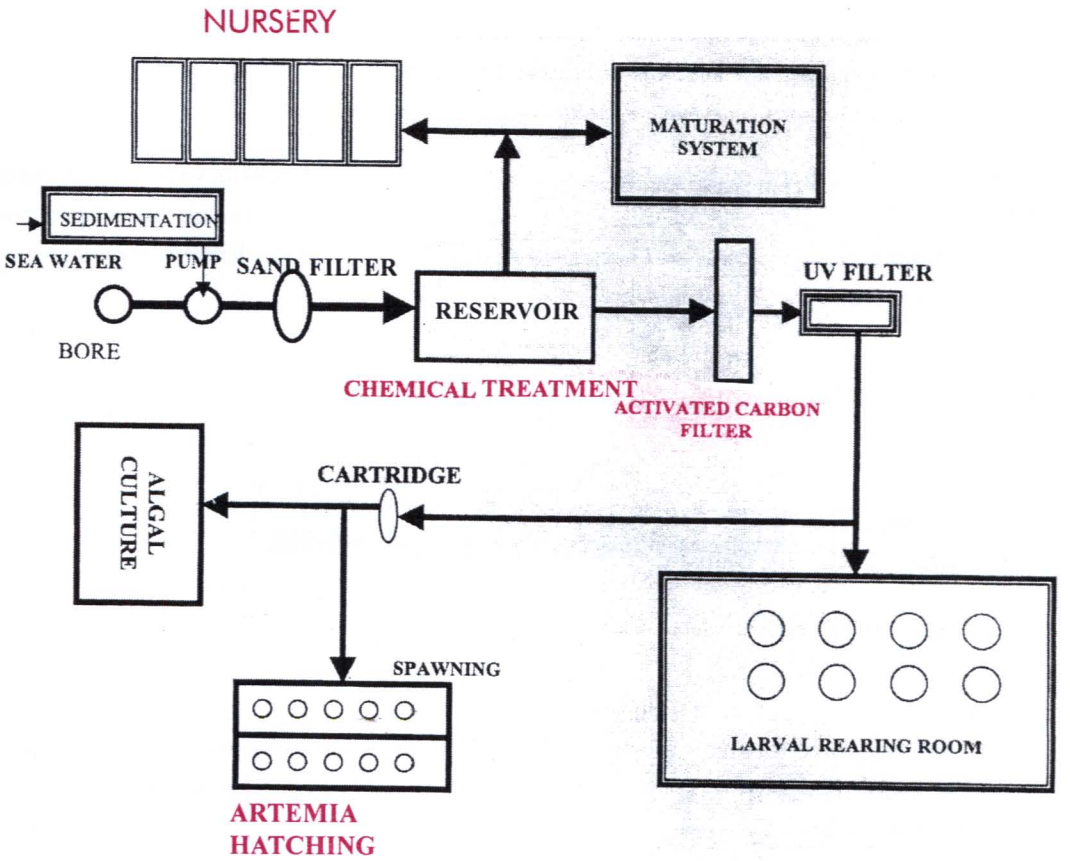


The filtered water might still contain micro organisms like bacteria, which can cause diseases. Hence, it is desirable to disinfect the water before use. Several chemicals have been commonly used for disinfection *viz.*, chlorine, hypochlorite, ozone, etc., UV sterilization is also carried out to disinfect the water.



The recommended concentration of disinfectants in water depends on the level of bacterial load. The usual dosage of chlorine ranges 5-20 ppm of active chlorine. Treatment should last preferably for 24 hours. Before use, the excess chlorine should be neutralised from seawater by adding sodium thiosulphate. The flow-diagram for water treatment is presented below.

FLOW-DIAGRAM FOR WATER TREATMENT



3.2.2 Pumps

The seawater is highly corrosive and hence great care should be taken while selecting the material by which the pump is made. Pumps made of cast iron or stainless steel will last longer in the saline environment. The capacity of the pump to be used depends on the scale, design and nature of operation in the hatchery. While calculating the pump capacity, the following criteria should be taken into account :

a) total tank capacity of the hatchery,
b) maximum water requirement per day
c) duration of water exchange in the tanks.

Accordingly, the maximum water flow rate and the required horse power of the pump can be calculated.

3.2.3 Pipes and piping system

The pipes for the water supply system should be made of non-toxic material. The most commonly used material is PVC. The water system is meant to distribute water from the overhead tanks to each and every section of the hatchery. The pipelines are to be laid in such a way that there are independent inlets for each tank with valve arrangement. Since the pipeline is to be maintained and repaired regularly, it should be kept exposed and not buried in the ground or concrete.

The size of the main line and secondary lines is fixed based on the height of the overhead tank and the volume of water required per minute.

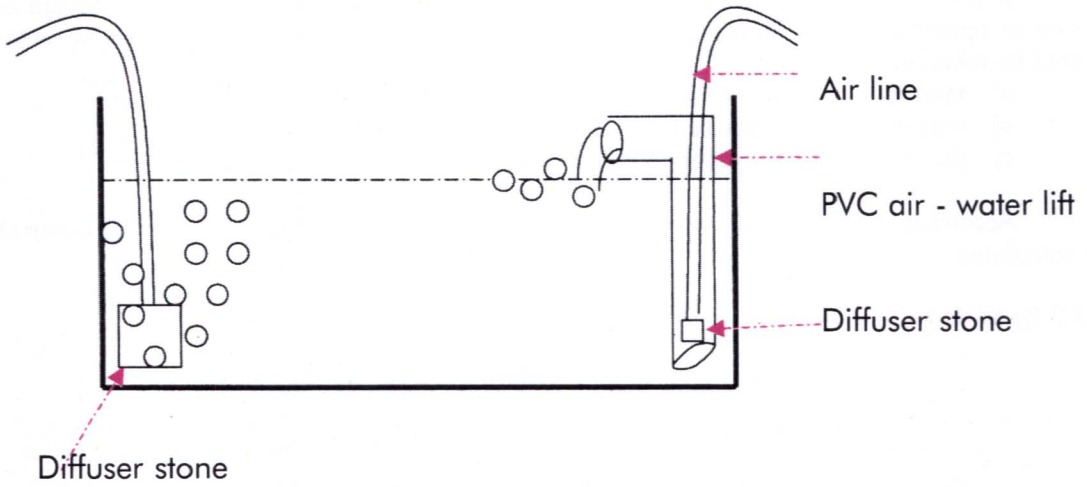
3.3 Air supply system

A continuous supply of air is required in all the tanks where aquatic organisms are maintained, to increase the dissolved oxygen levels. In the hatchery, continuous aeration is maintained to provide the dissolved oxygen required for the biological needs of the shrimps and for the stabilization of dissolved organic matter resulting from the decomposition of excess feed and metabolic wastes. At the same time, it provides sufficient turbulence to maintain uniform suspension of both the larvae and the feed.

Air blowers and compressors are the two equipments which can provide air. While the air blower yields high volume of air at low pressure, compressor generates low volume of air at high pressure. Since, a high volume of air at low pressure is required in the hatchery, air blowers are preferred. Further, the air being discharged by compressor is likely to contain oil particles which are harmful to larvae. The airblowers provide oil-free air. The required capacity of the blower is calculated based on the number of outlets, the depth of water column in tanks and the amount of air needed per minute from each outlet.

The pipe lines used for air supply, as in the case of water supply, should be made of PVC and polythene. The pipelines should be laid in such a way that uniform levels of air is distributed in all tanks irrespective of their location. It is desirable to have the air distribution system kept exposed for ease in maintenance and repairs.

The air delivery into the larval rearing tanks could be either through diffuser stones or through air-lift pumps as shown below.



3.4 Tanks

The tanks in the hatchery are named according to the purpose for which they are used i.e., reservoirs, overhead tank, maturation tanks, spawning tanks, larval rearing tanks, nursery tanks or postlarval rearing tanks and algal culture tanks.

The materials used for construction vary depending on the nature of site and the availability of materials. Depending on the scale of operations and the desired longevity / durability of the facilities, the tanks may be consitructed with any one of the following materials:

a) Plastic lined with Aluminium frame : Usually used for small - scale operations; longevity minimal.

b) Fibreglass Reinforced Plastics: Portable, longevity high; can be used for small - scale operations.

c) Concrete hollow blocks: Cheap and easy to install; permanent installation; can be used for large-scale operations.

d) Reinforced concrete: More expensive than hollow blocks; permanent installation; can be used for large-scale operations.

Concrete tanks should be coated with epoxy paint to provide smooth interior surface. This would prevent leaching of harmful chemicals into the tank and prevent the growth of pathogenic organisms which may flourish in the crevices of unpainted surface. All the angled parts of the tank should be rounded off to facilitate cleaning and minimise 'dead spots' in the tank.

The common shape of tanks is rectangular, circular or oblong. The rectangular tanks are preferable for permanent installations where the scale of operations may be expanded at a future date.

Reservoirs serve to provide the water needs of the hatchery during emergency when the pump is not in operation or when the water demand is much greater than the pump capacity over a relatively short period. They can also be used for chemical treatment of the seawater. The capacity of the reservoir depends on the nature of operation in the hatchery, pump capacity, the treatment measures used and the duration of the treatment.

An overhead tank can maintain continuous water supply to the different tanks by gravity. Absence of water supply from overhead tank to individual tanks will necessitate secondary pumping. The capacity of the overhead tank and its height depends on the actual water required per day, pump capacity and the dimensions of the pipeline.

Maturation tanks with a water capacity of 5 - 10 m^3 with 1 m effective water depth are suitable. Tanks should be housed in closed sheds under darkness to avoid disturbances from human movement.

Spawning tanks of 250 - 500 litre capacity may be used.

Larval and postlarval rearing tanks of 10 - 50 m^3 capacity with effective water depth ranging from 1 - 1.5 m should be housed in a shed with reduced light conditions to prevent heavy growth of algae.

Algal culture tanks of 1 - 10 m^3 capacity may be used depending on the scale of hatchery operation and the daily requirements. The effective water depth should not be more than 1 m to allow light penetration through the whole water column. Tanks of 5 - 10 m^3 capacity are more suitable for small - scale operations and tanks of higher capacities for large - scale operations.

3.5 Hatchery building and other facilities :

In the sub-tropical climatic conditions, the hatchery building need not be as elaborate as that located in temperate areas. The building need not be totally enclosed. Roofing is necessary to shield the larval rearing tanks from direct sunlight and rain. Walls may be necessary in areas where there is heavy cold draft wind.

The building should provide space for the living quarters of technicians, phycology laboratory, feed preparation room, laboratory for water quality and biological analyses and a packing room. Pumps and filtration units in the seaward side and blowers and generators on the landward side should be located in separate buildings.

The lay-out of the various units of the hatchery should be made in such a way that there is sufficient space for easy movement, optimal use of water and air supply system.

4. INDUCED MATURATION

There are three different ways by which a hatchery can obtain nauplii for rearing. One is to capture fully matured and impregnated spawners from the wild and spawn them in the hatchery.

The second is to procure adult immature females from the sea and induce them to mature through eyestalk ablation. The third approach is to mature and spawn adult shrimp that have been reared in captivity. Shrimp hatcheries around the world continue to be heavily dependent on wild spawners since the quality of the eggs and larvae are high from such spawners. The prevalence of viral pathogens in the wild stock has made the development of disease free captive broodstock an essential requirement for sustainable shrimp farming.

Males of *P. monodon* weighing above 40 g are found to mature in estuarine water while females do not mature. The female maturity is governed by neuro hormones secreted by the X organ situated in the eye stalk and thoracic ganglion. The gonad inhibiting hormone (GIH) is secreted by the X organ and stored in the sinus gland for release, whereas the gonad stimulating hormone is secreted by the thoracic ganglion. The GIH appears to be very active in estuarine and captive conditions thereby preventing maturation. Removal of one eyestalk helps to reduce the level of gonad inhibiting hormone and accelerates ovarian development. This method of unilateral ablation was successfully used to induce maturation and spawning of captive penaeid shrimps.

4.1 Selection of females

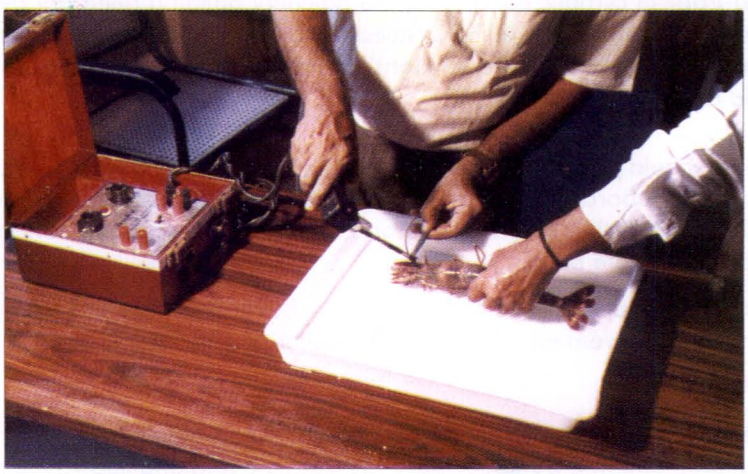
Hard shelled, healthy intermoult female shrimps free from disease or injury having spermatophore in the thelycum should be selected for eyestalk ablation. The females should be above 100 g in size for ensuring good quality eggs. Eyestalk ablation is to be avoided for newly moulted and ready to moult female shrimps.

4.2 Eyestalk ablation

Unilateral eyestalk ablation is done by any one of the following methods.

a) Cutting
b) Incision and pinching
c) Electrocauterisation

Cutting is done by complete removal of an eye with eyestalk using a sharp instrument. Incision and pinching is done by making an incision on the eyeball using a sharp blade and squeezing out the contents of the eyeball. Electro cauterisation is done by cutting the eyestalk using cautery apparatus. Electrocauterisation is the best way of ablating the eyestalk since it causes minimum stress. Ablation should be done as quickly as possible to minimise the stress. After ablation, the females should be released into the maturation tanks kept in a closed shed.



Eyestalk ablation using electrocautery apparatus

4.3 Stocking

The ablated female shrimps are stocked in the maturation tanks along with unablated males @ 4 no./m^2. Stocking of females and males in the ratio of 2: 1 ensures the best mating success.

4.4 Feeds and Feeding

It is essential to feed the ablated shrimps with quality feeds since the fecundity and quality of eggs depend on the quality of feed given.

Fresh feeds such as the flesh of clam (*Meritrix casta*), mussel (*Perna viridis*) and squid (*Loligo sp.*), polychaete worms and *Artemia* biomass rich in long chain poly unsaturated fatty acids are used as maturation feeds. Clam, squid, mussel, and oyster meat is given on rotation @ 15 % of the total biomass and distributed 4 times in a day, while polychaete worms (6% of the biomass) or *Artemia* biomass (3% of the biomass) is given once in a day.

Research on the nutritional requirement of penaeid shrimps showed that polyunsaturated fatty acids (PUFA) such as arachidonic acid, eicosapentaenoic acid and docosahexaenoic acid are essential for the shrimps to attain maturity. Therefore, pelleted feeds with 50 % protein and 10 % PUFA are to be provided to achieve the desirable results. The best results can be obtained by using fresh feeds along with pellet feeds.

4.5 Environmental conditions

The physical and chemical quality of seawater and light intensity exert a strong influence on the maturation process. Optimum environmental conditions required for maturation of captive females of *P.monodon* are given below.

4.6 Seawater quality

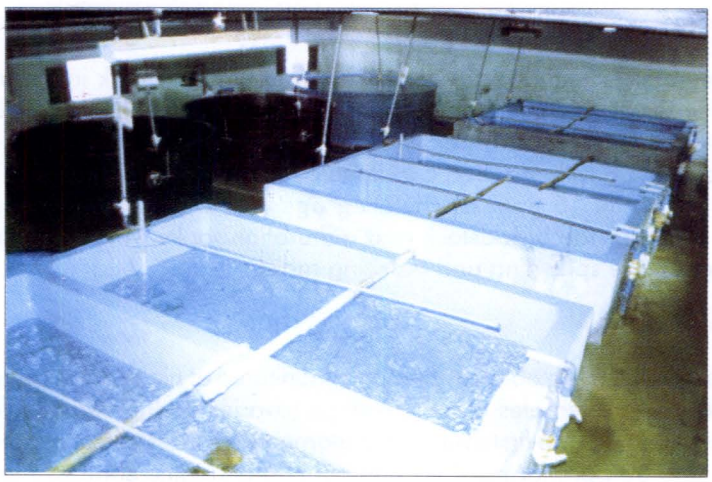
The seawater obtained either from sea or from a bore well sunk in the intertidal zone is pumped into reservoir where it is treated with calcium hypochlorite or sodium hypochlorite depending on the turbidity, vigorously aerated to expel chlorine and allowed to settle for 6 -12 hours. The residual chlorine is neutralised with required quantities of sodium thiosulphate and passed through sand filters. EDTA is added @ 10 ppm as chelating agent. The clean seawater passed through fabric filters is finally used for the broodstock and maturation tanks while that passed through 5 micron cartridge filters for the spawning and hatching tanks.

4.7 Monitoring of spawners

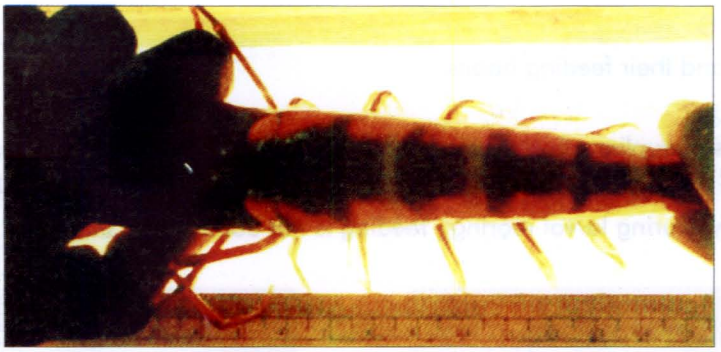
Ovarian development in the ablated shrimps is monitored at night/dawn using an underwater light 3 days after ablation. The females in mature stage (ovaries dark green in colour with distinct diamond - shape clearly visible at the first abdominal segment) are transferred to individual spawning tanks after treatment with 50 ppm formalin for one hour. The ablated shrimps mature and spawn repeatedly 3-5 times during intermoult period and remain productive for 50-60 days. It is essential to check the health condition of the broodstock at regular intervals.

Optimum conditions for maturation of *P. monodon* in captivity

Housing	Ventilated roofed shed
Tank size	5-15 circular or rectangular made of fibre glass or concrete
Light intensity	Reduced, 100 lux (artificial) dim light
Light quality	Blue or green
Photoperiod	12 hours light : 12 hours dark
Water depth	80 - 100 cm
Water quality	
Salinity	30-36 ppt
pH	8.0-8.5
Dissolved oxygen	Saturation by continuous aeration
Stocking rate	4 /m ^{2}
Stocking size	Females 90 - 180 g ; Males 60 - 90 g
Sex ratio	2 Females : 1 male
Water management	100 % exchange/day using filters; 200 % exchange by flow through system per day.
Feeds (Fresh)	Clam, mussel, squid & oyster meat @ 15 % of the total biomass/day, polychaete worms @ 6 % of the total weight or *Artemia* biomass @ 3 % of the total biomass
Artificial (Pellet)	2 % of the total biomass per day
Feeding schedule	Four times in a day



Broodstock maturation facility



Fully mature *P.monodon*

4.8 Spawning and hatching

The mature shrimps are transferred @ 1 shrimp/tank into the spawning tanks (500 l capacity) filled with filtered seawater and provided with gentle aeration. Spawning usually takes place in the early morning hours. The eggs are released from the gonophores, simultaneously a portion of the contents of spermatophore is ejected out of the thelycum. Fertilisation is external. The spent spawners are returned to the maturation tank. The eggs are siphoned out, cleaned with seawater and transferred to a 4 l capacity basin. After thorough mixing, two 10-ml samples are taken and the number of eggs present are counted and computed the number to the total volume of water to get the total number of eggs released per spawning. About 100 eggs are examined under a microscope to determine the quality of eggs.

Wild females have a fecundity of 2,00,000 to 10,00,000 eggs depending on the size of the shrimps with an average of 4,00,000 eggs/female. But ablated females of 90 - 150 g spawn 1,00,000 to 5,00,000 eggs with an average of 2,00,000 eggs/shrimp. The fecundity and the quality of eggs gradually decrease with repeated spawning. Egg size appears to be a critical factor for survival and growth of the larvae.

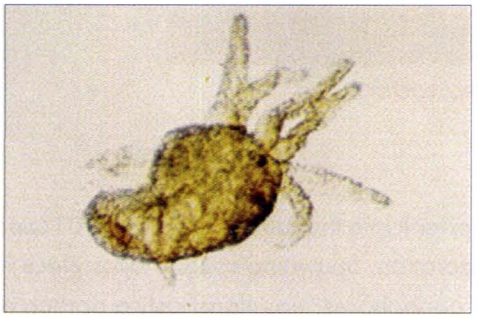
The eggs from each spawning tank are transferred into another tank containing 300 l of filtered seawater and provided with gentle aeration. The eggs hatch out into nauplii in 12 - 17 hours after spawning, depending on the water temperature. The production of nauplii for each spawning is estimated by counting four 100 ml random aliquot samples and this number is multiplied by the to the total volume of water to get the total number of nauplii.

5. LARVAL REARING

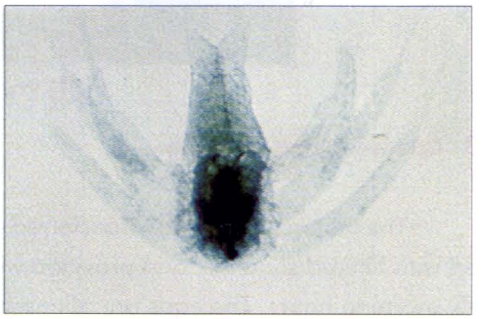
5.1 Larval stages and their feeding habits

5.1.1 Nauplius

There are six naupliar sub-stages in penaeid shrimps. These stages pass through six moultings within a period of 24 – 36 hours. The nauplius does not have mouth and subsists on the yolk present in the body. During larval rearing, feeding is not done at this stage.



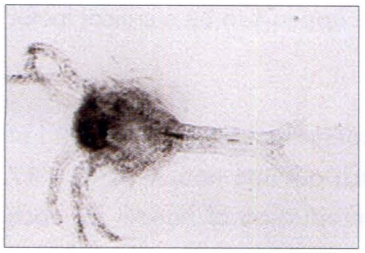
Freshly hatched nauplius



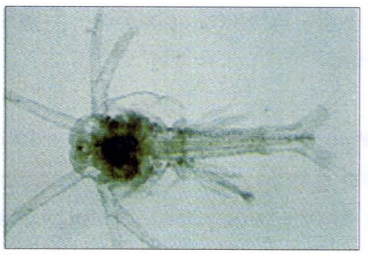
Naplius – 6th stage

5.1.2 Zoea

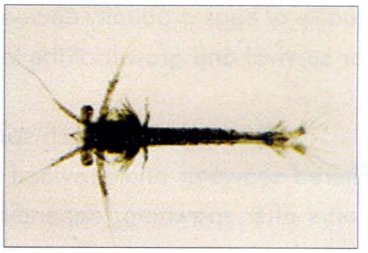
There are three sub-stages of zoea, following three moultings. Zoea are filter feeders and they consume particles of 5 micron size. As they grow and metamorphose, the size of the feed particles ingested also increases. Unicellular diatoms and algae are the most suitable feed for this stage. In hatcheries, unicellular algae such as *Chaetoceros calcitrans, Skeletonema costatum, Tetraselmis sp. and Isochrysis sp.* are used as feed.



Zoea I



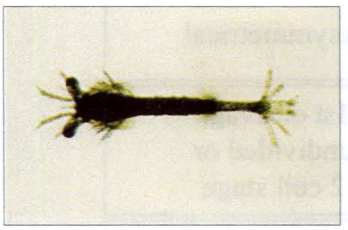
Zoea II



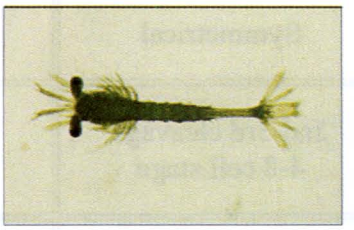
Zoea III

5.1.3 Mysis

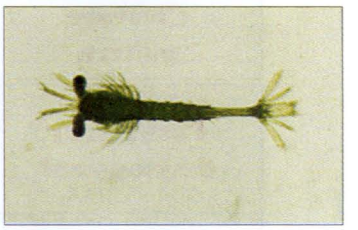
There are three sub-stages in mysis. Mysis generally feed on zooplankton in the natural conditions. In hatcheries, freshly hatched *Artemia* nauplii are used along with the unicellular algae as feed for mysis stage.



Mysis I



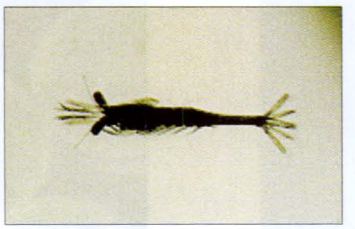
Mysis II



Mysis II

5.1.4 Postlarvae

Postlarvae resemble the adult in all characteristics and they are omnivorous. In hatcheries, they are fed with *Artemia* nauplii and other suspension diets especially of *Artemia* biomass or clam meat.



Postlarva

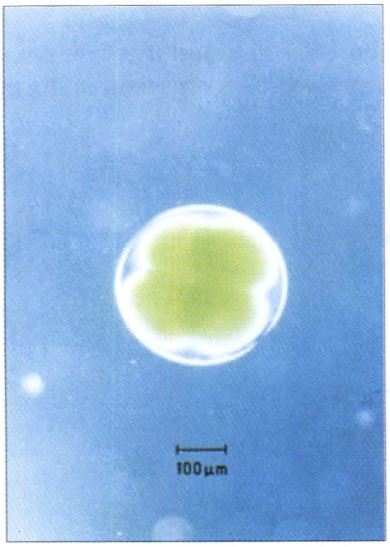
5.2 Hatchery operation

5.2.1 Collection and disinfection of eggs

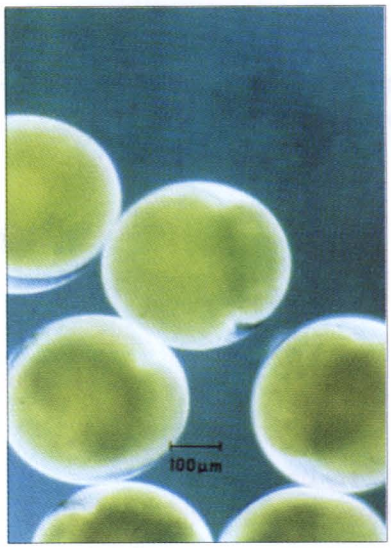
The occurrence of spawning is associated with the release of spawning scum, which floats on the surface as well as attaches on the sides of the tank. The eggs are demersal in nature and settle at the bottom. The eggs start development immediately and the quality of the eggs is assessed by microscopical examination. Based on the developmental criteria they are classified into normal, abnormal and unfertilised. When the percentage of normal eggs are less than 50%, the eggs can be discarded.

Differences between fertilised and unfertilised eggs

Characteristics	Fertilised egg	Unfertilised egg
Cleavage pattern	Symmetrical	Asymmetrical
Post-1 hour development	2nd-3rd cleavage 4-8 cell stage	1st cleavage undivided or 2 cell stage
Other	Rapid cell division after 1st cleavage	Erratic cell division after 1st cleavage



Fertilized egg



Unfertilized egg

The total number of eggs spawned is estimated using random sampling method. The eggs are uniformly disbursed by thorough mixing of water and a random sample of 100 ml is collected in a beaker. The eggs present in the sample are counted manually and the total number is estimated using the following formula:

$$\text{Total No. of eggs} = \frac{\text{No. of eggs in the sample} \times 1000 \times \text{Total volume of water in tank in litre}}{\text{Volume of sample (100 ml)}}$$

The eggs should be kept in a healthy environment to ensure normal development. To achieve this, the eggs should be separated from the spawning scum and washed repeatedly in fresh sea water. Collection of eggs is done using a specially made, double chambered collection tub by stopping aeration and allowing the eggs to settle at the bottom of the tank. The settled eggs are siphoned into the central chamber of the collection tub. The central chamber is provided with windows made of 100 micron velon net, which allows the waste materials to pass through to the outer chamber, but retains the eggs. The collected eggs are disinfected by dipping for a minute in 10 ppm formalin and then dispersed in fresh sea water for hatching. Gentle aeration is maintained.

5.2.2 Collection of nauplii

The eggs hatch out into nauplii within 10 - 14 hours after spawning, depending on the water temperature. The hatching will be quicker, if water temperature is above 28°C and will be delayed, if water temperature is below 28°C.The total number of nauplii hatched out is estimated by counting random samples as in counting the eggs. Nauplii are collected and stocked in larval rearing tanks for further rearing. The healthy nauplii are collected using their phototactic behaviour. Along with aeration, a strong source of light is provided at the surface. Healthy nauplii swim towards the light source and congregate at the surface and they are siphoned out.

The nauplii are also washed thoroughly, disinfected by dipping in 10ppm formalin for a minute and then stocked in larval rearing tanks.

5.2.3 Stocking

While stocking the nauplii in larval rearing tanks or PL-5 in nursery tanks, care should be taken to avoid sudden changes in environmental conditions. The larvae must be given sufficient time to gradually adapt to the new conditions to avoid stress and consequent mortality. At the larval rearing phase, nauplii are stocked at 50 - 100 nos./l. Stocking in lower densities is less risky due to lower incidence of disease. At the nursery rearing phase, PL-5 are stocked at a density of 10-30 nos./litre. In some hatcheries larval rearing and nursery rearing are carried out in the same tanks after thinning the population at postlarval stage.

5.2.4 Water quality management:

During the course of larval rearing, there is build up of metabolites in the rearing water from unconsumed feed, faecal matter, excretion of ammonia and dead larvae. The levels of ammonia and nitrite should be low so as to avoid stress to the larvae. This can be achieved by replacing the rearing water with fresh filtered seawater.

In high-density culture (80-100 nos./liter), water change is done daily starting on the second day of the first protozoeal substage. About 30% of the water is changed at the protozoeal stage and 50% at the mysis and postlarval stages. However, water change is avoided at lower levels of stocking

density (50-75 nos./l) and only filling is practised. This type of water management is fully dependent on the water quality at the source and the requirements of the species reared.

During water exchange, water from the rearing tanks is drained at first through specific net filters so as to allow the waste materials to pass through and retain the larvae. Different mesh sizes are used depending on the size of the larvae. The mesh sizes generally used are: protozoea - 100 microns; mysis - 150 microns; and postlarvae - 200 - 500 microns. In smaller tanks, draining is done through siphoning with net filters, while it is effected through standpipes covered with suitable mesh screens fixed in the outlet pipe in larger tanks. The temperature and salinity of the water before and after water change must not differ more than 1°C or 2 ppt, respectively.

Sedimentation of dead algae and faecal matter result in the fouling of the tank bottom. Such sediments should be removed once in three days, during the course of larval rearing, by siphoning out from the bottom.

5.2.5 Feeding schedule and feed management

The nauplius has yolk stored in its body and hence does not require food. Penaeid shrimp larvae start to feed from the first protozoeal stage onwards. Unicellular algae such as *Skeletonema*, *Chaetoceros or Tetraselmis* can be used for feeding the protozoea. Since the larvae are filter feeders and do not seek feed actively, the required density of the algae should be maintained in the rearing medium. Algae or diatoms are cultured in separate tanks and the required quantity is added to the larval rearing tanks. The quantity and quality of the feed is very important for good growth and survival. Low quality feed will prolong moulting duration, while insufficient feed may result in mortality of the larvae. The volume of algal culture water (VF) to be added to the larval rearing tanks depends on the

a) existing density of algae in the tank (ID),

b) desired density in the larval rearing tank (DD),

c) density in algal culture tanks (AD) and

d) volume of water in the larval rearing tank (V).

It is computed using the following formula:

$$VF = \frac{(DD - ID) \times V}{AD}$$

The density of algae in the larval rearing and algal culture tanks are estimated microscopically using Haemocytometer and it is expressed as cells/ml. Constant monitoring of the quantity of feed in larval tanks is essential to avoid under feeding/ over feeding. Well - fed protozoea will have long trailing faecal strands attached to them.

Animal protein is essential at the mysis stage of penaeid shrimp when they generally consume zooplankters along with phytoplankters. Freshly hatched *Artemia* nauplii are the best food for the mysis and postlarvae and they are widely used in shrimp hatcheries. Artificial microparticulate diets are also used during mysis and postlarval stages.

The feeding schedule generally followed in penaeid shrimp hatcheries is given below:

Days	0	1	2	3	4	5	6	7	8	9	10	12	15	20	30
Larval stages	Nauplius			Protozoea					Mysis				Postlarva		
Feeding schedule															
Algae/Diatoms				20 - 50,000 cells/ ml											
Artemia nauplii									3 - 5 no/ml				2-5 no /ml		
Suspension Pellet feed														5 - 10 g/t/day in small doses	

The general water and feed management measures followed in a 5 tonne larval rearing tank for *Penaeus monodon* are given in the following table:

Days	Stage	Water drained (lit)	Algal feed added (lit)	*Artemia* nauplii (no./ ml)	Particulate feed (g/ t/day)	Sea water added (lit)	Tota Volume of water in tank (lit)
1	N-2	-	-	-	-	2000	2000
2	N-5	-	300	-	-	700	3000
3	PZ-I	-	300-400	-	-	1600-1700	5000
4	PZ-II	2000	300-400	-	-	1600-1700	5000
5	PZ-III	2000	300-400	-	-	1600-1700	5000
6	M-1	2000	300-400	3-5	-	1600-1700	5000
7	M-2	2000	300-400	3-5	-	1600-1700	5000
8	M-3	2000	300-400	3-5	-	1600-1700	5000
9	PL-1	2500	200-300	2-5	-	2200-2300	5000
10	PL-2	2500	200-300	2-5	-	2200-2300	5000
11	PL-3	2500	200-300	2-5	5-10	2200-2300	5000
12	PL-4	2500	200-300	2-5	5-10	2200-2300	5000
13	PL-5	2500	200-300	2-5	5-10	2200-2300	5000

5.3 Nursery management:

The nursery phase consists of rearing the early postlarval stage to the older and, presumably more hardy and tolerant stage. In the hatchery, nursery rearing usually refers to the period from PL5 to PL20 and normally done in outdoor tanks.

Feeds during the nursery phase include squid or mussel meat, raw trash fish, egg custard, *Artemia* nauplii or adults and formulated diets. Feeds are either broadcasted over the tank or placed on feeding trays.

A Substrate such as nylon netting is usually installed in the nursery tanks to provide surface for the postlarvae, especially those of tiger shrimp (*Penaeus monodon)* to cling, and ensures shelter and protection from cannibalism during moulting, and provides surface area on which food organisms can grow on.

5.4. Harvesting, packing and transport:

Harvesting of larvae/ postlarvae should be done carefully so as to avoid any stress to them. It is done by draining the water through the filter nets placed in large containers, so that the retained larvae remain in water. The larvae collected in the net are removed periodically to other containers to avoid over crowding.

Packing is done in polythene bags under oxygen. The volume of water used for packing and the packing density depend on the duration of transport and the stage and size of the larvae. A packing density of 200 to 500 larvae per liter is advisable with about 5 liters of water per bag. Long distance transportation should be done under reduced temperature by placing the bags in cartons lined with thermocole.

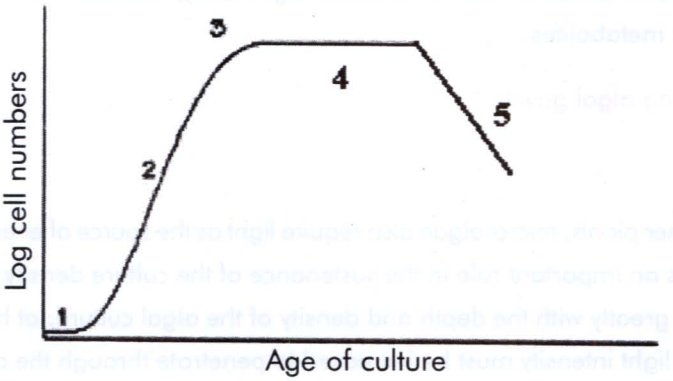
6. ALGAL CULTURE

Shrimp hatcheries that use unicellular algae as feed for zoea and mysis should have an algal culture section in the hatchery for the production of required quantities of algae. Algal culture, in itself is a specialized work since it requires continuous maintenance of the system without any contamination. Algal culture requires two basic facilities for its continuous maintenance. They are (a) Axenic or pure culture room and (b) Outdoor culture facilities. Isolation of the required species is first done through serial dilution method in the pure culture room which is provided with required level of light intensity and temperature.

6.1 Algal growth dynamics

Algal growth follows a curve with five distinct phases. 1. Lag or induction phase, 2. Growth or exponential phase, 3. Phase of declining relative growth, 4. Stationary phase, and 5. Death phase.

Growth curve of algae



1) Lag or induction phase

In this phase, during which the algal culture is transferred from a culture plate to liquid culture, minimum increase in cell density occurs. It is relatively of longer duration. The lag in growth is attributed to the physiological adaptation of the cell metabolism to growth.

2) Exponential phase

During the second phase, the cell density increases as a function of time. The specific growth rate is mainly dependent on the species of algae, light intensity and temperature.

3) Phase of declining growth

The cell division slows down when nutrients, light, pH, carbon dioxide or other physical and chemical factors begin to limit growth.

4) Stationary phase

In the fourth stage, the limiting factor and the growth rate are balanced, which results in a relatively constant cell density.

5) Death or "crash" phase

During the final stage, water quality deteriorates and nutrients are depleted to a level incapable of sustaining growth. The cell density decreases rapidly and the algal culture eventually collapses.

The key to the success of algal production is maintaining all cultures in the exponential phase of growth. Moreever, the nutritional value of the produced algae becomes inferior once the culture is kept beyond phase 3 due to reduced digestibility, deficient composition and possible production of toxic metabolites.

6.2. Factors affecting algal gowth

6.2.1 Light

Like in higher plants, micro-algae also require light as the source of energy for photosynthesis. Light intensity plays an important role in the sustenance of the culture density. The requirements of light intensity vary greatly with the depth and density of the algal culture; at higher depths and cell concentrations the light intensity must be increased to penetrate through the culture (*e.g.* 1,000 lux is needed for conical flasks; 5,000-10,000 lux is required for larger volumes). Light source may be either natural or from fluorescent tubes. The duration of artificial illumination should be kept at a minimum 18 hours of light per day, although cultivated phytoplankton develop normally under constant illumination.

6.2.2 pH

The pH range for most of the cultured algal species is between 7 and 9. The optimum range is 8.2-8.7. pH generally increases with increase in cell density which can be maintained within the acceptable limits by aeration. Addition of carbon dioxide to the culture flask will also help in maintaining the pH.

6.2.3 Aeration/ mixing

Continuous aeration is necessary to prevent settling of the algae and to keep the cultured algae uniformly exposed to light and nutrients. Aeration also helps in improving the CO_2 exchange between the culture medium and air.

6.2.4 Temperature

The optimal temperature required for phytoplankton culture generally ranges between 20 and 24°C, although this may vary with the composition of the culture medium, the species and strain. The commonly cultured species of micro-algae tolerate temperature ranging between 16 and 27°C. Temperature lower than 16°C will slow down growth, whereas those higher than 35°C are lethal for a number of species. Pure cultures should therefore be maintained in air-conditioned rooms.

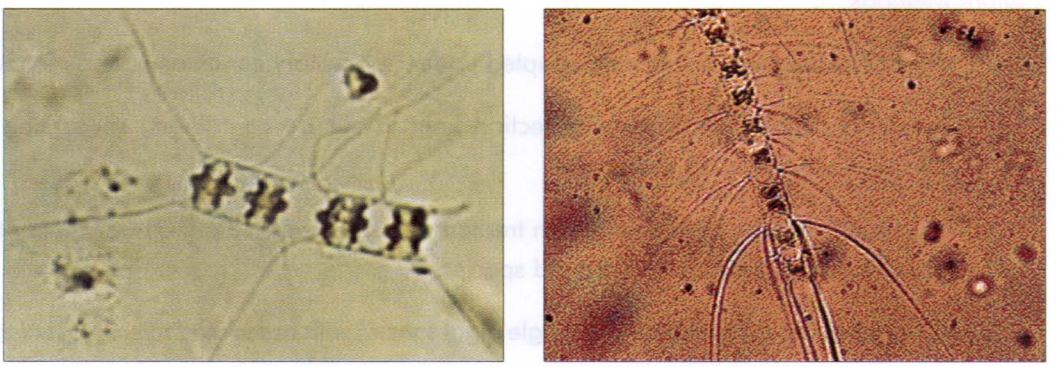
6.2.5 Salinity

Marine phytoplankton are extremely tolerant to changes in salinity. Most species grow best at a salinity that is slightly lower than that of their native habitat, which can be obtained by diluting sea water with tap water. Since the algae are to be fed to shrimp larvae maintained in sea water, it is advisable to culture the algae in waters of same salinity.

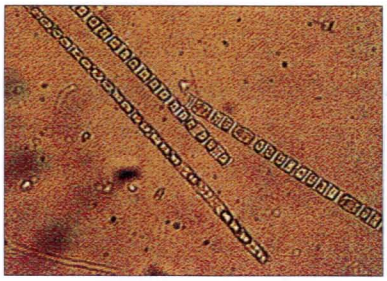
6.3 Algal species suitable for rearing shrimp larvae

The size and the nutrient quality of the algae are very important criteria for selecting the algal species for use in the shrimp hatchery. It is always better to choose endemic species from the local ecosystem as they will be adaptable to the water quality conditions. For penaeid shrimp larvae, the following four species have been found to be suitable.

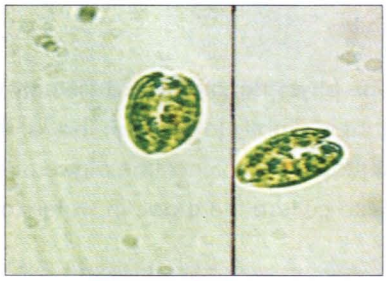
Species	Family/Class	Size range (in micron)
Chaetoceros sp. *(unicellular)*	Bacillariophyceae	5 – 6
Skeletonema costatum	Bacillariophyceae	4 – 15
Isochrysis sp.	Haptophyceae	3.5 – 4.5
Tetraselmis chuii	Flagellate	5 - 15



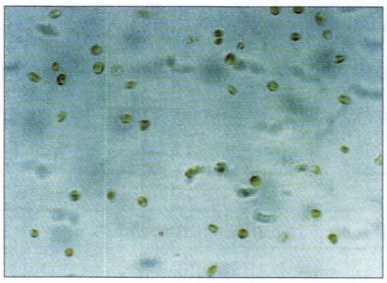
Chaetoceros sp. (single cell and filamentous)



Skeletonema sp.



Tetraselmis sp.



Isochrysis sp.

6.4. Culture Methods

The phytoplankton culture methods adopted under laboratory conditions are as follows:

a) Maintenance culture: Natural collection kept in culture containers; succession of dominant species takes place.

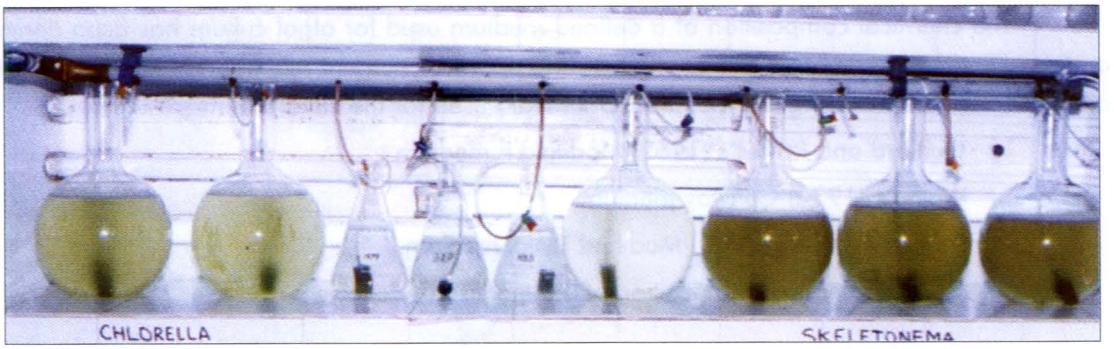
b) Enrichment culture: Crude collection treated with selected media that may favour the rapid increase in number of desired species.

c) Uni-algal culture: Population of a single algal species with associated micro-organisms.

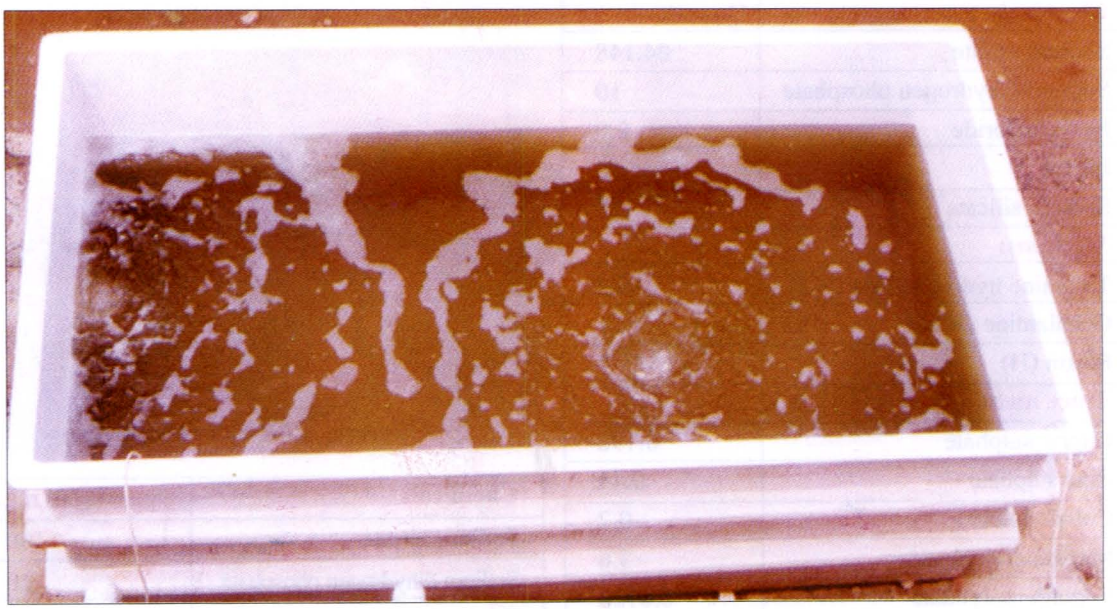
d) Axenic culture: Population of a single algal species without any other living organism.

e) Clonal culture: Population of organisms descended asexually from single individual.

In shrimp hatcheries the cultures are mainly maintained as axenic cultures in indoor temperature controlled rooms. Mass culture is done for large scale requirements in outdoor tanks.



Axenic culture



Outdoor mass culture

6.5. Nutrient media

Algae are generally cultured at a high density and the nutrients available in the water will not be sufficient for sustaining such high density culture. For proper growth and propagation, phytoplankton require a number of mineral elements classified as macro nutrients (N,P,S,K, Mg) and micro nutrients (Fe, Mn, Cu, Zn, Mo, Sl). These mineral elements are added to seawater (enriched seawater media) or distilled water in sufficient amounts. In addition, vitamins are also added to the axeninc culture. Although artificial seawater media yield constant results in algal culture, enriched seawater media are preferred, as they are cheaper and simpler.

The chemical composition of a defined medium used for algal culture has been derived and modified from basic formulations depending upon the nutrient requirement of the cultivated algal species. The following are the important media used for the culture of micro-algae

a) Guillard and Ryther's (1962) Modified F medium

b) Walne's (1974) Conway medium

c) Liao and Huang (1970) Modified TMRL medium

The chemical composition of the media are follows :

Guillard and Ryther's Modifed 'F' Medium

Chemicals	Quantity in mg.
Sodium nitrate	84.148
Sodium dihydrogen phosphate	10
Ferric chloride	2.9
EDTA	10
Sodium silicate	12
Vitamins:	
Thiamine hydrochloride (B 1)	0.2
Cobalamine (B 12)	1
Biotin (H)	1
Trace metals:	
Cupric sulphate	0.196
Zinc sulphate	0.44
Cobalt chloride	0.2
Manganese chloride	3.6
Sodium molybdate	0.0126
Sea water	To 1 litre

Walne's Conway medium

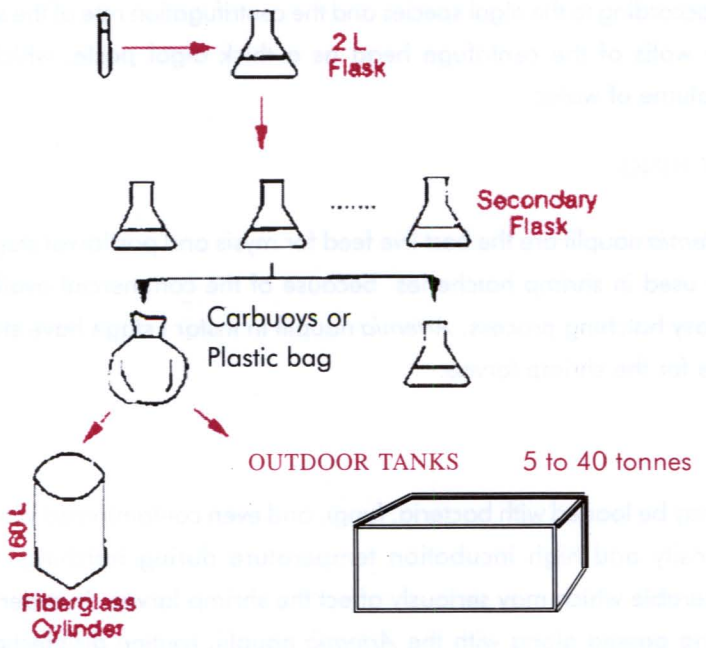
Chemicals	Quantity in mg.
Sodium nitrate	100
Sodium dihydrogen phosphate	20
Ferric chloride	1.3
EDTA	45
Boric acid	33.6
Manganese chloride	0.36
Vitamins:	
Thiamine hydrochloride (B 1)	0.1
Cobalamine (B 12)	0.005
Trace metals:	
Cupric sulphate	0.02
Zinc chloride	0.021
Cobalt chloride	0.02
Ammonium molybdate	0.009
Sea water	To 1 litre

Liao and Huang's modified TMRL medium

Chemicals	Quantity in mg.
Potassium nitrate	100
Sodium mono hydrogen phosphate	10
Ferric chloride	3
Sodium silicate	2
Seawater	To 1 litre

6.6 Scaling - up of culture

Stock solutions of pure cultures are maintained in un- aerated smaller containers of 50 - 100 ml. Scaling - up of volume is done according to demand. Before scaling - up, cultures are examined for contamination and a new seed or starter is selected for a new batch, based on cell quality. Transfer is always done when cultures are at lag phase of growth. The flow - through for scaling up is presented below:



The volume of starter culture depends upon the species, the capacity of culture tank and the time of requirement. Usually diatoms require little inoculum compared to green algae. The volume of inoculum needed for large scale culture is around 10 - 20 % of the total volume of the culture tank.

Continuous culture system is usually adopted for smaller culture volumes (300 l or less). For larger volumes (500 l to 10 tonnes) semi-continuous culture system is adopted. This is also called sustenance culture. A portion of the culture is withdrawn at certain periods and replaced with an equal amount of seawater and nutrients to retain the original culture volume.

6.7 Harvesting and feeding

In normal circumstances, there is no need to separate the algae from the medium of culture. Hence feeding is done directly by adding the required volume of culture water to the larval rearing tanks. In case where the culture density is poor and a large volume of culture water is to be added, it is better to concentrate the algae before feeding to avoid pollution of the nutrients in the culture water. This could be done by flocculation or by centrifugation. Flocculation is done by increasing the pH or by addition of some chemicals. Before feeding the algae the flocculated mass should be re-suspended by readjustment of pH to the original levels.

Centrifugation of large volumes of algal culture is usually performed using a cream separator; the flow-rate being adjusted according to the algal species and the centrifugation rate of the separator. Cells are deposited on the walls of the centrifuge head as a thick algal paste, which is then re-suspended in a limited volume of water.

7. ARTEMIA CYST HATCHING

Freshly hatched, *Artemia* nauplii are the best live feed for mysis and postlarval stages of the shrimp. It is predominantly used in shrimp hatcheries because of the commercial availability of cysts and also due to their easy hatching process. *Artemia* nauplii in instar I stage have stored yolk which is nutritionally suitable for the shrimp larvae.

7.1 Disinfection of cysts

Artemia cyst shells may be loaded with bacteria, fungi, and even contaminated with organic impurities. At high cyst density and high incubation temperature during hatching, bacterial development can be considerable which may seriously affect the shrimp larvae. In order to avoid bacterial contamination being passed along with the *Artemia* nauplii, routine disinfection of the cysts with hypochlorite is essential. Cysts are dispersed in water at 50 g/l and soaked with the addition of 200 ppm hypochlorite solution for 30 minutes. After disinfection, the cysts are colleted in a nylon net (125 micron mesh) and washed in fresh seawater. The washed cysts are dispersed @ 5 g / l in hatching containers containing fresh and filtered sea water.

7.2 Decapsulation of cysts

After hatching, complete separation of *Artemia* nauplii from their shells is not always possible. Unhatched cysts and empty shells may cause harm to the larvae as they cannot be digested and may obstruct the gut. The hard shell that encysts the dormant *Artemia* embryo can be completely removed by short term exposure to a hypochlorite solution. This procedure is called decapsulation. Decapsulated cysts offer a number of advantages compared to the non-decapsulated ones:

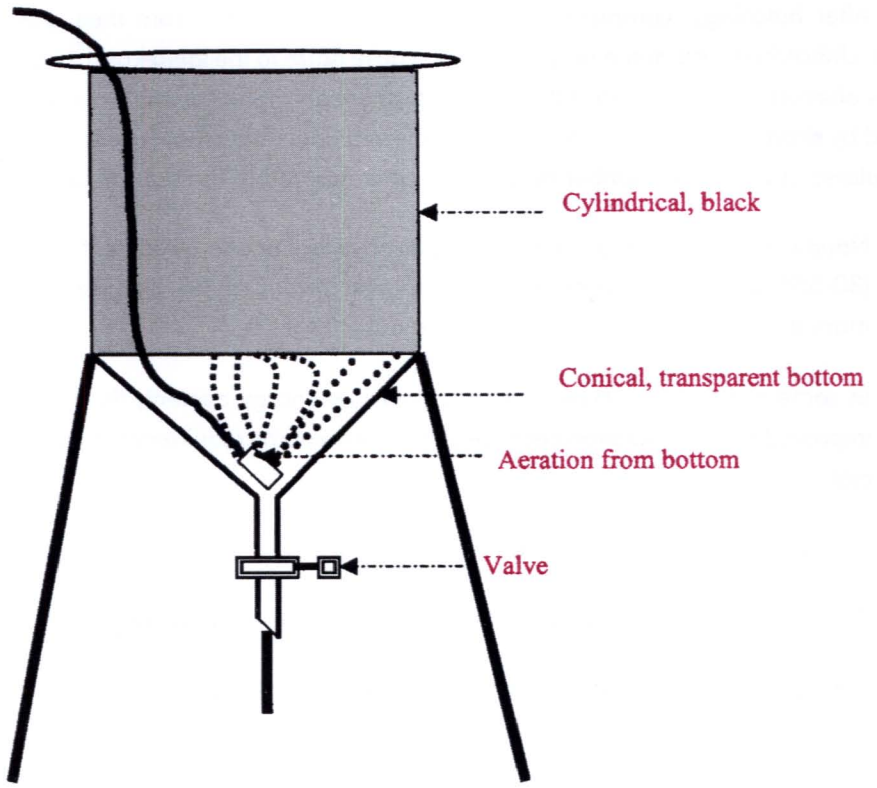
- Nauplii obtained from decapsulated cysts have higher energy content and individual weight (30-55%) depending on the strain than regular instar I nauplii, because they do not dispense more energy to break the shell to come out.
- In some cases where cysts have relatively low energy content, the hatchability might be improved by decapsulation because of the lower energy requirement to break a decapsulated cyst
- Decapsulation results in disinfection of the cyst.
- Decapsulated cysts can be used as a direct energy-rich food source for shrimp
- Low illumination is sufficient for hatching decapsulated cysts

Procedure

Decapsulation involves hydration of cysts by soaking them in seawater for 1 – 2 hours. The fully hydrated cysts are treated with decapsulation solution consisting of sodium hypochlorite (2 ppm) and 40% sodium hydroxide under aeration. The cysts turn into an orange colour indicating complete removal of the cyst wall. After decapsulation, the cysts are washed thoroughly and then disbursed in the hatching container.

7.3 Hatching container

Best hatching results are achieved in containers with a conical bottom and aerated from the bottom. Cylindrical or square-bottomed tanks will have dead spots in which *Artemia* cysts and nauplii accumulate and suffer from oxygen depletion. The top cylindrical portion of the tank should preferably be black and the bottom conical portion transparent. The valve is placed at the bottom for facilitating the harvest of nauplii.



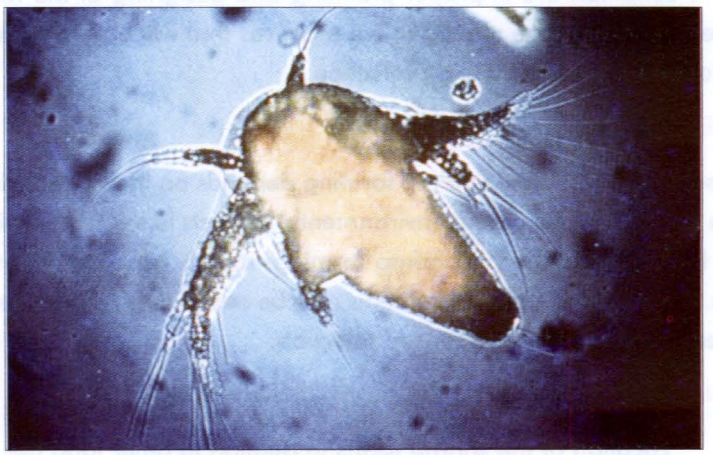
Artemia hatching tank

7.4 Hatching conditions

Hatching small quantities of cysts is a very simple procedure but when larger quantities to be are hatched as a routine activity in large shrimp hatcheries, the following conditions are to be adopted for better hatching rates :

- Dissolved oxygen should be above 2 ppm with optimum around 5 ppm.
- Temperature should be preferably in the range of 25 – 28°C. Temperature above 33°C will interfere with cyst metabolism
- Optimum hatching occurs in the salinity range of 5 – 35 ppt. Since *Artemia* nauplii are to be fed to shrimp larvae which are maintained in sea water, it is preferable to hatch them in sea water.
- pH should be above 8 for optimum hatching of cysts
- Cyst density of 5 g /l is optimal for smaller volumes of 30 – 40 litres. For larger volumes, the density should be reduced to 2 g/ l.
- A strong illumination (about 2000 lux at the water surface) is essential, at least during the initial period after complete hydration, in order to trigger embryonic development.

7.5 Harvesting and feeding



I Instar Nauplius

The hatched - out nauplii should be separated from the empty cysts before feeding. This is achieved by collecting the nauplii using their positive phototactic behaviour. By providing a strong source of illumination at the conical, transparent bottom of the hatching container, the nauplii can easily be concentrated at the bottom while the empty cysts will be floating at the surface. The concentrated nauplii can be collected through the outlet valve at the bottom.The collected nauplii may be directly fed to the shrimp larvae.

PART - II

SHRIMP FARMING TECHNOLOGY

1. INTRODUCTION

The shrimp farming sector is a high potential sector with an enormous scope for increasing the foreign exchange and employment generation for a developing country like India and it needs to be made sustainable with social acceptability, equity, economic viability, technical appropriateness, environmental soundness and conservation of resources. Brackishwater aquaculture in India is synonymous with shrimp farming , with the major contribution made by *Penaeus monodon.* Presently, out of 1.2 million ha of brackishwater area available for development, about 150,000 ha is under shrimp farming with a total production of about 115,000 metric tonnes of shrimps. In 2001-2002, shrimps contributed about 128,000 metric tones for export worth Rs. 41,320 million. Among the total shrimps exported, shrimps from culture contributed nearly 85% of the total value i.e., Rs. 36,450 million.

However, the shrimp farming sector in the country today is facing serious problems of disease outbreaks and consequent reduction in production levels. The major factors responsible for the present condition are improper planning and designing of the farms, lack of awareness among farmers regarding the management practices that will ensure sustainable production with due consideration for environmental protection.

2. SITE SELECTION

The success or failure of shrimp farming depends on the local environmental conditions at the site of the farms. The social and environmental impacts like soil and drinking water salinisation and nutrient loading attributed to shrimp farming, mainly arise due to improper location of the shrimp farms. A vast majority of the problems may be avoided by proper site selection. The following criteria are recommended for proper site selection:

2.1 Location of the site

Location of the shrimp farms in relation to other land use and human habitation assumes greater importance in view of the various social conflicts reported due to shrimp farming. The following aspects should be considered while deciding on a suitable site for shrimp farming.

- Mangrove forests play a very important role in the coastal ecosystem. They are a source of livelihood for the coastal population. They protect the coastal settlements. They also serve as a habitat for a variety of marine organisms. Hence, destruction of mangroves for any purpose will cause adverse social and environmental impacts. Further mangrove areas are generally acidic in nature and are not suitable for shrimp farming. In view of these facts, shrimp farms should not be located in the mangrove forest area.

- Similarly, shrimp farms should not be located near ecologically sensitive areas like marine parks and sanctuaries to avoid any disturbance to such fragile ecosystems.

- Establishment of shrimp farms by converting productive agricultural lands and salt pans will cause social problems since these are essential commodities for human beings and involve the livelihood of many farmers. Use of unproductive agricultural lands located in the tail end of the river systems may be used for setting up the shrimp farms, but only after it is re-classified by the concerned Government authorities/ agencies.

- The nearness of shrimp farms to various other land use may have some negative impacts due to water seepage. To avoid such salinisation impacts, buffer zones should be provided in such areas depending on the soil conditions. Sandy and/or porous soils should be avoided.The extent of buffer zones required is given below.

Land use	Buffer zone
Agriculture/ Horticulture	50 – 100 m
Human settlement	100 – 300 m
Freshwater/ Drinking water source	100 – 200 m
Major towns/ Heritage areas	1 – 2 km

- Locating shrimp farms close to one another prevents access to the traditional users of the water front. Hence it is advisable to leave enough space between the farms for free access to the water front. Smaller farms of 2-5 ha should leave a minimum area of 20 m between the farms. Larger farms of above 5 ha should design their farm in clusters each of at least 5 ha., with free access provided between clusters.

- Shrimp farms should not be located on natural flood drains. Construction of shrimp farms adjoining each other without any space between them will lead to flooding of human habitations.

- Wherever the intake and outfall regions of farms are located together in the same creek, over crowding of the farms should be avoided.

2.2. Soil quality

Soil is the most important component in a culture system. The quality of soil should be ascertained for pH, permeability, bearing capacity and heavy metal content. Soil with pH below 5

should be avoided. Similarly soils with high concentrations of heavy metals should not be slected. The soil characteristics suitable for shrimp culture are :

Soil quality paramenters		Optional range
pH		7-8
Organic carbon (%)	-	1.5 to 2.5
Calcium carbonate (%)	-	>5
Available nitrogen (mg/100 g soil)		50 to 75
Available phosphorus (mg/100 g soil)	-	4 to 6
Electrical conductivity (mmhos/cm)	-	> 4

Generally clayey loam soils are preferred. Sandy soils are prone to seepage and will cause problems of salinisation of adjoining land and water resources. Further, maintenance of a farm in a sandy area needs high capital and operational costs. Hence, sandy areas should be avoided. The best farm site is the one which involves lesser capital investment for constructing fully drainable ponds.

2.3. Water quality

Availability of good quality water in sufficient quantity is one of the most important pre - requisite for sustainable aquaculture. While locating the farm site, a careful study should be made on the source of water, quality and quantity of water available during the different seasons. The optimal level of various water quality parameters required for the best growth and survival of cultured shrimps are presented below.

Water quality parameters	Optimal range
Temperature (°C)	28 to 33
Transparency (cm)	25 to 45
pH	7.5 to 8.5
Dissolved oxygen (ppm)	5 to 7
Salinity (ppt)	15 to 25
Total alkalinity (ppm)	200
Dissolved phosphorus (ppm)	0.1 0.2
Nitrate N (ppm)	< 0.03
Nitrite N (ppm)	< 0.01
Ammonia N (ppm)	< 0.01
Cadmium (ppm)	< 0.01
Chromium (ppm)	< 0.1
Copper (ppm)	< 0.025
Lead (ppm)	< 0.1
Mercury (ppm)	< 0.0001
Zinc (ppm)	< 0.1

2.4. Site elevation

Since drying of the pond bottom and proper water exchange form an integral part of the technology of shrimp farming, ponds that are drainable by gravity are desirable for a successful venture. Hence, the elevation of the site from the lowest low - water level of the supply creek should be considered while selecting the site. A minimum elevation of 0.45 to 0.6 m is essential to ensure proper drainage.

2.5 Hydro - meteorological parameters

The hydro - meteorological data (viz., rainfall, tidal fluctuation, wind direction and velocity, flood levels, frequency and time of occurrence of natural calamities such as storm, cyclone, hail storm etc.) of the proposed area is very important to develop the design of the farm. Construction of farms in cyclone prone areas should be avoided.

2.6 Infrastructure facilities

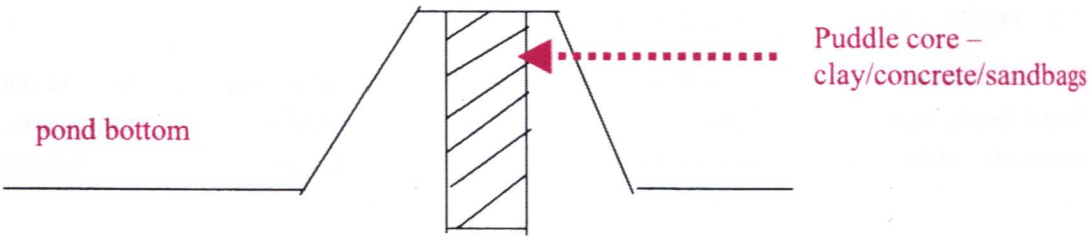
Infrastructure facilities like roads, electricity, proximity to hatcheries, ice plants, processing plants etc., should be considered while choosing the site for a shrimp farm since these will play important roles in the economics of culture operations.

POND DESIGN, LAY - OUT AND CONSTRUCTION

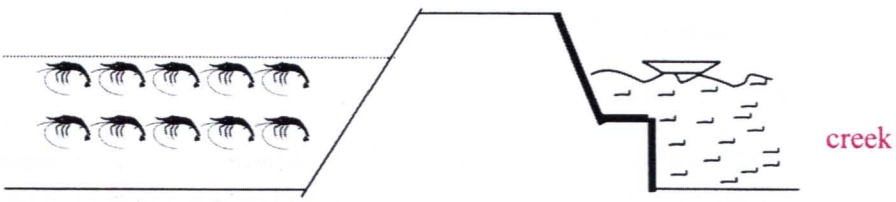
Proper designing and construction of farms are essential for their efficient management and for promoting environmental protection. Good site selection and incorporation of mitigative features in the design of the farm are the best ways to avoid problems related to flood levels, storms, erosion, seepage, water intake and discharge points. Proper planning during the construction is important. Since site characteristics vary greatly from place to place, a site-specific approach to design and construction is necessary. The following aspects of design and lay - out of the farm should be given importance to avoid major problems during culture.

3.1 Peripheral dyke

The peripheral dyke of a farm is the most important structure since it protects the farm against flood, tidal thrust and cyclone. The structure of pond dykes depends on the load bearing capacity of the soil and its compactability. In areas with sandy soil, impervious materials like concrete, clay or sand bags should be used as the core of the dyke

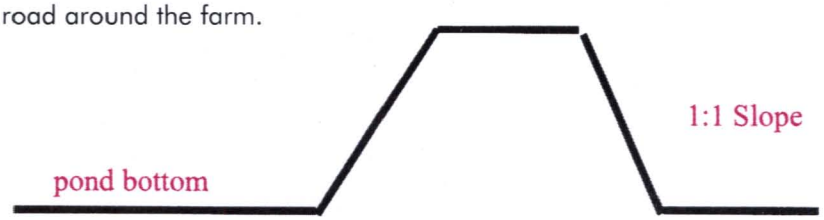


Wherever the outer side of the dyke faces the water front, it should contain a berm and stone pitching or a retaining wall should be constructed.



The height of the pond dyke should be atleast 1.5 m so as to retain a maximum of 1.0 m water in the pond. The height may vary depending on the highest flood level and highest hightide level (Spring tide). A free board of 0.6 to 0.7 m is required above these levels.

The slope of the dyke may range from 1:1 for clayey soil and 3:1 for sandy soil. The top width of the dyke (crest) should be large enough to hold the supply channel and also to be used as a road around the farm.



3.2. Water intake system

The design of the supply canal mainly depends on the daily water requirement of the farm. Depending on the soil quality, earthern, stone pitched or concrete supply canals are designed. In small farms of 3 to 5 ha, PVC pipelines with valves are used for the water supply. The supply inlets can be simple PVC pipes or concrete structures with suitable screens to prevent the entry of pests and predators. The outlet is generally made up of wood or concrete with provisions for harvest bags, straining nets and wooden shutters.

Water intake systems

For efficient and best possible water exchange, the outlet should be located diagonally opposite to the inlet. The wooden shutters should be made of small planks so that the draining of water either from the surface or the bottom could be effected easily. The width of the outlet sluice may vary from 0.3 m to 1.0 m depending on the size of the pond and the daily rate of water exchange. The bed of the drainage canal should be at least 30 cm below the pond bed level with adequate slope (1:2000) towards the main outlet. The size of the drainage canal depends on the maximum amount of water to be discharged in a day. It can have a bottom width of about 1 m.

3.3 Culture pond

Rectangular or square ponds are appropriate for shrimp culture. Natural aeration through wind action could be maximised by designing the longest axis of the pond parallel to the wind direction.

The rearing pond must have a minimum depth of 1 m and a maximum of 1.5 m. The pond bottom should have a slope of 1:2000 towards the outlet with an overall drop of 20 to 30 cm for a 1 ha pond. This will facilitate easy draining and drying of the pond bottom.

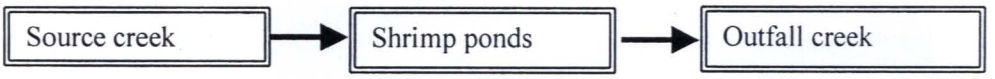
3.4. Reservoir/Effluent treatment pond

In areas where the source water is very turbid with suspended solids, a reservoir pond is required to act as settlement pond. Two such reservoirs are needed for alternate use. In places where disease outbreaks have occurred in the past, these reservoirs may be used for chemical treatments.

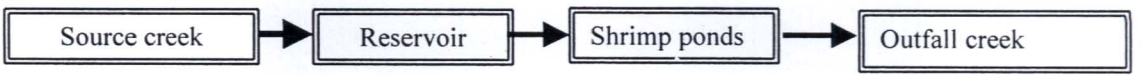
Effluent treatment pond (ETP) becomes an essential part of a semi - intensive farm, if the drainage water has to be released back into the source creek. Culture of molluscs and seaweeds can be taken up in the ETP as they serve as biological purifiers of suspended solids and dissolved nutrients, respectively.

Flow through system - Site specific designs

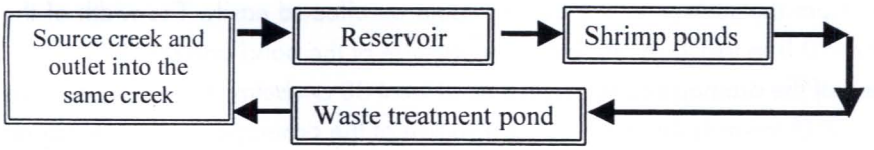
i) Source water clean and clear, good water current; intake and outfall into different creeks



ii) Source water turbid, good water current; intake and outfall into different creeks



iii) Source water turbid, low water current; intake and outfall into the same creek



3.5 Construction

An experienced construction team under the supervision of a qualified aquaculture engineer should be employed to ensure proper construction of the pond dykes. Earthmoving equipments like bulldozers, scrapers, hydraulic shovels etc. can be used to execute the work expeditiously. In areas where soil productivity is less, the top fertile soil layer should be removed and relaid after the construction of the ponds. Construction of sluices and supply channels should be done carefully so as to avoid future problems in water management.

4. POND PREPARATION

Pond preparation or pre - stocking management, aims at making the pond water suitable for the delicate shrimp postlarvae. Primarily, its purpose is to remove or reduce the 'stress' causing factors and eliminate pathogens, pests and predators. The following methods should be adopted to ensure good survival of the cultured shrimps and It also enhances the availability of natural food.

4.1. Cleaning of the pond bottom

4.1.1. Drying and tilling

Proper selection of site and design of the farm will facilitate complete drying of the pond bed.Thus drying of the pond bed, till it cracks, ensures :

(a) Complete elimination of pests and predators,

(b) Mineralization of the residual organic matter and release of nutrients and

(c) Oxidation of hydrogen sulphide and other obnoxious gases.

Tilling or ploughing or raking the pond bottom and exposing the sub - soil, speeds up the oxidation process and release of nutrients. Presence of moisture in the soil during ploughing allows bacteria to act better in breaking down the black organic matter thus making the ploughing process more effective. After ploughing, the pond bottom is allowed to dry for 5 – 7 days and the process is repeated till no more black soil is seen. Compaction of the ploughed soil using heavy rollers before intake of water will reduce the suspension of soil particles in the water. Tilling and ploughing should not be done in acidic soils since it will expose the acid soils at the bottom and thereby increase the acidity in the pond.

Ploughed pond bottom

4.1.2 Removal of top soil

During the course of culture, the pond bottom becomes black owing to the accumulation of harmful sulphides. If these harmful nutrients are not completely eliminated by drying and tilling, it is advisable to remove the top black soil manually upto 10 to 15 cm and disposed off away from the farm site so that it does not seep back into the water ways and cause environmental problem. The removal of top soil, over a period of time, leads to the gradual deepening of the pond and will make it undrainable. Hence, this method should be resorted to only when it becomes absolutely essential. Normally in improved traditional culture systems where the stocking density is low (6 – 10 no/m^2) such removal of top soil will not be required. Removal of top soil should not be done in acid sulphate soils.

In some areas it may not be possible to dry the ponds at any time of the year. In such ponds, flushing the pond water through pressure pumps and water - jets may be helpful to clear the bottom. Repeated flushing of the pond bottom removes the wastes in a suspended form. These wastes should be allowed to settle in a treatment pond before discharging out the water into the creek.

When complete drying is not possible, chemical methods are to be adopted to eliminate undesirable species from the pond. Chlorination of the pond water with bleaching powder is a common method to eliminate the undesirable organisms from the ponds. A dose of 10 to 20 ppm chlorine can be used. After 7 – 10 days of chlorination, liming, pond manuring and fertilization should be carried out. Since all the living organisms including plankters will be removed during chlorination, development of natural food will be delayed.

4.2. Reconditioning of the pond bottom

The pH of the water has a profound influence on the growth and survival of the cultured shrimp. A pH range of 6 to 9 may be tolerated by the shrimp, but pH of 7.5 to 8.5 is the optimal range for best growth. The pH of the soil influences the pH of of the water standing above it. Hence when the soil pH is below 7, it has to be corrected by the application of lime and the dose is dependent on the soil pH and the type of lime to be used.

The lime should be distributed uniformly at the pond bottom and dykes, water is then allowed to a depth of 30 cm and retained 5 - 7 days. Then the water should be completely drained. Draining and flushing of the pond should be continued twice or thrice till the soil pH stabilizes above 7.

Soil pH	Quick lime* (tonnes/ha)	Slaked lime** (tonnes/ha)
5.0	9.2	17.0
5.5	6.9	12.7
6.0	4.6	8.5
6.5	2.3	4.2

* - During pond preparation ** - During culture

Pond preparation - Liming

In case the soil pH is above 6.5, though liming for pH correction is not required, it is recommended for conditioning and disinfecting the pond bottom. Acidity of the pond bottom soil due to organic wastes will inhibit its bacterial decomposition. Liming corrects the soil pH, ensures complete decomposition of the wastes and also disinfects the pond bottom. For general conditioning, lime @ 500 kg / ha is uniformly spread on the wet pond bottom and the pond is filled after 2-4 days to a depth of 30 cm with water screened through a fine mesh.

4.3. Natural food population

The shrimp postlarvae stocked in the pond, require an abundant supply of natural food in the form of plankton. If natural food is insufficienct, the larvae are under - fed and will become weak, and may result in heavy mortality. Enhancing natural productivity of the pond through the application of fertilizers is an established practice.

The dosage of organic manure to be applied is dependent on the organic carbon content of the soil. The following basal doses are prescribed:

Organic carbon in soil (%)	Prescribed basal dose	
	Raw cow dung (kg/ha)	Dry chicken manure(kg/ha)
1.00	500	175
0.50	1000	350
0.25	2000	700

Pond preparation - Manuring

The manure is soaked overnight and distributed uniformly in the water phase maintained at a level of 30 to 40 cm. Manuring at the soil phase should be avoided to prevent the development of benthic algae.

Similarly, application of inorganic fertilizers should be based on the nitrogen and phosphorus content of the soil as given below.

Available N in soil (mg/100 g soil)	Urea to be applied (kg/ha)
12.5	100
25.0	50
50.0	25
Available P in soil (mg/100 g soil)	**Super phosphate to be applied (kg/ha)**
1.5	100
3.0	50
6.0	25

The initial dose of inorganic fertilizer should be dissolved in water and distributed uniformly in the pond water. The pond water level should be gradually raised to 80 cm and the change of colour should be monitored. Within 4 to 5 days, the pond water will turn green or light brown indicating the development of algal bloom. Subsequently, the water level is raised up to 1.0 m and inorganic fertilizer @ 2 to 3 kg/ha should be added as maintenance dose. If the algal bloom fail todevelop, a further dose of 25 kg/ha of inorganic fertilizer should be added at an interval 4 to 5 days till the bloom appears. The colour of the pond water should not be allowed to become dark green, blue or yellow. The best time for stocking of shrimp is when the water is either light brown or light green in colour.

The Secchi disc transparency should range between 25 to 40 cm. When the transparency drops below 25 cm, the surface water should be drained immediately and fresh seawater/ brackishwater pumped into the pond. Regular (weekly or fortnightly) application of fertilizers should be done to maintain the desired level of algal bloom.

5. STOCKING

Stocking of postlarvae in ponds is an important aspect of the culture technology. Sudden transfer from an ideally by controlled hatchery condition to the fluctuating pond conditions is critical for the postlarvae. Hence careful pre-stocking measures should be followed. The water quality parameters of the pond should be within tolerable limits, otherwise the shrimps will be under severe stress and will become weak and susceptible to diseases which may result in their mortality.

5.1. Seed quality

Good quality hatchery produced seed, free from any infection and stress should be procured for stocking. The seed should be purchased from a reputed hatchery where prior inspection of the stock is permitted. Morphologically, the postlarvae should be free from any lesions and black discolouration. They should be uniform in size and colour, active and react swiftly to any external stimuli and should swim against the water current created in the container. Two step Nested - PCR testing of the seed for Monodon Baculovirus (MBV) and White Spot Virus (WSV) should be carried out. Seed which are negative to PCR testing should be selected for stocking.

5.2. Stocking density

The rate at which the shrimp seed is stocked in the pond depends on many factors. Over - stocking may lead to high mortality and poor growth, whereas, under - stocking may lead to uneconomical culture with less profit. The optimal stocking density is generally dependent on the type of management followed, duration of culture and the expected size at harvest. High density culture requires intense water quality management. Further, this will lead to serious deterioration of pond soil conditions. At presentl, due to the prevalence of viral diseases and environmental problems, low-density culture is being practised. A maximum density of 6 no./m^2 within the Coastal Requlation Zone (CRZ) and a maximum of 10 no./ m^2 outside the CRZ, is permitted by the Aquaculture Authority.

5.3 Packing and transportation

The postlarvae should be transported with minimal stress. Packing of seed under oxygen in polythene bags is usually practised. The polythene bag should be filled with water upto 1/3 of its capacity and PL 20 should be packed @ 500 to 1000 no./litre under oxygenation.

As far as possible, the duration of transport should not exceed more than 6 hours. Transportation should be done in the evening or night to avoid higher temperature. If transport lasts more than six hours, the bags should be placed in thermocole boxes with packets of ice placed around the bag to maintain the temperature between 20 to 25°C.

5.4 Acclimation and release of larvae

Before stocking, the postlarvae should be acclimated to the pond water pH, salinity and temperature, to avoid stress and shock. Acclimation to salinity should be done very gradually @ 3 ppt/day. Hence, it is advisable to inform the hatchery operators regarding the ambient pond salinity so that the acclimation can start at the hatchery itself. Already some of the private hatcheries are obliging the farmers in this manner. Acclimation to temperature is easily achieved by floating the seed bags for about 30 minutes in the pond before release of the larvae. Acclimation to pH is done by mixing an equal volume of pond water with the water held in the seed bags and retaining the seed for 30 minutes before their release into the pond.

Weak and dead postlarvae should be removed before stocking. This is achieved by keeping the postlarvae in FRP tanks and treating them with 100 ppm formalin for 30 minutes under strong aeration. After the treatment, the strong postlarvae should be stocked in the nursery ponds. Nursery rearing of PL 20 for 2-3 weeks will reduce the risk of disease outbreaks.

6. FEED MANAGEMENT

Feed management is a very important aspect in the overall pond management since about 40 to 60% of the recurring cost of the culture operation is spent on feed. The aim of feed management is to avoid over - feeding or under - feeding. Over - feeding leads to in pollution while under - feeding results in reduced growth.

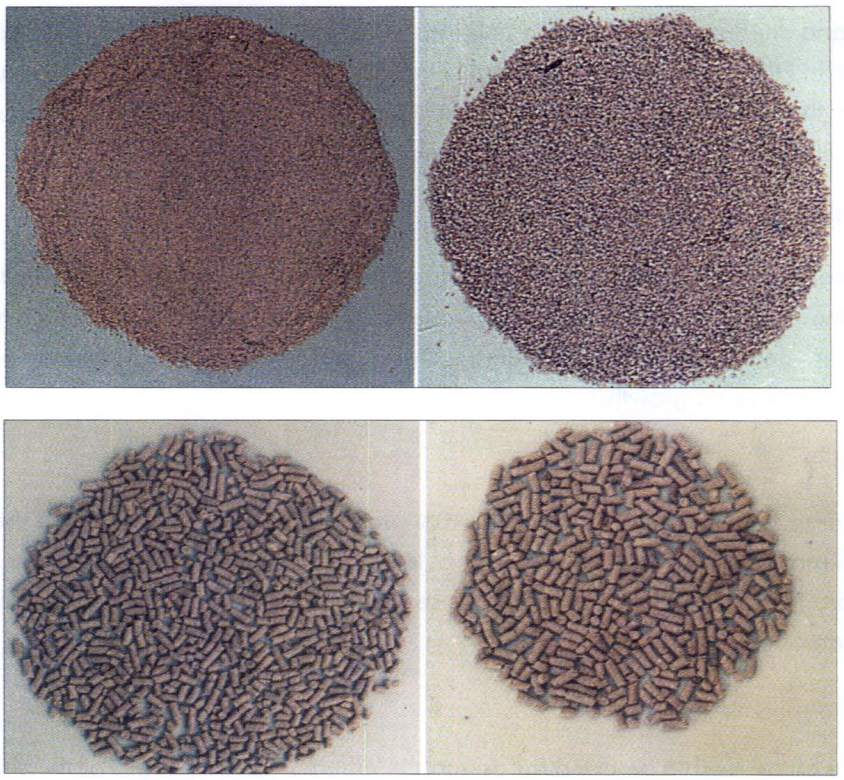
6.1. Feed quality

The shrimp feed should contain 38 to 40% protein to yield good growth. It should contain less than 10% moisture. It should be stable for at least 4 hours under pond conditions. Feed that is stored for more than 3 months should not be used Generally the feed manufacturers provide the proximate composition of the feed.

6.2. Feed size and feeding rate :

The size of the feed to be given for during the different growth stages of the shrimps is very important to avoid wastage. The feed manufacturers generally prepare different grades of feed and provide a manual with the necessary information reparding the size of feed to be gaven to the different size of stock and the rate to be fed. This varies widely from feed to feed. A general pattern is given below :

Feed grade	Pellet size (mm)	Size range of shrimp (g)	)Feeding rate (%)
Starter (Granules)	1.0	0.1 - 3.0	10 - 8
Grower (Pellets)	2.0	3.0 - 15.0	8 - 5
Finisher	2.5	15.0 - 35.0	5 - 3



Different grades of shrimp feeds

6.3. Sampling of shrimps

Sampling is regularly done (weekly/ fortnightly) to understand the growth rate and survival of the shrimps in order to plan feed and feeding schedules and other management measures. The quantity of feed to be given is based on the average body weight and estimated survival of the shrimp. The average body weight is calculated by weighing a sample of shrimps collected by a cast net during early morning or evening time when the temperature is not high. To get an accurate estimate of the surviving shrimps, at least 9 to 10 cast net hauls should be made and the number collected in each haul should be noted. To avoid selective catching, a small meshed cast net should be used.

6.4. Monitoring of feed intake

Feed intake of shrimps is influenced by various external and internal factors. The external factors include water quality and pond bottom condition while the internal factors include moulting stage and disease condition. Though the quantity of feed to be given is estimated accurately, the shrimps may not consume all the feed given. To have an idea about the quantity of feed actually taken by the shrimps, feed check trays are used. For a 1 ha pond 4 to 6 check trays are essential. In each check trays 1to 2% of the feed is kept in order to ensure uniform distribution. The shrimps are expected to consume feed completely within 1 to 2 hours. Hence, the check trays are examined after 2 hours. It unconsumed feed is left in the tray, the feeding rate is to be reduced, proportionately. If the tray is found empty, the feeding rate is increased. By such continuous monitoring, both over feeding and under - feeding can be avoided.

Monitoring feed check - tray

6.5. Feeding frequency

It is a well known fact that the feed consumed by shrimps remain in their digestive system for 3 to 4 hours. Hence it is essential to feed them once in every 4 to 5 hours. It is a general practice to feed the shrimps 5 to 6 times in a day.

It is also known that shrimps are active during night and hence the feeding schedule is adjusted in such a way that maximum percentage of the total feed is given during evening/ night hours, based on the check tray observations.

7. WATER QUALITY MANAGEMENT

Management of water quality is another important aspect of shrimp pond management. The aim is to maintain the different water quality parameters within the optimal limit and the concentration of pollutants, below their 'safe levels'. Temperature, salinity, pH, dissolved oxygen and transparency

should be monitored daily to get an idea of the ambient pond water quality. Apart from these, certain physical factors like colour of the pond water, formation of bubbles and colour of the bottom soil can also give an indication of the condition of the pond.

The general management measures for maintaining water quality include:

- Water exchange
- Aeration
- Liming
- Fertilization
- Application of chemicals

7.1. Water exchange

Water exchange is the easiest and cheapest management measure for maintaining the water quality, provided the required quantity and quality of water are available and the ponds are well designed. In prepared ponds with low stocking density, there is no need for water exchange during the first 30 days. Water has to be filled -in to compensate evaporation loss. After the first month, water exchange should be need based for maintaining the optimal water quality and reducing the levels of toxic metabolites.

Water exchange is the only method to ameliorate certain emergency situations that arise under pond conditions such as:

Water exchange

(a) Water transparency greater than 50 cm (low - plankton) or less than 20 cm (high plankton bloom)

(b) pH less than 7.5 or greater than 8.5

(c) pH fluctuation in a day greater than 0.5 (due to algal bloom)

(d) Persistence of bubbles on the water surface

(e) Shrimp are noticed on the water surface or on the sides of the pond.

7.2. Aeration

Aeration is required in culture ponds to (1) keep the pond bottom clean and (2) maintain the required dissolved oxygen (D.O) level in the pond. Paddle wheel aerators @ 4 to 6 no./ha are generally used in shrimp ponds. The positioning of the aerators in the ponds should be done properly to ensure maximum water flow within the pond.

In culture systems with a stocking density of 6 – 10 no/m^2, aeration is generally required during the last 30 – 45 days depending on the water quality conditions. Normally aeration will be required during the early morning hours when the DO level will be at its minimum. Aeration is also provided during the following emergency situations.

(a) Cloudy and rainy days

(b) Dissolved oxygen level dropping below 4 ppm

(c) Crash of algal bloom

(b) Application of chemicals for treatment

Pond aeration

7.3. Liming and fertilization

Liming and fertilization is essential to maintain good water quality and should routinely be followed during the culture. Liming is done whenever the pH drops below 7.5 or the daily fluctuation in pH is more than 0.5. Further, liming has to be done after every water exchange and heavy rains.

Lime application during culture

In addition to the initial fertilization done during pond preparation, additional fertilization is required during the course of culture to maintain good algal bloom. 10% of the original dose of fertilizer should be applied at weekly or fortnightly intervals depending on the percentage of water exchange and the algal bloom.

7.4. Application of chemicals

Apart from lime and fertilizers, various other chemicals are generally being used to maintain good water and soil quality. The major ones are water probiotics, soil probiotics, and water conditioners. The utility and efficiency of most of these chemicals are yet to be confirmed. Farmers are extensively using zeolite, as a means to reduce ammonia concentration in the pond water based on its adsorbing capacity. But its efficiency in saline water is yet to be established. Chemicals such as formalin, potassium permanganate, copper sulphate, iodine compounds are also being used as disinfectants. For low density culture, there is no need of these chemicals.

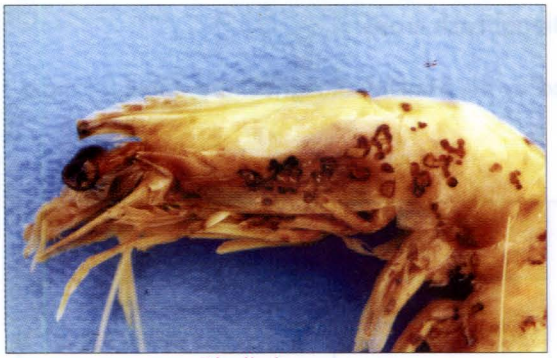
8. HEALTH MANAGEMENT

The health of the shrimps should be monitored continuously. Shrimps with any one or more of the following conditions are diagnosed to have disease. They are inactive and sluggish behaviour, empty gut, bluish/blackish coloration, body blisters, flared up gills, broken appendages, black/white spots, coloured gills and opaque muscles. Apart from these signs, behaviour of the

shrimp and their feeding trend should also be checked. A record of all these observations should be maintained which will help in identifying the cause of the disease.

In case of any visible change in the conditions of the shrimps and their behaviour, the disease should be diagnosed with the help of a Pathologist. Water and soil conditions of the pond should be checked for any abnormalities and remedial actions (like aeration/ water exchange) should be taken to correct them. Dead animals should be removed from the pond and buried. If there is continuous mortality during consecutive days, emergency harvesting should be carried out, without discharging the water from the pond. After harvesting, the pond water should be disinfected with bleaching powder and allowed to remain for 10 days.

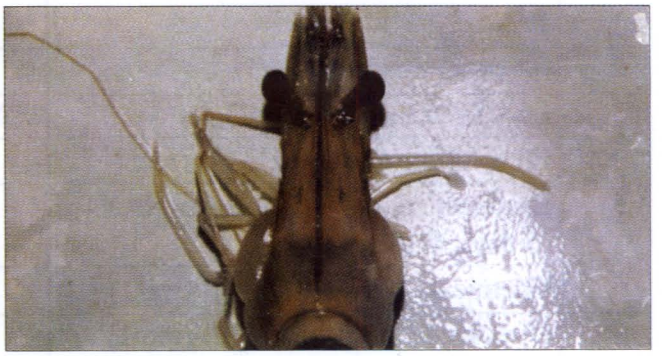
In there are reports of disease outbreak in the surrounding areas, water exchange should not be done and movement of persons or equipments from the neighbouring farms should be avoided. It is a well understood fact that control and prevention of diseases in aquaculture is a function of management. Disease problems arising in aquaculture can be attributed primarily to environmental insult and most of the pathogens are facultative pathogens. Hence, management of the pond environment is of utmost importance for the prevention and control of diseases.



Shell disease

Vibriosis

White Spot Virus infection



Vibriosis

9. WASTE MANAGEMENT

The waste from shrimp culture ponds contains mainly suspended solids, comprising of unconsumed feed, faecal matter and plankton and dissolved nutrients such as ammonia, nitrite, phosphorus, carbon dioxide, hydrogen sulphide etc. The former component is intluenced by the physical quality of the feed and levels of fertilization while the latter component is affected by the chemical composition of the feed ingredients and the nature of fertilizers. Biological and chemical oxygen demands (BOD and COD) of the wastewater are indication of the level of microbial and chemical interactions.

Proper site selection, design, construction of ponds and responsible management of water, soil and feed will reduce the nutrient loading from the shrimp culture ponds.

Construction Effluent Treatment System (ETS) is mandatory for farms above 5 ha within CRZ and above 10 ha outside CRZ. At east 10 percent of the total pond area should be ear - marked for the ETS. Guidelines issued by Aquaculture Authority should be followed in the design and operation of ETS. ETS may be used for secondary aquaculture, particularly for the culture of mussels, oysters, seaweed, other finfishes, etc. This will offer scope for improving the wastewater quality, reducing the organic and nutrient loads and producing additional cash crops.

The following standards have been prescribed by the Ministry of Agriculture, Govt. of India for the shrimp farm waste water.

S No	Parameters	Final Discharge Point	
		Coastal marine waters	Creek or estuarinecourses when the same inland water courses are used as water source & disposal point
1	PH	6.0 – 8.5	6.0 – 8.5
2	Suspended solids (mg/1)	100	100
3	Dissolved oxygen (mg/1)	Not less than 3	not less than 3
4	Free Ammonia (as NH3-N) (mg/1)	1.0	0.5
5	Biochemical Oxygen Demand-BOD (5 days @ 20°C) (mg/1)	50	20
6	Chemical Oxygen Demand (mg/1)	100	75
7	Dissolved Phosphate (as P) (mg/1)	0.4	0.2
8	Total Nitrogen (as N) (mg./1)	2.0	2.0

10. HARVEST AND POST-HARVEST

Harvesting of the shrimps can be done by completely draining the pond water through nets placed in the pond outlet combined with cast netting. After complete draining, the shrimps that are left in the pond bottom should be handpicked. During the final phase of draining the pond, high quantity of suspended matter will be present in the water and hence it should be drained into a sedimentation tank to avoid sedimentation in the creek.

The harvested shrimps should be iced immediately. Generally, the processors or their representatives will buy the produce at the farm site itself and transport them in refrigerated vans. In areas where such facilities are not available and the produce has to be transported over a long distance then beheading of the shrimps should be done at the farm site itself.

Cast netting

Hand picking

Draining

Icing and packing

11. ECONOMICS OF SHRIMP CULTURE

Capital Investment for the construction of a 5 ha farm will be to the tune of Rs. 15 – 20 lakh depending on the soil characteristics, distance and elevation of the site with reference to the source water.

Recurring Expenditure for a 5 ha farm will be Rs. 12 to 16 lakh per annum with the cost of production at Rs. 120 and 160 per kg of shrimp. A total production of 10 tonnes of shrimp at a total farm gate price of Rs. 30 lakh is the expected revenue from a 5 ha farm. An average profit of Rs. 2 lakh per ha is possible with this technology.

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