Hatchery design

This manual deals with the design and operation of small-scale, or 'backyard', hatcheries. The brine-based recirculation hatchery described may not be adaptable to large-scale production due to the considerable requirement of brine.

The definition of 'small-scale' or 'backyard' is quite flexible and depends upon the owner's production target and financial capabilities. In countries such as Thailand, where the industry is well developed, a wide variety of designs and production capacities exist. The design and construction details depend not only on the owner's financial resources, but also on his or her ingenuity.

Hatchery site selection

Factors to be considered are groundwater quality, access to brine, availability of electricity, adequacy of drainage and the availability of semi-skilled labour.

Water supply

The success of a hatchery rests on water quality, which is why the subject is stressed in this manual. No amount of remedial measures can completely overcome the problems caused by poor water quality. *Macrobrachium* hatcheries are usually established along the seacoast. However, it is possible to produce *Macrobrachium* **PL commercially in a** backyard hatchery at inland sites. Good freshwater as well as brine are required. In many areas of the world, saline- and freshwater are pumped from underground aquifers and supplied to hatcheries for prawn seed production. For hatcheries situated some distance from the sea, brine collected from salt beds in coastal areas can be stored for use the year round. Some water quality parameters for rearing water in a hatchery are shown in Table 2 (page 19).

Underground water is best for hatchery use. Deep tubewells are expensive, so a site should be chosen where shallow ground- or pond/riverwater of low iron content is available. Freshwater is best stored in an overhead tank.

Aeration during pumping can remove a major portion of the dissolved iron by precipitation, but in cases of very high iron levels, special treatment may be necessary.

Other site selection criteria

- Electric power should be 3-phase 220/440 V and supply reliable. A generator or diesel engine for the air **blower may be necessary** to cope with power failures.
- There should be good road communications for transport of brine, everyday materials and post-larvae throughout the year.
- The site of the hatchery should be near *Macrobrachium* farms supplying broodstock (at least within 16 hours' journey).
- Hatchery land should be well above sea level, in a flood/cyclone-free area.
- Adequate drainage for brine and wastewater must be provided, but drains should not discharge into paddy or other croplands.

Facility design

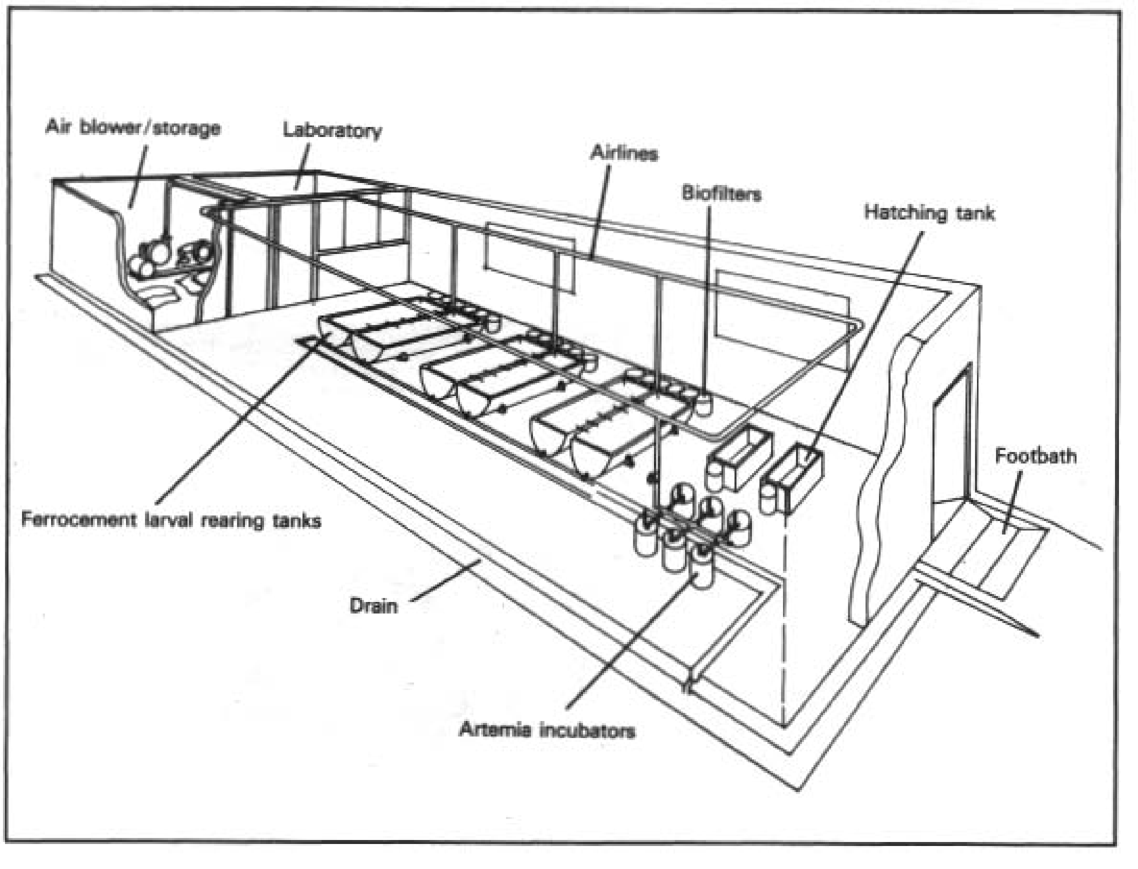
The plan and design of the hatchery should be prepared on the basis of production targets, weather conditions, geographical environment and situation, land conditions, availability of construction materials, skill of local labour and the availability of finance. The interior of a small demonstration hatchery built in Bangladesh is shown in Figure 5.

The hatchery building

The size of the hatchery shed depends on the number and the sizes of the tanks. Hatching tanks, larvae rearing tanks and Artemia incubators have to be accommodated. There should also be space for a small laboratory and a machine-cum-storage room. Broodstock tanks, post-larvae holding tanks and brine storage and mixing tanks may be located outside the main hatchery building, but require covers. A typical layout is shown in Figure 6.

Ag. 5 Interior of small-scale freshwater prawn hatchery. Larval rearing tanks in the foreground, brine storage and mixing tanks and sand filters In background

Fig. 5 Sample layout for freshwater prawn hatchery



A concrete structure would be preferable, but **it would prove expensive. A shed made** with galvanized **steel sheets, thatch or bamboo mat is a less expensive alternative. But whatever material is used** in constructing the shed, provision must be made for enough light and air **to enter.**

Floor

The floor of the hatchery should

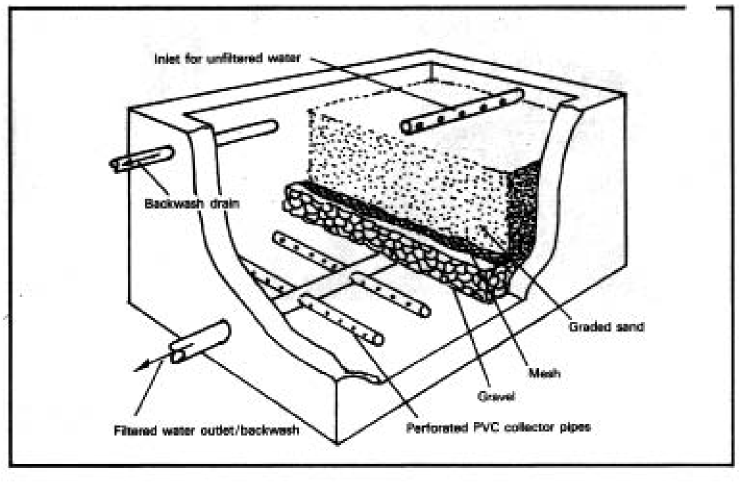
- **be cemented and smooth, to allow thorough and rapid cleaning;**
- **be provided with adequate drainage; and**
- **be strong enough to bear the weight of rearing tanks** and the water in them.

Footbaths should be placed at all entrances to the building.

Drainage

Good drainage is essential for maintaining hatchery sanitation. **Inside drains should be at least** *50* cm wide, to allow operators to reach inside them while cleaning. All drains should have removable gratings. Wastewater must discharge away from the hatchery and no water should be allowed to collect and stagnate in drains.

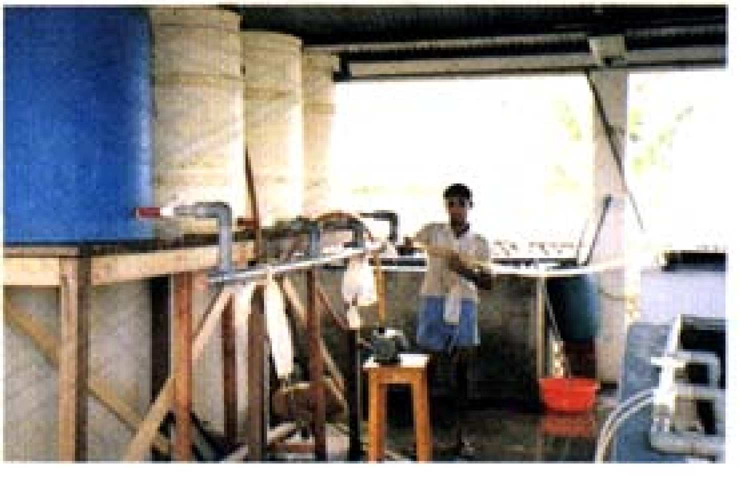
Fig. 7a Basic design for a rapid sand filter



Sand filter

It is advisable to pass rearing water through a sand filter after treatment to remove particulate material which **may** form during **aeration. The** size **of the filter will depend on water demand.** Almost any container can be **used, but the** basic design should **follow the illustration in Figure 7a.** Almost any nontoxic **container can be used. Plastic barrels** are **very useful** (see **Figure 7b).**

Fig. 7b 200 l plastic barrels converted to rapid sand filters



Air system

Air supplied to a hatchery has to be oil-free, so piston-type compressors are unsuitable unless equipped with oil separators. Twin-lobe or vortex air blowers are preferable. They supply relatively large volumes of low pressure air with minimum maintenance.

A twin-lobe, or remote drive, vortex blower can be set up to be powered by an electric motor and an auxiliary diesel engine (Figure 8). The diesel engine is to power the air blower during power cuts.

The selection of a properly sized, dependable air blower is crucial to reliable hatchery operation. It is one of the most expensive components of hatchery equipment and, in some countries, has to be imported. The blower is selected according to the maximum depth of water to be aerated plus allowances for friction loss in the piping system and the pressure drop across airstones where

$$\text{Total head (cm)} = \text{Submergence} + HL_{pipe} + HL_{airstones}$$

Submergence represents the maximum depth to be aerated in cm, HL_{pipe} the friction loss in cm and $HL_{airstones}$ is the pressure drop across airstones, or diffusers, in cm.

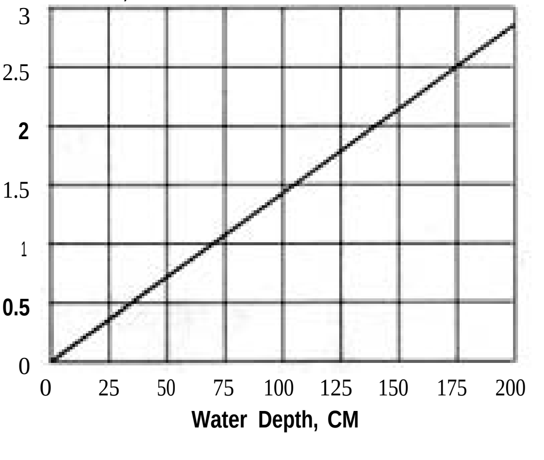
Figure 9 shows the pressure in pounds/in^2 (PSI) for various water depths (in cm). Air blower ratings are usually given in pounds/in^2. This graph can be used to help select an appropriate blower by reading off the pressure for any water depth up to 200 cm. The pressure drop across airstones depends on the pore size and air flow, and ranges from about 0.25 to 0.40 PSI, equivalent to 17.5 -34 cm water depth. Friction loss in pipes is related to air flow, pipe diameter and the length of the pipe. For the average hatchery, 25 cm can be assumed as the water depth to be added for friction loss in the air line. For example, if a hatchery has a maximum depth of 150 cm to aerate, the required pressure output of the blower would be estimated by

$$\text{Total head} = 150 + 25 + 18 = 193 \text{ cm}$$

Referring to Figure 9, we fmd the blower should have an output of about 2.8 PSI. Air blower manufacturers will recommend an appropriately sized model if information on maximum water depth to be aerated, type and number of airstones and length and diameter of main air line is given.

Fig. 8. Rotary lobe air blower with auxiliary diesel power.

Fig. **9 Water depth (cm)** *vs.* **pressure (lbs/in2)**



Electrical system

Electricity and saline water are a dangerous mixture because of the high electrical conductivity and corrosiveness of saltwater. High quality connectors, plugs and plug points must be used.

Hatching tanks, larvae rearing tanks and Artemia incubators should be provided with individual plug points. Care must be taken to ensure:

- electric lines and fittings do not come in contact with water;
- plug points are elevated well above water surfaces; and
- ‘there is a ground fault fuse to protect personnel from electrocution.

An example of the calculation of power generation required for a hatchery producing 5 million PL a season is given alongside.

In this case, a 20 KVA generator would be required, if the heaters are turned off when the blower is started up. A generator is not necessary if auxiliary diesel power is provided for the air blower. However, a generator will allow continuous heater operation, as well as provide lighting during prolonged power cuts.

	KVA
5 hp blower motor	6.7
6 x 2-KVA heaters	*12.0*
Lighting	*0.5*
Submergible pump	*0.5*
	19.7

Tanks

A variety of tanks are required for hatchery operation and these are described below. There are a variety of construction materials that can be used, the choice depending upon availability, cost and durability. They include:

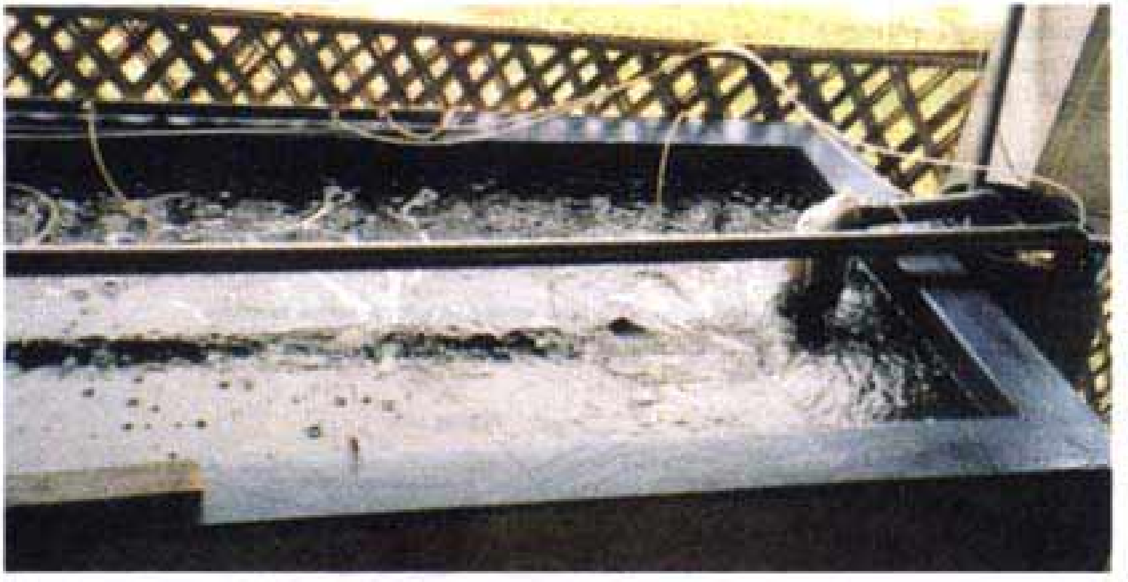
- Fibreglass: Ideal, but prohibitively expensive in some countries.
- Ferrocement: Much cheaper than reinforced concrete and can be cast into any desired shape; however, requires properly trained masons.
- Reinforced concrete: Very suitable, but also expensive.
- PlaStered brick: Easy to use, but prone to leakage without costly epoxy coating.
- Plastic-lined wooden or bamboo tanks: The cheapest, but not very durable.

Holding tanks

Round, rectangular or square tanks of 8-10 m2 and 1 m depth are suitable for holding broodstock and gravid females before they are transferred to the hatching tanks. Post-larvae may also be kept in holding tanks for a few days before sale. Draining and filling of the tank can be controlled by a standpipe, either at the centre or at either end. (see Figure 10).

Fig. **10 Plastered brick outdoor holding tanks for broodstock, berried females and post-larvae.**

Fig. 11a 1.5 t hatching tank



Hatching tank

Fig. 11b 60 I biofilter for hatching tank.

Tanks of any type or size, or aquaria, can be used as hatching tanks. Both portable or fixed tanks are suitable. The larvae rearing tank may also be used for hatching purposes, if necessary. Small,tanks with conical bottoms made of cement or fibregiass are suitable (see Figure 1 la). Provision should be made fcsr regular water changes. Alternatively, a biofilter may be installed (see Figure 1 1b).

Larvae rearing tank

Larvae can be reared in any kind of tank, round, square or rectangular. Round or conical bottom tanks are superior to flat bottom configurations.

They give better circulation and are easier to clean. The sides of the tank should be smooth and sloped towards the drain. A PVC stand pipe should be fixed with an elbow at the end to drain the water (see Figure 12).

Larvae tanks should hold at least 3-4 tonnes but should not exceed 10 t as large tanks are difficult to manage. If the tank volume is too small, diurnal temperature fluctuations will be excessive.

Fig. 12 **Round bottom, 5 t larval** rearing **tank showing interior epoxy coating, stand pipe drain and 2 kva immersion heater**

In an open system hatchery, such as would be located on the seashore, biofilters are not required. However, they are essential in a closed, recirculation system. The purpose of a biofilter is to remove ammonia and nitrite, which are toxic. Removal is done by the bacteria which grow on the filter medium, as the water flows through it (see Figures 13a and 13b).

The bacteria need a surface to grow on, so the filter space is filled with 'substrate'. Substrate can be gravel, clean shells or inert plastic material, such as bottle caps. Biofilters use large quantities of oxygen and must be well aerated by an airstone or air line placed in the bottom of the biofilter.

Fig. 13a **Basic design for a biofifter equipped with aeration facilities**

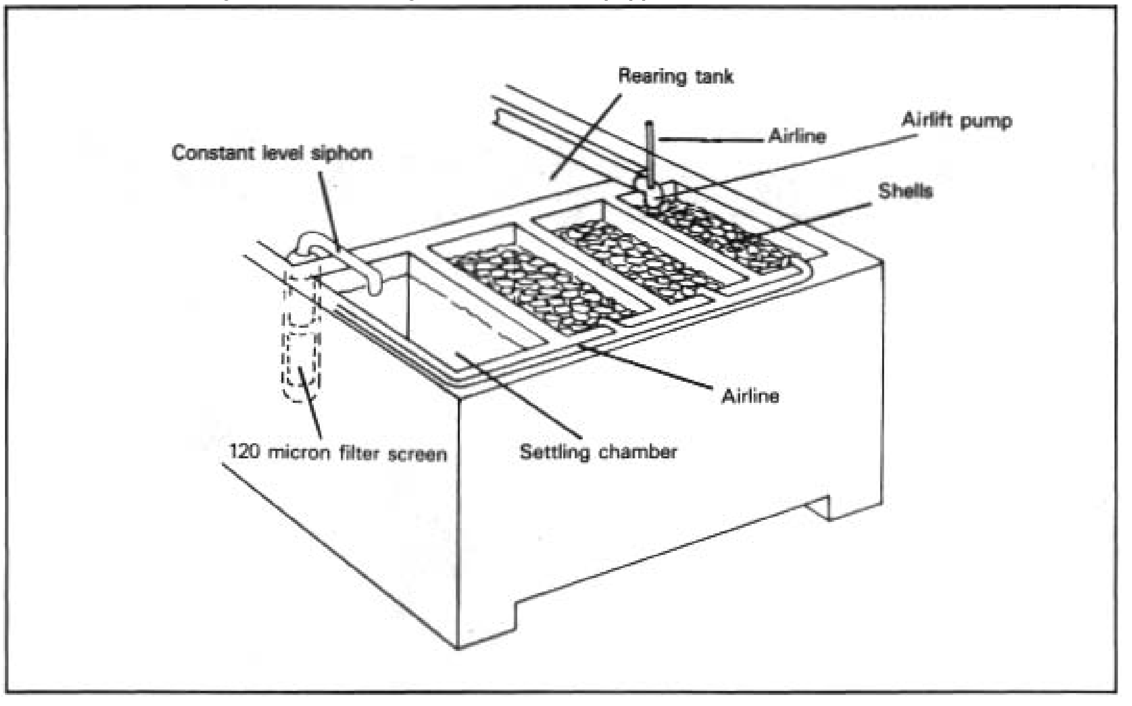
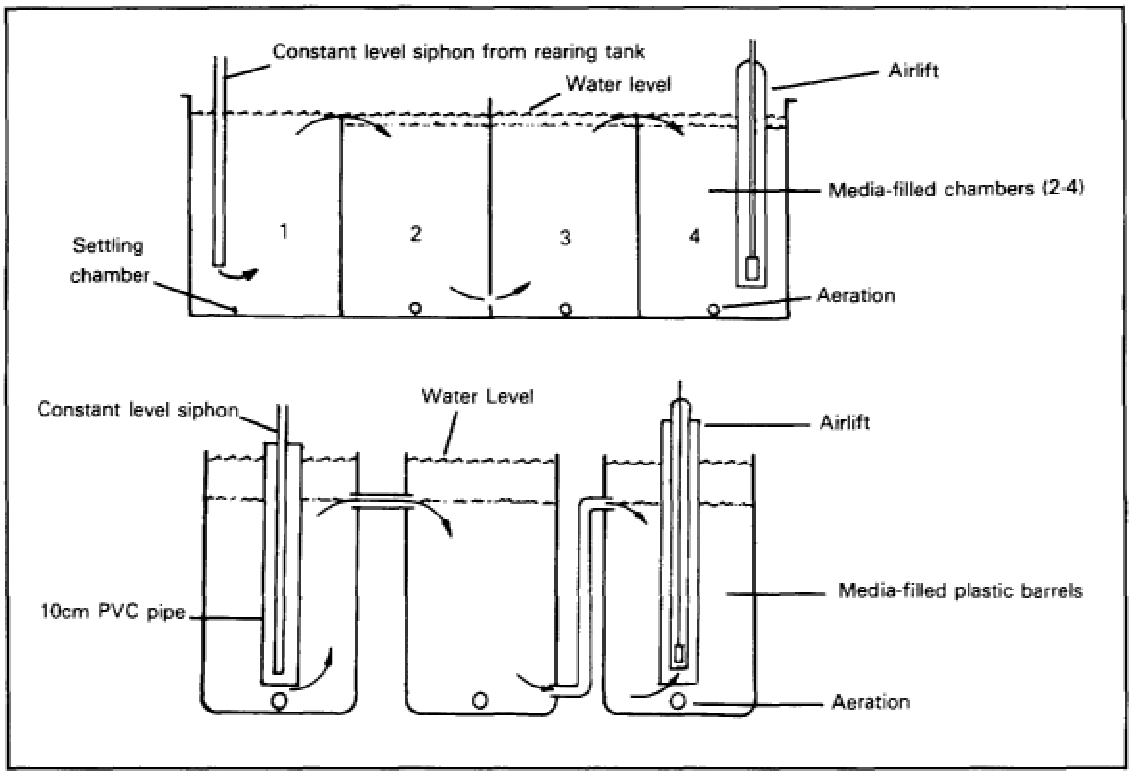


Fig. 13b Biofilter attached to larval rearing tank

Biofilters are more efficient if they are divided into chambers with water flow as in Figure 14. There is no precise data to indicate how large a biofilter should be for larvae rearing tanks, but about 6 per cent of the tank volume seems sufficient. Water can be circulated through the biofilter using an airlift and a constant level siphon. The circulation rate may vary between 2-5 times the rearing tank volume per day.

Fig. 14 Cross-section of box type and plastic drum type biofilters



Artemia *incubator*

A cylindrical tank with a conical bottom is used for hatching *Artemia* (brine shrimp, on whose nauplii the larvae feed). A tank of 60- *75* cm diameter and 60cm height, which can hold *150-250* l of water, is generally used for *Artemia* hatching. A 60-watt light bulb should be hung Im above the incubator. The light stimulates hatching. A small window at the bottom of the tank aids in harvesting nauplii. The tank should be covered at night with a screen cloth to exclude insects.

If the incubator is made of fibreglass, the cylindrical portion should be opaque and the lower conical portion translucent.

Brine storage tank

Brine is required throughout the rearing season; in areas where brine is only seasonally available, the storage tank for brine must be large enough to accommodate an entire season's requirements.

Reinforced concrete is preferable for this tank. Brick and mortar can be used, if lined with plastic sheet to prevent leakage. An interior coat of epoxy can also be used for the same purpose.

The size of the brine storage tank will depend on the larvae rearing tank capacity of the hatchery. An example of how to calculate the amount of brine and, hence, the size of the storage tank is given below

$$\text{Volume of brine required} = \frac{(\text{salinity of rearing water}) \times (\text{volume of rearing water})}{\text{salinity of brine}}$$

Suppose, larvae are to be reared at 12 ppt in a 5 t (5000 l) tank with 200 ppt brine being used, the amount of brine required is calculated as follows

$$\text{Volume of brine} = \frac{(12\ \text{ppt}) \times (5000\ l)}{200\ \text{ppt}} = 300\ l$$

Each larvae rearing tank will, thus, require 300 l of brine and 4700 l of freshwater.

Now, suppose, the production season is 210 days, and each brood takes 40 days to complete metamorphosis. Four cycles could then be produced per season. So, each tank will require *300 1 x 4 cycles, or 1200 1 of brine.*

We also have to allow for two partial water changes, totalling 40 per cent of the FL tank volume or 5000 l x 0.4 = 2000 l.

$$\text{Volume of additional brine} = \frac{12\text{ppt} \times 2000 l}{200\ \text{ppt}} = 120\ l$$

For four cycles, an additional 480 l of brine will therefore be needed, bringing the total brine requirement per tank per season to *1200 l + 480 / = 1680 l*

If the hatchery has four 5 t tanks, the brine storage tank would have to hold

$$1680 \times 4 = 6720\ l$$

An additional amount of brine will also be required for *Artemia* incubation. To estimate the brine requirement for *Artemia* required in the above example, it is assumed that the *Artemia* cysts (eggs) are stocked in the incubators at 2g/l and the salinity of incubation water is 30 ppt. From Day 1 to Day 10, the *Artemia* nauplii are fed to the larvae at a rate of 5/mi and, thereafter, until Day 40, at *2.5/ml.*

Estimate the volume of *Artemia* incubation water as follows:

$$\frac{(5\ \text{cysts/ml}) \times (5 \times 10^6\ \text{ml})}{2.50 \times 10^5\ \text{cysts*/g} \times 0.8\ \text{hatching rate}} \div 2\ g/l = 62.5\ l$$

Four tanks will, therefore, require 250 l of *Artemia* incubation water per day for 10 days. After Day 10, the incubating water requirement would drop to 125 l per day for 29 days, totalling 3600 l. One cycle in the sample hatchery would, therefore, consume 6125 1(2500 l + 3625 l) of incubation water and would need:

$$\frac{6125\ l\ \text{incubation water} \times 30\ \text{ppt}}{200\ \text{ppt}} \quad 920\ l\ \text{brine}$$

A four-cycle season would, thus, need 3700 l of 200 ppt brine for *Artemia* incubation alone.

The total brine requirement for the breeding season would, thus, total 10,400 1(6720 l + 3700 l). Some additional quantity of brine should be stored to provide for emergencies, but this requirement can only be estimated on the basis of experience. An additional 1000 l should give an adequate margin of safety. Therefore, in the above example, the total brine **needed for one season of four cycles would be 11,400 l.**

Note : See pp. 24-26. The hatching rate varies from 70 to 90%, depending on quality.

Mixing tank

Saline water and groundwater are mixed to get the required salinity of 12 ppt. The volume of the mixing tank can be equal to or double that of a larvae rearing tank. The mixing tank must have an aeration system and drain.

Water pumps

Submersible stainless steel pumps of 0.75-1.5 kw are suitable for transferring water within the hatchery. These pumps can also be used if pondwater is used as the freshwater source.

If a tubewell is the source of freshwater, the size of the pump will depend upon the depth and diameter of the well and the flow rate required.

Additional equipment

There are some basic additional items required to efficiently operate a prawn hatchery. These are listed below. Other equipment, such as electronic pH meters, are useful, but not essential.

A **refrigerator** is necessary, to keep prepared supplemental feeds, nauplii of *Artemia* and antibiotics.

A stereo microscope is sufficient to examine larvae growth and monitor health in the hatchery. A more powerful compound microscope would be required for disease diagnosis. All optical parts should be stored in a desiccator.

A refractometer is essential to measure the salinity of water. The instrument should read in ppt (0/00).

A simple beam balance is required to measure *Artemia* cysts, feed ingredients and medication.

Other apparatus and instruments, for everyday use, like beakers, conical flasks, glass jars, Petri dishes of various sizes, watch glasses, 20-1 buckets, baskets, basins, magnifying glass, test tubes, pipettes, dissection tools and a desiccator, will be needed.

Paper or liquid pH indicators, in the range pH 6-10, can be used.

An electronic pH meter is very useful and is recommended if affordable. Easy-to-use kits are available to measure ammonia, nitrite, nitrate, hardness, chlorine and iron.

Immersion heaters of high quality are the most practical solution to the problem of diurnal temperature changes, which **are** relatively great during the early and late part of the rearing season in Northern India **and Bangladesh. Larvae** are very sensitive to fluctuations of more than $\pm$**1°C.** Great care must be taken in the installation and use of these heaters. Brackishwater is very corrosive, so it should be ensured that only stainless steel or titanium is in contact with it.

Various **chemicals** are used for treatment of prawn seed, preparation of feed and pasteurizing water. The most commonly used substances are listed in Table I.

The required quantities of these chemicals will vary, of course, with the rearing capacity of the hatchery. If the example we have been using is considered, that is, a 20 t hatchery producing four cycles a year, the following would be the estimated requirements:

- **Bleaching powder:** 50 kg for one four-cycle season.
- **Sodium thiosulphate** to neutralize treated water: *5.5* kg.
- **Otherchemicaistobestocked** : 1 kgofeach.

Table 1 : **Commonly used hatchery chemicals and feed ingredients.**

Water treatment	*Disease control*	*Feed Preparation*
Calcium hypochiorite	Chioramphenicol	Agar
Sodium bicarbonate	Tetracycline	Corn starch
Calcium oxide	Sulfamerazine	Milk powder
Sodium thiasuiphate	Farmalin	Vitamin mix
Sodium carbonate	Furanace	
Sodium EDTA		
Sodium hydroxide		

Technical grade chemicals are sufficient for hatchery work. All antibiotics should be of veterinary grade.

Miscellaneous items

Several other items are needed for everyday use. They include:

Nylon nets of different mesh sizes: To catch and transport mother prawn and PL.

Polythene (Netlon) **plankton nets** of different mesh sizes: To collect nauplii of Artemia, for food preparation and to change/filter the water. Mesh sizes of 120 to 200 microns are most useful.

120 **micron** screens: To retain Artemia cysts.

Plastic hose of different diameters: To siphon, clean and aerate tank bottoms and supply water.

PVC pipe and gate valves of different sizes: To control air and water flow. Brass and copper should not come in contact with rearing water in a closed system.

Saucepans, a heater, pressure cooker, spoon, strainer and knife: To prepare food.

Screens: To wash prepared feed.

A blender: To grind the steamed custard.