

Marine Fish Hatchery: Systems, Equipment and Facilities

Anuraj A

Mariculture Facility-Narakkal, Mariculture Division, ICAR-CMFRI, Kochi

Marine fish hatcheries are specialized facilities designed to produce high-quality fish seed through controlled breeding, egg incubation, larval rearing and nursery rearing. They play a vital role in the expansion of sustainable mariculture by providing a reliable supply of healthy seeds for commercial farming. The availability of quality hatchery-produced seed also reduces dependence on wild seed resources, improves farm productivity, enhances profitability, and contributes significantly to coastal livelihood development and the blue economy. Modern marine hatcheries integrate scientific broodstock management, larval rearing, live feed production, water quality control, disease prevention, and advanced engineering systems to maximize seed production while maintaining high survival rates. The expansion of marine finfish mariculture is fundamentally constrained by the availability of high-quality, disease-free seeds. Unlike freshwater aquaculture, where seed production is well established and widely commercialized, marine fish hatchery production is more challenging. It requires advanced technology, careful control of environmental conditions, and strict biosecurity measures to produce healthy and high-quality seed.



A marine fish hatchery consists of various units like seawater intake, water treatment and storage, broodstock holding, indoor algal stock culture, intermediary and outdoor algal culture, rotifer culture, artemia hatching and enrichment, larviculture, nursery rearing, laboratory, feed and chemical storage, aeration facility, wastewater treatment and disposal, workshop and staff accommodation facility. The layout of a marine fish hatchery should facilitate smooth movement of water, personnel, materials, and fish while minimizing the risk of disease transmission.

Site selection

Site selection is one of the important criteria before designing a marine hatchery. The facility should preferably be located close to a clean seawater source. The intake point must be located away from river mouths, industrial discharge zones, agricultural runoff, and urban centres to prevent contamination from chemical pollutants, pesticides, heavy metals, and sudden salinity fluctuation. The site selected must be having reliable electricity, freshwater availability, transportation facilities, and protection from flooding. The topography of the selected site should ideally possess a gentle slope from the land toward the sea to facilitate gravity-assisted drainage, which reduces long-term operational pumping costs.

Ideal water quality parameters for selecting hatchery site

Salinity: Stable baseline of 30–35 ppt with minimal seasonal variations (<2ppt)

Temperature: Typically, 26–30°C for tropical and subtropical species like cobia, pompano, trevally etc.

pH: Maintained within the alkaline oceanic range of 7.9–8.3

Dissolved Oxygen (DO): Near saturation levels (>5ppm) at the source

Turbidity & Total Suspended Solids (TSS): Minimal baseline turbidity to reduce the mechanical load on primary filtration infrastructure. Areas prone to chronic harmful algal blooms (HABs) or heavy siltation must be avoided

Hatchery design

A modern marine fish hatchery is designed around a strict spatial zonation strategy. Rather than functioning as a single open space, the facility is segregated into discrete biosecurity zones managed under a strict linear or unidirectional workflow. This architectural framework creates physical barriers against pathogen entry and minimizes cross-contamination between different life stages. Water, air, personnel, and equipment must flow strictly from areas of high biosecurity (clean zones, such as live feed cultures and egg incubation) to areas of lower biosecurity (dirty zones, such as broodstock maturation and effluent treatment). Every section of the hatchery should have separate entry to avoid cross contamination from one section to other.

Structural Zonation and Access Control

The hatchery infrastructure is divided into distinct, isolated units

1. **Quarantine facility:** Physically isolated from all other sectors, this zone receives wild or external broodstock candidates. It operates on an independent, zero-discharge recirculating aquaculture system (RAS) or tank-based systems. Incoming wild fishes or farmed reared fishes are treated in the quarantine facility to ensure incoming pathogens are isolated and eradicated before entry into broodstock unit. The quarantine facility should be placed either near to the entrance of the hatchery or far off from the production area to avoid cross contamination. Generally the quarantine period varies from 1 to several weeks and are carried out in small tanks of 1-2 m³ to facilitate easy handling.
2. **Broodstock Maturation and Spawning facility:** A controlled environment housing large-volume tank. Broodstock holding facilities are fundamental hatchery components designed to maintain optimal numbers of parent (brood) fish, guaranteeing the reliable production and delivery of high-quality fertilized eggs to larval rearing units. It features restricted access, photoperiod-regulated lighting, and independent climate control to manipulate seasonal spawning cues.

The positioning of these facilities, either indoors or outdoors depends entirely on the physiological requirements of the broodfish. Indoor setups are typically reserved for species that require strict regulation of temperature and photoperiods. Enclosed indoor facilities protect broodstock from environmental fluctuations. Holding tanks must feature reliable water supply, aeration, and lighting to promote gonadal development. During the design phase, ensure adequate space near the tanks to house Recirculation Aquaculture System (RAS) equipment, such as mechanical and biological filters, pumps, sterilizers, and temperature-control units. In contrast, outdoor systems are primarily utilized for the long-term maintenance of immature fish or as quarantine zones for treating wild-caught and post-spawned (spent) brooders before they are relocated to indoor environments.

Broodstock tanks serve multiple purposes, including the culture, maturation, and spawning of the fish. Depending on the species and size of the fish, tank capacities range from 10 to 100 m³



with depths between 2 and 2.5 meters. While tanks can be circular, square, or rectangular with rounded corners, a round design is generally preferred. For optimal results, the interior should be a medium-range blue, green, or grey. For smaller species like berda, rabbit fish, a separate spawning tank of 1-2 m³ is used as spawning tank. Fertilized eggs are collected using surface egg collectors or overflow systems before being transferred to incubation tanks. In RAS, a 500 µm mesh size bag is tied in egg collecting chamber to collect the eggs.

3. Egg Incubation and Larval Rearing Facility (LRF)

The fertilised eggs collected from broodstock/spawning tanks are incubated in incubation tanks till hatching. Most of the times, the hatched-out larvae in incubation tanks are reared in the incubation tanks itself till metamorphosis. The Larval Rearing Facility (LRF) is the biological core of the hatchery, where newly hatched larvae develop into functional post-larvae. This phase is characterized by rapid morphological transformations and high sensitivity to environmental variables.

This unit shall be separate from all other units and have proper bio security to avoid cross contamination from outside and within the facility. Larval tanks are usually circular fiberglass tanks with smooth internal surfaces. Tank capacities range from 1 ton to 20 tons



depending on the species and production scale. The hatched-out fish larvae will be initially fed on live feed and on later stage gradually weaned from live feed to formulated pellet diets.

4. Live Feed Production Facility (Microalgae & Copepod/Rotifer/Artemia Cultures):

As the larvae of most marine finfish are extremely small and possess underdeveloped digestive tracts at first feeding, they cannot utilize inert commercial crumbles. The live feed production sector functions as a specialized primary factory within the hatchery, culturing live planktonic organisms to serve as nutrient delivery capsules. Each live feed unit must be housed in separate designated bio secured area to avoid cross contamination and should be provided with proper aeration supply, treated seawater and fresh water supply

lines, lighting, proper floor slopping and drainage system. The size and area of the unit should be decided based on the requirement of each live feeds.

Microalgae provide food for rotifers, bivalve larvae, and directly for certain marine larvae. Microalgae unit includes stock culture section, starter culture section, indoor culture section and outdoor mass culture area. The stock and starter culture section can be housed in same room provided with air conditioning facility. In this section, microalgae are maintained as stock in glass test tubes (20 ml) or conical flasks (100 ml to 500 ml) and cultured as starter cultures in conical flasks/haffkine's flasks (100 ml to 5 L) and in 20 litre carboys. In the indoor intermediate section, microalgae are cultured in large quantities in FRP of 100-1000 L. In outdoor culture section, microalgae are cultured in large quantities in FRP/ concrete tanks with a capacity of 5 -10 tons.

Rotifers (*Brachionus spp.*) are small, slow-moving zooplankton utilized as the first live prey for marine larvae. They are cultured at high densities (500 to 2,000 nos./mL) in dedicated 1-10 t capacity tanks based on requirements. The conical design of tank is suitable for effective bottom aeration to keep the rotifers and their feed in suspension, and simplifies harvesting and regular debris removal. As the rotifers naturally lack essential highly unsaturated fatty acids (HUFAs) like DHA and EPA required by marine finfish, they should be enriched for 4-6 hrs with microalgae or commercial enrichment products.

Copepod culture unit is essential in marine fish hatcheries for rearing of larvae with small mouth. Copepods are also more nutritionally Stock culture can be done in tanks of 50-500 L capacity. Tanks of PVC, HDPE or fibre are ideal. Cement tanks are not preferred for stock culture. For stock culture, white colour or light colours are desirable because it gives an idea about the population and health of copepods. Dark colour tanks of 1000-5000 L are ideal for mass culture. The production of *Artemia* larval stages are usually carried out in adjacent area to the rotifer culture unit. Separate seawater and freshwater lines, aeration lines should be provided. The tanks should be made of FRP material with conical bottom for easy harvest of nauplii. The number of tanks for *Artemia* cyst hatching is based on the requirement for larval rearing.

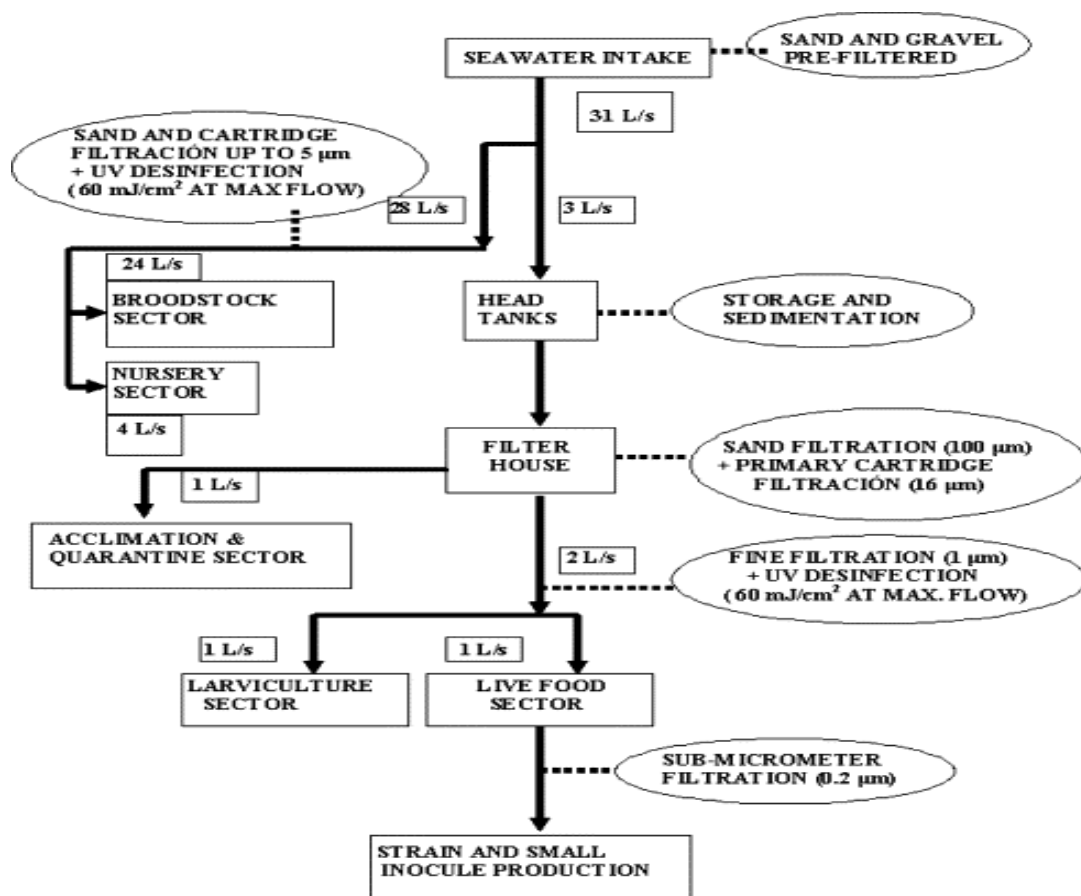
5. **Nursery Facility:** A transitional zone where advanced fry from LRF are adapted to commercial inert diets and variable ambient conditions before field deployment. Nursery rearing is the crucial phase in farming practices, where properly managed and well nurtured individuals will perform better with high growth, better survival, and reduced culture duration in grow-out period. Nursery rearing practices in hatchery is carried out in flow through or recirculation-based concept in FRP or concrete tanks. Circular or square shaped 1-10 tonnes

capacity of FRP tanks or concrete cement tanks with flow through facility having 1 meter water holding height and central drainage system can be employed.

Supporting components

1. Water Supply System

The water supply system is one of the most critical components of a marine hatchery. Continuous access to high-quality seawater is essential for broodstock maintenance, spawning, larval rearing, and live feed production. Seawater is generally pumped using borewell installed in the sea below the low-tide level to ensure uninterrupted water availability throughout the year. During rough season, surface water can be pumped with coarse screens that are installed at the intake point to prevent entry of debris, seaweed, jellyfish, and large organisms. The size and capacity of the pumps are calculated according to the water requirement. Freshwater is also required for cleaning, salinity adjustment, and preparation of culture media. Many hatcheries use borewell water, treated municipal water or rainwater harvesting systems as supplementary freshwater sources.



Simplified diagram flow-chart of seawater distribution and treatment system
(Alvarez-Lajonchère et al, 2007)

2. Water Treatment System

Raw seawater contains suspended particles, microorganisms, plankton, parasites, and potential pathogens. Therefore, it must undergo several treatment steps before use.

The treatment system generally includes:

Sedimentation tanks

Sand filtration

Activated carbon filtration

Cartridge filters

Micron bag filters

UV sterilization

Ozone treatment

Chlorination and dechlorination

Mechanical filtration removes suspended solids, while UV and ozone destroy bacteria, viruses, fungi, and protozoans

3. Air blowers

The capacity of air blower is determined based on the scale of operation and aeration requirement in each section. Small scale hatcheries require 0.5-1.5 hp ring blower whereas large scale commercial hatchery requires 2 HP to 7.5 HP blowers. The capacity of air blower is determined based on the scale of operation and aeration requirement in each section. Small scale hatcheries require 0.5-1.5 hp ring blower whereas large scale commercial hatchery requires 2 HP to 7.5 HP blowers. It is always advisable to have a standby blower in the vent of failure of main blower.

4. Pumping station

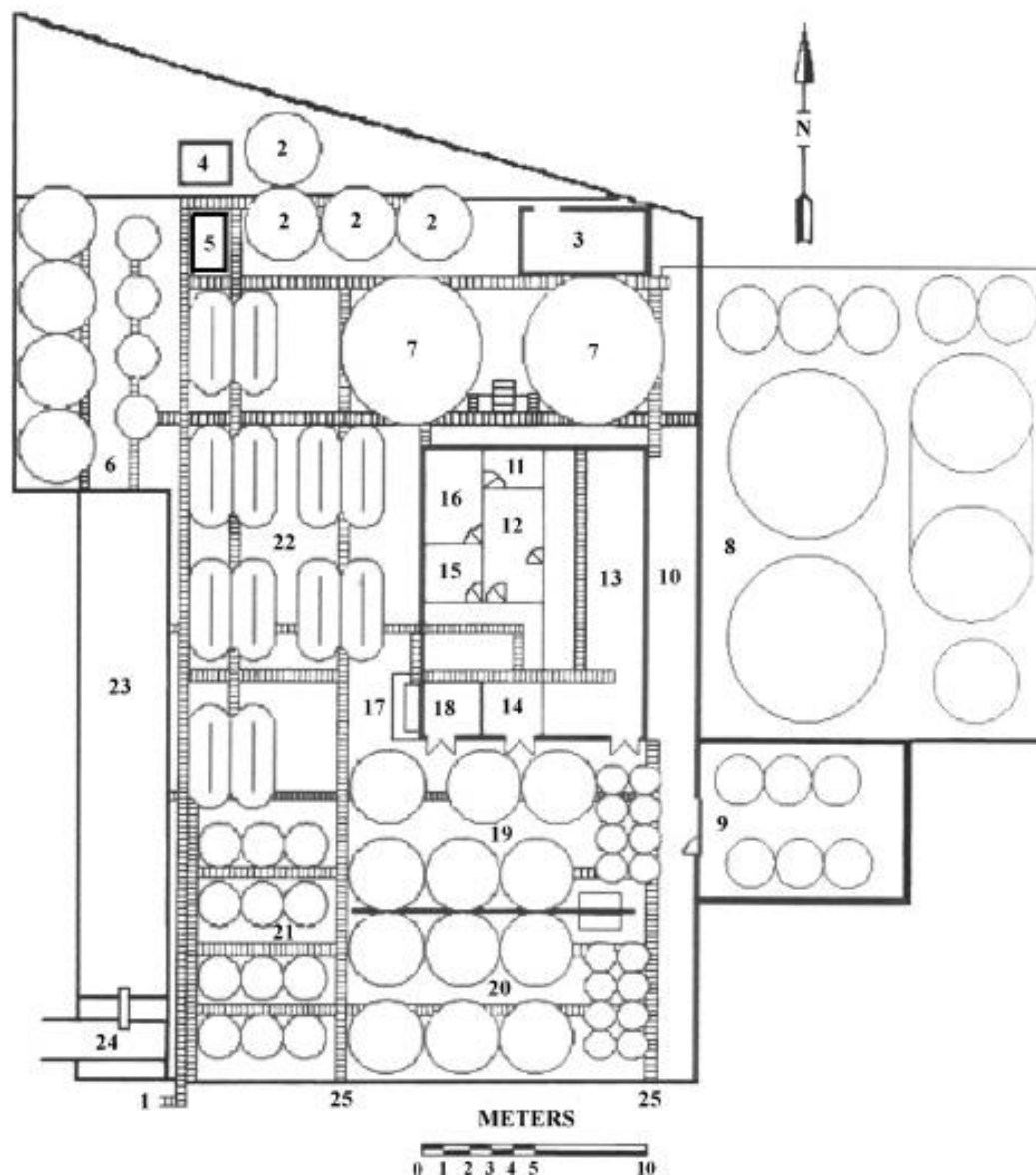
The pumping station of the hatchery should have preferably a seawater pump that can withstand the two pumps each with the capacity to fulfil daily water requirements. The size and capacity of the pumps should be

5. Electricity supply

The hatcheries electrical supply system typically rely on the public electrical service system. Tank areas and rooms sockets should be of waterproof and weatherproof standard. Electrical cables and connections are not kept clear of water tanks, and equipments should be positioned above water lines. The facility should have a backup diesel generator of sufficient capacity. The generator should be able to operate simultaneously most of the essential equipment like blowers, seawater pumps, sand filters, disinfection systems etc...

Common laboratory equipment for a marine hatchery

Compound microscope	Digital weighing balance
Stereomicroscope	pH meter
Haemocytometer	Dissolved oxygen meter
Sedgwick–Rafter counting chamber	Spectrophotometer
Salinity meter	Autoclave
Conductivity meter	Refrigerator and Deep freezer



General plant schematic upper view with all main outdoor and indoor areas of a tropical marine finfish hatchery (Alvarez-Lajonchère et al, 2007)

(1) main supply pipes ; (2) seawater storage 25-tonne tanks; (3) sand and big cartridge filter house; (4) blower house; (5) water treatment area for broostock and nursery areas; (6) acclimation and quarantine sector; (7) 50 m³ broodstock tanks; (8) broodstock tank area; (9) larval rearing room; (10) live food indoor building; (11) microalgae stock room; (12) microalgae

small inocule room; (13) live food 80 and 700 L culture room; (14) zooplankton inocules and rotifer intensive culture room; (15) glass ware washing and sterilization room; (16) general dry laboratory; (17) Artemia cysts decapsulating area; (18) Artemia incubation and enrichment room; (19) microalgae outdoor large scale culture area; (20) zooplankton outdoor large scale culture area; (21) artificial diet experimental tank area; (22) intensive nursery area; (23) stabilizing pond; (24) drainage trench