

Technological advancement in Mariculture in India for production enhancement and sustainability

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Mariculture is the farming and husbandry of marine plants and animals in the marine environment. Mariculture produces many high value finfishes and shellfishes (crustaceans, and molluscs - oysters, mussels and clams). As the production from the capture fisheries reached its sustainable limits, mariculture is the next viable alternative for increasing seafood production of the country. Indian coastline offers immense potential for the expansion of mariculture activities. CMFRI through its research programmes over the years has developed technologies for seed production and farming of bivalves, marine pearl oysters, marine food fishes and ornamental fishes, marine crustaceans and seaweeds.

Existing major mariculture species and farming technologies

Mussel farming

Commonly adopted species for mussel farming are *Perna indica* and *P. viridis*. Various methods for mussel farming like raft method (in bays, inshore waters), rack method (in brackishwater, estuaries) or long line method (open sea) were developed by CMFRI to suit Indian conditions..

Recently CMFRI has perfected spat production and nursery rearing system for green mussel at its Vizhinjam Centre. An average small scale unit can produce 10 million spats /annum. Nursery production of green mussel spat can significantly reduce wild collection of seeds.

Edible oyster farming

Commercially important edible oyster species are *Crassostrea madrasensis*, *C. cucullata* and *C. Gryphoides*. CMFRI has developed methods for edible oyster (*Crassostrea madrasensis*) culture and has produced a complete package of technology, which is presently being widely adopted by small scale farmers in shallow estuaries, bays and backwaters all along the coast. Technology for production of oyster spat was also perfected by CMFRI.

Marine pearl culture

Technology for the production of spherical pearls from *Pinctada fucata* and *Pinctada margaritifera* was developed by CMFRI. Raft culture and rack culture in nearshore areas are the two methods commonly adopted techniques for rearing pearl oysters. Shell bead nucleus (3-8 mm) implantation along with graft tissue is done in the gonads of the oyster through surgical incision for production of pearls. Implanted oysters were stocked in suitable cages for rearing in the farm. Harvesting of Pearls was carried out after 3-12 months and harvested pearls were graded based on their quality as 'A', 'B' and 'C' grades for marketing.

Mabe pearls

Technology for production of image pearls/designer pearls is very simple and can be easily carried out by farmers, unlike the technology for free round pearl production. A Mabe pearl is a dome-shaped or image pearl produced by placing a hemisphere or miniature image against the side of the oyster shell interior. The result is an exquisite pearly nacre-coated miniature image which can be made into pendants, eardrops, rings etc.

Clam Culture

Package of clam culture practices has been developed for the blood clam *Anadara granosa* and *Paphia malabarica*, where production of 40 tonnes/ha/6 months and 15-25 tonnes/ha/4-5 months have been achieved in field trials. Induced spawning and larval rearing to setting of spat has been perfected for clams like *P. malabarica*, *Meretrix meretrix* and *Marcia opima*.

Lobster farming and fattening

Increasing demand for live lobsters in the export market led the farmers and entrepreneurs to collect juvenile lobsters from the wild and grow to marketable size in ponds, cages and tanks by feeding trash fishes and other discards.

Crab farming / fattening

Seed production of the blue swimming crab, *Portunus pelagicus*, has also been developed. Protocols for fattening and grow out in salt water ponds have been successfully developed.

Seaweed Culture

Since 1972 the CMFRI is engaged in the cultivation of important seaweeds such as *Gracilaria edulis*, *Gelidiella acerosa*, *Sargassum wightii*, *Acanthophora spicifera* and *Ulva lactuca*. Earlier, mariculture of seaweeds in India mostly deals with cultivation of *Gracilaria edulis*. Very recently the cultivation of *Kappaphycus sp*, gained popularity among farmers. There are two methods for cultivation of seaweeds - Vegetative propagation using fragments and also by different kinds of spores.

Marine ornamental fish culture and trade

Based on the Global Marine Aquarium Database (GMAD) the annual global trade is between 20 - 24 million numbers for marine

ornamental fish, 11-12 million numbers for corals and 9-10 million for other ornamental invertebrates. A total of 848 numbers of reef associated fishes are reported in Indian waters. Out of which about 350 species are reported to be of ornamental value. Some important ornamental fish families are Family Pomacentridae (Clownfishes and damsel fishes), Family Labridae (Wrasses), Family Scaridae (Parrot fishes), Family Chaetodonidae (butterfly fishes and banner fishes) and Family Acanthuridae (Surgeonfishes).

Marine ornamental fishes are caught in India either as a by-catch in collection practices followed at coral reef habitats inflict damage to the ecosystem.

Hatchery Production of marine ornamental fishes

CMFRI developed package of technologies on broodstock development, captive breeding and larval rearing of several species of marine ornamental fishes. The methodologies developed can be scaled up for commercial level production and a hatchery produced marine ornamental fish trade could be developed in the country. It is high time that the fisheries developmental agencies should come forward with attractive schemes to popularize the technology.

Hatchery technology for following species marine ornamental fishes was developed at CMFRI and these technologies are being transferred to fishermen/women SHG's at various maritime states of the country.

Clown fishes: *Amphiprion sebae*, *A. ocellaris*, *A. percula*, *Premnas biaculeatus*, *A. sandaracinos*, *A. frenatus*, *A. clarkii*.

Damsels: *Dascyllus trimaculatus*, *D. aruanus*, *Pomacentrus caeruleus*, *P. pavo*, *Neopomacentrus nemurus*, *N. filamentous*, *Chrysiptera unimaculata*, *C. cyanea*, *Chormis viridis*, *D. carneus*

Dottybacks: *Pseudochromis dilectus*

Marcia'santhias: *Pseudanthias marcia*

Marine invertibrates: *Rhynchocinetes durbanensis* (Camel shrimp)

Marine Cage farming

In India, the first marine cage (15 m diameter HDPE) was launched by ICAR – Central Marine Fisheries Research Institute in Bay of Bengal off Visakhapatnam coast during May 2007. With further modifications, a revised version of marine cage was fabricated and launched and successful harvest was obtained 2008. Subsequently, for easy manoeuvring and cost effectiveness in terms of reduced labour, the size of the HDPE cages has been reduced to 6 m, which were found to be successful in all maritime states along the coastline. Also cost effective GI cages have been designed for low investment farming operations. Presently, the country has close to 2000 marine cages, wherein marine finfishes (seabass, cobia, grouper, pompano and snapper) and shellfishes (lobster) are commercially reared by private entrepreneurs/fishfarmers with production estimates exceeding 2000 tonnes. Operating Ratio or Cost Benefit Ratio varies between 0.35 to 0.5, depending on the site and the species being farmed. ICAR – Central Marine Fisheries Research Institute has demonstrated that production per m³ in cage farming is 50 times more than shore based (coastal) aquaculture systems. Also, recurring expenditure associated with development and maintenance of infrastructure are lower in cage farming. Stock monitoring is easy and harvesting can be planned as per the demand offering better quality product at higher price.

Production of finfishes from marine cage varies from 15 to 25 kg/m³. Dimensions of the cage, size and density at stocking, species, feed and feed management, cage management and culture

duration are found to significantly influence cage production. Circular HDPE cages of 6 m diameter and 4 m net depth and rectangular or circular GI cages of similar water volume are found best suited. The optimum stocking density is 8 - 10 numbers / m³ for cobia (15 cm/35 g), 15 - 20 numbers / m³ for seabass and grouper (15 cm/40 g) and 30 - 40 numbers / m³ for pompano (10 cm/30 g). Pelleted feed (40 - 45% CP and 10% CF) with FCR of 1:2 provides best production. Culture duration of 6 - 8 months is found to be conducive for all finfish species. Lobster rearing in marine cages has proved to be highly lucrative with fish farmers able to raise more than four times revenue by rearing it within a span of 3 months.

Mapping of suitable cage culture sites

The primary requirement for development of sea cage farming is the selection of suitable sites with required depth, current and water quality parameters. Suitable locations all along the East and West Coast of India for sea cage farming of high value marine finfishes were mapped in GIS platform. Satellite data were also used in identification of suitable sites for cage farming. The available physico-chemical and oceanographic parameter data obtained from Landsat 8 and MODIS satellite data were pooled and used on GIS based platform. The maps were layered, and were combined to generate a final output showing the "most suitable, suitable, moderately suitable and unsuitable", locations for open sea mariculture development along the Gujarat coast. Such maps were developing almost all coastal districts for the easy execution of sea cage farming.

Integrated Multi-Trophic Aquaculture (IMTA)

On a global basis the current mariculture practices are dominated by intensive monocultures which have led to sustainability problems, environmental degradation and consequent disease

outbreaks. Integrated Multi Trophic Aquaculture (IMTA) is the practice which combines in appropriate proportions, the cultivation of fed aquaculture species (eg. finfish/shrimp) with organic extractive aquaculture species (eg. shellfish/herbivorous fish) and inorganic extractive aquaculture species (eg. seaweed) to create balanced systems for environmental stability (bio-mitigation), economic stability (product diversification and risk reduction) and social acceptability (better management practices).

The CMFRI has successfully conducted the demonstration of IMTA under participatory mode with fishermen groups by integrating seaweed with cage farming of cobia. A total of 16 bamboo rafts (12× 12 feet) with 75 Kg of seaweed per raft can be integrated with one cobia (*Rachycentron canadum*) cage of 6 meter diameter. It has been proved that in one crop of 45 days the seaweed rafts integrated with cobia cage will give an average yield of 260 Kg per raft while the same was 150 Kg per raft for the rafts which were not integrated.

Recirculating Aquaculture system

Recirculation aquaculture is essentially a technology for farming fish or other aquatic organisms by re-using the water in the production. The technology is based on the use of mechanical and biological filters, and the method can in principle be used for any species grown in aquaculture such as fish, shrimps, clams, etc. In a recirculation system it is necessary to treat the water continuously to remove the waste products excreted by the fish, and to add oxygen to keep the fish alive and well.

A recirculation system is in fact quite simple. From the outlet of the fish tanks the water flows to a mechanical filter and further on to a biological filter before it is aerated and stripped of carbon dioxide and returned to the fish tanks. This is the basic principle of recirculation. Several other facilities can be added, such as

oxygenation with pure oxygen, ultraviolet light or ozone disinfection, automatic pH regulation, heat exchanging, denitrification, etc. depending on the exact requirements.

Hatchery technology for marine finfishes

Non availability of the seed for farming in quantity and quality at the right time, will affect the production plans of an aquaculture enterprise. . Most of the world's fish aquaculture still depend on the fry almost comes exclusively from wild. Seed supply from the wild is often unpredictable and seasonal. Hatchery production of seeds of economically important finfish ensures a steady supply of quality seeds for aquaculture operations.

CMFRI has developed hatchery production technologies for marine food fishes like Cobia (*Rachycentron canadum*), Silver Pompano (*Trachinotus blochii*), Indian Pompano *Trachinotus mookalee*), Orange spotted grouper *Epinephelus coioides* and Pink ear emperor (*Lethrinus lentjan*). A constant survival rate of 10-25% was obtained in hatchery production of these species in hatcheries.

Operating procedures for broodstock maintenance, induced breeding, larval rearing and nursery rearing of all these 5 species was standardised and the technology packages were transferred to promising entrepreneurs through consultancy services of the institute.

Live feeds

Live feeds like microalgae, rotifers and copepods are very much essential for larval rearing of marine finfish larvae. The technologies were developed for culture of these live feeds in large quantities in tanks as a feed for larvae at CMFRI.

Conclusion

India is still in infancy in mariculture production in comparison with the global scenario. When we compare the situation in the Asia-Pacific region also, we can find that a lot of advances have been made in the development and expansion of mariculture. Since, mariculture is the only sunrise sector for increasing seafood production in the coming years, the research and development in this sector is of paramount importance to develop mariculture as a substantial contributor of seafood production in the country.

