

Mariculture research towards a sustainable blue revolution in India

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Mariculture involves the cultivation of marine organisms in seawater for food and other products either in the open ocean, an enclosed section of the ocean, or in tanks, ponds or raceways. About 600 aquatic species are cultured all over the world in a variety of farming systems and facilities of varying input intensities and technological sophistication. Mariculture activities other than for human consumption include live bait farming for fishing, live ornamental animal and plant species and ornamental products (pearls and shells), fishes cultured as feed for certain carnivorous farmed species, culture of live feed organisms such as plankton, Artemia and marine worms for use as feed in hatcheries and grow-out systems, aquaculture hatchery and nursery outputs for on-growing in captivity or stocking to the wild and capture based aquaculture. Asia accounted for 89% of world aquaculture production by volume in 2010, up from 87.7% in 2000. Mariculture represents an opportunity to provide a sustainable supplement to the marine

capture fishery. Mariculture has a relatively long history, while, the modern intensive mariculture is only 35 years old, producing a steadily increasing proportion of the world's seafood during this period. Aquaculture production currently makes up almost half of the marine capture fisheries. Moreover, aquaculture production has more than doubled over the last fifteen years and this trend is continuing whilst traditional fishing production is declining as a result of over exploitation. But aquaculture, both in inland waters and marine and coastal areas, has problems, including habitat degradation, disruption of trophic systems, depletion of natural seed-stock, transmission of diseases, and reduction of genetic variability. To solve these problems it is needed to diversify aquaculture and improve its sustainability. In particular, we need to better understand possible interactions between mariculture and natural environments to minimize the potential for habitat degradation, introduction of invasive alien species, etc.

The ICAR-Central Marine Fisheries Research Institute (CMFRI), the premier marine fisheries research institute in India has been taking up active interest in mariculture since its inception in 1947 and many technologies have been developed by the Institute during the past six decades. The earlier investigations were mainly directed to obtain the basic information on the biology of the cultivable species and on the environment in which they live. At a later stage, increased awareness on the importance of mariculture in augmenting fish production and improving rural economy has provided greater emphasis and thrust on mariculture research by CMFRI. The need for mariculture in India was emphasized by CMFRI in 1952, by advocating the conversion of low-lying areas along the Indian coast, which yield nothing, into fish farms. Although a variety of marine organisms suitable for culture were available in the country, the initial investigations were mostly concentrated on shell fishes (molluscs and crustaceans) in view of their greater economic importance at that time.

Mussel farming became the main focus for mariculture during the seventies. In 1975, culture of green mussel in the open sea at Kozhikode employing raft-culture techniques was taken up and the production rate for a period of 5 months amounted to 235 tonnes/ha. The technique of rope culture was yielding 150 tonnes of mussels/ha/year at Vizhinjam near Trivandrum (Achari, 1975). Culture of green mussels on rafts in the open sea at Kovalam near Madras also yielded commendable results. Commercial mussel farming gained rapid strides since 1996 in India. In the recent years mussel farming showed spectacular improvements with the farmed mussel production of the country reaching a total of about 20,000 tonnes. Though efforts to popularize the technology were undertaken in the States of Kerala, Karnataka, Goa, Maharashtra and Tamil Nadu

a quantum leap in the mussel production was observed only in the state of Kerala mainly due to the preference of mussel meat in Kerala. The availability of large extent of natural mussel beds along the Indian coast for sourcing the seeds, high price realized for the produce in domestic market, minimal operational expenditure and short term eco-friendly farming techniques are all positive note for more farmers to adopt the practice in future years.

One of the remarkable contributions of CMFRI which made to promote mariculture in our country was the successful development of the techniques of pearl production under controlled conditions. Researches leading to this achievement were started in 1972 using pearl oyster *Pinctada fucata* cultured by the raft culture method and by artificial nucleus implantation. On shore pearl production was also attempted and made successful.

CMFRI had taken up investigations on edible oyster *Crassostrea madrasensis* culture in late 1970s. The techniques of oyster culture includes collection of spat and growing them to marketable size by different methods such as rack culture, long-line culture, pole culture and tray culture. Farming is not widespread in the country and that practiced on a very small scale at certain locations in Kerala also requires to be expanded. The two major concerns which have to be addressed are the low value- high volume production of spat to cater to the seed requirement and the development of suitable marketing channel. Culture of the backwater clam, *Meretrix casta*, was initiated at Porto Novo in Tamil Nadu and at Buminipatnam in Andhra Pradesh and that of cockle, *Anadara granosa* at Kakinada in Andhra Pradesh. As such no commercial farming for any of these species are prevalent in the country.

CMFRI has carried out a series of demonstrations on culture of marine prawns with a view to transfer the technology developed by it to the actual farmers

and to promote prawn culture on scientific lines during 1970s. The result of some of these demonstrations has resulted in widespread farming of prawns at different states in the country. CMFRI established the field laboratory at Narakkal, Cochin in 1974 under the Scheme, Culture and propagation of marine prawns and as a result of the investigations carried out at this centre, commercial prawns such as *Fenneropenaeus indicus*, *Penaeus monodon*, *Metapenaeus monoceros*, *M. dobsoni*, *M. affinis* and *Parapenaeopsis stylifera* spawned in the laboratory and their larvae were reared through different stages up to stocking size under controlled conditions. The Seed production of prawns by induced maturation through eyestalk ablation by CMFRI has made revolutionary change in the hatchery technology for prawns. This has resulted in widespread establishment of prawn hatcheries in the country with further innovations and modifications of the technology by hatchery operators and entrepreneurs. Seed production of marine blue swimmer crab *Portunus pelagicus* was developed by CMFRI and farming in ponds was also initiated. Among crustaceans, shrimp has been produced in coastal ponds in the country and about 300,000 tonnes of American white shrimp *Litopenaeus vannamei* is produced in the country outpacing the tiger shrimp *Penaeus monodon*. However, the two promising marine crustacean species are the blue swimmer crab *Portunus pelagicus* and the sand lobster *Thenus orientalis*. Though seed productions of these species have been developed by CMFRI, commercial level seed production technology for both the species are yet to be achieved.

Culture of seaweeds was initiated by CMFRI during late 1970s and was mainly carried out at Mandapam and Tuticorin, along the southeast coast of India. Though CMFRI is in a lower profile now in seaweed culture, the majority commercial farms of

Kappaphycus alvarezii are located along these coasts in the country.

The Institute was also successful in culture of other marine organisms such as sponges, holothurians and marine turtles. Among the echinoderms occurring in India, holothurians belonging to the families Holothuridae and Stichopodidae are commercially important. *Holothuria scabra* were widely fished, processed and exported as *Beche-de-mer* till late 1990s and of late it is banned due to over exploitation. CMFRI found the species to be suitable for conservation mariculture and has successfully developed the seed production technology during 1990s.

For production of live feed for molluscan and prawn larvae in the hatchery CMFRI has isolated and maintain the stock and mass culture of phytoplankters such as *Tetraselmis gracilis*, *Chlorella marina*, *Isochrysis galbana*, *Chaetoceros calcitrans*, *Skeletonema coastatum* etc. Mass culture of rotifer *Brachionus plicatilis* and *B. rotundiformis* are also carried out in the institute. Other zooplankters, calanoid, cyclopoid and harpacticoid copepods are also cultured in the hatcheries of the institute at different locations in the country.

Marine finfish mariculture was initiated of recent, since it was felt that fish seed production also is essential for the country to meet the ever increasing demand for fish. The concerted efforts of more than a decade or so, CMFRI could achieve the seed production of cobia *Rachycentron canadum* and silver pompano *Trachinotus blochii* during 2009-10.

With global expansion of marine ornamental fish industry about 20 to 25 million marine ornamental fishes are traded annually. Nearly 98% of the marine ornamental species marketed are wild, collected mainly from coral reefs of tropical developing countries. This has been demonstrated as a viable enterprise in India threatening the long term

sustainability of the trade due mainly to indiscriminate exploitation of coral reef areas, leading to degradation of the reef habitat and over exploitation of desired species. In this context CMFRI has been focusing on this aspect for the past few years and a variety of marine ornamental fishes have been bred by the institute. Techniques for broodstock development, breeding and seed production of 16 species of pomacentrids were developed and standardized by CMFRI.

CMFRI has pioneered in open sea cage culture during the last decade and has standardized cage design and mooring for Indian waters. Many species of finfishes like Asian sea bass, cobia, pompano, mullets and pearl spot were successfully reared in cages in different maritime states of the country. Among shellfishes capture based aquaculture of spiny lobsters were found to be highly profitable. CMFRI has also set up a model for community development through cage culture as in the case for *Sidi* tribe in Gujarat. Cage culture developed and popularized by CMFRI was developed as a social movement and the progress made in the coastal community in different maritime states can well be taken as a model for community development through public-private-

partnership (PPP) mode. At present more than 300 cages are operated along the Indian coast in PPP mode and in the coming decade, sea cage farming will be a major fish production system in the country.

In the world scenario, contribution of India in mariculture production is very negligible. However, the contribution of CMFRI towards development of mariculture technologies are significant. In India mariculture sector is looked forward as the sector for increasing seafood production in the coming years leading into a blue revolution to provide cheaper protein and healthy food to the domestic and international populations. The role of developmental agencies as partners is prerequisite and very essential for transfer of technology through massive demonstrations. The role of agencies like National Fisheries Development Board (NFDB), Hyderabad, Marine Products Export Development Authority (MPEDA), Kochi, National Bank for Agriculture and Rural Development (NABARD) *etc.* is crucial in mariculture. Subsidies have to be pursued until the industry is well established in the country. Promotion of mariculture through natural resource management has to be emphasized for years to come towards development of sustainable mariculture in India.