Mariculture for Income, Employment and Empowerment

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Mariculture involves the cultivation of marine organisms for food and other products in an enclosed section of the sea (cages/pens), or in tanks, recirculating systems, ponds or raceways in seawater. It is a promising sector by which the additional marine fish requirement can be met in the future years. It is also the fastest growing sub-sector of aquaculture. At global level, mariculture produces many high valued finfishes, crustaceans and molluscs *viz.* oysters, mussels, clams, cockles and scallops. Total fisheries and aquaculture production reached a record 214 million tonnes in 2020, comprising 178 million tonnes of aquatic animals and 36 million tonnes of algae and consumption has now reached 20.2 kg per capita, more than double the consumption in the 1960s (SOFIA, 2022). An estimated 58.5 million people were employed in the primary sector. It is estimated that about 600 million livelihoods depend at least partially on fisheries and aquaculture for subsistence and secondary sector workers and their dependents. In 2020, the global aquaculture production was 122.6 million tonnes, with a total value of USD 281.5 billion. Aquatic animals accounted for 87.5 million tonnes and algae comprised 35.1 million tonnes. India is the world's second-largest aquaculture nation and the third-largest fish producer after China. Aquaculture in brackish or saline water has flourished in India. Farmed shrimp production increased from 20 MT in 1970 to 7.47 lakh MT in 2020. Presently, India produces 7.96% of the world's fish. The total fish output for 2020–21 was 14.73 million metric tonnes (MMT), with contributions from the inland and marine sectors at 11.25 MMT and 3.48 MMT, respectively.

Government initiatives

Through concerted and collaborative efforts by the government and private sectors, India's fisheries and aquaculture sectors have made remarkable advancements towards modernisation and sustainable economic growth over the past few years. The government of India, has recognised the substantial potential of this industry and unveiled the Pradhan Mantri Matsya Sampada Yojana (PMMSY), a new flagship programme with a significant investment of Rs.20,050 crores (US$ 2.46 billion) for the growth and expansion of fisheries sector in the country.

The main objectives of PMMSY are:

- Utilising the potential of fisheries in an equitable, responsible, inclusive and sustainable way

- Expanding, intensifying, diversifying and productively using land and water to increase fish production and productivity
- Doubling the incomes of fish farmers and fishermen and creating more jobs
- Ensuring social, physical and economic security of fishers and fish farmers
- Creating a solid regulatory and management framework for fisheries
- Increasing contribution to agriculture's gross value added (GVA) and exports

The Department of Fisheries, Ministry of Fisheries, Animal Husbandry and Dairying, Government of India is implementing the PMMSY in an effective manner in the country.

Indigenous and cost-effective farming technologies

i) Shrimp seed production and farming

Shrimp farming started in India in the early 90s especially in the coastal districts of Andhra Pradesh and Tamil Nadu. So far, shrimp remains as the single largest and maximum value earner among the seafood exported from the country. Shrimp farming in India, till 2008, was synonymous with the monoculture of tiger shrimp, *Penaeus monodon.* Since 1995, culture of *P. monodon* is affected by White Spot Syndrome Virus (WSSV) and the development of shrimp farming has become stagnant. Most of the Southeast Asian countries like Thailand, Vietnam and Indonesia shifted to culture of exotic white leg shrimp, *Litopenaeus vannamei.* The successful development of Specific Pathogen Free (SPF) and Specific Pathogen Resistant (SPR) broodstock of *L. vannamei* also favoured the large scale expansion of its farming. However, in India, pilot-scale introduction of *L. vannamei* was initiated in 2003 and after risk analyses large-scale introduction was permitted in the year 2009. Currently, farming of *L. vannamei* has gained momentum in India and is contributing to the bulk of farmed shrimp production. Of late *L. vannamei* farming is being threatened by outbreak of new diseases namely Early Mortality Syndrome (EMS), Acute Pancreatic and Haematopoietic Necrosis Syndrome (APHNS) and many viral diseases.

Shrimp being a highly valued export commodity, its farming is considered a lucrative industry. Depending on the area of the pond, inputs like seed, feed and management measures like predator control, water exchange through tidal effects or pumping, etc., farming systems have been classified into extensive, modified extensive, semi-intensive and intensive. The farming community has now become more responsive to the concepts of environment-friendliness and sustainable aquaculture. Disease problems are being overcome through adoption of closed system of farming (recirculation system, zero water exchange) in grow outs, application of probiotics, secondary aquaculture of selected fishes like mullets, milkfish, molluscs and seaweeds in reservoirs and drain canals, adoption of indigenous, good quality seed, feed and reduction in stocking density. The recent advances in shrimp farming are directed towards, disease prevention, environment safety and food safety. Bioremediation has assumed a greater importance with the intensification of farming. A number of culture systems have been evolved which incorporates sustainability as the main criteria.

The very fact that diseases are common to many of the shrimp species, the aqua farmers are now desperately looking for additional species for farming. Hence, species

diversification with viable finfish can be one of the best options for a long term solution for sustaining the sector.

ii) Marine finfish seed production and farming

In recent years at global level a rapid growth in marine finfish culture is noted which has shown an average annual growth rate of 9.3% from 1990 onwards. The major finfish groups which are sea farmed include salmonids, amberjacks, sea breams, sea basses, croakers, groupers, mullets, flatfishes, snappers, cobia, pompano, cods, puffers and tunas. The expansion of sea cage farming on a global basis can be attributed as a shot in the arm for the increased farming of marine finfishes. Cage farming has made possible the large-scale production of commercial finfish in many parts of the world and can be considered as the most efficient and economical way of rising fish for doubling or even multiplying farmers' income. The most vital prerequisite for the development of sea cage farming is *technology* for breeding and seed production and the reliable supply of good quality seeds of suitable high value marine finfishes. We have commercial level seed production technology available for the Asian sea bass (*Lates calcarifer)* and pompano *Trachinotus* spp., which are in government set up. Unless an intensified effort on development of private entrepreneurship for commercial level seed production technologies is taken up, marine fish culture cannot emerge as a major seafood production sector in the country. ICAR-Central Marine Fisheries Research Institute (CMFRI) has been actively involved in research commercial level seed production of high valued marine finfish like cobia *Rachycentron canadum*, orange spotted grouper *Epinephelus coioides*, John's snapper *Lutjanus johnii*, Vermiculated spinefoot *Siganus vermiculatuus*,pink ear emperor *Lethrinus lentjan* and Fanged seabream *Sparidentex jamalensis*.

i) Asian seabass *Lates calcarifer*

Comprehensive technology for controlled breeding of seabass was developed in 1997 by ICAR-Central Institute of Brackishwater Aquaculture (CIBA) and since then the technology has been further refined and validated. The technology includes captive broodstock development, acceleration of maturation, providing optimum conditions like water quality management, health management and feed management, induction of spawning through hormonal administration and facilitating natural spawning in the Recirculating Aquaculture System (RAS).

ii) Cobia *Rachycentron canadum*

Fast growth rate, adaptability for captive breeding, low cost of production, good meat quality and high market demand are some of the attributes that makes cobia an excellent species for mariculture. In recent years the seed production and farming of cobia is rapidly gaining momentum in many Asian countries. Envisaging the prospects of cobia farming in India, CMFRI has developed for the first time in the country the broodstock development, breeding and seed production of cobia and several successful seed production trials were conducted. The farming protocols for the hatchery produced cobia fingerlings in sea cages

with different feeding strategies were developed, tested and validated and an economically viable farming model has been evolved.

iii) Silver pompano *Trachinotus blochii* and Indian pompano *T. Mookalee*

Among the many high value marine tropical finfish that could be farmed in India, the silver pompano, *T. blochii* is one of the topmost, mainly due to its fast growth rate, good meat quality and high market demand. It is a much sought after species and hence the demand can only be met through farming. CMFRI has successfully developed and standardised the broodstock development, spawning, larviculture, fingerling production and farming of silver pompano in India. Commercial level seed production has been established in hatcheries in Kerala and Andhra Pradesh.

Indian pompano *T. Mookalee* is faster growing than *T. blochii* and the technology for broodstock development, spawning, seed production and farming in ponds and cages have been standardised by CMFRI.

iv) Orange spotted grouper *Epinephelus coioides*

The species has wide spread domestic as well as live trade market in South East Asian countries. The technology for broodstock development, spawning, seed production and farming in ponds and cages have been standardised by CMFRI.

iii) Ornamental Fish Production

On a global basis marine ornamental fish trade has emerged as a highly profitable business as a low volume high value industry. Central Marine Fisheries Research Institute has pioneered in the development of techniques for breeding, seed production and culture of more than a dozen species of marine ornamental fishes which are in heavy demand in the national and international trade. They include *Amphiprion percula, A. ocellaris, A. perideraion, A. ephippium, Dascyllus aruanus, Pomacentrus caeruleus* and *Chrysiptera cyanea.* Hatchery production and culture of marine tropical ornamental fish is very lucrative due to the high price per unit of ornamental fish.

iv) Recirculating Aquaculture System (RAS)

Closed-system aquaculture presents a new and expanding commercial opportunity. Recirculating aquaculture systems (RAS) are tank-based systems in which fish can be grown at high density under controlled environmental conditions. They are closed-loop facilities that retain and treat the water within the system. In a RAS, water flows from a fish tank through a treatment process and is then returned to the tank, hence the term recirculating aquaculture systems. Recirculation systems use land based units to pump water in a closed loop through fish rearing tanks and consist of a series of sub-systems for water treatment which include equipments for solids removal, biological filtration, heating or cooling, dissolved gas control, water sterilization and photo-thermal control. Sustainable production of bio-secure cobia seed all through the year employing photo-thermal conditioning is possible only by recirculating systems.

v) Cage Farming

Cage farming is considered as the future of fish production in India. It is presumed that of the Indian sea coast which spans to 8129 km at least 1% can be brought under cage farming in the coming few years. Cage farming can be established in sea, estuaries, brackishwater or in rivers as per the requirement and convenience of the site. After identifying a suitable site that meets the required parameters, cost-effective cages of different dimensions can be installed with proper permissions from the local authorities.

Enhancing Income, employment and empowerment through mariculture

The strategies and means for income multiplication, employment generation and empowerment of weaker sections through mariculture activities are given below:

- Developing seed production units near farm sites (for shrimp/fish/molluscs). This can reduce the cost of transport charges and oxygen packing incurred during seed procurement. The seed quality also will be better which would reduce the loss of seed on any exigencies during long distance transport. More farms also will become operational in such instances and thereby production will be enhanced.
- Establishment of nursery rearing units for hatchery produced fish fry at different locations to rear them up to fingerling/or size ready to stock in cages or ponds. By doing integration of activities additional income can be earned by family members.
- Establishment of feed mills along all the coastal districts so that smaller units would flourish with involvement of small scale entrepreneurs. Feed ingredient supply units also can be established at farm levels so that availability of ingredients will be assured for feed mills.
- Establishment of cage and net fabrication units wherever cage culture activities are going on. Indigenous designs and materials to be promoted by levying extra duty on imported items. There should be quality assurance in all instances to assure safety and security of items thus manufactured.
- Establishing post-harvest facilities for regular supply and assurance of product quality. Farmers should be promoted to sell their products at premium price without intervention of middlemen. Direct sale at farm sites to be promoted to assure product quality.
- Post-harvest processing of surplus/excess produce to be promoted. Use of by-products for any other purpose like nutraceuticals, medicines, or manures to be encouraged so that farmers will ensure additional income from their produce.
- Human resource development at all levels of aquaculture production has to be assured, so that farmers can have their own trained personnel in every aspect of farming operations.
- Analytical labs to be established as many as possible, based on requirement and extent of farming, so that immediate attention will be obtained to farmers at any stage of farming.

- Establishment of shore based RAS and aquaponics for fish farming in areas constrained with regular water exchange or land availability.
- Continuous R & D activities for updating of technologies and farming operations

Linkage with research institutions, developmental bodies and government establishments are to be made mandatory for all farmers to ensure success of any activity related to aquaculture and proper dissipation of technology as well as financial benefits through schemes.

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