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44 Perspective on coastal aquaculture in India

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ABSTRACT

The slow growth rate in marine capture fisheries of the coastal sector world over, capital intensive and risk prone deep sea and oceanic harvest coupled with great demand for target groups for domestic and export markets have created a pressing necessity to evolve viable options for aquaculture of most wanted species. Although the aquaculture is rapidly growing in the Asia-Pacific region, its techno-economic and commercial viability in Indian condition is yet to be demonstrated and practiced except in the case of some shrimps and bivalves. Eventhough the country is blessed with vast cultivable coastal and brackish water areas and with rich potentially cultivable candidate species for farming (20 species of finfishes, 29 crustaceans, 17 molluscs, 7 seaweeds and many other species of ancilliary resources), we have yet to go a long way to achieve our targets in aquaculture. The paper reviews the R&D works carried out by CMFRI for crustacean, molluscan, finfish mariculture, seaweed culture and their developmental programmes required to be undertaken in the future.

Introduction

Aquaculture has emerged as a major activity to enhance fish production in the developing countries in recent years both for domestic consumption and for export. Since 1984 the Food and Agricultural Organisation of the United Nations has been making all efforts to augment fish production through aquaculture in most of the developing countries, especially in Asia. The global fisheries growth rate during the last decade (1984-94) is 3.2% per year; whereas the aquaculture growth is estimated around 9.6% per year. The slow growth rate of world capture fisheries coupled with the greater demand for both domestic and export points to the necessity for evolving suitable options for increased production either

through deep sea and oceanic harvest or by aquaculture. The former is capital intensive, risk prone, and the marketing of non-conventional deep sea resources and their economic harvest and post harvest technologies are yet to take off at commercial level; whereas the latter is techno-economically viable and eco-friendly. Production through aquaculture is rapidly growing in Asia-Pacific region and the countries such as China, Japan, India, Korean Republic, Indonesia, Philippines, Thailand and Vietnam which produce more than 80% of world's farmed aquatic products. Asia being the cradle of aquaculture continues to be the dominent area in the world in the production of aquatic plants and animals such as fish, shrimp, mollusca and seaweed.

In the world aquaculture production of 22.6 million in 1993, fishes contribute 49.5% followed by aquatic plants 27.7%, molluscs 18.2%, crustaceans 4.1% and others 0.5%. Asia contribute 85.8% followed by Europe 7.3%, N. America 3.5%, S. America 1.5%, former USSR 1.1%, Africa 0.47% and Oceanica 0.4%. The world aquaculture scenario is mainly occupied by fresh water farming (41.4% of global aquaculture production of 1992). Where as the mariculture/brackishwater aquaculture remains a new frontier and continues to experience ups and downs which typifies frontier situations.

India is endowed with a long coastline of 8129 km, 0.5 million sq.km of continental shelf, 2.02 million sq.km of EEZ and a catchable annual marine fishery potential of 3.9 million tonnes. The Indian marine fisheries sector plays an important role in supplying protein-rich food to the increasing population, employment potential and foreign exchange earning. The vast shallow water areas all along the coastline offer ideal site for seafarming and coastal mariculture. The present marine fisheries scenario is characterised by declining yields from inshore waters, increasing conflict between different resource users, increasing demand for domestic use, export diversification and prospects for large scale seafarming and coastal mariculture. In India 58% of the total aquaculture production is from freshwater . As the commercial fisheries from the coastal aeas upto 50 m depth have almost touched the potential of 2.21 million tonnes, no more additional mechanised fleet in the coastal water is recommended. This situation can lead to reduction of active fishing man days and idling time for vessels and other coastal postharvest infrastructure facilities.

These idling mandays could be profitably utilised through their involvement in mariculture/aquaculture.

In India the traditional system of coastal aquaculture is done in about 50,000 ha in the low lying estuarine areas in West Bengal, Kerala, Karnataka and Goa and this has been in equilibrium with the environment. Government, as part of aquaculture development activities, has encouraged farmers to develop an additional 50,000 ha over a period of 10 years under extensive to intensive culture of shrimp. In 1994-95 the aquaculture production of shrimp is estimated as 74,850 t from the 1,00,000 ha of brackishwater area placing India 4th among the shrimp culture countries of the world. Besides the brackishwater area, the shallow coastal areas upto a depth of 30 m is suitable for seafarming of 20 species of finfishes, 29 crustaceans, 17 molluscs, 7 seaweeds and many species of ornamental fishes, seacucumber and other invertebrates (corals, sponges, gorgonids, ascidians, gastropods, king crab)of potential drug/pharmaceutical importances.

The Central Marine Fisheries Research Institute (CMFRI) had developed many need based technologies for farming prime value candidate species of crustacean, molluscs and finfishes and relevant physical and infrastructure facilities at Mandapam,Tuticorin, Madras, Vizhinjam, Calicut and Cochin. But many mariculture technologies did not take off in commercial scale for want of public awareness and entrepreneurship. With the diversification of Indian marine products export, many species of crustacean, molluscs and finfishes, either in preserved, processed and value added from or in live condition gain considerable importance during the last few years. This situation gave impetus to venture into commercial sea farming by many farmers and entrepreneurs.

Crustacean mariculture

In the global aquaculture production, crustacean contribution is less than 1 million metric tonne and the group is dominated by shrimps, lobsters and crabs. The major producers of cultured crustaceans are Thailand, Ecuador, Indonesia, India, Taiwan, USA and Australia. In the global shrimp farming scenario *Penaeus monodon* accounts for 61% of the total shrimp aquaculture harvest followed by *P. vannameii* (15%), *P. merquiensis* (7.5%), *P. indicus* (5.7%) and others. Although shrimp cul-

ture is practised traditionally in India, scientific farming is comparatively young and it became commercialised only recently. With the scientific support from CMFRI now the country could produce through traditional extensive and semi-intensive farming about 83,000 tonnes (1995) from an area of 80.000 ha spread over West Bengal, Kerala, Andhra Pradesh, Orissa, Tamil Nadu and Karnataka. In terms of water area 65% was under traditional and extensive systems. Productionwise *P. monodon* contibuted 75% and *P. indicus* 20%. Since Govt. of India's economic reform process and the rupee becoming fully convertible and trade procedures getting simple in the last couple of years there has been an unusual rush towards shrimp culture and more and more entrepreneurs/industrialists entered the arena, often leading to disproportionate growth of semi-intensive farming along Andhra Pradesh and Tamil Nadu. As a result, in order to meet the seed requirements, many hatcheries for prawns came into existence (70 hatcheries with the total capacity of 3,900 million seeds of *P. indicus, P. monodon. Macrobrachium rosenbergii* etc. at different parts along both the coasts. Similarly more than 30 feed mills operate along different parts of coast with an annual production capacity of 60,000 tonnes of prawn feed. In the process of the semi-intensive culture, often the carrying capacity of the environment was not taken care of; with the result the environmental stress caused widespread mortality through parasitic infestation and system generated pollution hazards.

Increasing demand for live lobsters and crabs in export market further kindled the interest of farmers and entrepreneurs to collect juvenile lobsters and crabs from the wild and grow these to the marketable size in ponds and tanks by feeding trash fishes and other discarded bycatch. In many maritime states juvenile lobsters, pueruli of *Panulirus homarus, P. ornatus, P. polyphagus* and *Thenus orientalis* are grown in captivity and the eye stalk ablated lobsters attained 180-200gms in 5-6 months period. This type of lobster fattening at a stocking density of 10-15 young ones per squre meter yielded appreciable growth rate with profit margin of Rs.50,000/- from a pond of 70m^2. Similarly the juveniles of crabs such as *Scylla serrata, S. tranqubarica, Portunus pelagics* etc. are fattened in tanks, cages and earthern ponds with a growth rate of 10-29 gms/months. The estimated production rate in ponds ranged from 500-700 kg/ha. Recently the CMFRI has achieved success in the hatchery production of marine pelagic crab *Neptunus pelagicus* in its Mandapam laboratory. The lobster

and crab fattening is slowly getting commercialised in Kerala, Andhra Pradesh, Tamil Nadu and Gujarat. In recent years the culture of *Macrobrachium* is also gaining momentum.

Developmental programmes: Considering the scope for development of shrimp farming in India,Government has set up a Brackishwater Fish Farmers Development Agency with its district level units spread over 9 maritime states. BFFDA's provide a package of technical, financial and extension support to shrimp farmers. The government has taken up a number of steps for upgradation of technology through bilaterally and internationally funded programme. The Department of Agricultural and Cooperation constituted an Expert Committee with representations of various ministeries/departments, selected coastal states, MPEDA,ICAR Fisheries Institutes, Aquaculture Industry etc., to evolve guidelines which could be suggested to the State Pollution Control Boards and Agriculture units besides State Government and other end users for guidance and adoption. The guidelines formulated by this Expert group outlines the measures to be adopted for development of sustainable aquaculture as an ecofriendly farming activity, reducing the adverse impact of the waste water discharged from shrimp aquaculture units, treatment of such waste and mitigation of adverse impact of aquaculture on environment. For sustainable development and management of shrimp farming some of the measures suggested are:

1. Scientific extensive and semi-extensive farming.
2. 2 tonne/ha/yr production for extensive and 5 tonne/ha/yr from semi-intensive in two crops.
3. No construction within the natural mangrove area or ecologically sensitive wet lands, swamps etc.
4. Conversion of agriculture land for aquaculture should be discouraged.
5. Detailed master plan for development of aquaculture using remote sensing data, GIS and socio-economic packages should be evolved.
6. Environment Impact Assessment (EIA) studies should be made at planning stage itself for aquaculture units above 40 ha.
7. Stocking desities should be less than 1-5 pl/sq. m for extensive farm

and 15 pl/sq.m for semi-extensive system.

8. Use of wet diets to be avoided.

9. Organic load in the pond should match with the carrying capacity of outside environment.

10. Use of chemical inorganic fertilisers, chemical piscicides, chemical/ hormonal growth promoters, chemotherapeutents, antibiotics/drugs etc. in shrimp pond should be avoided.

11. Introduction of imported shrimp seed and use of exotic seed in culture system should be prohibited.

12. Access to sea front and common resources to the coastal communities to be ensured. Encourage rotation of crops instead of monocropping to avoid environmental stress. As far as possible use only locally available species for farming.

13. Saltwater incursion from shrimp farms to nearby agricultural land and ground water sources to be prevented.

14. Water spread area of the farm shall not exceed 60% of the total land area.

15. About 10% of the total pond area is to be provided/equiped with waste water treatment and secondary aquaculture practices.

Apart from these, research thrust on upgradation of hatchery technologies for *P. semisulcatus*, *P. merguensis*, *P. pencillatus*, marine crabs, rock and sand lobsters and the threatned king crab, development of effective sea ranching programmes and development of indigenous feed formulations for crustacean mariculture and microencapsulate feed for crustacean larvae are also suggested.

Molluscan mariculture

Molluscs form about 18% of global aquaculture production. Of a large number of molluscs occurring in India the major species suitable for coastal mariculture with high growth rate are mussels, oysters, clams and pearl oyster. If appropriate culture technologies are applied, all these bivalves could be mass produced. The Central Marine Fisheries Research Institute has perfected technologies for mussel culture in ropes suspended

from rafts and longlines along the coastal waters of 3-10 m depth realm. The production rates which varied from 5-12 kg/m rope/5-6 months are very impressive and proved to be economically viable. Mussel farming in estuaries of southwest coast has also been initiated in 1996 with technical helps from the CMFRI and financial assistance from governmental agencies. Groups of farmers in the coastal area have taken up the mussel culture as a small-scale farming activity with good profit. The Institute has also developed appropriate indigenous technology for edible oyster culture *(Crassostrea madrasensis)* in brackishwater areas, location tested and was found successful for commercialisation. Its production rate per hectare is 10t/ha/5-8 months. Off bottom culture in stake and longline, rack and ren (rack culture) on strings yielded high rate of production per hectare with natural spat settled on oyster shell strings as the source of seed.

Another major technological achievement in bivalve mariculture has been the indigenously developed method for the culture and production of pearl, from the pearl oyster *Pinctada fucata*. As the natural pearl oyster production declined considerably in the Gulf of Manner, Gulf of Kutch and Andaman and Nicobar areas, it has become essential to produce the oyster seeds through hatchery technique. The CMFRI has perfected technique for pearl oyster hatcheries, mother oyster rearing, pearl oyster surgery and nucleus implantation and quality pearl production within a period of about 24 months. The survival rates at different stages of farming was quite satisfactory and rates were 40% at spat settling time, 80% at mother oyster rearing and 30% at pearl production. All the rearing and pearl culture activities carried out in shallow sheltered bays (more than 5 m depth) in wooden cages suspended from a raft. Recent attempt to culture pearl oysters in onshore tanks by the Institute has also proved to be successful. Further, attempts are being made to transport black lip pearl oyster *(P. margaritifera)* from Andamans to mainland for culture in onshore tank facility developed by the Institue. From the Institute's hatchery at Tuticorin and Mandapam seeds as well as nucleus implanted mother oysters are supplied to entrepreneurs. With the result, the Institute could launch commercial pearl culture at any part of the maritime state. A number of clam species are commercially exploited for their meat as well as for lime shell. Of late, frozen clam meat are exported to Europe, SE Asia and USA to the tune of 520 t valued Rs.1.01 crores (1990). Species

such as *Anadara granosa, Paphia malabarica, Meretrix, Katelysia and Villorita cyprinoides* are suitable species for clam culture along brackish and coastal waters. The Institute has perfected on-bottom clam culture technologies for various backwater and estuarine bodies. The production rates of 39-42 t/ha/5-6 months is quite comparable with production figure obtained in China, Malaysia and Thailand. Hatchery technology for seed production of commercially important clams was also developed by the CMFRI at its Shellfish Hatchery at Tuticorin. Experiments conducted by the Institute to culture cephalopods (squids and cuttlefishes) from wild egg/seed collection is gaining importance and expected to yield fruitful results. The eggs/seeds of cephalopods could be easily collected from the artificial reefs and other already known grounds.

Developmental programmes: Seed production through multispecies hatcheries for molluscan aquaculture, especially for pearl oysters, mussels, edible oyster and clam is essential for commercial scale operation of molluscan farming in India. Model farms are to be set up in different parts of the country to demonstrate the existing technologies of onshore and coastal farming of pearl oysters for pearl production, edible oysters and mussel farms in estuaries and on-bottom and off-bottom culture of clams in estuaries. The techniques of composite farming of edible oyster, mussel, clams, shrimps, groupers in coastal areas and brackishwater bodies are to be upgraded and demonstrated to the end users for better utilisation of the candidate species for culture. Development of suitable post harvest technology for processing and product development are yet to be perfected. There is a need for developing state level facilities for testing the qualities for farm grown bivalves on their bacteriological load, toxicological analysis and heavy metal contents before domestic and export market. It is suggested that effective extension programmes should be conducted for rational exploitation of the existing molluscan resources, popularisation of molluscan farming technologies and the nutritional values of molluscan meat. Efforts should be made for proper financial support from Government Agencies and legislation by government for leasing out coastal intertidal areas/brackishwater area for molluscan farming by co-operative societies, marginal farmers, fishermen, unemployed youths and small-scale entrepreneurs. Research thrust should be given for upgraduation of bivalve hatcheries, pearl production by onshore farming of pearl oyster, ploidy manipulation in edible bivalves, genetic improve-

ment of stocks, disease diagnosis and control. The farming techniques require upgradation and refinement to suit different environmental conditions prevailing in east and west coast of India. Hatchery and growout techniques for *Tridacna*, *Trochus*, *Turbo* and *Haliotis* are to be prefected for commercial production.

Finfish mariculture

In the global aquaculture production, fin fishes formed about 49% (1992) which could be split up into freshwater fishes (41.4%, diadromus fishes 5.6% and marine fishes 2.0%). Commercial finfish mariculture has not been established in India. Whereas the freshwater finfish aquaculture has developed considerably with an annual production of 1.305 million metric tonnes. The potential species available for brackishwater aquaculture/mariculture are milk fish *(Chanos chanos)*, mullets *(Mugil cephalus)*, Seabass *(Lates calcarifer)* and several species of groupers *(Epinephelus* spp.*)*, most of the species are ideal for mariculture as they exhibit fast growth rate, euryhaline and high rate of production. Small scale farming practised in certain areas, fully depend on the availability of seeds/juveniles from the wild. Laboratory level experiments are progressing to mass production of their seeds through induced spawning techniques. Of late the grouper fattening in cages and ponds is picking up at different parts of the east coast to meet the increasing demand for live export. They fetch high prices of Rs. 200 per kg. at farm site. The offshore cage culture for groupers is also gaining importance at certain areas along the coast within 60 m depth belt. Yet another promising high priced group under finfishes are ornamental fishes, many of which could be multiplied by induced spawning technique and reared in ponds and cages along the lagoon areas of Andaman and Lakshadweep Islands. Already the CMFRI has successfully developed the technique for spawning and rearing of clown fishes. The CMFRI has also set up model facility for grouper culture at Mandapam, Tuticorin and Kochi to test their commercial viability for fattening and live export and for possible composite culture in onshore tanks, raceways with crabs, oysters, pearl oysters and seaweeds.

Developmental programmes: With the recent breakthrough in hatchery

level production of seed of seabass at Chennai by the Central Brackishwater Research Institute, the possibilities of setting up commercial hatcheries for seabass is bright. Seed production and grow out techniques of groupers are being developed for commercial production. It is suggested to set up model farms for cage and pen culture of milkfish, seabass, grouper and ornamental fish. Research thrust must be given for grouper and ornamental fish breeding techniques.

Seaweed culture

Seaweeds form about 28% of world's total aquaculture production. Although many species of agarophytes occur along the Indian coast, their mariculture has not yet been commercialised. However, indigenous technology is available for growing seaweeds along the shallow coastal waters through different methods. The vegetative propagation of *Gracilaria edulis*, *G. corticata*, *Gelidiella acerosa* and *Sargassum weighti* has been developed and demonstrated the technology for industrial applications. A production rate of 5 kg/m^2 of coir net in the case of *G. edulis*, 3 kg in the case of *G. acerosa* in about 80 days has been achieved in the institute.

Developmental programmes: To commercialise seaweed production, demonstration farms can be set up along shallow bays, lagoons of coral reefs and intertidal coastal areas along mainland of India. Develop facilities for commercial scale production of agar, algin and other byproducts of seaweeds. Introduction of economically important high phytocolloid carreigeenan yielding and fast growing exotic species like *Euchemia* into India. Research thrust may be given for upgradation of farming techniques, screening of seaweeds for bioactive substances which have antiviral, antibacterial and antifungal qualities and genetic researches and tissue culture applications for developing new strains of high agar and algin yielding seaweeds.

Mariculture of other invertibrates of potential edible/ pharmacological importance

Many species of unconventional marine invertibrates are of considerable importance for export. Often the exact biochemical composition and use of the animals or their products abroad are unknown to Indian producer or exporter. One of the common export item, sea cucumbers are at present irrationally exploited and thus warrants conservation strate-

gies. The induced spawning of sea cucumbers, achieved in CMFRI, is a real breakthough to undertake commercial farming of this group in the intertidal waters.

The marine arachnid, king crabs of the species *Trachypleus gigas* and *Carcinoscorpius rotundicauda* occuring commonly in the deltric regions of Ganges and Mahanadi are economically important for various bio- medical applications. They are at present irrationally exploited for the extraction of their blood, which has tremendous biomedical use and exported to Western Countries. The resource requires conservation through sea ranching techniques.