PERSPECTIVES IN MARICULTURE

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Status and prospects of bivalve mariculture in India

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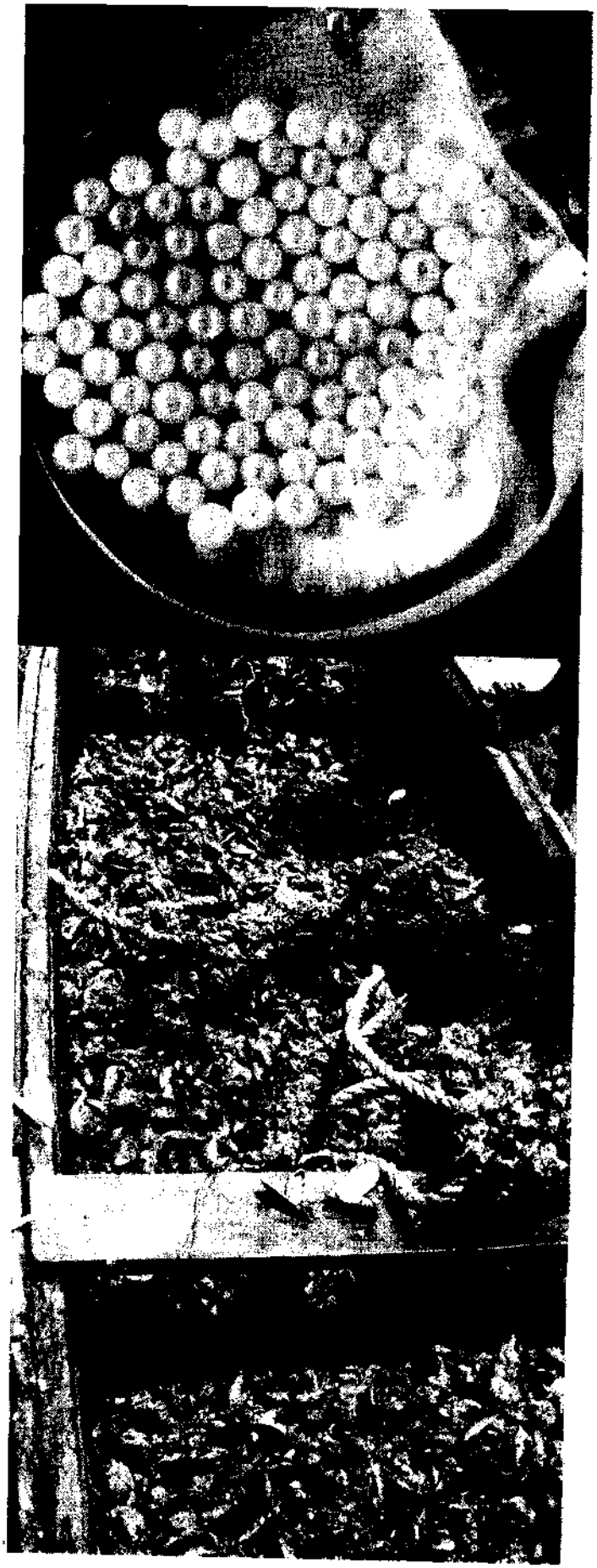
ABSTRACT

Farming systems and hatchery techniques for mussels, edible oysters and pearl oysters were developed at the Central Marine Fisheries Research Institute by late 70's. In the present decade intense efforts were made to test the suitability of different ecosystems for bivalve mariculture. The attempts made to demonstrate the economic feasibility of mussel and oyster culture in Kerala had a positive impact leading to development of group farming activities in the coastal communities. Relative to this intensification of farming, preliminary attempts were made to explore the potential domestic market. The changing scenario from experimental farming to commercialisation of mussel and oyster culture in India is



presented. New strides have been made in large-scale production of pearl oyster spat and pearl culture. Initiation of pearl culture projects by private entrepreneurs has widened the scope for marine pearl production in India. A review of the status, opportunities and prospects for expansion of the bivalve mariculture along with the technical, economic and social problems are analyzed and discussed. Enhanced use of underutilized areas for future mariculture programmes are analyzed in the light of potential new markets. Thrust areas for future research and development activities are also highlighted.

Introduction

The occurrence of fast growing species of edible bivalves like mussels and oysters in the Indian coastal regions prompted marine researchers to evolve bivalve mariculture technologies. The pearl culture technology was also developed utilizing the pearl oysters from the Gulf of Mannar and Palk Bay. These technologies were tested in different regions. The chronological events in the development of pearl culture as an industry in India are given in Table 1. Consequent to the technology development, efforts were made to transfer these to the end users through implementation of pilot projects, short term and long term training programmes, publication of experimental results, and through organization of symposia, seminars and workshops. These efforts were successful and the main constraints, which impeded commercialisation of the technologies developed, were identified as lack of awareness about the technologies among the end users, financial constraints and low market demand. Hence the research programmes were reoriented and thrust was given to Transfer of Technology programmes with direct participation of the fishers. The accomplishments were encouraging leading to industrialization of pearl culture and development of mussel/oyster farming as a rural / community development programme in the southeastern and southwestern states of India. A brief account to the developmental activities of bivalve mariculture is presented.

Table.1. Chronological events in the development of bivalve mariculture in India

Pearl culture

1972	Initiated a project on pearl culture at Tuticorin Research Centre of CMFRI along the southeast coast
1973	Production of first cultured marine pearl in India
1981	First batch of pearl spat produced in hatchery
1985 - 87	Initiation of pearl culture programmes in different maritime states
1985 - 90	Sea ranching of pearl oyster larvae and spat to revive the natural stock
1991	India hosted the FAO/NACA* training programme on pearl culture at CMFRI –imparting training on pearl culture to trainees from other South, South East and East Asian countries
1993	Village level pearl production through direct involvement of small-scale fishers. Pearls worth US $ 2178 were produced
1994	Pearl produced along west coast through farming operations in the Arabian Sea
1996 - 99	Signing of memorandum of understanding with private entrepreneurs, increased survival rates in hatchery production, initiation of experiments for pearl production through tissue culture

Mussel farming

1973	Development of brown mussel culture technology at Vizhinjam
1974	Green mussel successfully cultured at Calicut
1977	Technology for edible oyster culture developed at Tuticorin
1976-82	Raft / longline culture of mussel tried at Madras,Karwar,Goa, Ratnagiri, A& N Islands, Vishakapatnam, Kakinada
1979	Pilot scale culture at Calicut
1984-85	Experimental brown and green mussel hatchery set up at Vizhinjam and Madras respectively
1997 -99	Production of green mussel spat at Calicut RC of CMFRI under DBT sponsored project
1995-2000	Intensification of transfer of technology programmes through

	farmers participation, establishment of small rack units through group farming activities under DWCRA/ IRDP programmes, Commercial opensea farms set up by fishers along Kerala and Karnataka coast

Oyster farming

1977	Development of farming systems for oyster
1979	Lab to Land programme on oyster culture
1982	Succesful spat production in the hatchery, production of cultchless spat
1992 –95	Implementation of NABARD sponsored project for commercialisation of oyster culture
1993 - 95	Location testing programme at different maritime states
1996	Technology adoption by different fishers, setting up of oyster farms in the estuaries of Kerala
1999 –2000	Financial support extended by BFFDA for oyster culture in Kerala

Clam mariculture

1978	Farming technology for culture of *Anadara granosa*
1987	Hatchery technology for clam seed production developed
1993 - 96	Seed production and ranching of *Paphia malabarica* seed under MPEDA sponsored project
1994 - 99	Production and stock enhancement programmes of *Meritrix casta*
1998-2000	Trial expeiments to test the feasibilty of bivalve culture in shrimp ponds for maintaining water quality

* Network of Aquaculture Centres in Asia

Pearl mariculture

The need to develop pearl culture as a rural upliftment programme was recognized only in the early nineties. One of the successful programmes involving fishermen was carried out at Valinokkam, a small coastal village of Tamil Nadu in southeast coast of India. Twenty-five fishermen of the village

were selected and given training in various aspects of pearl culture. The initial reluctance noticed among the fishermen was overcome by proper motivation. They were educated about the importance and economic returns of the pearl culture. Active participation of the fishermen and their family members was observed from the fabrication of grow-out structure to pearl harvest. Part of the pearls produced was given to the fishermen as an incentive. The scope for large scale pearl production through village level community participatory programmes with proper technical and financial support from developmental organizations was clearly indicated by the 'Valinokkam Bay Programme' which yielded the following result.

Number of oysters implanted	9414
Total expenditure incurred	Rs.65982
Total pearls harvested	1849
Pearls distributed to fishermen	250
Revenue earned from sale of pearls	Rs.91476

Industrialization of pearl culture

Along the Tamil Nadu coast, M/s Tamil Nadu Fisheries Development Corporation Ltd (TNFDC) and M/s Southern Petrochemicals Industries Corporation Ltd (SPIC) took up a joint commercial project on pearl production in 1983 with technical know-how from CMFRI. This was a laudable pioneering effort by the government and the industry. The technical problems faced when the technology was commercialized were duly solved. The Department of Fisheries, Gujarat started a research and development programme along the Gujarat coast with the natural pearl oyster resource. Later, to enhance the depleted stock, pearl oyster spat were also supplied from the shellfish hatchery of CMFRI at Tuticorin. However, commercial ventures by industrial houses were restricted to the areas around the natural pearl oyster beds in India.

After a gap of nearly a decade, other firms also started pearl culture programmes. They are ITAP Ltd, Tuticorin; Orkay Company, Mandapam;

Master Pearls Ltd, Chirala and Pearl Beach Hatcheries, Visakhapatnam. Some of the pearl farms are located in the Krusadai Island while others are in the Palk Bay, Gulf of Mannar and in Andhra Pradesh. What started as an experiment in 1972, has supported the growth and development of an industry. While India has been a net importer of raw pearls during the early nineties, from 1996 onwards it has also been able to export cultured pearls, albeit in small quantities.

Development of mussel and oyster farming as seasonal group farming occupation

a) Oyster culture: Though oyster farming was successfully done in the farms of CMFRI's research centres, the actual momentum of technology adoption was felt only during the past five to six years. Considering the wide variation in the different water systems, a programme on location testing and demonstration of oyster farming with farmer's involvement was started in 1993 in Ashtamudi Lake. The livelihood of more than 3000 villagers of this area is linked directly or indirectly to this resource. First, a trial was done to test the growth and survival of oysters by suspending a few oyster rens from the platform of a Chinese dipnet in the Lake. Later, by the beginning of 1994, a demonstration farm was set-up by constructing a bamboo rack by involving fishermen. The first commercial oyster farming area was developed in Kerala in Ashtamudi Lake (Dalavapuram) during 1995-96. In August 1996, more than 100 tonnes of full-grown oysters were harvested. This motivated several farmers to arrogate edible oyster farming leading to the establishment of a number of commercial oyster farms in this large estuarine system.

The rens were harvested after a period of 5 to 6 months. The heat-shucked meat in the frozen form was sold in the internal market. Later, the Institute refined on the technology by introducing seasonal and perennial oyster farming depending on the estuary's physico-chemical characters. By the year 1997, oyster farming became increasingly popular, and a progressive farmer took up oyster farming on a large scale producing annually 10 to 15 tonnes of oyster. This hard working hexagenrian farmer received the ' Best Farmer ' award from the Government of Kerala for his integrated farming approach. Similarly, in other estuaries also the farming methods were

demonstrated. In Kerala, the BFFDA now gives financial assistance to farmers to set up oyster farms. This confirms the fact that the end users and the planners have recognized oyster culture as a viable project ideal for rural development and income generation.

In addition to creating awareness on the profitability of oyster farming, the demonstrations in the states of Karnataka, Tamil Nadu and Andhra Pradesh, gave valuable information on the spatfall, growth, and optimum period of harvest, etc. Though the level of technology adoption varied from place to place, the overall impact was acceptance of the farming method as a part time avocation for additional income to rural fishers.

b) Mussel farming : In the past decade several demonstration farms were set up along the southwest coast of India mainly in Kerala and Karnataka. These two states have well-established traditional mussel fishery. The demonstration farms in the open sea and the estuarine systems were fabricated, stocked, managed and with full participation of the coastal fishers. The estuarine ecosystems are calm and shallow (< 4m). Accordingly, racks were constructed in different estuaries to suspend the seeded ropes. The first site was in Padanna (Kasargod region), which is famous for its offshore mussel fishery. About 100 seeded ropes were suspended during January 1996, which reached harvestable size within 5 months with a total weight of 12-15 kg/m length. A farmer who was impressed by the farming methods set up his own farm for mussel in a 200 m2 area and seeded 175 ropes during the same period. The meat yield was 30% of shell-on weight. This was the first instance of large-scale mussel farming in the estuaries of India. This demonstration impressed the local mussel picking families as well as the village level co-operative sector banks and what followed was a virtual revolution in mussel production from the region.

The scientists of the CMFRI in consultation with the district administration developed a master plan to transfer the technology to potential women beneficiaries. The Development of Women and Children in Rural Areas (DWCRA) was identified as the most suitable scheme intended for groups of women beneficiaries below the poverty line. The local governing bodies identified the beneficiaries with the help of village extension officers and district

administration. The selection criteria took into consideration (i) primary school as the minimum education level; (ii) age of the beneficiaries between 28-62 years, and (iii) fisheries / agriculture as the major occupation. After the selection of beneficiaries, a series of awareness camps on mussel farming were conducted by the Institute in each panchayat (village). Beneficiaries were given training in their own farms from seeding to harvesting. One-day workshops were organized in different villages involving bank officials, officers of the district administration and village extension workers.

Loans from the government developmental agencies like DWCRA, IRDP (Integrated Rural Development Programme), TRYSEM (Training of Rural Youth in Self Employment) and Farmers Co-operative Banks to newly formed village mussel farming groups (average 13 members in each group) resulted in starting of several mussel farms in this region. All technical help to the farmers was provided by the CMFRI.

The entire farming operation viz., starting from seed collection to marketing was done by the women themselves. They were able to pay back the loan within the stipulated period. In succeeding years the farming activities were intensified by the involvement of more groups. Now, mussel farming is a part time avocation of the coastal women of North Kerala. The local banks and district administration have taken a lead in providing financial assistance to these fishers. Mussel farms are usually set up by November-December and the crop is harvested before June (to avoid large-scale destruction due to monsoon). Though, it is only seasonal, women have recognised that it is something which they can do with minimum effort.

Open sea mussel farming by the longline was demonstrated at Andakaranazhi and at Byndur in Karnataka while mussel rafts were deployed at Narakkal in Kerala. Motivated by the CMFRI's demonstration at Byndur, a small scale gillnet fisherman launched his own mussel line during December 1996. With CMFRI's help he set his long-line with seeded ropes of 4m at a depth of 6 m. Floatation was ensured through small buoys and FRP drums. He looked after his line by examining them during his fishing trips in the sea. In total he harvested close to 400 kg of mussels from his single line and it

fetched him US $ 130. The profit margin was comparatively high because many of the materials he used were those already available with him.

Along Kerala coast, one group of fishers suspended the mussel ropes from racks constructed in the sea. This structure was able to withstand the turbulent sea during certain periods. The mussel growers were able to harvest about 2.4 tonnes from a small unit of 0.05 ha. From 1998 onwards opensea mussel farms (rafts and racks) have been launched in Central Kerala. The demonstration programmes reaffirmed the following facts

- High production rates and growth rate 15 kg per metre
- Possibility of two crops, Nov. – Feb; Mar- May
- High survival (>95 %) and growth of mussels in estuaries
- Low fouling in estuarine systems
- Possibility of Integrated bivalve farming of mussel and oyster
- Possibility of harvesting mussel in a phased manner for more profit.

In addition to the above mentioned facts bivalve mariculture programmes were able to make social changes such as

- Privatization of mussel farming
- Group farming activities by women under IRDP / DWCRA/ TRYSEM
- Employment opportunities for women during seeding and harvesting
- High consumer demand for farmed mussel

c) Clam mariculture: Experiments on culture of commercially important clams like *Anadara granosa,Meritrix casta* and *Villorita cyprinoides* have been done at different estuaries. Though the growth and survival rates were high, the technology transfer has not been intensified, mainly due to the low market demand. Moreover clams being bottom dwellers, the growth largely depends on the substratum of the ecosystem. In the recent years clam fishermen of Kerala have resorted to clam relaying or semiculture. The black clam *Villorita cyprinoides* and the yellow clam , *Paphia malabarica* are commercially fished from Vembanad and Ashtamudi Lakes of Kerala. When seed clams occur in the catch, the fishermen segregate these and stock them in the areas adjacent to their homestead. Later when they reach marketable size these are harvested and sold.

Bivalves being filter feeders have been used to control the water quality of the shrimp ponds in many Southeast Asian countries. Experiments to try the efficiency of this system has been initiated in Kerala, Karnataka, Goa and Gujarat using different species of bivalves like *Perna viridis*, *Villorita cyprinoides*, *Paphia malabarica* and *Crassostrea madrasensis*.

Hatchery development

Availability of seed is recognized as one of the major requirements for farming and aquaculture industry throughout the world. Seed production for commercially important pearls, mussels, oysters and clams were developed in CMFRI. The ' cultch less ' or the free spat of edible oyster produced in the hatchery can be used for the production of the highly priced individual oysters. For the present, the requirement of spat of edible oyster and mussel is met from the nature, although, the hatchery technology is perfected. However, with the growth of pearl culture industry, entrepreneurs have realized the importance of producing pearl oyster spats in areas where natural resources do not exist, by adopting the pearl oyster hatchery technology. In the last two years the survival rate of spat has been improved through repeated trials at the shellfish hatcheries of CMFRI at Tuticorin and Mandapam. The Institute has also supported the growing pearl culture industry by supplying spat.

Stock enhancement of pearl oysters and clams

Revival of pearl oyster beds from extinction and creation of new beds in the Gulf of Mannar and Palk Bay through ranching of the seed produced in the hatchery is one of the most significant achievements of CMFRI. The first programme on ranching was launched in 1985 and in the subsequent years, this was continued and more than one million spat were ranched during a period of 5 years. Subsequent dives made in the beds clearly indicated replenishment of the pearl beds as seen in the number of oysters collected in one diving hour. Similarly hatchery produced seed of *Paphia malabarica* in the Astamudi Lake of Kerala was done during 1992-93. This was significant as this clam supports the livelihood of more than thousand fishermen families living near this estuarine system which was under intense fishing pressure.

Market improvement

The establishment of mussel farms in Kerala State led to a dramatic increase in farmed mussel production (more than 500 tonnes in 1998). As a

direct result of this, new marketing channels were opened up and now there is wider acceptance by the public about mussels as quality seafood. This has partly solved the main constraint, which hampered the growth of bivalve mariculture in India. The edible bivalve market channel is relatively straightforward and fresh and frozen farmed mussels and oysters have a healthy and growing domestic demand in maritime regions of the country. There is now increasing appreciation of the fine texture and taste of mussel and oyster meat and these comparative new products look set to captivate the urban connoisseurs mainly through the developmental efforts of the Integrated Fisheries Project, Cochin. On the export front, in the case of mussels, Indian products have found a place in the markets of UAE, Germany and Republic of South Africa, and the list is growing. Although live oysters are an expensive gourmet food in Europe and America, they have not found such a niche in India. Markets are limited to few isolated pockets like the Parsi community in Mumbai, who have a specific preference to smoked oysters marketed in cans.

Problem areas

With the wider acceptance of bivalve mariculture it has been possible to scrutinize the technical constraints of culture systems and commercial constraints of production costs to maximize returns and minimize constraints. The developments made in the bivalve mariculture have been possible only with the interactions from other governmental agencies. However to make the development of bivalve mariculture complete the following technical points should be considered.

With the increased production of farmed edible bivalves more emphasis should be given to ensure that only high quality products reach the market. The European Community Directives, which are comparable with the FDA standards allow only those cultured in clean waters (A quality) can be marketed for direct consumption while those coming from other categories must be depurated. When the global demand for live shellfish is expanding it is essential that purification of farmed molluscan shellfish must be made an integral and mandatory part of Indian shellfish industry. In addition to these products such as oyster and mussel on half shell with different sauces, vacuum - packed /IQF bivalves, battered or breaded molluscs have to be developed.

Harvest and post harvest process in bivalve mariculture is labour intensive. Mechanization of bivalve processing which started years back in the major molluscs growing areas have developed Multifunctional Lines which can process a variety of resources from the same site. The Indian bivalve industry should concentrate to mechanize the various processes like washing, declumping, grading, debyssing to make " ready-for-cooking' products with its flavour and appearance intact.

Issues, which cannot be neglected, are those related to use of water bodies and theft of crops. Conflicts between fishermen and bivalve growers have posed problems in certain areas. Similarly poaching of farmed material when the crop is ready for harvest has also been reported. These issues can be solved through generating awareness among the fishermen and also through increased participation of small-scale fisher.

New areas for development

Along with pearl culture the scope for developing other products from pearl industry can be explored. The mother of pearl shells which are used to make buttons and inlays in jewelry and furniture are sold @ Rs 3 lakhs per tonne. Dried adductor muscle which is considered as an aphrodisiac is sold @ Rs.11, 500 /kg. In India the expanding pearl culture industry can support the growth and development of such small - scale industries.

The most promising new opportunities for aquaculture are the products, which are in demand by the tropical marine aquarium trade. Among bivalves giant clams have the highest potential to be cultured for marine trade. The giant clam resource of A&N islands is currently harvested for the ornamental shell industry. Development of giant clam mariculture, which can produce small sized clams for aquariums, can lead to improvement of island economy.