Mussel Farming and Its Potential in India

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Introduction

Marine mussels are bivalve molluscs belonging to the family "Mytilidae" and form one of the most dominant cultivable species all over the world (estimated culture production about 1.5 million tonnes in 2003). Total global trade of mussel is involving 300,000 t, worth about US $ 400 million. They give the highest conversion of primary producers (phytoplankton) to human food, and culture of mussels in the column waters can increase the seafood production several folds. In India, two species of marine mussels (green mussel, *Perna viridis,* and the brown mussel, *P. indica*) are distributed in the rocky coastal areas where they support a traditional sustenance fishery, but scope for increasing natural production from the existing beds is rather limited (Appukuttan et al. 2001).

During post-monsoon period, there is a heavy settlement of mussel spat along the west and east coasts in the intertidal and subtidal rocky areas. During this season, many millions of mussel seeds are attached to the hard substratum, but only a small percentage of these grow to become adults, mainly due to sand deposition and receding tides. The mussel culture technology developed by CMFRI during the early 1970s envisages using these perishing spat for seeding ropes.

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Technology Development

Giving priority to the development of a technique for farming mussels, the CMFRI started a project at Vizhinjam in Kerala in 1971. In 1976, at Calicut, attempts were made to develop open sea farming of the green mussel. The programme was extended to the east coast at Madras during the same year. All these efforts led to the development of technology for mussel culture in the open sea and in protected bays. The mussel seeds collected from the natural beds are wrapped around a thick nylon rope by using a biodegradable cloth, which degenerates within a fortnight. The seeds get attached to the rope by this time and continue to grow there, utilising the natural food. These "mussel ropes" are suspended from grow-out structures like raft or long line deployed at a productive and unpolluted site (Box 1). Harvestable sizes are usually attained within 4–6 months depending on the area of grow-out.

Maritime states along the west coast of India have extensive estuaries, which open to the Arabian Sea. These estuaries are subjected to wide variations in hydrographic condition due to the southwest monsoon during June to September and a less intense northeast monsoon from October to November. The mean of annual rainy days in Kerala has been estimated as 130 days, and of this, 66 % is during June to September, 19 % during October to December and 15 % during January to March. Based on the

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Box 1: Methods of Farming

1. *Rack (Trestle) Method*

This method is especially suited for estuaries and shallow seas. Bamboo or *Casuarina* poles are driven into the bottom spaced 1–2 m apart. These stakes are connected horizontally with poles forming a trestle. The horizontal poles should be above the level of water at high tide. Seeded rope can be suspended into the water for farming from these poles. Three seeded ropes can be suspended from 1 m^2 area of the rack.

2. *Long-Line Method*

This method is considered ideal for unprotected open sea conditions. Synthetic rope of 16–20 mm diameter is used for the long line (main line). The main line is supported with 220 l barrels tied to it, spaced at 5 m. The long line and barrels are anchored in position at either ends using concrete blocks and nylon ropes. Seeded ropes are suspended from the long line.

3. *Raft Culture*

Ideal for open sea conditions which are not rough. Square or rectangular rafts are made with sturdy bamboo or *Casuarina* poles. Buoyancy for the raft is given by tying 5 barrels of 200 l capacity (metal oil barrel painted with anticorrosive paint or synthetic barrel). Ideal size of the raft is 5 × 5 m. The rafts are to be positioned at suitable site in the sea using anchors (grapnel, granite, concrete). Three seeded ropes can be suspended from 1 m^2 area of the raft.

hydrographic condition, in most estuaries, two phases, viz., a marine phase during December to May and a brackishwater phase during June to November, have been observed. It is during the marine phase that the ecosystem becomes conducive for mussel culture. The offshore of this coast is subjected to strong currents and upwelling phenomenon during the monsoon season. However, in the fair season, these areas can be used for mussel farming. Long-line units and rafts were utilised for mussel farming in the deeper offshore sites. Both these methods proved to be highly successful.

Transfer of Technology

The constraints which were foremost in stalling the development of mussel culture industry in the 1970s and 1980s were lack of awareness, social inhibitions and finance. Perceiving the drawbacks in extension programmes, in the beginning of the 1990s, an action programme was initiated for location testing as well as for disseminating farming technology in estuaries, backwaters and coastal seas. It was decided to set up demonstration units at several sites along the coastline with the direct involvement of fishermen. This led to the growth and development of mussel farming as a rural development programme especially in the southwestern parts of India, in the states Kerala and Karnataka, especially in the former (Mohamed et al. 1998; Sasikumar et al. 2000, 2006).

Compared to the open sea, the estuarine ecosystems are less turbulent and shallow (<4 m) and, therefore, less prone to risks like loss due to heavy weather and poaching. The demonstrations with fisher participation in north Kerala convinced them about the feasibility of mussel culture, and the local fishers of this area set up their own mussel farms with technical guidance from CMFRI and financial assistance from local governing bodies. From the ensuing season onwards, different fisher groups took up mussel farming as a seasonal avocation, and farmed mussel production in the region was trebled (Appukuttan et al. 2000).

The scientists of the CMFRI in consultation with the district administration created a master plan to transfer the technology to potential women beneficiaries. The DWCRA (Development of Women and Children in Rural Areas) was identified as the most suitable scheme intended for groups of women beneficiaries (Box 2) 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

(1) primary school as the minimum education level, (2) age of the beneficiaries between 28 and 62 years and (3) 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 organised in different villages involving bank officials, officers of the district administration and village extension workers. Besides, the National Bank for Agriculture and Rural Development (NABARD) approved mussel farming as a bankable scheme having IRR (internal rate of return) above 50 % and benefit cost ratio of 1:1.34.

Box 2: Technology Adoption by Women

In 1996, groups of women from the North Kerala (Kasaragod district) started their own mussel farms with the financial support extended by the Development of Women and Children in Rural Areas (DWCRA) and Training of Rural Youth in Self-Employment (TRYSEM). 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 vocation 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 and financial commitment.

Loans from the government developmental agencies like DWCRA (Development of Women and Children in Rural Areas), IRDP (Integrated Rural Development Programme), TRYSEM (Training of Rural Youth in Self-Employment), BFFDA (Brackishwater Fish Farmers Development Agency) and Farmers Cooperative Banks (such as Malabar Gramin Bank) to newly formed village mussel farming groups (average 13 members in each group) resulted in the start of several mussel farms in this region. All technical help to the farmers was provided by the CMFRI.

These developments paved the way for a consistent increase in farmed mussel production in the state of Kerala. The horizontal spread of the technology in Kerala is shown in the map below (Fig. 1). The major farming area is Kasaragod district, but recently farming has spread in Ernakulam and Kollam districts. The farmers themselves have innovated in the technology used, and many farmers in Kannur, Kozhikode, Malappuram and Kollam districts practise on-bottom farming where seed mussels are spread on the bottom and allowed to grow. In this method the input costs are minimal. Besides, some farmers in Kadalundi and Korapuzha estuaries where the water depth is shallow (about 1 m) practise horizontal rope culture method. In this method unit area productivity is low, but growth is comparable to that in the traditional rack (trestle) system (Velayudhan et al., 2000).

During 2009, the estimated farmed mussel production is more than 18,000 t. About 75 % of this production is from Kasaragod district, and other major districts contributing to the production are Malappuram, Kozhikode and Kannur. Ernakulam, Thrissur and Kollam districts contribute only a small percentage. The growth in production has been particularly steep after 2004 (Fig. 2).

Technological Innovations

Refinements in the technology have been made to reduce capital costs (mainly on nylon ropes) by using alternate core materials (flexible

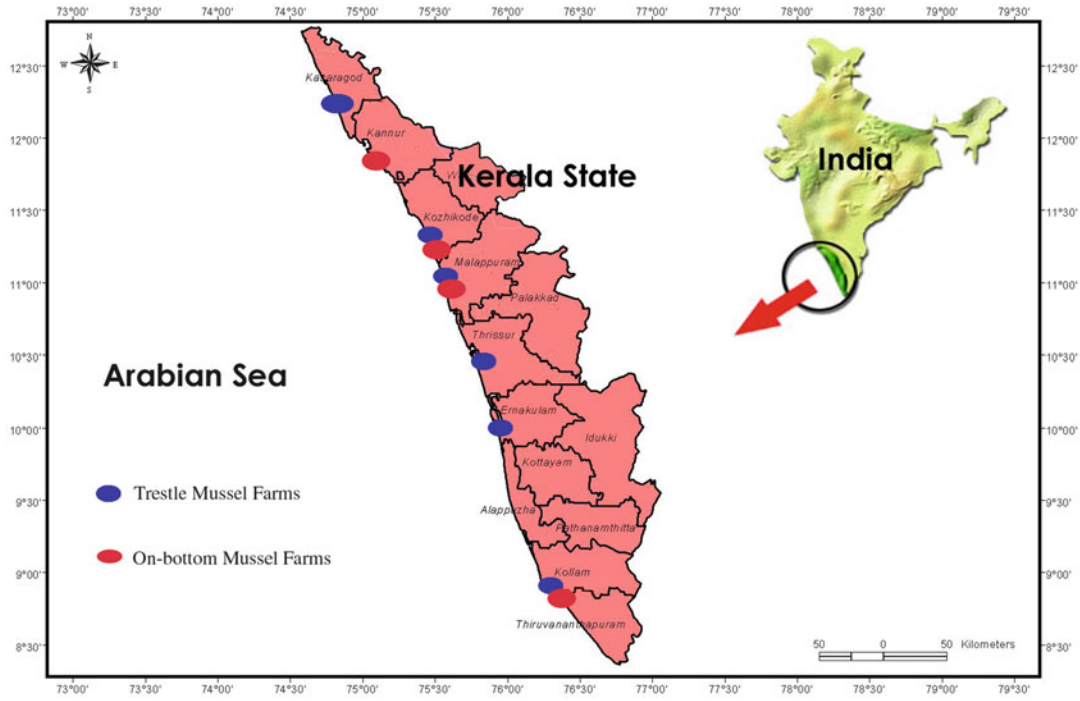

Fig. 1 Map showing the mussel farming technology implemented in Kerala

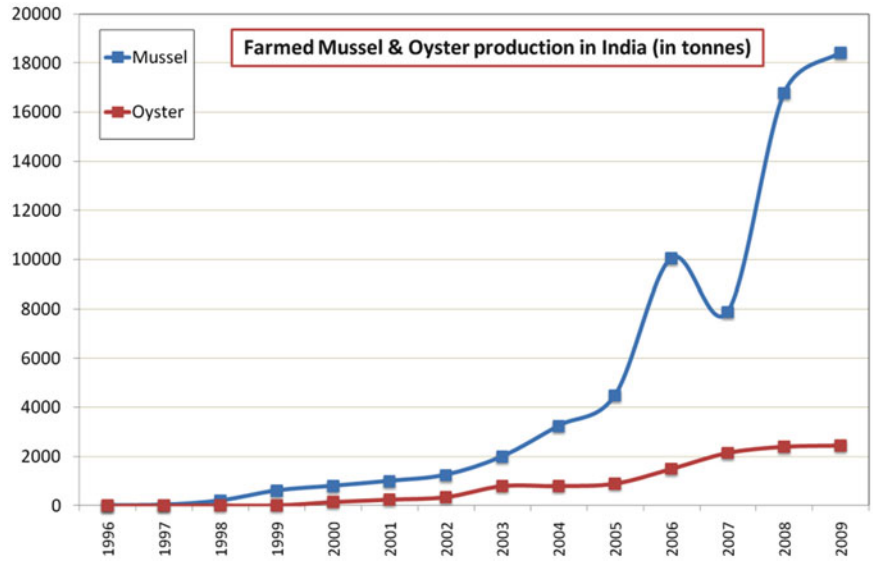

Fig. 2 Farmed mussel and oyster production in India (in tonnes)

plastic strips – FPS) and pre-stitched cotton net tubes. Seeding is one of the most critical activities in mussel farming. The process which is physically demanding (as farmers have to kneel and bend down to do it) is crucial to the success of farming as the uniform attachment of mussel seed around the rope is dependent on how well it is done.

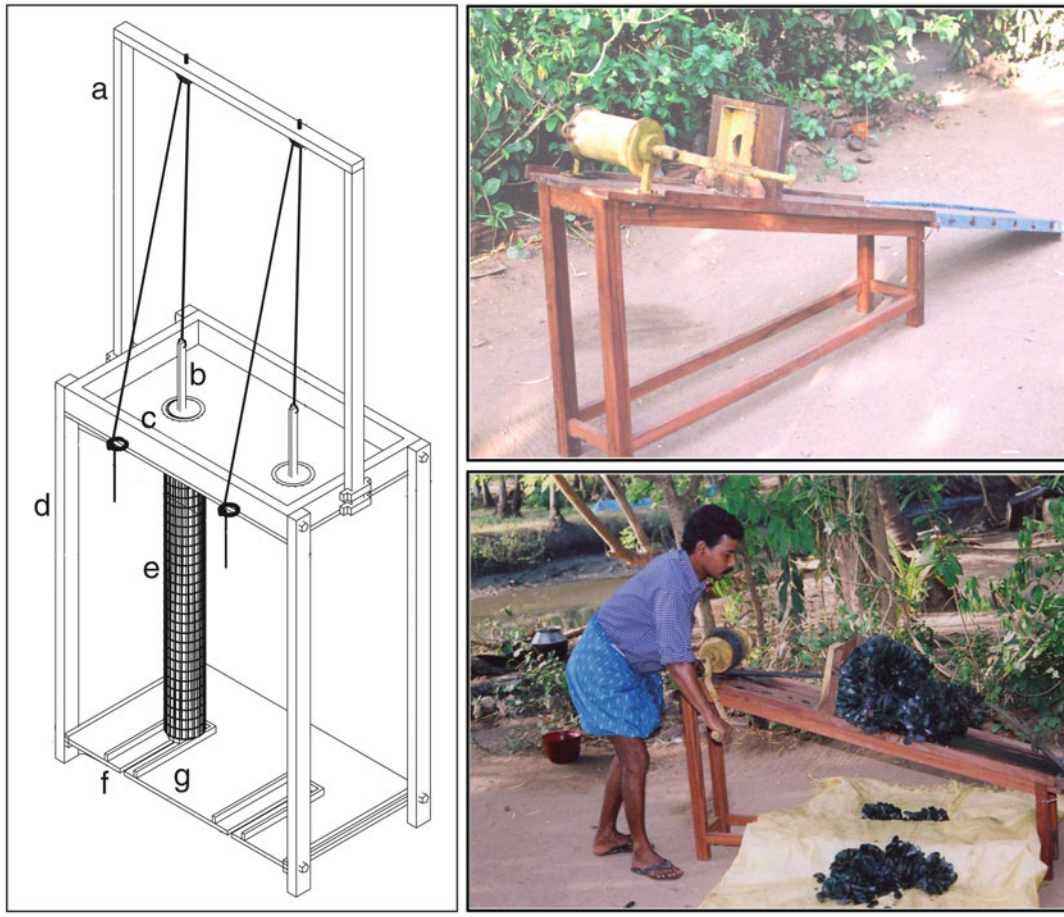

Fig. 3 Details and parts of the mussel seeder (*left*) (*a*) top stand, (*b*) FPS, (*c*) seed holder, (*d*) vertical support, (*e*) PVC pipe, (*f*) notch for PVC pipe and (*g*) base plate. *Right panel* shows the parts of the mussel declumper and its working

Now, to reduce the physical strain and to increase efficiency during this process, a *semiautomated mussel seeder* has been designed (Fig. 3), developed and field tested. The seeder, which has an estimated cost of Rs. 2,500, was successfully field tested and demonstrated to mussel farmers in Kerala. The chief advantages of the seeder are reduction in time taken for seeding resulting in increased efficiency and lower labour costs and reduction in physical strain during the process (Mohamed et al. 2003). The time taken for manual stitching of 1 m rope by the conventional method is 8 min, whereas in the seeder the same can be accomplished in 2 min (Kripa et al. 2001).

Harvesting and declumping (separating mussels from the rope) farmed mussels is done by lifting the mussel ropes and by plucking the mussels from the rope or by stamping if the byssal attachment is very strong. To easily separate the mussels from the rope, the concept of a *semiautomated mussel declumping machine* was developed. The machine had two separate units, a metal drum and a metallic circular, fixed shield with a central opening and with a diameter of 10 mm fixed on a stand and a ramp for placing the harvested rope. One metre mussel rope could be declumped in 2 min. The chief advantages were that physical exertion during harvesting could be avoided and that it was more hygienic and efficient (Mohamed et al. 2005).

Impact of Mussel Farming

The experiences of CMFRI, in the transfer of technology programmes, have clearly shown that fishermen can accept a scientifically proven technology only if they actually observe the benefits from it. Participation by the villagers was found to make the demonstration and adoption processes a sure success. Though the culture technique is the same, to give wider publicity, different small mussel farms were set up in the estuarine systems. The overall social impact was the emergence of mussel farming as a group/community activity with the recognition of scope for income improvement and women empowerment (Kripa and Mohamed 2008). A number of ancillary industries (rope making, seed collection, seeding and marketing) have also opened up. The sector has also become organised in the northern districts with the formation of the Green Mussel Farmers Society (GMFS) at Kasaragod.

Ecological Impacts

Although widely perceived as an environmentally safe technology, mussel farming has also got ecological impacts to the farming system which needs to be seriously addressed. A major impact is the accumulation of sediment (detritus) in the farming areas due to faeces production of mussels resulting in lowering of depths especially in estuaries where flushing and tidal flow is minimal. As a consequence, the benthic ecology can undergo detrimental changes. Based on scientific studies, the CMFRI has recommended that continuous farming for more than 2 years at one site is not advisable and it is necessary to shift the farm to an adjacent site every 2 years.

Prospects for Future Development

It is quite clear from the fast pace of its development in the state of Kerala that mussel farming can develop as a new sunrise mariculture industry in India. Unlike other aquaculture industries, it is not capital intensive and offers great scope for improving the incomes of the rural fishers as an alternate livelihood. But primarily, what has spurred its growth in Kerala is the considerable demand for the produce among the populace. Other mussel-consuming states like Karnataka, Goa and Maharashtra can also be targeted in the next phase of development. Policymakers and planners need to address the following for sustained development of this spanking industry.

1. Promote mussel farming in other maritime states using Kerala as a developmental model.
2. Since farming depends on seed availability from natural sources, development of methods to collect mussel seeds from the wild is necessary.
3. Encourage hygiene (depuration) and value-added products (VAP) for mussels to increase marketing possibilities and to make the farming practice more remunerative.
4. Determine carrying capacity of backwaters/estuaries for mussel farming and restrict farming accordingly.
5. Demark areas for mariculture and create mariculture parks with adequate legal protection and articulate open-access waterbody leasing policies.
6. Make a prospective (5 years) plan to improve hygiene in farming areas using EC guidelines as a criterion.
7. The current international prices for mussels (Fig. 4) are not remunerative enough for India to encourage exports to European markets. Besides, the European markets demand meeting very strict environmental standards which we will be able to fulfil only in the next 5 years. The domestic market retail price for mussels are in the range of Rs. 60–100. The Arabian Gulf markets for expatriate Indians can be explored.

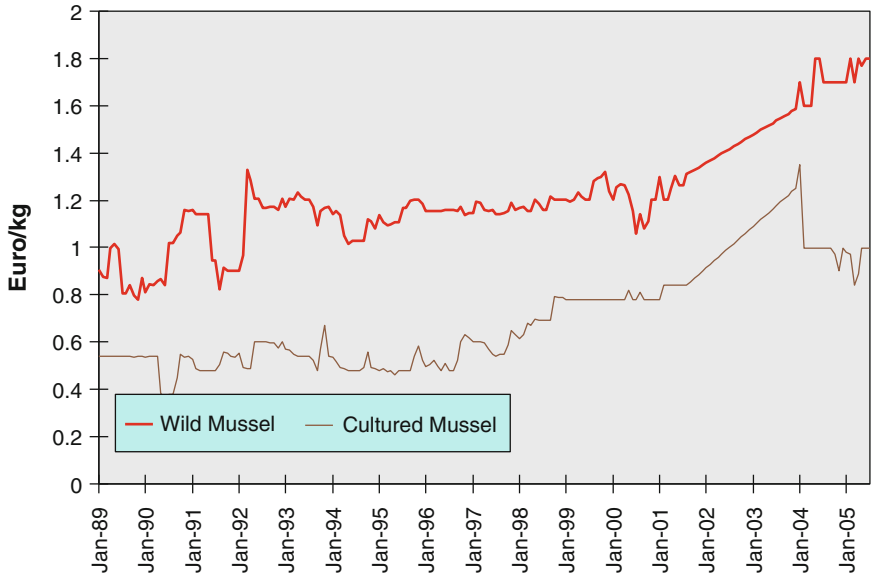

Fig. 4 Price movement in wild and cultured mussels in Barcelona (Spain) markets (Source: Globefish)

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