Mussel farming initiatives in north Kerala, India: a case of successful adoption of technology, leading to rural livelihood transformation

Laxmilatha, P.[1], Thomas, S.[2], Asokan, P.K., [3], Surendranathan, V.G.[3], Sivadasan, M.P.[3], and Ramachandran, N.P.[3]

1. Vishakapatnam Regional Centre, CMFRI, Vishakapatnam, Andhra Pradesh, laxmil@yahoo.com; 2. Mumbai Research Centre, CMFRI, Mumbai, Maharashtra; 3. Calicut Research Centre, CMFRI, Calicut, Kerala.

The Malabar region, extending from Malappuram to Kasargode districts of Northern Kerala, is a well-known mussel fishery zone of India. Over 7,000 t (80%) of the total green mussel *(Perna viridis)* catch is exploited annually from this zone. The Central Marine Fisheries Research Institute (CMFRI) developed techniques for mussel culture in 1971 and subsequently field demonstrations in different areas with direct involvement of local rural folk were carried out[1]. Demonstrations to popularise this technology have led to adoption of this simple farming method particularly in the Malabar region[2]. The Malabar coast has extensive backwaters and estuaries, which are suitable for mussel farming during the post monsoon months (November to May) when higher saline conditions prevail. Farming activity during this period provides an opportunity for supplementary livelihood and additional income to the coastal rural population.

Mussel farming trials were initiated in 1995, by suspending four seeded ropes in Dharmadom Estuary, in Kannur District. This trial was successful and was the forerunner of mussel farming in estuaries in the Malabar region. Mussel farming demonstrations were carried out in the Dharmadom Estuary in 1996 and 2 t of mussels were harvested. Simultaneously, group farming by women was initiated in Padanne, Kasargode District. Women's groups in Kasargode District set up their own mussel farms with financial support extended by Development of Women and Children in Rural Areas (DWCRA) and the Training of Rural Youth in Self Employment (TRYSEM) programmes. The women repaid the loan within the stipulated period. Thus, the all women initiative was tremendously successful and mussel farming became a supplementary avocation for the coastal women of North Kerala[3]. Further field demonstrations were continued in new areas in different estuaries.

This article presents the technology transfer through community based interventions in the Malabar region, North Kerala, during the period 2001-2004, which ultimately resulted in widespread adoption of mussel farming as an alternate livelihood option among the coastal communities and rural empowerment.

The Malabar Coast has extensive estuaries and backwaters, which are suitable for farming the green mussel during the summer months, when higher salinity conducive for the growth prevails. The transfer of the mussel farming technology to the rural population was affected through a multi-stage dissemination process. The technology of mussel farming is simple, economically viable and eco friendly. The dissemination process involved four steps:

Malabar map.

1. Technology demonstrations through a participatory and co-management approach with the farmers and end users. The growth of mussels (specific growth rate) cultured in the demonstration farms were monitored.

2. Training by experts through hands on practice.

3. Technical assistance in site selection, setting up farms, seeding and management.

4. Information sharing and evaluations. Linkages were developed with the Kerala State Fisheries Department and their subsidiaries including the Brackish Water Fish Farmers Development Agencies (BFFDAs), Aquaculture Development Agency of Kerala (ADAK), NGOs and other national agencies.

Farming demonstrations

Open sea farming, raft culture, Thikkodi, October 2001

A demonstration raft (3 x 3 m) for mussel culture was launched in the mussel beds off Thikkodi, Kozhikode district, which has extensive mussel beds with excellent seed settlement. However, the mussel pickers discard the seed that is extracted along with the adult mussels. Over 25% of the seed is thus lost to the fishery, which can be effectively used for farming. In order to create awareness regarding this, the mussel farming demonstration was carried out with the help of two mussel pickers. 16 seeded ropes of 3 m each were suspended horizontally from the raft using the seed discarded by the mussel pickers. This experiment was successful in that, the mussel pickers started collecting the mussel from the next season onwards and sold them to interested persons, thereby gaining additional income besides preventing wastage of seed.

However, open sea farming, in spite of successful demonstrations has few takers due to the inherent management problems. The limiting factors are high investment, frequent monitoring which entails high cost in terms of hiring canoes, unpredictable environmental conditions, poaching etc. Although, there is increased consciousness of the effective utilisation of the mussel seed which would otherwise be wasted, the above stated factors impede the adoption process. Governmental support in this regard is essential in terms of financial assistance and security assurances.

Group farming initiative in Korapuzha estuary, Kozhikode District, 2002-2003

Korapuzha Estuary is a fairly large estuary suitable for mussel and oyster farming. The successful adoption of mussel farming in the adjacent districts of Kasargode and Kannur prompted the Aquaculture Development Agency of Kerala to initiate a group farming initiative in the Korapuzha estuary in December 2002. In collaboration with CMFRI, training was organised for a hundred farmers. Financial support was provided to each group of five members to set up one mussel-farming unit. Bamboo, nylon ropes and cotton net were provided to each group. The cost of procuring seed was also provided. Technical assistance was provided by CMFRI. 41 farmers (groups), who started mussel farming in Korapuzha estuary with ADAK-CMFRI support, harvested their fully-grown mussels in June 2003. A total of 62 t shell-on mussels were harvested from the 41 units. The production per meter rope was 20 kg. The meat content was over 30%. These farmers have been harvesting mussels every year since then. Details of farming demonstrations in different estuaries are given in tables 1 and 2.

The farming demonstrations in different estuaries of Malabar region have effectively established the technological and economic viability of mussel farming besides identifying suitable sites for farming. The production and growth rates may vary depending on the salinity and productivity of the estuaries. It is evident that higher salinity promotes faster growth as observed in the Puduponnani, where the growth rate is higher compared to Purangara, Korapuzha. Meat content also is greater at higher salinities. However, mean production rates of 10-12 kg can be obtained in a period of 4 months in most of the estuaries. These demonstrations have conclusively shown that mussel farming can provide an excellent alternate livelihood option for the communities dependent on these water bodies.

Linkages

For effective dissemination of the mussel farming technology to the grass roots level and particularly to those whose livelihood is dependent on the backwaters and estuaries, it was essential to involve and connect all the stakeholders in the technology transfer and dissemination process. Linkages were developed between governmental, non-governmental organisations (NGOs) and enterprising individuals, mussel pickers and mussel farmers. In the transfer of the farming technology, technology demonstrations were carried out at suitable sites to establish the technical and economic viability. Training was the second step in the process to impart skill, technical knowhow and facilitate adoption. Technical support was also provided at each level of the adoption process. These were rendered through governmental and nongovernmental linkages. The state fisheries department was the important linkage at the provincial level. The Brackish Water Fish Farmers Development Agency (BFFDAs) and Aquaculture Development Agency of Kerala (ADAK), their two subsidiaries, were the instruments through which the transfer of technology was implemented. The BFFDAs and ADAK provided financial assistance and technical support,

Table 1: Technology demonstrations and their impact

Demonstration	Place	Group	Impact
Open sea mussel culture demonstration raft in (3 ft x 3 ft), 2001	Mussel bed, Thikkodi, Calicut	Mussel pickers	The effective utilisation of the mussel seed for farming, which the mussel pickers used to discard
Mussel culture demonstration farm, 2002	Purangara, Badagara	Women self help group	Viability of mussel farming technology
Mussel culture demonstration farm, 2002	Poorapuzha Estuary Parappangadi, Malappuram district	NGO (Unemployed youth)	Viability of mussel farming technology
Demonstration cum research farm for edible oyster culture 2002	Korapuzha estuary Kozhikode,	Local rural group	Viability of oyster farming technology
Integrated bivalve farm 2003, 2004, 2005	Moorad estuary, Kozhikode	Local rural group	Viability of mussel and edible oyster farming technology
Integrated bivalve farm 2004, 2005	Chaliyar estuary, Kozhikode	Local rural group	Viability of mussel and edible oyster farming technology

Table 2: Growth and production of cultured mussels in different estuaries

Estuary / year / site	SGR % month^{-1} (Length: mm)	SGR % month^{-1} (Weight: g)	SGR % month^{-1} (Meat: g)	Meat %	Salinity (ppt)	Production (T)
Moorad, 2002 Purangara	0.68	0.65	0.19	37.1	9-30	**
Korapuzha, 2003, Korapuzha	0.78	2.23	2.15	32.5	1-31	62
Elathur, 2003, Korapuzha	0.49	1.48	1.94	35.3	16-33	**
Korapuzha, 2003, Konganoor	0.29	0.76	0.32	33.7	15-32	**
Poorapuzha, 2003, Parapanangadi	1.07	2.89	2.42	33.0	2-35	0.042
Ponnani, 2002, Puduponnani	1.8	1.01	1.21	38.0	10-40	5
Moorad, 2004, Kottakal	0.65	1.79	2.06	27.0	23-35	**
Korapuzha, 2004, Korapuzha	0.53	2.02	1.28	39.5	10-31	40

***Not estimated due to rains / poaching*

besides facilitating the dissemination process. A few enterprising mussel farmers served as models and proved to be catalysts in the technology adoption process. Shri Gul Mohamed was the first such mussel farmer who ushered in mussel farming into the Padanne village. He received the *"Karshaka Shri"* Award from ICAR in 2002. NGOs and self help groups also played a key role in the adoption process. The BFFDAs in Kannur and Kozhikode have developed into major catalysts in the technology adoption process. The BFFDA identifies prospective farmer groups in areas suitable for mussel farming. The groups are usually dependent on the water body for their livelihood and mussel farming serves as supplementary option. Training courses are arranged for the identified groups in collaboration with CMFRI. CMFRI provides necessary technical guidance besides hands on training. The financial support is provided by BFFDA to the farmer groups. The mussel culture activity is subsidised up to 25% of the total cost. 75% of the total cost input is by the farmers themselves. The BFFDAs of Calicut and Kannur have thus promoted mussel farming along the Malabar Coast.

The ADAK also provides financial support to prospective mussel farmers. Farmer groups are identified and provided training on mussel farming in collaboration with CMFRI. Each group is provided with materials for setting up one unit (bamboo, nylon rope, cotton netting, etc.) The cost of seed is also reimbursed to the farmers.

National Agricultural Technology Project (NATP) on mussel mariculture aided by the World Bank

As part of this national programme, two major initiatives in mussel farming were carried out in the Malabar region. With the increased interest and adoption of mussel farming in the Malabar zone, availability and abundance of the mussel seed for the farming sector was crucial. In order to address this issue, a focused survey of the distribution and abundance of mussel seed along the Malabar coast was carried out. Experiments were carried out to collect spat by setting artificial collectors in natural mussel beds.

Mussel seed production from wild

Spat collectors of different types were fabricated for collecting mussel spat from mussel beds. These were attached to a 3 x 3 x 3 GI frame. The frame was established in mussel bed area in Elathur in Kozhikode District. The frame was anchored using 200 kg concrete blocks. The following materials were used as spat collectors: Nylon net wall - old fish net was used to prepare a net wall suspended from a nylon rope and this was set over sides of the frame. Coir ropes of 1.25 and 2.5cm' thickness and 75 cm length were tied from one end to other of the frame. Nylon frilled ropes provided by M/s Garware ropes were also used as spat collector. They were attached to frame from one end to the other. Coir mats, bamboo baskets and tiles etc. were also used as collectors. The GI frame along with the spat collectors were set in September. However, the whole structure was destroyed and washed away in a heavy rains and turbulence developed due to the rough weather.

Mussel seed survey along the Malabar Coast

Mussel seed distribution and abundance was assessed along the Malabar Coast extending from Malappuram to Kasargod districts during 2001. The major mussel beds in Kozhikode district are South beach, Chaliyam, Elathur, Kollam, Moodadi, Thikodi and Chombala constituting about 435 ha. Mussel bed off Mahe constitutes nearly 20 ha. The major mussel beds in Kannur district are Thalassery, Thalai, Koduvally, Kadalai constituting 125 ha. In Kasargode district, the mussel beds of Kasargod are off Chembarika, Kottikulam, and Bekel constituting 40 ha. There is no significant mussel resource in Malappuram District. The total area of mussel beds along the Malabar Coast constitutes 620 ha in area. Spat settlement occurs on lateritic formations along South beach, Chaliyam, Elathur, Kollam, Moodadi and Thikodi. Granite rocks are observed in Chombala, Mahe, Thalassery, Thalai, Koduvally, Kadalai, Chembarika, Kottikulam and Bekel. Kozhikode had the highest seed biomass forming 68% of the total seed resource, followed by Kasargode (20.2%) and Kannur (9.8%) districts. The total seed biomass estimated for Malabar area as 8,221 tonnes. In Kozhikode district, Thikodi / Moodadi area contributes about 66% of the total seed. About 42% is distributed in Thalassery / Thalai areas of Kannur district.

Table 3: Trends in mussel farming adoption during 2000-2006

Year	Number of farmers	Estuary / place	Production (T)
Rack culture			
2000	250	Padanne, Kasargod district	250
2002-03	200	Korapuzha estuary, Kozhikode	62
2003-04	200	Korapuzha estuary, Kozhikode	40
2003-04	290	Kadalundi estuary, Malappuram district	380
2004-05	350	Kadalundi estuary, Malappuram district	420
2004-05	400	Padanne, Kasargod district	2500
2005-06	300	Moorad estuary Korapuzha estuary	9 77
2005-06	210	Kozhikode, Malappuram districts	
2005-06	414 individuals 180 societies	Padanne, Kasargod district	3086 4410
Bottom culture			
2004-05	14 10 50 75 20	Kannur Mahe estuary Kahalundi estuary Chaliyar estuary Kokuvally (intertidal beds)	268

Maximum spat settlement per unit area as observed in Kottikulam and Chembarika, where 4.6 and 3.8 kg m^{-2} was recorded.

Training

Training for prospective mussel farmers were conducted in collaboration with the Trainers Training Centre (TTC) of CMFRI, BFFDAs of Kozhikode and Kannur Districts, State Fisheries Department, Kerala. The response was often overwhelming and technology adoption was enthusiastic especially among women self help groups. A total of 536 persons, comprising 235 women and 281 men were trained during this period.

Tangible impacts of the mussel farming initiatives

Over the past five years, the mussel farming initiatives have paid rich dividends in terms of increasing mussel production through farming besides increasing the social and economic benefits to the rural farmers both men and women who have taken to this method of farming (Table 3). Technology adoption, increased production through farming, women's empowerment, development of mussel seed trade and rope making and technology diversifications are the visible and tangible outcomes.

Technology adoption by women

In Padanne, Kasargode district "a silent, gentle transformation" is taking place, driving home a significant and poignant point that, given the opportunity, women can empower themselves. And that technologies are not inhibitive rather appropriate technologies are easily adopted. In Padanne, there is no significant mussel fishery in the region and mussels are not consumed locally; therefore introducing mussel farming as a supplementary livelihood option was constrained by several factors: acceptance and adoption of the technology, marketing and other social/ religious considerations. Yet, mussel farming has found wide acceptance and high adoption rate in this region.

At present there are nearly 200 women mussel farmers' societies. Each societies comprises 15 -20 members. Besides this Kudumbasree groups aided by village Panchayats have also adopted mussel farming on a large scale. Each Kudumbasree also comprises 15-18 women. Several individual farmers and groups formed by men have also taken to mussel farming. These groups have availed loan from banks. The mussel production from farming has risen from 250 t to nearly 7,000 t in 2005-06.

Mussel seed trade

With increased adoption of mussel farming, demand for mussel seed increased tremendously as a result of which trade in seed has developed into an allied mussel farming activity generating additional income to mussel pickers. Active mussel seed trade occurs in South beach, Elathur, Kappad, Thikodi, Moodadi, Koduvally, Bekal and Kottikulam. About 100 kg seed costs Rs. 400-450.

Bottom culture of mussel

This has become widespread among farmers as well as mussel pickers in the Malabar region. The farmers themselves have resorted to this system as against the suspended method of culture. Here, the farmers collect seed from mussels beds and spread it near their homestead for harvest during lean season when fish is scarce. The mussel pickers also now relay the seed in inter tidal beds for harvesting later. They sometimes stock even the adult mussels. Bottom culture is being carried out by 14 farmers in Kannur, 10 pickers in Mahe estuary, over 50 farmers in Kadalundi, Kozhikode district, over 75 persons in Chaliyar. Over 20 mussel pickers in Koduvally, Kozhikode district relay mussels in the intertidal beds.

Technology modification

The technology of mussel farming extended by CMFRI was the vertical suspended rack/raft system. However, in shallow areas where depth is inadequate for suspending vertical ropes but which were otherwise suitable for mussel farming, farmers have resorted to suspending horizontally seeded ropes, thus adapting to the given conditions. Also

they use old nets and coir ropes for the seeding. Others have simply resorted to bottom culture to keep costs low. The people of this region have become more receptive to newer technologies such as seaweed farming, oyster farming etc.

In conclusion, the sustained mussel farming initiatives and interventions carried out by CMFRI has provided alternate livelihood options and livelihood diversification. It has led to increased fishing income, besides supporting complementary household activities particularly among womenfolk, rather than substituting one secure income source for another. Encouraging alternate livelihood options raises the opportunity income of fishing with potential conservation and economic benefits[4]. There is further scope for widening the horizons of these interventions by introducing other allied activities like small scale homestead processing units such as depuration, pickling, dried mussel and ready to eat processed products.

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Selective study on the availability of indigenous fish species having ornamental value in some districts of West Bengal

Panigrahi, A.K.[1], Dutta, S.[1] and Ghosh, I.[2]

Fisheries and Aquaculture Extension. Laboratory, Department of Zoology, University of Kalyani, Kalyani 741235, Nadia, West Bengal, India, email sarbanidutta8@gmail.com; 2. Department of Aquaculture, West Bengal University of Animal and Fishery Science, Kolkata, West Bengal, India, email wbuafs@gmail.com.

The term ornamental fish needs no introduction. The global trade of the ornamental fish industry is increasing rapidly, at around 6% annually[1]. In the aquaculture sector, ornamental fish breeding, culture and trade provide excellent opportunities as a non–food fishery activity for employment and income generation. It is environmental friendly, socially acceptable and involves low investment for adopting as a small scale enterprise with high return. The attractive coloration and quiet disposition of ornamental fish provide a source of joy and peace for people irrespective of age group. Increasingly, ornamental fish is becoming a fashionable activity with new fish varieties entering the market from time to time. By concentrating on such fish only, we may lose our indigenous fish biodiversity, some of which are edging towards extinction. Many indigenous ornamental fishes are very much useful for developing new strains to compete in world market. They are also used as a tool in biotechnological research in all over the world[2].

The history of culturing ornamental fishes in West Bengal is age old. A rich aquatic biodiversity, favourable condition, cheap labour and easy distribution make West Bengal as a pre-eminent hub for this promising industry[3]. Most of the indigenous and endemic fish species available in this state have significant potential for the purpose of ornamental fish culture. However, severe depletion in the natural fish population of the state has largely been driven due by destruction of habitat, unsustainable modes of exploitation and other stresses. So with the present investigation, an attempt has been made to ascertain an overview of the availability of indigenous ornamental fishes in some districts of West Bengal.

A survey was carried out for 60 days (September-October, 2008) in four districts of West Bengal namely Howrah, Hooghly, and North and South 24 Parganas, because these districts are rich in different types of indigenous fish species which have got tremendous ornamental status in the international market. A considerable number of fish culture units have been concentrated in these four districts[1] (Table 1). The entire region under study is highly variable as far as topographic and climatic conditions are concerned. This region enjoys a tropical monsoonal climate, receiving an annual medium range of rainfall with high temperature in summer (30-39°C) and a sharp fall of temperature in winter(15-25°C).