# Mussel Farming Methods and the Prospects and Problems in India

**P. K. Asokan, K. S. Mohamed and Geetha Sasikumar**
Central Marine Fisheries Research Institute,
Ernakulam North P. O., P. B. No. 1603, Cochin - 682 018, Kerala, India

## Introduction

Mussel farming has a long history that dates back to the thirteenth century. Mussels are farmed in many areas of the world with the most common species cultured being the blue mussel, *Mytilus edulis*. The main producers of mussels are countries such as China, Korea, Spain, Netherlands, Denmark, France and New Zealand. In 2012, 1.829 million tonnes of mussels were produced worldwide valued at 2.053 billion US Dollars (FAO). The Indian mussel production is relatively small and the production is around 10,000 tonnes for the past few years.

In India, mussel culture (*Perna viridis*) is becoming popular in the Malabar area since 1996 following the success achieved by CMFRI in rearing and popularizing green mussel in the backwaters. The simple methods employed for mussel farming was transferred to progressive farmers who took up mussel culture in the backwaters. Soon they found the venture profitable. Demands came from new entrepreneurs for training and mussel farming spread from Kasaragod to Ponnani.

Mussel culture in the backwaters of Kerala was first started in Padanna and Cheruvattur Panchayats in Hosdurg Taluk of Kasaragod district. Later it was taken to Elathur in Calicut district and Vallikunnu and Ponnani in Malappuram district.

Initially this low cost technology of farming was transferred to five groups with 15 to 21 members at Cheruvattur and Valiyaparamba. Financial assistance was provided by the North Malabar Gramin Bank and Cheruvattur Farmers Co-operative Bank. They provided a loan of Rs. 2,60,200/= for the implementation of the project with a subsidy component of 50% subsidy. These groups harvested 67.4 tonnes of mussels during May-June 1997. A portion of the harvested and shucked meat (2000-Kg) was sold to the Integrated Fisheries Project, Cochin at a rate Rs. 45 per Kg. The remaining harvest was sold in the domestic market. The groups could realise Rs. 3,34,555/= from the harvest with a net profit of Rs. 1,04,455/= within a period of 6 months.

Many culture techniques are used for growing mussels worldwide and the most popular are described below:

**1. Bouchot or Intertidal Pole Culture**

In France, mussel culture is believed to have started in 1235, when an Irish sailor Patrick Walton survived a shipwreck on the Bay of Aiguillon. He found that the wooden poles and nets that he had kept for trapping birds attracted mussel spat settlement. This became the basis for *Bouchot* method which is the oldest and the main method utilised in France on the Atlantic and English Channel coasts. This method, well suited to the large intertidal mud flats facilitated the development of the blue mussel (*Mytilus edulis*) industry in France (Gosling, 2007). The *Bouchot* method extended to other suitable intertidal areas along the Brittany and Normandy coast. The spats are collected on spat collecting ropes made of coir. These spat bouchots are situated offshore and consists of parallel rows of poles with horizontal coir ropes for collecting seeds.When the seed are a few months old, they are removed from the ropes, placed in mesh tubes and transferred to *bouchots* for growth.

Mussel seeds are harvested from August – December depending on the size and density of settlement. The seeds are scraped from the poles using a steel blade attached to a metal wire to hold the scrapped off mussel. In this method, ropes with spat attached are wound around large vertical poles *(Bouchots)* in the intertidal zone. The line of poles mainly oak tree trunks 4-7 M long, 12-25 cm diameter at the wider end and about 7 cm at the opposite end. The lower 3 meter of the pole is inserted in the seabed. Mesh netting is used to cover the mussels to prevent them being detached and lost. A barrier is placed at the bottom of the pole to prevent predators such as crabs from reaching the mussels. *Bouchot* are placed perpendicular to the shoreline and consists of 125 poles running for 50-60m and spaced 15-25m from the next line. This method of culture requires large tidal ranges, in order to supply the densely packed mussels with plankton.

Marketable mussels of 4-5 cm shell length are harvested when they are 12-18 months old. On an average, 25 kg of mussels are harvested from each pole annually. The entire produce is sold domestically. 4000 poles can produce 100 tonnes of mussel per year.

**2. Stake culture**

In Thailand and Philippines, mussels are grown on bamboo poles (6-8m long) staked at half meter depth and one meter apart or in circle and tied at the top to form a wigwam structure in soft, muddy bottoms. Mussels (*Perna viridis*) settle on the submerged bamboo stakes. Bamboo poles are often observed to monitor growth as to eliminate predators like starfish and crabs. Bamboo stakes are placed in areas where natural spatfall is expected. Mussels are harvested after a growing period of 6–10 months after stocking or when the animals reach 5–6 cm in length. Each pole yields 8-12 kg of mussel. Harvesting is done by hauling up the bamboo poles and loading them into a raft. Divers are employed to pick out the larger mussels and the small ones left for the next harvest season. This selective harvesting results in two or more yields within the 6–8 months of the farming period. Harvested mussels are cleaned and then placed in baskets and shaken vigorously in seawater until they are clean of barnacles and dirt. Bamboo poles that are worn out are removed while the good ones are cleaned for the next culture season. The stake method is an economical and easy way of growing mussels but has also some shortcomings. The bamboos decay easily and it is at times difficult to match staking operations with spatfall. This culture system also facilitates siltation which makes bays and estuaries too shallow for mussel farming. In Philippines a rope strung in a zigzag fashion or rope web method is used. Each unit consists of two bamboo poles 5 meters apart are driven into the substratum. Two polypropylene rope, 2 meter apart are tied to the bamboo poles. 40 m rope of 10-12 mm diameter is used to connect in a zigzag manner. Pegs are inserted at 40 cm intervals (Joseph, 1998).

**3. On-bottom culture**

This method is widely used in Netherlands, Denmark and Germany. The culture is based on the principle of transferring seeds from areas of great abundance where growth is poor to culture plots in lower density to obtain better growth and fattening of the mussel. The culture plots must have a firm substratum and less of drifting sand and silt particles. In Netherlands, the seeds are dredged from Waddenzee. The seeds are laid in intertidal areas to produce mussels with thick shells and strong adductor muscle. In the sub-tidal areas higher meat yield and thinner shells are produced fit for processing industry. The whole process is highly mechanized from collection of seeds to harvesting and marketing. Waddenzee and Zeeland are the important areas for mussel (*M. edulis*) farming. In Zeeland, the town of Yerseke is the important mussel trading area. Waddenzee in the northern part of Netherland was used as a source of seed. Since 1950, farming plots were also created here. The seeds which are which are fished from the seed beds during the short well defined period are scattered evenly on the beds allotted by the government to mussel farmers. The seeds are gathered by special mussel boats. About 10 tonnes of mussel seed can be gathered in one hour of dredging operation. The seeds gathered are replanted the same day over the plot measuring 500 x 200 meters. 20 to 35 tonnes of seed are used per hectare for relaying depending upon the size of mussel seed. The mussels are distributed evenly by the farmers if the stocking is found crowded. The starfish problem is managed by salt treatment or removal using starfish nets. The filtering activity of the mussels produces silt which gets deposited under the mussel carpet. This hinders the growth of mussels. Chain harrow are used to level the ground. In the Waddenzee the mussel are usually kept in the same area but in Zeeland the half grown mussels are relocated to deeper areas where conditions for fattening and growth are better. Waddenzee mussel being slightly larger are suitable for half shell trade and Zeeland mussels are preferred as raw material for canning factories fetching higher price.The mussels are marketable in the Dutch mussel farming areas when they are 2-3 years old. The production by on bottom culture is about 8 Kg per $m^2$ of mussel plot or 80 tonnes per hectare. An essential part of the on bottom Dutch mussel farming is the 're-watering' process. Here before marketing the mussels, they are kept in special lots for 10-14 days for the process of eliminating the weak and damaged mussel.

**4. Long line culture**

This method is becoming very successful in open sea mussel farming. A rope is stretched horizontally near the water surface and maintained 1-2 m from the surface with buoys. Mussels are grown on vertical ropes known as 'droppers' which hang from the horizontal rope for a length of 4 m. Mussel seeds are collected from natural beds and transplanted onto the ropes into a continuous sock-like cotton tube, which is approximately 17.5 cm in width. Small mussels stripped from the collection ropes are inserted. This cotton sock is then wound around the dropper. The mussels grow and attach to the ropes using their byssal threads and the cotton sock slowly disintegrates and falls away. The droppers are placed a minimum of 0.5 m apart and have at least 4 m of free space from the bottom. In deeper waters the gap between the bottom of the line and the sea floor is greater. Anchor ropes extend from each end of the horizontal rope to anchors buried in the mud of the bottom. As the ropes are kept taut, there is no movement around the anchor to disturb the bottom as occurs when boats are anchored. The density at which mussels can be cultured on long lines could be about 300 per meter, but depends on the food availability, which varies from site to site. Mussels grown on long-lines can become smothered by naturally settling juvenile mussels and other fouling organisms. For this reason, most farmers prefer to position their farms away from heavy spat settlement areas to avoid layers of spat attaching to larger mussels.

**5. Raft Culture**

The basic principle of raft culture is similar to long line culture in that the mussels are suspended on droppers but these are suspended from the raft instead of the long lines. The raft itself is anchored to the seabed removing the need for several anchoring systems. Long line culture however, creates less of a visual impact, and the droppers can be spaced farther apart to maximize the use of the available phytoplankton. Raft culture is more suited to areas of dense phytoplankton and to smaller operations, as there is less scope for mechanical harvesting. This method of culture is used in the Galician Bays in Spain, Saldahna Bay in South Africa but has been abandoned by the New Zealand industry in favour of long lines. This method has its origin in Spain in the Galician Bay. Mussel seeds (*Mytilusgollo provincialis*) settle profusely in the inter-tidal zone in the coastal waters of Galicia. Rias are deep sunken river valleys upto 25 km in length ,2-25 km wide and 40-60m deep. As these rias are protected by islands at their mouth, these sheltered, nutrient rich rias with 3-4 m of tidal range provide ideal environment for suspended mussel culture. The rafts are constructed using a wooden framework of timber and floats of concrete, steel, styrofoam or fiberglass material. The average size of the raft is 23×23 meter which supports 700 ropes. The rafts are anchored along the sides with large concrete moorings. There are over 3000 rafts in the Galician rias. The rafts are spaced at a distance of 80-100m from each other and positioned in groups called parks. These seeds are collected by scrapping the rocks with spade-like steel blades. Seeds can be collected by suspending ropes vertically from the rafts in December and January to catch seeds in February and March. Seeds also settleon the mussel ropes. The length of the mussel ropes varies from 6-9 meters according to the depth of the culture site. Pegs are used at 40 cm intervals to avoid slippage. The average weight of seed per meter of rope is 1.5 to 1.7 kg. About 4600 t of seed per year are needed to maintain the present level of production (Gosling, 2002).

Thinning out of the mussel ropes are done in 3 to 6 months depending upon the growth. The ropes are removed when the weight attain 10 Kg of mussel per meter. The ropes are hoisted and the mussel transferred to new ropes. About 3.5 Kg of half grown mussels are attached per meter of rope. After 8 to 12 months of growth the mussels attain marketable size of 8-10 cm (Korringa, 1976). Growth of mussels on inshore rafts is less than on rafts in the mouth of the Rias, which demonstrates food constraint at inshore sites (Navarro *et al.*, 1991). Temperature plays an important part on the growth as the mussels in the upper part of water column, above the thermocline (2.5m) were significantly larger than those cultivated in deeper waters (7.5 m) (Gosling, 2002). Harvesting is done using mussel boats outfitted with power crane and metal baskets to collect the mussel ropes. As the production is about 10 Kg of mussel per meter of rope, a raft having 600 to 1000 ropes of 6-9 meter may produce 30000 to 90000 Kg of mussel per year.After harvesting, the mussels are kept for depuration for 24-48 hours before they are marketed (Korringa, 1976).

**6. Rack culture**

This is the simplest of the rope method used for green mussel cultivation in India and Philippines. The main purpose of the pole is to support the structure. In between these poles, ropes are suspended either vertically or kept horizontally where the depth is a limitation. The construction is labour intensive but the simplicity in harvesting and accessibility of local materials for farming purposes makes it very adaptable under local conditions. Mussel culture is fast becoming popular in the Malabar area since 1997 following the success achieved by CMFRI in rearing green mussel by rack culture in the backwaters. The simple methods employed for mussel farming was transferred to progressive farmers who took up mussel culture in the backwaters. Soon they found the venture

profitable. Demands came from new entrepreneurs for training and mussel farming spread from Kasaragod to Ponnani. Mussel culture in the backwaters of Kerala was first started in Padanna and Cheruvattur Panchayats in HosdurgTaluk of Kasaragod district. Later it was taken to Elathur in Calicut district and Vallikunnu and Ponnani in Malappuram district. The total production in 2008 was 16,500 tonnes. Some of the constraints are regarding the availability of seed. The seeds required for culture is presently collected from traditional fishing areas and these are often causing conflicts between farmers and mussel fishermen. Hence it is essential that additional spat collectors have to be established along the coast to ensure supply of seeds to the farmers.

The harvesting seasons of cultured mussels is mostly during April – May months and farmers are forced to sell their crop before the onset of monsoon to avoid mass mortality of mussels due to freshwater influx into the backwater system. At present only a few processing plants purchases cultured mussels from the farmers and as a result the local market are flooded with cultured mussels during these months resulting in fall in the prices and thereby affecting the profitability of the operation. Siltation in the backwaters is another problem. This often results in mortality of mussels in the farms. Hence scientific feasibility studies are required to demarcate potential culture sites. Mussel farming is a decade and half old farming practice in India. This is a low investment activity with very good returns. If promoted properly, mussel farming can be used as a tool for women empowerment in the coastal areas and can stimulate a healthy socio-economic development in the area. Better post harvest technologies can develop attractive value added products. Since very good export markets are available for mussels there is further scope of extending the farming practice to suitable areas.

**Prospects:**

1. Backwater mussel culture opens immense potential for resource and employment generation among coastal communities especially women living below poverty line.
2. Mussel culture is a low investment activity with very good returns. If promoted properly, mussel farming can be used as a tool for women empowerment in the coastal areas and can stimulate a healthy socio-economic development in the area.
3. Better post harvest technologies can develop attractive value added products. Since very good export markets are available for mussels, they can be taken up as a challenging opportunity.

**Constraints:**

1. Availability of seed:

   The seeds required for culture is presently collected from traditional fishing areas and these are often causing conflicts between farmers and mussel fishermen. Hence it is essential that additional spat collectors has to be established along the coast to ensure supply of seeds to the farmers.

2. Season of harvest:

   The harvesting seasons of cultured mussels is mostly during April – May months and farmers are at times forced to sell their crop before the onset of Monsoon.

3. Storage facility:

   If sufficient cold storage facility is provided, cultured mussels can be depurated, shucked and stored not only for export market but also for local market throughout the year. This will increase the profitability of the culture operation.

4. Post harvest technology:

   Value added products of longer shelf life need to be developed from mussel meat to increase the revenue realization from cultured mussels. Mussel fry, mussel pickle etc. are some of the best examples for value added products. More studies are needed to develop ethnic cuisines with longer shelf life.

5. Siltation of backwaters:

   Some areas in the backwater system have very high siltation levels especially during rainy season. This often results in mortality of mussels in the farms. Hence scientific feasibility studies are required to demarcate potential culture sites.

**For further reading**


1. AQUACOP, 1983. Mass production of spat of green mussel *Mytilus viridis* Linnaeus in French Polynesia. *Proc. Symp. Coast. Aquac.*, 2, 539–543
2. Appukuttan, K. K., Mathew, Joseph, Thomas, K. J., 1987. Larval rearing and spat production of the brown mussel *Pernaindica* Kuriakose and Nair at Vizhinjam, southwest coast of India. Nat. Sem. Shellfish Res. Farming, Tuticorin. CMFRI Bull. 42, 337–343.
3. Gosling E. 2002. Bivalve Molluscs: Biology, Ecology and Culture. Blackwell Publishing Limited. 456 pages.
4. Joseph, M. M.1998. Mussel and oyster culture in the Tropics. In: Tropical mariculture. Ed. by: Sena S. De Silva. Academic Press. 487 pagers.
5. Korringa, P. 1976. Farming marine organisms low in the food chain. A multidisciplinary approach to edible seaweed, mussel and clam production. Elsevier Sc. Publ. Co. 264 p.
6. Navarro, E., J. I. P. Iglesias, A. Perez Camacho, U. Labarta & R. Beiras, 1991. The physiological energetics of mussels from different cultivation rafts in the Ria de Arosa. *Aquaculture,* 94 (2/3): 197–212.