Recent developments in edible bivalve farming in India

About the authors

This article was written by V. Kripa, K.S. Mohamed, T.S Velayudhan, P. Laxmilatha, P. Radhakrishnan, M. Joseph, P.S. Alloycious, J. Sharma and K.K. Appukuttan, of the Molluscan Fisheries Division, Central Marine Fisheries Research Institute, PO Box 1603, Cochin 682014, Kerala State, India.

The Central Marine Fisheries Research Institute (CMFRI) has helped popularize bivalve farming in Kerala State by setting up demonstration farms and conducting training programmes for fishers. This has created opportunities for rural development and self-employment. Since 1995, edible bivalves like the Indian backwater oyster, *Crassostrea madrasensis* and the green mussel, *Perna viridis* have been farmed on a commercial scale in the estuaries of Kerala. Along the Malabar Coast, especially in the estuaries of Kozhikode, Malappuram and Kasaragod districts (Fig. 1) mussel farming by ropes suspended from racks is now a popular seasonal vocation through which about 500-800 tons of mussels are produced annually. Along central and south Kerala (Alappuzha and Kollam districts), edible oyster is more popular and in the Ashtamudi and Kayamkulam lakes, more than 150 farmers carry out rack and ren method. In 1996, edible oyster production was 9 tons; it increased to 15 tons in 2000. Green mussel culture was nil in 1996, but reached 800 tons in 200 from an initial production of 27 tons in 1997.

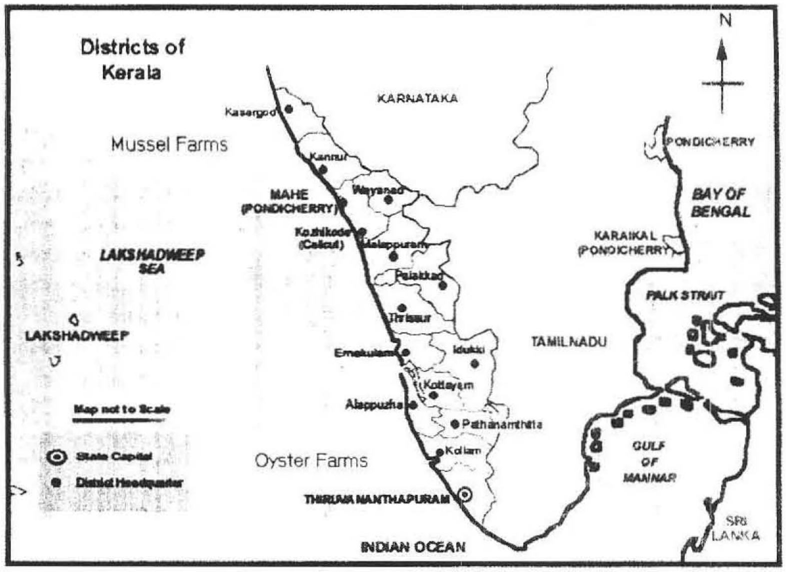


Fig. 1. Map of southwest coast of India showing the location of Kerala State and concentration of edible oyster and mussel farms

Table 1. Comparison of instantaneous growth rates, fallout percentage and production rates in different treatments of mussel culture, Ashtamudi rack farm, 100 days after culture, 2000

Treatments	Instantaneous growth rate		% fallout	Production kg/m
	Length	Weight		
GM - 5cm plastic strip	0.835	2.343	55.02	11.47
GM - Fuzzy white	0.902	2.503	83.42	4.71
GM - Fuzzy grey	0.841	2.386	69.25	7.10
GM - 12mm nylon	0.935	2.606	39.38	12.60
BM 12mm nylon	0.446	1.628	82.55	1.93
PM - 12mm nylon	0.482	1.841	74.67	4.69

PM- Green mussel, BM- Brown mussel, PM -- Light green (parrot) coloured mussel

With the commercialization of edible bivalve farming, it was felt that refining this technology could help increase profits. Our project had the following objectives:

- Increasing the profit margin in bivalve mariculture by reducing capital and recurring expenditures
- Examine the potential for culturing brown mussel *(Perna indica)* and parrot mussel (light green mussel which could be a hybrid between brown and green mussel) in the estuarine ecosystem
- Produce eonomically viable single oyster culture for supply to the live oyster trade
- Integrated culture of finfish in estuarine bivalve farms

Experiments to achieve the above objectives were carried out at the Institute farm in Ashtamudi Lake from 1997 to 2000 and the results are given in this article.

Increasing the profit in bivalve mariculture by reducing capital and recurring expenditures

The experiment aimed to reduce the capital investment on 12-18 mm nylon rope (a major capital investment) used for mussel seeding and the recurring expenditure on replacing bamboo and wooden poles used in constructing racks in oyster and mussel farms. To meet these objectives experiments tested the following.

1. Efficiency of different low cost materials for mussel seeding
2. Reduction in labor during seeding
3. Modification of grow out structures

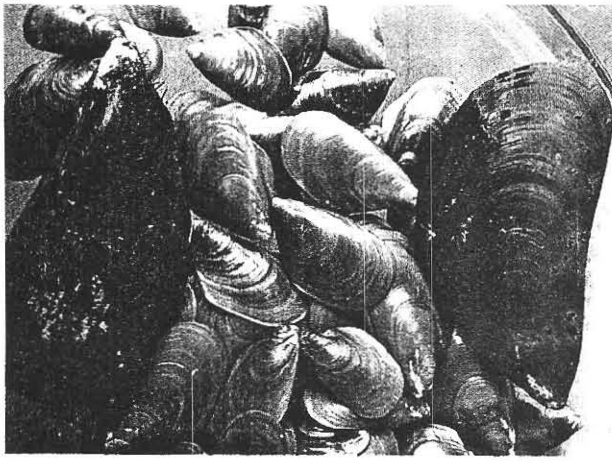
Low-cost seeding material

An experiment to study the efficiency of low cost materials that can be used instead of the expensive nylon rope was conducted using the following materials.

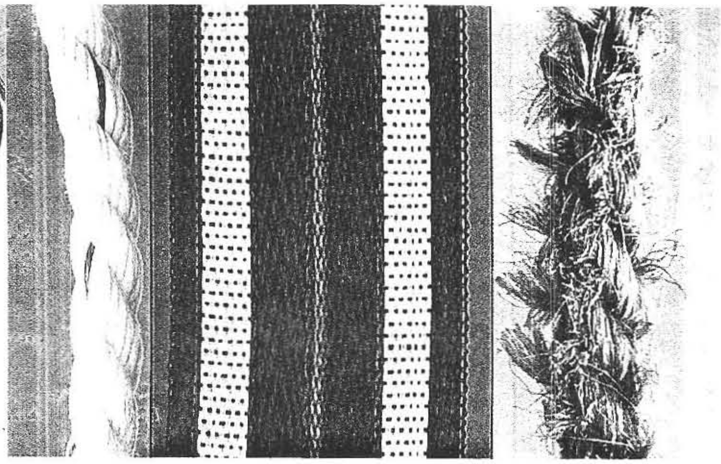
1. Imported mussel rope (Fuzzy™) with bristles having biodegradable cotton stocking (White-Gifted from Canada)
2. Imported mussel rope (Fuzzy™) with bristles having semi-degradable synthetic stocking (Grey-Gifted from Canada)
3. Flexible plastic strip of 5 cm width (commonly used in camp chairs and cots)
4. Control – 12 mm nylon rope

These were seeded uniformly at a stocking density of 1 kg per meter of rope.

We found that the rate of growth in length and weight of green mussel were highest (0.902 and 2.606 respectively) in control followed by fuzzy white rope.



The experiments used brown mussel (*Perna indica*), parrot mussel (hybrid), and green mussel (*Perna viridis*).



The seeding materials used: 12 mm nylon rope as control (left), flexible plastic strip (FPS) and Fuzzy™ rope (right).

The fallout percentage of seeded mussel was lowest in the 12 mm nylon (39.38%) and highest in the fuzzy white treatment (83.42%). The production rates in each treatment were calculated after a culture period of 105 days (Table 1). Highest production of 12.6 kg per meter was obtained for nylon rope followed by plastic strip, 11.47 kg per meter. Overall, we found that the control (12 mm nylon) was the best performer in terms of growth rate, production and in terms of fallout percentage. However, when the costs of materials (excluding imported materials) were compared, it was found that nylon rope is 12 times more costly than the plastic strip per meter of seeded length. Considering that the fallout percentage is also low (55.02%) in plastic strips, they can also be used as a cost efficient seeding material in mussel culture. This can greatly reduce the capital investment on nylon ropes.

Reducing labor costs

Mussel seeding is labor intensive as it involves stitching and wrapping individual ropes with degradable cotton material. To reduce labor, we pre-stitched the degradable wrapping material (cotton mosquito net) into tubes of 20 to 25 cm width and 1.25-inch length. During seeding, the nylon rope was placed within the pre-stitched tube and filled with mussel seed. The ends were tied and these seeded ropes were suspended from the rack. This method halved the manpower needed for seeding from eight mandays for seeding 100 ropes to four mandays.

Reducing the cost of rack structure

The constant replacement of bamboo or casurina poles used for fabrication of grow out racks due to fouling and boring is the main recurring cost in bivalve farming in estuaries. PVC poles of 5-cm diameter filled with concrete were laid down instead of bamboo poles in 1997. These have withstood three seasons without any fouling or boring or natural degradation. The capital investment in the first year is high but maintenance on the farm is reduced. The results are shown in Table 2.

Adopting these new methods increased farm income by more than 18 percent (Table 2) The added costs of the refinements was minimal considering the extra life of the PVC poles.

Plastic strips can also be used as a cost efficient seeding material in mussel culture. This can greatly reduce the capital investment on nylon ropes.

Table 2. Comparison of expenditures and profit on mussel farming by present (existing) and new methods (US$1 = Rs. 47).

Existing method	Amount in Rupees	Per crop
A. Fixed cost (0.0025 ha; 100 seeded ropes of 1m length, cultivation period six months)		
1. Bamboo poles (15 @ Rs. 90 – 2 year life)	1,350	675
2. Nylon rope 1kg @ Rs. 85/kg	85	85
3. Nylon rope for seeding @ 12kg @ Rs. 85 – 3 year life	1,020	340
Sub-total		1,100
B. Operating cost		
4. Cotton netting 20 meters @ Rs. 20/m & needle	450	450
5. Seed 150kg @ Rs. 6/kg	900	900
6. Canoe hire charge 15 times @ Rs. 50	750	750
7. Seeding charge 8 man days @ Rs. 150	1,200	1,200
8. Marketing expenditure including transportation	700	700
Sub-total		4,000
Total		5,100
New Method		
A. Fixed cost		
1. PVC concrete pole 30m – 5 year life	3,850	770
2. Nylon rope 1kg @ Rs. 85	85	85
3. Flexible plastic strip 2 kg @ Rs. 100/kg – 3 year life	200	67
Sub-total		922
B. Operating cost		
4. Cotton netting 20 meters @ Rs. 20/m & needles	450	450
5. Seed 150kg @ Rs. 6/kg	900	900
6. Canoe hire charge 15 times @ Rs. 50	750	750
7. Seeding in prefabricated netting 4 man days @ Rs. 150	600	600
8. Stitching charges	100	100
9. Marketing expenditure including transportation	700	700
Sub-total		3,500
Total		4,422
C. Income: Production @ 7.5kg/m x 100 – 750kg @Rs. 10/kg		= 7,500
Net profit		
Existing method	7,500-5,100	= 2,400
New method	7,500–4,422	= 3,078
Comparison		
A. Benefit	B. Cost	
Added income = nil		Added cost = Rs. 95
Reduced cost (reduced income = nil)		0
a. Rs. 340-67		= Rs. 273
b. Rs. 1,200-700		= Rs. 500
c. Total		= Rs. 773
Benefit – costs = 773-95 (per 6 months)		= Rs. 678
Additional gain (profit) as percentage of total cost		
1. Existing method		= 13.3%
2. New method		= 18.3%

The live oyster trade principally depends on production of single oysters with good shape and size. The main objective of this experiment was to grow large and uniformly shaped oysters which can be marketed live as a shell-on product.

Potential for the Culture of Brown and Parrot Mussel in the Estuarine Ecosystem

A mussel seed resources survey along the Kerala coast indicated that brown and parrot mussel seed is available during the post monsoon period along southern regions of Kerala State. We seeded about 15 ropes each with brown and parrot mussel seed to test their potential for mussel culture in the estuarine system. We found that both of these species have a low growth rate and high fall-out percentage (Table 1) indicating that they are not suitable for culture in the estuarine ecosystem. This is because brown and parrot mussels are not tolerant to salinity fluctuations which are common in estuarine conditions.

Fig.2 Growth of Oysters Stuck on Bamboo Strips

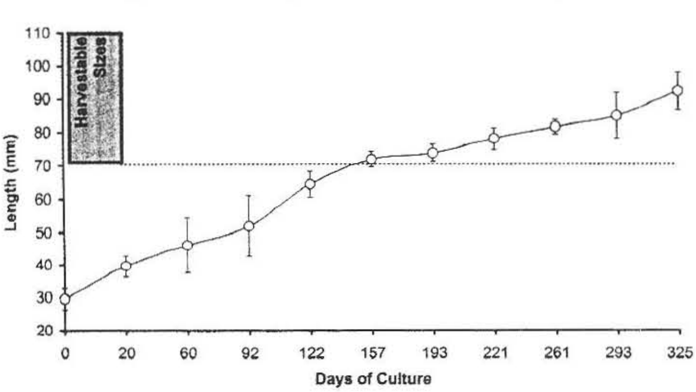
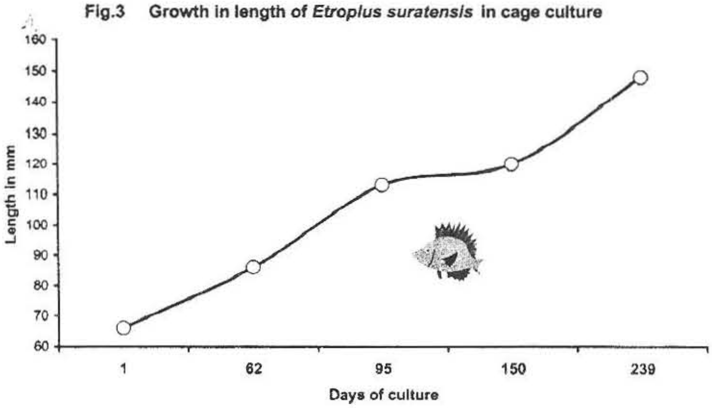
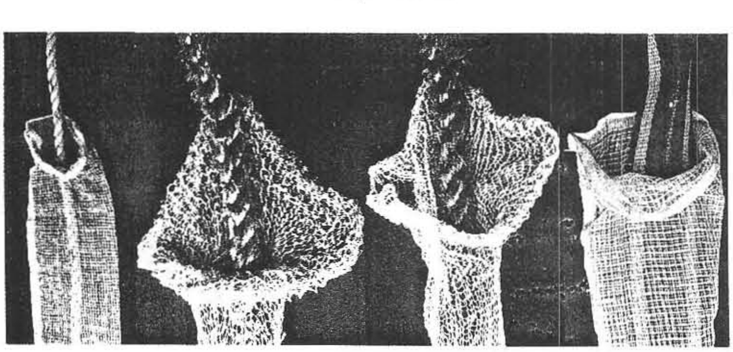


Fig.3 Growth in length of *Etroplus suratensis* in cage culture





Single Oyster Culture

The earlier method developed to grow single oysters was the rack and tray system. This proved to be expensive and hence the present system of rack and ren method was developed. However, the growth and shape of the oysters grown by rack and ren are not uniform and individual oysters cannot be easily separated. The live oyster trade principally depends on production of single oysters with good shape and size. The main objective of this experiment was to grow large and uniformly shaped oysters which can be marketed live as a shell-on product. This is highly priced compared to the assorted size oysters which can be marketed only as heat shucked and processed products.

The experiments which were carried out in the Ashtamudi Lake rack farm included fixing individual oyster spat on split bamboo poles, suspended flexible plastic strips (FPS), FPS attached to an aluminum frames and oyster spat stuck to knots of a stretched nylon net on a PVC frame. Oysters were stuck to FPS and nylon net knots using Fewikwik™ Oysters 15 to 85 mm in length were collected from natural beds, declumped, cleaned, measured and fixed on split bamboo pieces (5 cm width and 1.5 m length) using cement. To ensure proper fixing, iron nails were driven at intervals of 10 cm into the bamboo pole before placing cement. The oysters were placed on the cement and after 6 hours the bamboo strips with oysters were hung horizontally from the rack. The survival of the oysters on the different materials tested is given in Table 3.

The oysters fixed with cement showed good growth and survival rate. The survival percentage after 35 days was 68%, loss due to detachment 20% and loss due to natural mortality 12% (Table 4). After this initial mortality no further loss was observed. In the case of suspended FPS loss due to detachment was 100% during the first 35 days and in the case of FPS attached to aluminum frame and nylon net on PVC frame survival percentage was very poor after 60 days. This indicated that that use of synthetic instant adhesive is not suitable for sticking oyster spat. It was observed that small oyster (less than 65 mm) had an average growth rate of 8.5 mm/month while large sized oyster had only 3.07mm per month. Harvestable sizes could be reached within 5 months of culture (Fig. 2).

Seeding labor charges could be reduced by using pre-stitched biodegradable cotton mosquito nets (left and right panes). The middle panes show the Fuzzy ™ rope with white biodegradable cotton stocking and gray semi-biodegradable synthetic stocking.

Integrated Culture of Finfish in Bivalve Farms

To utilize the space in between the rack farm and as a means of improving the profit, integrated farming of finfish together with bivalves was attempted. Two nylon net cages (1.3 x 1.3 x 1.5 in, 1.5 cm mesh) were tied to the vertical poles in the rack farm and stocked with pearl spot fry *Etroplus suratensis*, which is a favoured food fish of the region.

The mean seed size was 6 6 cm (6.8 g) and the stocking density was 22 fish per m^2. The fishes were fed with dried clam meat and pellet feed through a feeding tray at 5% of body weight per day. The growth observed is shown in Fig. 3 and there was 100% survival. The average growth was estimated as 10.3 mm per month, which is considerably more than that observed for this fish in pond culture (CIBA, 1995). The average production obtained was 1.6 kg per m^2 from an initial 0.15 kg per m^2 within less than 8 months.

Since pearl spot fetches a high price (Rs. 70/kg) in the local markets, it is clear that cage farming of quality food fishes in estuarine bivalve rack farms could form a significant source of additional income to farmers.

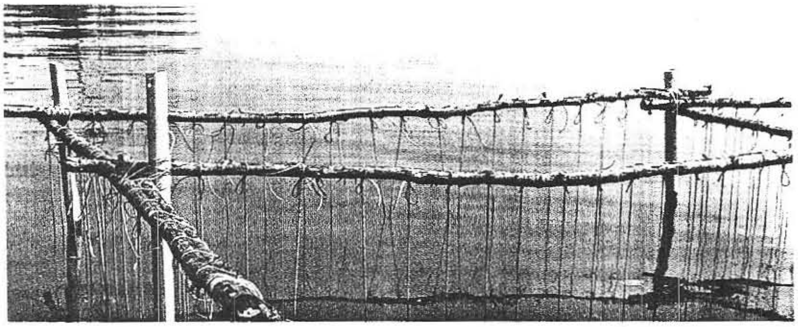
Conclusion

These experiments on technology refinement of edible bivalve farming have shown that conventional methods of farming can be improved and made more profitable (Table 4). The flexible plastic strip is cheap and available in the local markets and can be used as a seeding material. Similarly by using pre-stitched cotton tubes labor cost can be reduced. The grow-out structure itself can be made more durable by using PVC pole filled with concrete. These refinements are simple, and as the economic analysis shows will benefit the farmer.

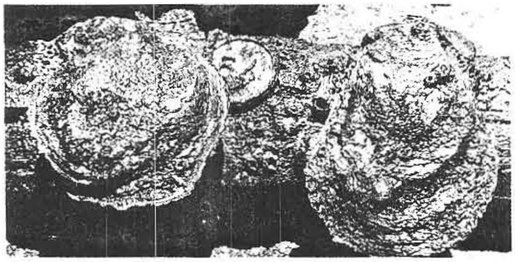
The technique for single oyster culture on split bamboo strips has been developed, but the adoption level by the farmers will depend on the market demand for live oysters. There is a growing demand for live oysters in metropolitan cities like Bombay. Instant adhesives like FewiKwikTM cannot be recommended for sticking oyster spat to synthetic surfaces. The low survival rates of brown and parrot coloured mussel in the estuarine system clearly indicates their unsuitability for farming in areas other than open sea and bays with high salinity.

The high survival rates and growth of finfish in the cages erected in the space within the bivalve farms (racks) indicated the potential to develop the concept of integrated farming.

These results clearly indicate that simple modifications to the existing farming systems for bivalve production in the estuaries can definitely enhance the profit level of small-scale farmers.



Expenditures on rack structures could be reduced by using 2-inch PVC poles filled with concrete.



Well-shaped oysters growing on bamboo strips.

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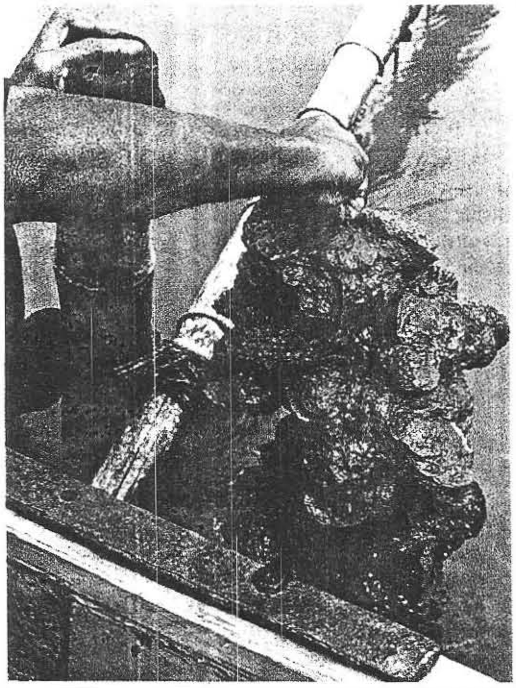
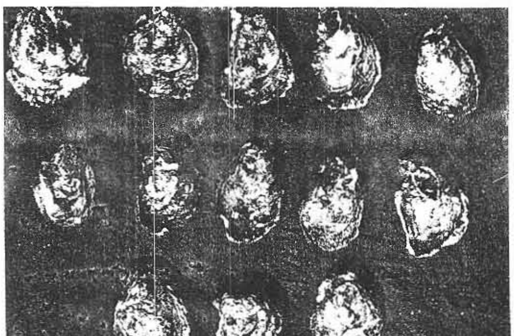


Irregularly shaped oysters of assorted sizes grown on a ren.



Edible oysters of uniform shapes and sizes. They are grown on bamboo strips which can be used for the live oyster trade.