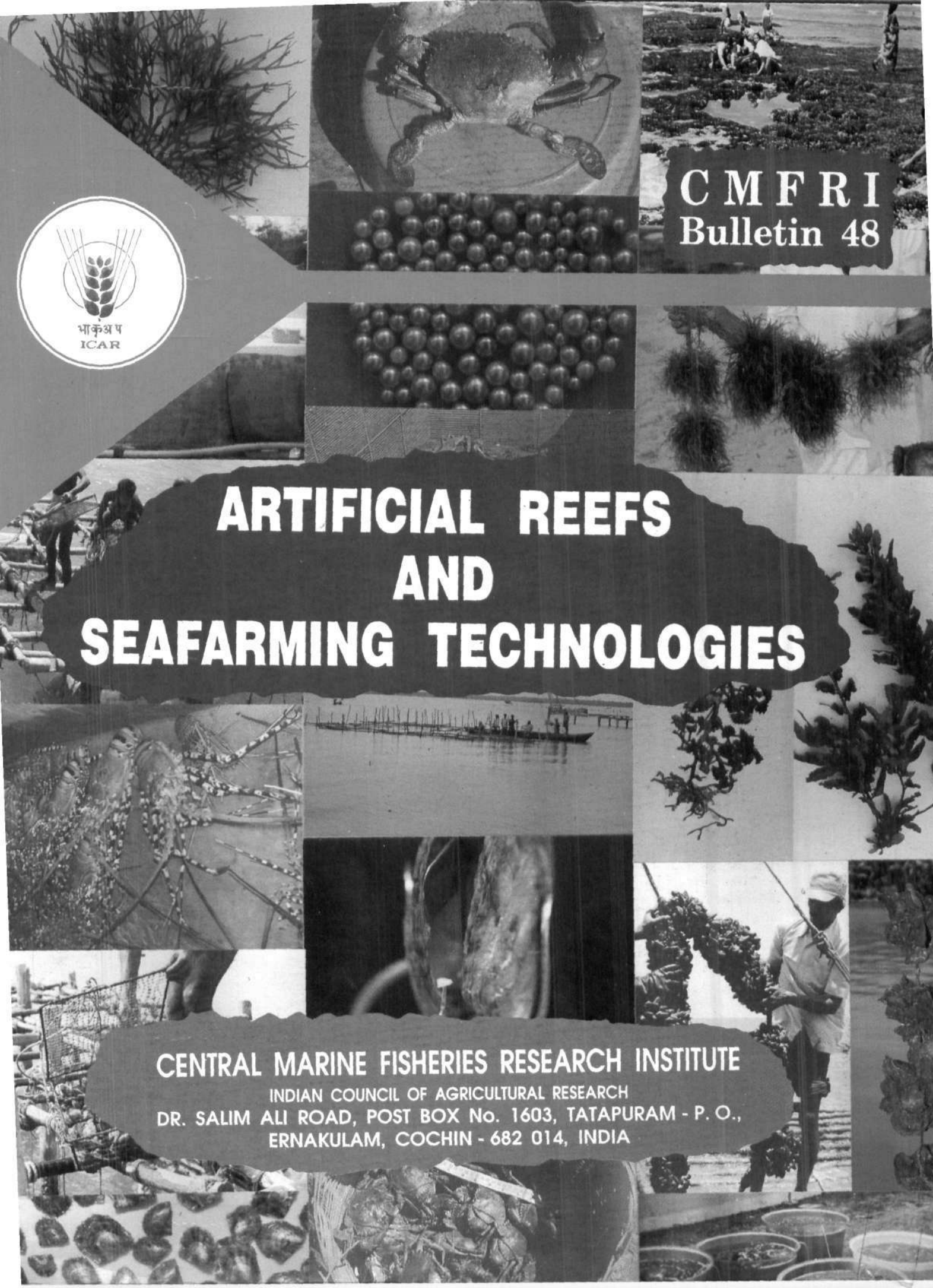

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CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
INDIAN COUNCIL OF AGRICULTURAL RESEARCH
DR. SALIM ALI ROAD, POST BOX No. 1603, TATAPURAM - P. O.,
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C M F R I
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Dr. K. Rengarajan

Editor

January 1996

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TECHNOLOGY OF EDIBLE OYSTER CULTURE

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Introduction

Oysters, mussels, clams, scallops, cockles and abalones are major groups of molluscs which are cultured in different parts of the world. Edible oysters are the most important among them, as they are great delicacy and there is growing demand. There is an increasing interest in oyster culture in tropical countries in recent years. Apart from the edibility of meat, the shells have various industrial and agricultural use. Considering the oysters as a renewable resource of much needed animal protein and the employment potential, oyster culture offers to the rural communities, its culture has been taken up as an R & D programme of the Central Marine Fisheries Research Institute. The studies carried out since 1970, have resulted in developing simple culture methods suitable for Indian conditions.

The Institute is operating a pilot scale semi-commercial oyster culture project at Tuticorin in collaboration with the National Bank for Agriculture and Rural Development and the oysters grown in this farm are marketed by the Integrated Fisheries Project, Cochin. The Institute has undertaken a research programme on location testing to assess the suitability of various areas in the States of Karnataka, Kerala, Tamil Nadu and Andhra Pradesh for developing oyster culture.

Resources and distribution

The edible oysters enjoy wide distribution along the Indian Coast. Out of six species of oysters belonging to the family Ostreidae, *Crassostrea madrasensis, C. gryphoides, C. rivularis* and *Saccostrea cucullata* are commercialy important.

Crassostrea spp. are euryhaline and occur in estuaries, creeks, backwaters, lagoons and shallow coastal regions. *S. cucullata* is purely a marine form.

In Orissa, oyster beds are located in Bahuda Estuary near Sonapur. In Andhra Pradesh oyster beds occur in Sarada, Bihmunipatnam, Kakinada and Gokulpalli. Along Tamil Nadu Coast, oysters are distributed in the Pulicat, Ennore, Killai Backwater, Muthupet swamp, Athankarai, Tuticorin and Tambraparani Estuaries. Along Kerala Coast, Ashtamudi, Cochin Backwater, Korapuzha, Dharmadam, Valapatinam and Chandragiri Estuaries have sizeable population of oysters. There is regular exploitation of oysters along Kerala Coast in small quantities from natural beds. In Karnataka, the oysters are distributed in Nethravathi, Mulki, Sharavathi and Kali River Estuaries.

C. gryphoides occurs along north Karnataka, Goa and Mahrasthra.

C. rivularis occurs along the coastal creeks of Gujarat and the oysters are mainly exploited for the shells.

S. cucullata is distributed throughout the Indian Coast on rocky substrata, in swallow intertidal areas and withstands surf and wave action.

Biology

Edible oyster is sedentary animal usually elongate with highly variable shape. The animal is attached to the substratum by lower left valve which is cup-shaped. The upper valve is flat, acts as a lid covering the soft body of the animal. The two valves are hinged at the anterior which is pointed and termed the umbonal end. If the upper right valve is removed, mouth or labium lies at hinge end and the posterior is the rounded end. This long axis in common usage is indicated as the length. Food of oyster mainly consists of diatoms and detritus. Sexes are separate, but hermaphrodites also occur. Oysters spawn throughout the year with 2 peak periods in April-May and

August-September. The peak period varies from place to place, depending on environmental factors. In Kerala Coast, the peak spawning occurs during postmonsoon months (September-December); in Mulki, Karnataka, peak period is in April-June followed by a minor one during November. At spawning, eggs and sperms are discharged directly outside into the water where fertilization and subsequent development takes place. The larvae are pelagic. When the larvae attain pediveliger stage, they begin to crawl with the help of foot and settle on suitable substratum. This process is called spatting or setting and the young oyster is called spat or seed oyster.

Growth

Growth of oyster is generally measured by volume, length or weight. Oyster growers measure volume by the number of oysters required to fill a standard box. Length of oyster is measured usually with a caliper. In *C. madrasensis* the growth of spat is rapid during the first 3 months, with a growth increment of 12.6 mm per month, attaining 38 mm in length. At the end of one year a mean length of 87 mm is obtained. The growth of oysters varies from place to place and depends on food availability and environmental conditions, particularly temperature and salinity.

Meat condition or condition factor

Condition of oyster meat denotes the degree of fatness or the extent to which the meat fills the shell cavity. The size and weight of meat undergoes changes associated with breeding. This is accomplished by increase in size of gonad during maturation followed by considerable reduction after spawning. In temperate water subsequent to spawning slow increase in the size of the meat, is due to accumulation of glycogen. In tropics, development of gonad takes place without a significant glycogen phase. The condition factor is a ratio of dry meat weight to volume of shell cavity and is calculated by

$$\text{condition factor} = \frac{\text{dry meat weight} \times 1000}{\text{volume of shell cavity}}$$

The knowledge on condition factor is essential for determining the harvest time and for successful marketing of the oysters.

Technology of oyster farming

As early as the first century BC, the Romans practiced simple method of oyster culture by collecting oyster seeds and growing them for food. The important oyster producing countries are Japan, Korea, France and China and together they contribute 78.7% of the total oyster production by culture.

The technique of oyster farming involves two important phases namely (i) oyster seed collection/production and (ii) rearing seed oysters to marketable size.

Seed collection from wild

The seed required for culture is met either from natural spat collection or through hatchery system. For collection of spat from nature, suitable spat collectors or cultch materials are provided at appropriate time. The spat collectors should be able to retain the oysters till they reach marketable size or upto the size at which they could be scrapped for further rearing. The choice of spat collectors depends on the culture method adopted, local availability, economic and practical considerations. In culture experiments at Tuticorin, cultch materials *viz.* semi-cylindrical roofing tiles, oyster, mussel and coconut shells, asbestos sheet, netlon and automobile tyre pieces were used. The tiles are given lime coating for roughness. The oyster shells are made into strings on a G.I. wire or synthetic rope. The collectors are laid on the racks. Of these collectors, lime coated tiles (with an average of 34 spat/tile) and oyster shell (with an average 7 spat/shell) were found suitable for large scale spat collection from wild.

Spat fall prediction

The prediction of spat fall is essential for collecting seed oysters in the appropriate time with minimum foulers interference. This time is called as cultching time. The prediction of spat fall is based on the study of maturation and spawning of ripen gonads in the oyster population or by the appearance of oyster larvae in the plankton samples of the area. The collectors are exposed just a week before peak spawning period. Large scale spat collection experiments showed the abundance of seed oysters in intertidal areas, creeks and bays. The method, season of spat collection and the type of spat collectors to be used

vary from place to place, depending on the local conditions.

Seed production through hatchery system

On the establishment of a Shellfish Hatchery in 1980, the Central Marine Fisheries Research Institute succeeded in mass production of both cultched and cultch free spat. The production of seed through hatchery system involves 6 phases of operation *viz.* (i) Selection and holding of broodstock, (ii) induced spawning, (iii) larvel rearing, (iv) preparation of cultch materials, (v) production of spat, and (vi) culture of algal food.

The broodstock of oysters are conditioned at 4° to 5°C below the ambient temperature for 10-15 days. During this period they are intensively fed with algae. The conditioned oysters are induced to spawn by thermal stimulus, by transferring them to seawater with a temperature of 34 - 35°C. The thermal stimuli induce spawning and the gametes are mixed and fertilization is effected. The fertilized egg undergoes divisions and at the end of 20 hrs, 'D' shaped veliger larvae develop and they are transferred to rearing tanks. The larvae are fed with micro alga *Isochrysis galbana* in the following schedule :

Larval stage	*Size*	*Cells/larva/day*
'D' shape veliger	60 - 70 µm	3000 - 4000
Umbo stage	150 µm	4000 - 5000
Eyed stage	280 - 290 µm	5000 - 8000
Pediveliger	330 - 350 µm	10000 - 12000

On 18-20th day the larvae settle down as spat. The cultch material provided is oyster shell valves for attached spat or polythene sheet for production of cultchless or free seed.

Methods of culture

The farming methods are broadly divided into (i) on-bottom and (ii) off-bottom culture. In the on-bottom culture, the seed oysters are sown on the ground. This method is substrata-specific and the area sown be free from silting and predators. When oysters are grown by off-bottom methods, the advantages lie in better growth and good condition of the meat. The methods involved in off-bottom culture are (1) rack & tray, (2) rack & string, (3) stake and (4) raft.

Site selection

The following requirements are essential in the selection of farm site:

- sheltered areas offering protection from strong wave with a depth ranging from 2-5 m.
- salinity range of 22 to 35 ppt.
- temperature range is 21-31°C.
- area with pollution free water.

Rack and tray method

The spat, attached on lime coated tiles, on attaining 25 mm were scrapped or the cultchless seeds produced in the hatchery are stocked in box type cages. The cages are of 40 x 40 x 10 cm size webbed with 2.5 mm synthetic twine. For nursery rearing of hatchery produced cultch free seed (of 5-10 mm) the cages are covered with velon screen.

Fig. 1. Rack and tray method of oyster culture.

The cages are suspended from a rack. After 2 months rearing oysters attaining 50 mm and above, are transferred to rectangular trays. Each tray is of 90 x 60 x 15 cm size. Twenty such trays are placed on a rack. Rack, a wooden platform for this purpose is constructed using casurina or eucalyptus poles. Each rack occupies an area of 25 sq. m and holds 3000 - 4000 oysters.

Rack and string method

This method can be practiced in areas having 1-2.5 m depth. The oyster spats collected on shells are made into strings having six shells using

5-6 mm synthetic rope. These strings numbering 2 to 3 are kept inside a velon screen bag and suspended from racks for nursery rearing. After 2 months, the velon screen bags are removed, the strings are suspended from the racks in the farm. Rack-and-string method is mainly advocated for oyster culture in shallow esturies, bays and backwaters. A series of vertical poles are driven into the bottom in rows and horizontal bars are connected on the top of the poles. Oyster shell rens made of 5-6 empty cleaned oyster shells strung in 5 mm thick nylon rope and positioned 10 cm apart are suspended from the racks.

Stake method

Stake method is adopted if the substratum of the culture site is soft and muddy. Casurina or eucalyptus poles act as stakes and level support to the spat, set on shells. Each stake occupies 0.6 sq.m. A stake with a nail on the top and two nails on the sides, is driven into the ground. The nail holds a shell with spat. To protect the spat against predation, initially the top of the stake with shells is covered with a piece of velon screen. Once oysters attain 25-30 mm the velon screen is removed and oysters are grown on the stakes upto harvestable size.

Raft method

In this system oysters are suspended from floating rafts. Rafts are constructed using bamboo or wooden poles and are floated with empty oil drums or wooden barrels. Once raft is positioned by anchors, shell strings with attached oyster spat are hung from the raft for further growth. An alternative to the raft is the long line method whereby a series of small floats are joined by synthetic ropes and the line is anchored at both ends. The trays or strings are suspended from the rope.

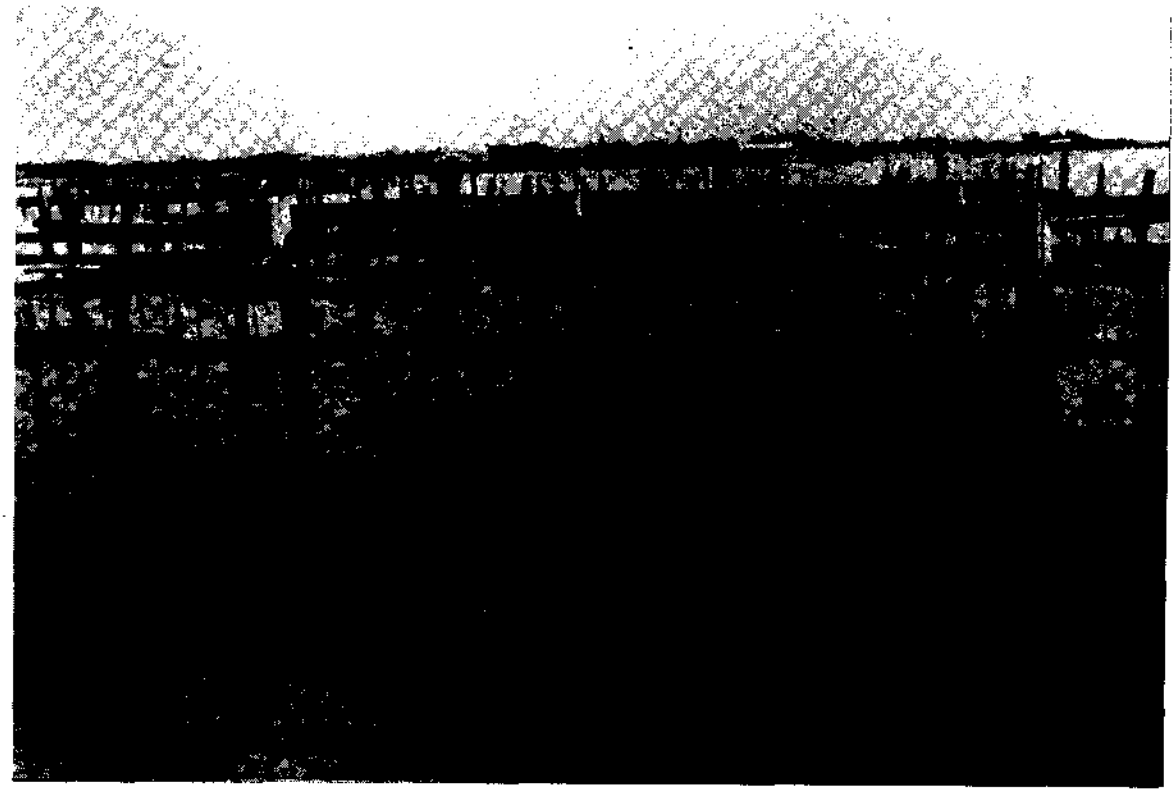

Fig. 2. Rack and ren method of oyster culture.

Foulers, predators and diseases

Fouling organisms such as barnacles, ascidians, sponges and algae settle on rearing trays and oysters and compete for food and space. They are

periodically cleaned. Wood borers like *Martesia* sp. and *Teredo* spp. damage the wooden farm structures. Crabs, fishes, starfishes and gastropods are the oyster predators. Predatory gastropod *Cymatium* spp. causes 13% mortality of oyster in the farm. Apart from these, diseases caused by Haplosporidians such as *Perkinsus marinus*, *Minchinia* spp. cause considerable large scale mortalities of oysters in temperate waters. Some of the trematodes notably Bucephalids cause castration of gonads.

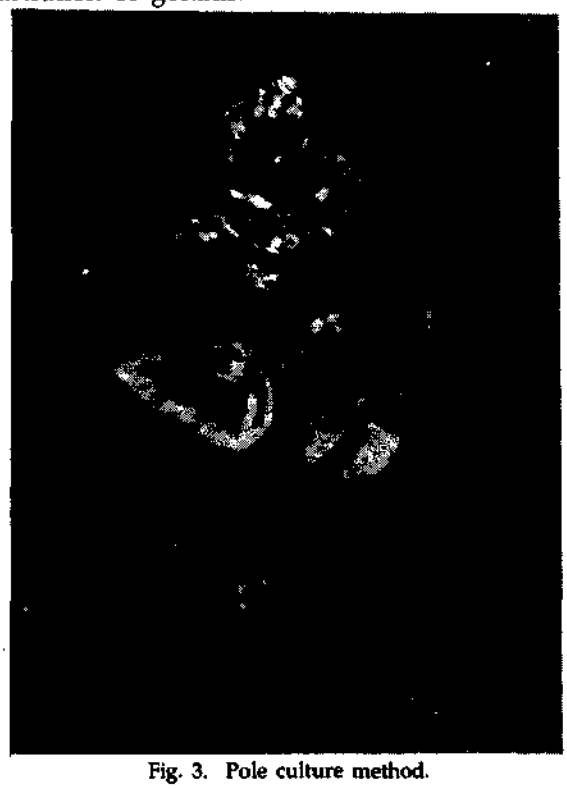

Fig. 3. Pole culture method.

Harvesting

Oysters reach harvestable size (above 80 mm) within 10-12 months. They are harvested when the condition of meat reaches high value. The condition factor of *C. madrasensis* at Tuticorin reaches maximum of 170 during prespawning periods (February-March and July-August). Harvesting is done manually.

Depuration and shucking

Harvested oysters are kept for 10-12 hours in the tanks under a flow of filtered seawater. As a result the bacterial load of the shellfish is reduced. The depurated oysters are taken for shucking. Shucking is the removal of meat from the oyster. Depurated oysters are kept in a gunny bag and held for 3 minutes in boiling sea water. This treatment makes the meat removed easy with a shucking knife. Shucked meat is washed and dipped for 10 minutes in salt solution containing citric acid. The meat is weighed and packed in polythene bags as 2 kg units. These are quick frozen at -30°C, using horizontal contact plate freezer. The frozen meat is transported to canning factory for canning and marketing. Live oysters could also be transported safely for 25-30 hrs by packing them in wet gunny bags.

Production and economics

Production rates differ according to the culture methods. Through rack and tray method, the estimated production is 120 t, and by rack and string method, it is 80-105 t/ha. The production rate through stake method is 20 t/ha. In rack and tray method the rate of return on investment was 30% and by string method it was estimated as 44.8%.

Production and economics of edible oyster farming by rack and ren method at Dalavapuram in 300 m² area

I. Material cost

	Rs.
(a) Poles	
Horizontal poles 6 m x 30	1,200
Horizontal poles 2 m x 9	120
Vertical poles 3 m x 126	2,520
Total	3,8410
(b) Nylon ropes and strings	
Nylon rope for strings and racks 40 kg	2,800
Number of strings 1060	110
Total (a+b)	6,750

II. Labour cost and other charges

Fabrication of oyster strings	480
Fabrication of racks	240
Harvest	640
Depuration	640
Shucking	880
Total	2,880
Total cost (I + II)	9,630

III Production and revenue

Shell-on weight of oysters	4.25 tonnes
Meat weight (10%)	425 kg
Value of meat @ Rs. 30/kg	Rs. 12,750
Value of shell @ Rs. 350/tonne (80% of 4250 kg)	Rs. 1,190
Gross Revenue	*13,940*
IV. Net Profit (III - I + II)	4,310

In an area of 1 ha, 24 units of 300 m^2 each can be accommodated. The cost of materials indicated are based on the present market rates. Production of meat and shell per hectare is estimated as 10.2 tonnes and 81.6 tonnes respectively. There is good demand for live shell-on oysters in the international market and the cost of 100 shell-on oyster is Rs. 25. The international export market value of 1 kg of chilled/frozen oyster meat varies from Rs. 125 to 300. The demand and high price of oyster meat in the international market augur well for the expansion of edible oyster culture in the country.

Utilisation of oyster shell

The empty oyster shells contain 52-55% calcium oxide and are used in the manufacture of calcium carbide, lime and cement. The shells crushed to suitable size are used as poultry grit.

Prospects of oyster culture in India

The experimental work carried out at Athankarai, Pulicat Lake and Tuticorin in Tamil Nadu, Kakinada Bay and Bheemunipatnam in Andhra Pradesh, Goa, Mulky Estuary in Karnataka and Ashtamudi Lake and Dharmadam in Kerala gave highly encouraging results for developing the culture of edible oyster along east and west coasts of India.

Suggested reading

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