CMFRI

WORKSHOP ON

MUSSEL FARMING

25 - 27 SEPTEMBER, 1980
MADRAS

CENTRE OF ADVANCED STUDIES IN MARICULTURE

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE

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SYSTEM DESIGN FOR MUSSEL CULTURE

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INTRODUCTION

Mussel culture has been proved as one of the feasible programmes for large-scale production of cheap protein food in many of the European countries having considerable potential for production to the tune of 600 tonnes/hectare as is reported from Spain. It also opens new avenues for generating employment possibilities for unemployed personnel and also for fishermen to take up as a subsidiary source of income in addition to their normal fishing activities, which may help in improving their social conditions also.

The progress in the line of work is recent in India and the Central Marine Fisheries Research Institute has initiated the work in 1971 at Vizhinjam on culturing brown mussels Perna indica and subsequently on green mussels P. viridis at Calicut and Madras. The results produced by National Institute of Oceanography (Qasim et al 1977) and the Konkan Krishi Vidya Peeth, Ratnagiri are also encouraging. The Central Marine Fisheries Research Institute has already sponsored a pilot project, which has been taken up at Vizhinjam by the Department of Fisheries, Government of Kerala. It is quite appropriate at this context to have a system design for mussel culture for formulating large-scale programmes to be taken up whereever it is possible in the Indian coast or elsewhere. The

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information given in this paper is only a broad outline of the system developed in many of the advanced countries and the production patential of mussel culture and the system suitable for our condition which could be considered with marginal variations at different places depending upon the cost of material and physical as well as biological features of the environment while formulating projects.

DIFFERENT ECOSYSTEMS AND THE SUITABLE METHODOLOGY

India is having an extensive coastline bordering the different maritime states with rocky as well as sandy shallow areas, intertidal flats, lagoons and bays with fully marine conditions where mussel culture is possible. As mussels prefer to have saline conditions ranging 25 to 36‰, suitable areas are to be identified at the above ecological regions before taking up large-scale programmes. As such rope culture using floating rafts and by using longlines, stake culture, tray culture and relaying or spreading mussels in favourable shallow areas are the methods developed and suitable farming procedures are to be adopted for the respective areas. Normally culture programme not only helps in increased production but also helps in conserving enormous quantities of spats or seed-mussel-settling on the inter-tidal areas which in course of time perish due to continued exposure. It is worthwhile to mention the different methods suitable for the different ecological conditions in this connection.

CULTIVATION IN DEEPER AREAS

Ropes suspended from fixed frames, floating raft method or suspending ropes from long-lines are the methods adopted in various countries whereever the depth is more than five metres.

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The method of suspending ropes from fixed frame is common in southern France, Spain, Yugoslavia and Italy(Mason, 1972). However, this can be possible only along the border areas of the lakes in shallow regions and is a flourishing industry in Naples, Italy.

An improvement on this method is made by suspending ropes from floating frame work and this has been impressively developed in Spain. These structures are known as floating parks and are anchored in the Galician rias which may extend up to 25 km length-wise and 3 to 12 km width-wise and having a maximum depth of 60 m. Earlier these rafts are constructed on old hulls of boats and at present four or more floats coated with cement or fibre glass are used for floation. If the float is single it is 12 x 4 x 2 m and if four floats are used it is 2.5 x 2.5 x 1.9 m. (Andreu, 1968a ;Ryther,1968). A frame-work of Eucalyptus beams is fixed over these floats and is supported by iron stays from the end of beams to the masts fixed on the floats. Generally a typical raft supports 500 to 600 ropes and is of $20m^2$ area with a working platform and shelter for workers. There are even larger rafts supporting even 1500 ropes (Andreu,1968 b) and the estimated cost in 1968 for a typical raft is about £2200-2800 (Wiborg and Bohle, 1968). Anchoring is done by chain, 32-36 mm thickness and 6 to 7 times that of the depth and using huge cement blocks as anchors. The annual mussel production is estimated at 50 tonnes per such raft (Andreu,1968 c).

At vizhinjam, rafts of 5m x 5m are constructed using 36 bamboos and using nylon rope of 4 mm ~~thickness to tie~~ them into a frame-work. Each raft is floated using 4-6 empty oil barrels (200 litre) and in few cases a coating of fibre glass is given. The raft is anchored using 12 mm nylon rope at four corners and using granite stones with iron clamps as anchors. This is found to be the cheapest method for calm areas. For rough conditions additional teak poles are used for the frame along with iron chain and iron anchors for anchoring ~~in the open~~ sea as is done at Calicut. Experiment is in progress for a design of

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submerged raft at Kovalam, Madras. A raft of the above dimension can support 50 ropes for culture. The annual production is estimated at 3 to 4 tonnes if six metre seeded ropes are suspended. The production potential and rate of growth of brown mussel Perna indica at Vizhinjam bay is presented in table I and fig. I for further details.

(1) Open Sea

If wave action is prevailing heavy investment is required for keeping floating structures, at least an average length of 5-6 metre is to be retained for the seeded portion of the rope for getting good returns. The production per raft and per hectare will depend upon the number of ropes suspended in the area as well as the length of the seeded portion of each ropes and invariably whenever heavy investment is required for the construction of the raft as well as for anchoring them in the sea the above factor is to be given special consideration. It is already observed that a reliable average production of 10 kg/metre of rope length could be obtained per metre of seeded rope at Vizhinjam (Achary and Thangavelu, 1980) and the production cost and returns can be computed as given elsewhere in this paper. If rafts cannot be permanently retained in the sea due to rough weather, an additional expenditure for the seasonal operation also is to be anticipated.

(2) Bays and Lagoons.

Raft culture is most successful in bays and lagoons where depth is more than 5 metres and having a rich production of phytoplankton. Areas protected by reefs and or islands also can be included under this type of ecosystem but the production can be at a higher rate because of the frequent replacement of water by tidal action.

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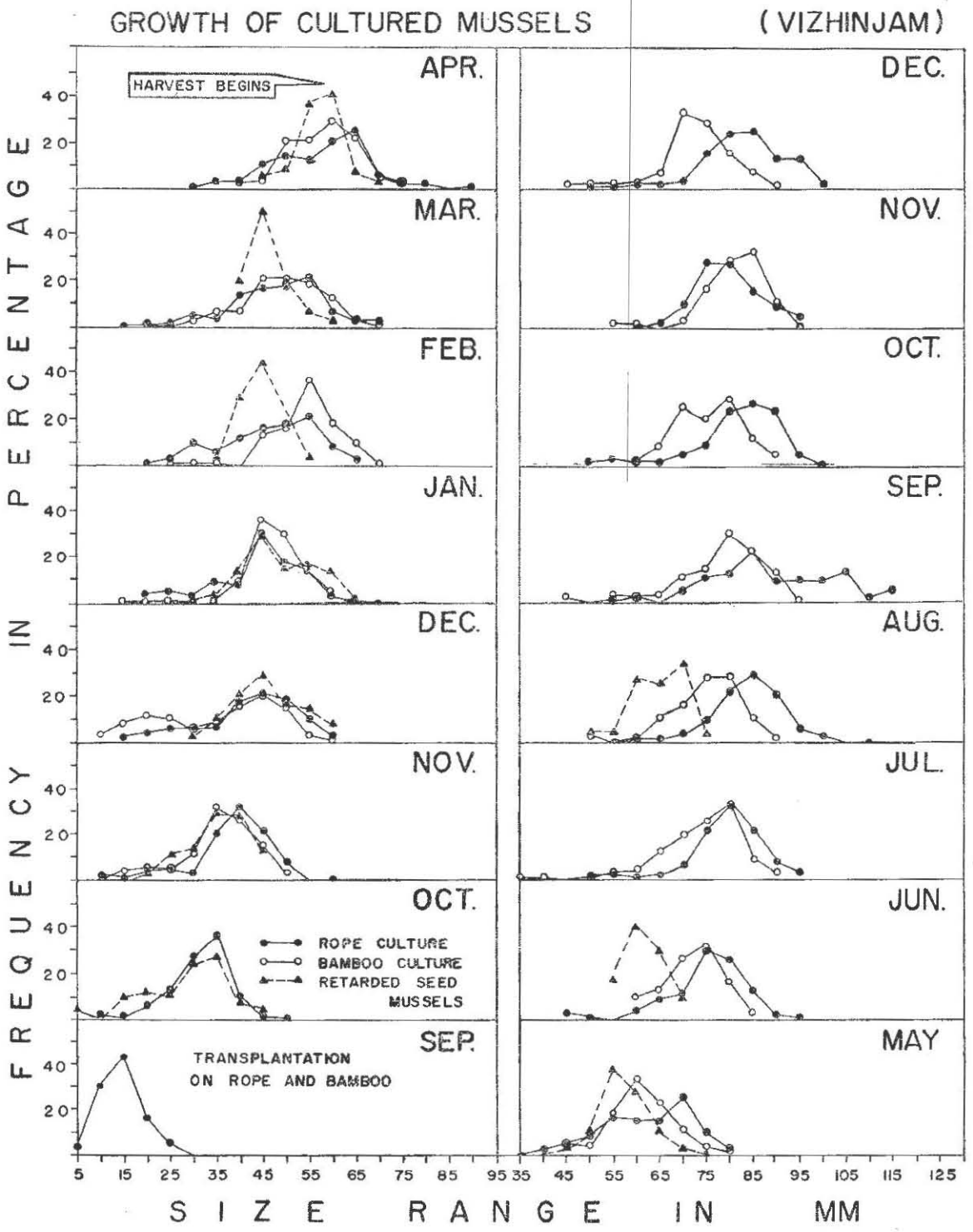
GROWTH OF CULTURED MUSSELS (VIZHINJAM)
HARVEST BEGINS
APR.
MAR.
FEB.
JAN.
DEC.
NOV.
OCT.
SEP.
DEC.
NOV.
OCT.
SEP.
AUG.
JUL.
JUN.
MAY
ROPE CULTURE
BAMBOO CULTURE
RETARDED SEED MUSSELS
TRANSPLANTATION ON ROPE AND BAMBOO
FREQUENCY IN PERCENTAGE
SIZE RANGE IN MM

CULTIVATION IN SHALLOW WATERS

The principles involved is to give a favourable environment for the mussels to grow at a faster rate compared with the growth at the normal mussel beds by either spreading them on very shallow areas having hard substratum or if the depth is at least 2 m. during the low tide; culturing them on stakes utilizing the three dimensional culture procedure. Since the procedure is too simple these methods have been evolved in U.K and France respectively much earlier to the introduction of hanging culture in Spain.

(1) Stake culture.

This method is used since the 13th century on the western coast of France and even now is the principal method in France, (Audouin, 1954) and is known as 'bouchot' system. Pine stakes are planted as collector bouchots off from the shore. Poles of 4-5 m length protruding 1.6-2 m are planted 35 cm. apart on the tidal flats. From these mussel spats of 20 mm size are collected and transferred to rearing bouchots planted at a distance of 75 cm and horrizontally interwoven with branches of willow or chestnut tree. Seed mussels are then transferred to them in bags of fine mesh netting and after disintegration of the netting, mussels attach themselves to the rearing bouchots (Mason, 1972). The total length of bouchots exceeds 600 km on the mid western coast of France (Lambert, 1939). Young (1969) reports about 900 km of them. Since natural spat fall is not available on the northern coast of Brittany they are collected by suspending loosely woven ropes at the natural beds at LaRochelle and are transferred to Brittany and wrapped spirally around the poles (Ryther, 1968). At an average a family maintains 10,000 to 25,000 poles in France (Mason, Loc cit) and the total mussel production in France amounts to 30,000 tonnes (FAO, 1970).

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Obusen and Urbano (1968) have described the methods of Philippines. By this the stake method is used in two ways. In areas of about 2.5 m depth during low tide, bamboos are staked at a distance of one metre in two rows and they are interconnected at the top by horrizontal bamboos. The second method which is known as 'wigwam' is by planting 8 radial bamboos just like the ribs of an umbrella from a central pole and the bottom portion of each bamboo will be staked at a standing position 1.5 to 2 metres away from the central pole. These methods are known to give good production of mussels in philippines.

In India, stake method is to be developed in shallow suitable areas. Experimental trials conducted at Vizhinjam bay using transplanted bamboo poles has been found successful and the production potential is given in table I and II. At Madras also this experiment is conducted at Kovalam in the open sea.

BOTTOM CULTIVATION OR RELAYING IN FAVOURABLE AREAS

This method, being the simplest, has been practiced in Great Britain, Ireland and many of the European countries including Denmark and West Germany (Korringa, 1970) and has become the chief method in Holland (Lambert, 1951) and Dutch mussel production has reached 1,00,000 tonnes per year (FAO, 1970). Areas of 5 to 10 hectares are alloted to farmers as mussel parks on a rental basis by the Government. Seeds are first transplanted to shallow grounds and subsequently to deeper areas (Havinga, 1956) and thinning is done to avoid overcrowding and for faster growth (Iverson, 1968; Havinga, 1964). As a very thriving industry, bottom cultivation is a mechanised activity in Halland using dredges of capacity 40 tonnes per hour (Walne, 1963). In Norfolk, England the annual output per man reaches 50-60 tonnes using hand net, rake, fork and small boat (Davies, 1968).

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However, in India this method is yet to be developed and suitable areas are to be identified for introducing the bottom culture of mussels.

SYSTEM DESIGN FOR MUSSEL CULTURE IN INDIA

The foregoing account gives a general picture of the various types of culture practiced in many of the developed countries and in India. Small, medium and large-scale culture of mussels is to be taken up by identifying suitable areas in the different maritime states. Based on the experimental results obtained by stake and the rope culture method at Vizhinjam it has been possible to trace the production pattern of the brown mussels (Achary and Thangavelu, 1980) and the investment required for taking up the work by single fisherman, a group of fishermen working under a village society or an entrepreneur may work as follows:

SINGLE RAFT SYSTEM (5 m x 5 m)

I Investment	Rs
1. Bamboo @ Rs. 15 x 36	540
2. Nylon rope @ Rs. 30 x 6kg	180
3. " x 8kg	240
4. " x 50 kg	1500
5. Granite block and Iron clamp @ Rs. 40 x 4	160
6. Diesel barrel (200 litre) @ Rs. 60 x 6	360
7. Fabrication and Launching	120
8. Unforeseen expenditure and working capital	400
Total	3500

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II Operational cost

		Rs.
1.	collection of seed, seeding etc.	300
2.	Cotton netting	190
3.	Maintenance of Raft and cost of 6 drums (150 + 360)	510
4.	Unforeseen expenses	100
	Total operational cost	1100

III	Sale value of Mussel 3000 kg @ Rs. 1.6 (6 m rope @10 Kg/m x 50 ropes) per Kg.		4800
IV	Gross surplus (III-II)		3700
V	Interest on capital @ 9 %	315	
VI	Depreciation @ 20 %	700	
VII	Net surplus		2685
VIII	Income of Fisherman		2685
IX	Percentage return on Capital	76.71	
X	Income for fisherman if two rafts are maintained		5370

If two rafts are managed by a single fisherman family the returns may come to Rs. 5370/- per season provided the quality of seed and transplantation season are properly maintained and periodic husbandry work is done upto the harvest stage properly. This system can work as a small scale programme whereever seed mussels are available in the nearby area and suitable farming area is also available near the farmer's village.

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50 RAFT SYSTEM FOR MEDIUM SCALE OPERATION

		Rs.	
I	Investment for 50 rafts (Rs. 3500 x 50)	1,75,000	
	Management and other expenses @ 30 %	52,500	
	Total	2,27,500	
II	Operational cost (Rs. 1100 x 50)	55,000	
III	Sale value of mussel (3 tonnes x 50 x Rs 1600/ tonne)		2,40,000
IV	Gross surplus (III-II)		1,85,000
V	Interest on capital @ 9 %	20,475	
VI	Depreciation @ 20 %	45,500	
VII	Net surplus		1,19,025
VIII	Net profit	1,19,025	
IX	Percentage return on capital	52.31	
X	Man power requirement	4250 man days for farming work.	

This could be taken up by a group of fishermen or by cooperative activity. The suitability of the area is to be considered with priority and technical as well as management support is also to be given before committing with heavy investment.

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STAKE METHOD FOR MEDIUM LEVEL OPERATION

(System of 10,000 stakes of $2\frac{1}{2}$ m length and 1.5 m settlement area/stake per hectare)

I Investment

		Rs.
1.	Bamboo 5 m. 25000 @ Rs. 15 (split and cut into 4 pieces)	37,500
2.	Netting 2500 m.	15,000
3.	Seed (2 kg/m. and 1.5 m. each for 10,000 poles)	30,000
4.	Seeding charges Re. 1/Pole for 10,000 stakes	10,000
5.	Unforeseen expenditure	7,500
	Total	1,00,000

II	Sale value of mussels 150 tonnes @ Rs. 1600/tonne (@ 10Kg/m production for 1.5 m)		2,40,000
III	Gross surplus (II-I)		1,40,000
	Interest @ 9 %	9,000	
IV	Net profit		1,31,000
V	Percentage return on capital	131 %	
VI	Man power requirement	4000 man days for farming work.	

Even though this system is to work as a medium level operation this method also has an advantage that those fishermen who can operate with even 100 or 200 stakes adjacent to their residence, where shallow areas and seeds are available, it can be a subsidiary income for the family and such small unit system also can be introduced in suitable areas.

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TABLE I

Average production per metre by culture at Vizhinjam (Weight in Kg. including shell)

Month	Average production per metre (in Kg.)			
	By rope culture	By bamboo culture	Average for Rope & Bamboo	Retarded seed mussel
March	-	-	-	1.848
April	10.166	8.621	9.640	3.045
May	12.942	10.505	12.115	2.467
June	15.816	12.835	14.831	2.292
July	17.360	16.065	16.947	-
August	18.512	14.352	18.613	2.222
September	22.969	19.163	21.737	-
October	16.204	15.577	15.987	-
November	13.697	14.545	13.977	-
December	13.258	11.083	12.533	-

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TABLE II

Average yield of flesh in Kg. per metre by culture at Vizhinjam

Month	Average production per metre (in Kg.)			
	By rope culture	By bamboo culture	Average for Rope & bamboo	Retarded seed mussel
March	-	-	-	0.631
April	3.773	3.123	3.551	1.104
May	5.895	4.369	5.377	0.914
June	6.499	5.211	6.025	0.728
July	7.362	5.500	6.764	-
August	7.083	4.918	6.383	0.819
September	9.735	7.222	8.942	-
October	6.262	6.039	6.185	-
November	5.120	5.786	5.340	-
December	5.283	4.389	4.981	-