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Session II

SHELLFISH CULTURE TECHNIQUES AND PRODUCTION

45. CULTURE TECHNIQUES AND PRODUCTION RATES OF MOLLUSCS IN INDIA

—Theme Paper

K. Alagarswami
Central Marine Fisheries Research Institute, Cochin

INTRODUCTION

The estimated world production through aquaculture in 1975 was 6.1 million tons, of which the molluscs formed 16.2% (Pillay, 1979). The production of oysters in the above was 591,386 t, mussels 328, 517 t, clams 38,851 t, scallops 62,600 t, and cockles and other molluscs 29,987 t, totalling to 1,051,341 t. In 1980, the estimated world aquacultured production was 8,707,363 t to which the molluscs contributed 3,196,308 t or 36.7% of the total production (Alagarswami, 1986). The production of molluscs in a five-year period appeared to have trebled, whereas the overall increase of fish, shellfish and seaweeds put together has been only 42.7%. The world aquaculture production figures have been cited here only to indicate the aquaculture species group, on which the scope lies for future expansion. Nutritionally speaking, the yield of high-quality protein by bivalves per hectare of surface sea water far exceeds the protein that could be produced on a hectare of land by any known terrestrial plant or animal (Hulse, 1982). But economically speaking, culture of bivalves may not be as attractive as shrimp farming or culture of some choice finfish species.

BACKGROUND OF EXPLOITATION OF MOLLUSCS IN INDIA

Considering the poor attention paid to the development of molluscan fisheries before or since Independence of the country, the conclusion that, with exception of pearl oyster and chank, these resources were not thought of as something to merit a place among the fishery resources of India, is inescapable. The one to whom these resources appealed most was the British biologist James Hornell who had contributed the most to our knowledge on these resources and had even indicated the culture potential of some of the species, particularly the oyster (Hornell, 1949). Rao (1939) recorded the fishery for *Turbo* and *Trochus* in the Andaman and Nicobar Islands and suggested certain measures for regulation. The biological and fishery aspects of many of the oyster, clam and mussel resources exploited at subsistence level by the coastal fishermen have been given by several workers (Rai, 1932; Rao, 1941; Rao, 1958; Durve, 1960; Joshi, 1963; Ranade, 1964; Jones and Alagarswami, 1973; Alagarswami and Narasimham, 1973 and others). These works were fishery management oriented rather than culture

oriented. However, the information contained in these publications were found immensely useful when the importance of mollusc farming was realised in the early 1970s and some experimental programmes were initiated.

DEVELOPMENT OF RESEARCH IN MOLLUSC CULTURE IN INDIA

In the year 1972, the Central Marine Fisheries Research Institute commenced for the first time a research project under the major title "Miscellaneous Investigations" and project title "Aquaculture, its potential and practical applications". The plan of work included culture of clams and oysters to be undertaken in suitable areas of Tuticorin and Mandapam. The experimental programme on pearl culture was initiated the same year at Tuticorin as a later addition. The project was expanded in 1973 under the revised title "Mariculture, its potential and practical applications", to include mussel culture at Vizhinjam and Madras, transplantation of clams and edible oyster at Tuticorin and Mandapam, and pearl culture at Tuticorin. In the subsequent period, with the esiablishment of the Molluscan Fisheries Division at the CMFRI, major thrusts were given to programmes of culture oysters, mussels, clams, pearl oyster and pearl culture at several centres of which Tuticorin developed itself as a strong centre of research for pearl culture and oyster culture. Having developed the basic techniques of production of these bivalves and experienced high levels of production rates, it became important to concentrate on seed production by hatchery technology which was achieved for pearl oyster in 1981, edible oyster in 1982 and mussel in 1983.

Concurrent to the above developments, the National Institute of Oceanography developed a research programme on mussel culture in Goa. The Konkan Krishi Vidyapeeth implemented a project on mussel culture at Ratnagiri. Several short-term experiments on oyster culture have been carried out sporadically in some of the estuaries by some university departments.

The fact remains that, in spite of the rapid strides made in research and successful experimental farming of molluscs obtaining high production rates, commercial farming remains a non-starter except in the case of pearl culture. The situation, therefore, needs a critical look at the constraints that hold up the progress and chalk out a practical plan of action to overcome the hurdles, keeping in view the nutritional potential of molluscs, economics of production and utilisation and the socio-economic goals aimed to be achieved by the action plan.

FARMING TECHNIQUES AND PRODUCTION RATES

Oyster culture

Spat of oyster *Crassostrea madrasensis* is collected in Tuticorin bay and creek by laying lime-coated roofing tiles in the oyster spawning areas. The spat that settle on the tiles are scrapped and reared in trays under the rack culture system (Nayar and Mahadevan, 1983). The estimated production is 119 tonnes of whole oysters per hectare per annum. In Vaigai estuary near Mandapam spatfall of the same species has been observed on several experimental collectors and culture duration has to be restricted to avoid floods in the estuary due to north-east monsoon (Rao *et al.*, 1983). Some short-term experimental work on spatfall and growth has been done in Cochin backwater (Purushan *et al.*, 1983). Mulki estuary (Joseph and Joseph, 1983) and Bheemunipatnam backwater (Reuben *et al.*, 1983).

Mussel culture

Seed of the green mussel *Perna viridis* and brown mussel *Perna indica* are collected from the intertidal rocky beds in their region of natural distribution. Both species are farmed by the raft culture method by seeding the ropes with the seed mussels using the standard techniques. The harvest is taken generally after about 5—6 months growth in the sea. Besides culture in the open sea and bay, experimental success has been achieved in growing green mussel by pole culture in the salt water lagoon at Muttukad near Madras.

The experimental production rates achieved are as given below :

P. viridis :

Calicut (open sea)	:	4.4—12.3 kg/m rope/ 5 months (Kuriakose, 1980)
Dona Paula Bay	:	6 kg/m rope/6 months (Qasim *et al.*, 1977)
Ratnagiri (open sea)	:	7 kg/3-m rope/ 6 months (Ranade and Ranade, 1980)
Kovalam (open sea)	:	2 t/raft/4 months (Rangarajan and Narasimham, 1980)

P. indica :

Vizhinjam Bay	:	10-15 kg/m rope/ 7 months (Appukuttan *et al.*, 1980)
Vizhinjam (open sea)	:	15 kg/m rope/ 5 months (Appukuttan *et al.*, 1980)

Based on average production rates obtained in raft culture, some authors have estimated production per hectare, *e. g.* 480 t/ha for green mussel (Qasim *et al.*, 1977) and 150 t/ha for brown mussel (Adpukuttan *et al.*, 1980).

Pearl oyster culture and pearl production

The technology for pearl culture was developed in India in 1973 (Alagarswami and Qasim, 1973; Alagarswami, 1974). Pearl oysters have been collected from the natural beds in the Gulf of Mannar and farmed by raft culture in the open sea at Veppalodai (since discontinued) and in the harbour basin. Nucleus implantation operation is done on oysters of suitable size and farmed again under raft culture. Gross pearl production rate is an average 60%. Pearl oyster farming is done for the pearls and not for the meat as in the case of edible bivalves such as oysters and mussels.

Clam culture

Simple transplantation of clam seed into manageable areas in the estuaries and bays has been done. In Kakinada Bay, consistent production results were obtained in the culture of the blood-clam (cockle) *Anadara granosa*. The production was 0.39 t/100 m^2/5 months, 2.6 t/625 m^2/5½ months, and 6.1 t/0.16 ha/7 months respectively representing production rates per hectare of 39 t, 41.6 t and 38 1 t (Narasimham, 1980). Short-term transplantation of the backwater clam *Meretrix casta* has been carried out by other workers in Mulki estuary Vellar estuary (vide Silas *et al.*, 1982).

Cephalopod culture

Some amount of success has been achieved in experimental rearing of cuttlefish *Sepia pharaonis* at Mandapam by collection of egg capsules, hatching them and nurturing the hatchlings to adult (Sivalingam and Pillai, 1983).

Hatchery production of bivalve spat

The development of technology for production of spat of pearl oyster (Alagarswami *et al.*, 1983), edible oyster (Nayar *et al.*, 1984), green mussel (Rangarajan, 1983) and brown mussel (Appukuttan *et al.*, 1984) have given a new dimension to shellfish farming in India. Both the pearl oyster (*P. fucata*) and oyster (*C. madrasensis*) spat are produced in large scale at the experimental hatchery of the Central Marine Fisheries Research Institute at Tuticorin.

Post-harvest technology

Simple chlorination technique has been used to purify the farm produced oyster *C. madrasensis* (Nayar *et al.*, 1983). Balachandran and Prabhu (1980) have summarised the development in post-harvest techniques for mussels. Balachandran and Nair (1975) developed a process for canning clams and mussels in hot, refined groundnut oil. Balachandran and Prabhu (1980) reported a method for preparing mussel pickle having a shelf life of upto 6 months. The Integrated Fisheries Project of Government of India is successfully engaged in oyster product development and trial marketing in India.

Toxicological problems in mussel have been studied by Menon *et al.* (1983) and Wesley and Raj (1983). An overview of molluscan toxicology and shellfish sanitation, referring also to the recent instances of death of people

due to consumption of contaminated clams (*Meretrix casta*) at Vayalur in Tamil Nadu and Arikadu in Karnataka as likely cases of paralytic shellfish poisoning (Ray and Rao, 1984).

TECHNOLOGICAL PROBLEMS

It has briefly been seen that the basic technology for culture of molluscs has been developed and the technical feasibility can be stated to have been established in the case of oyster, pearl oyster, mussel and the cockle through repeated experimental trials which have given consistent results. Production rates are fairly high and comparable with those obtained elsewhere adopting similar techniques. Culture duration is considerably less in the tropical waters. Oyster culture in Europe, U. S. A. or Japan requires 2 years or more but in India it takes only a year to get the marketable size. Mussel needs only 5-6 months. Growth of the species being faster, the time to reach marketable size is reduced.

There has been no major problem with the cleanliness and hygiene of the products from the experimental farms. Pollution levels are still low in the areas of production. The only disaster has been the two cases of suspected PSP deaths reported in Vayalur in Tamil Nadu and Arikadu in Karnataka after consuming contaminated clam *M. casta* collected from natural beds. However, there is a warning in this to be taken note of.

Technology has developed so far on its own momentum, but I am afraid that this cannot be taken to greater levels of production or perfection without a challenge from the development sector. There would be no incentive for further rsearch unless the demand is created by the industry or common producer. In other words, the utility value of research can be stated strongly only when there is concomittant use of the results. We are reaching towards a stage when decisions will have to be taken and directions given both to research and to development. If there is a gap between the two, it should be bridged *via* the extension link.

The technological problems that require immediate attention may be identified. The base of operation in terms of species, areas, ecosystems and techniques has been very narrow. Farming and production results have been shown for oyster *Crassostrea madrasensis* at Tuticorin, green mussel *Perna viridis* at Calicut, brown mussel *P. indica* at Vizhinjam and cockle *Anadara granosa* at Kakinada. Green mussel culture at Karwar and Madras, though seriously attempted, had to be suspended due both to technical and logistic reasons, such as seed non-availability or operational problems of rafts in rough sea conditions or poaching. With the diversity of ecological situations along the long coast line, perhaps greater thrusts are needed in diversifying the candidate species and techniques of culture to show production results even on a short-term experimental basis. A few points to be borne in mind are that (i) open-sea mariculture is beset with technological and logistic problems and the earlier we go in for appropriate technology the better would be the results; (ii) the estuarine or the backwater ecosystem is also dynamic subject to seasonal and annual variations controlling natural settlement and production of molluscs with an added dimension of indiscriminate exploitation of living resources and shell deposits; and (iii) the Andaman and Nicobar Islands and Lakshadweep which offer greater scope for mariculture in terms of suitable areas and species are as yet out of the mainstream of technological development.

Another important area for technological innovation is to reduce cost of production or to work out an acceptable cost-benefit ratio. In terms of available technology, this is a job to do. Raft culture and rack-tray culture require capital investment and involves short-term replacement costs and recurring maintenance expenditure. Farming technology should aim at reducing cost of inputs and increase production. This is essential as, in the Indian situation, the molluscs are not a luxury food as in the West or in Japan, and, therefore, the value of produce from the farm cannot go up beyond what the consumer is prepared to pay for it at present in the local markets selling the produce from the wild. This applies for the culture of oysters as well as mussels.

Production techniques require to be so improved as to yield a higher meat/total weight ratio. Mussel under culture gives a better ratio than what is obtained in the wild. In the case of oyster, the meat yield in fresh condition is a maximum 10%, but when processed the net yield ratio is reduced to less than half of this. Increase in yield ratio can improve the economics of oyster culture.

ECONOMIC DATA BASE

Admittedly, an economic data base for mollusc culture, based on pilot-scale operations is yet to be developed. Some authors have given projections based on estimates of several variables which may or may not be the true situations. The methods of estimating profitability or return on investment have been quite different. A cost-benefit study of oyster culture by the rack-tray method on 0. 25 ha, producing 3 t of oyster flesh annually, has been made. With cost of production at Rs. 19.00/kg flesh, and at a selling price of Rs. 28.00/kg, the net income before tax would be Rs. 27,000 —about a 30% return on invesiment (*vide* Silas *et al.*, 1982). A simpler estimate on oyster culture shows the per-annum cost of Rs.800/rack and gross income of Rs. 920/rack based on production of 4600 oysters/rack and selling cost at Rs. 20 per 100 oysters. On the above basis 250 racks in 1 ha area can produce 140 t of whole oysters grossing Rs. 30,000 a year (Nayar and Mahadevan, 1983).

For mussel culture, there are several projections. Qasim *et al*, (1977) have given the rate of return on investment as 181% for the green mussel in Goa. Ranade and Ranade (1980) have visualised a return of 168% in Ratnagiri. Achari (1980) projected a return of 76.71% on capital for single-raft production of brown mussel in Vizninjam Bay. Appukuttan (1980) calculated a net profit rate of Rs. 1480-2680 for a single raft for the same species in the same area. Kuriakose (1980) projected a profit of Rs. 4750 per raft at the end of 3 years on an investment of Rs. 14,000 for green mussel culture at Calicult.

For *Anadara* culture in Kakinada Bay, Narasimham (1986) projected a profit of Rs. 2550 on an investment of Rs. 7450 over 6 months in 1 ha area, showing a return of 34.2% on investment.

DEVELOPMENT PROBLEMS AND CONSTRAINTS

The only technology which has been taken up for commercialisation is pearl culture. A joint venture company, M/s. Tamil Nadu Pearls P. Ltd, by Tamil Nadu Fisheries Development Corporation and Southern Petrochemical Industries Corporation was established in 1983. It is worthwhile analysing why the other technologies, particulary oyster culture and mussel culture still remain on the shelves of the laboratory.

Coastal aquaculture development is new to the country and there is no awareness of its potential. Even when the scientists were directly involved in the transfer of technology to the fishermen, as in the case of the Lab-to-land programme (CMFRI, 1979) on mussel and oyster and the Operational Research Project on mussel, the results were not encouraging. The constraint analysis pointed out certain basic issues: part-time occupation in farming cutting into their period of essential rest is not ideally suited to their temperament; they would not invest; and they cannot afford to wait for a period of 6-12 months to realise the revenue from farming operations. The situation would hardly change with the fishermen unless these valid constraints are removed.

The entrepreneurs who prepared to invest need lot more information than what is currently available. They would like to have risk-proof project proposal for appraisal and investment. Mariculture is risk-prone and would need all support, particularly insurance, subsidy, soft loan, longer gestation period and other incentives.

Marketing is the major constraint if production is established. Eating habits of people hardly change. Except in small pockets in the coastal areas, mussels, oysters and clams are not known as wholesome food items. The situation would improve only with a major thrust in popularising mollusc sea food through appropriate nutrition extension programme. The Integrated Fisheries Project has been

fairly successful in trial marketing of oyster products in a few centres. But this effort is not adequate for popularising these food items so as to make an impact. Market promotion can be done only when there is an assured supply of production. The gap between production and marketing efforts can be linked only through a well planned strategy for simultaneous action on both the fronts. Export marketing was a good potential but supplies and quality standards will have to be assured.

Land and water use policy in the coastal sector for aquaculture is yet to be developed on a firm footing and the beneficiary groups for leasing will have to be identified on a realistic basis taking into consideration the effectiveness of such leases. Unless the farm sites come under the control of the lessees for appropriate period of time, investments will not be forthcoming.

In the present context, fisheries development organisations in the centre and States/ U.T.s will have to play a large and effective role in breaking the Ice. Fisheries is a highly supported and subsidised industry and it has grown with such support from the government. Mollusc culture is an area which deserves all the support that can be extended in view of the high production potential it offers. It needs setting of objectives and priorities right for providing the development support.

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