PROSPECTS FOR COASTAL AQUACULTURE IN INDIA

K. ALAGARSWAMI
Central Marine Fisheries Research Institute, Cochin

Coastal aquaculture is one among the age-old avocations of man. The Romans and the Japanese are known to have practised oyster culture in its primitive form for several centuries and the South-East Asian countries have been carrying out fish culture for at least five centuries now. While the developed countries, where aquaculture was started in recent times, have far advanced in the field with sophisticated technology, in the few developing countries, including India, which have traditional forms of aquaculture, it still remains at subsistence level, almost as it was in the distant past. But the recent developments in coastal aquaculture in this region signify the beginning of a new era in fisheries development with a thrust on the culture fisheries.

TRADITIONAL COASTAL AQUACULTURE IN INDIA

The traditional coastal aquaculture system of India is represented by the 'pokkali' fields of Kerala, 'bheries' of West Bengal, 'gazani' farms of Karnataka and 'khazan' lands of Goa. These are natural systems operated with the tidal resources of water as well as organisms. About 5120 ha of low-lying coastal areas in Kerala are utilised for growing a salinity-tolerant variety of paddy called 'pokkali' during the south-west monsoon season and prawns during the rest of the year. Besides the seasonal fields,there are perennial fields where prawn farming is done throughout the year. The estimated production in paddy-cum-prawn culture varies from 500 to 1200 kg of prawns per hectare for six months period. The total production from these fields is around 4800 tonnes.

The 'gazani' farms of Karnataka have a total spread of about 2320 ha mainly in the North Kanara district. In the brackishwater areas nearer to the coast, prawn/fish culture is carried out along with salt production, while in the interior areas, paddy-cum-fish culture is practised. The total production in these farms amount to about 600 tonnes of which 65% is constituted by prawns.

In Goa, prawn culture is done in the 'khazan' lands extending over an area of 1800 ha. Khariff crop of paddy is grown in the fields and after its harvest, the supply canals, as well as the fields in some cases, are used for culturing prawns.

In West Bengal, the 'bheries' extending over an area of about 20,000 hectares in the Hooghly-Matlah estuarine system are used for the culture of fish and prawns. The production rate in these fields is around 300 kg/ha/annum.

RESOURCES FOR COASTAL AQUACULTURE

Species resources

A rich variety of fishes, crustaceans molluscs and marine algae constitute the cultivable species resources. Traditionally the milk fish, *Chanos chanos* and mullets *Mugil* spp. form the two major cultivable finfish groups. Culture of the pearl spot *Etroplus suratensis*, 'bhekti' *Lates calcarifer*, threadfins *Polynemus indicus* and *Eleutheronema tetradactylum* has gained importance in the recent years. Experimental culture of sand-whiting *Sillago sihama* has indicated that it is a species with good potential. Other finfishes suitable for culture are species of *Caranx, Trachinotus, Megalops* and *Elops*. Besides the above species for direct use as human food, culture of anchovies and a few species for other use as live bait in tuna fishing has wide scope. Culture of *Tilapia mossambica*, a fast growing species and a prolific breeder, and an establisher in fresh as well as brackishwater areas, needs control for making it more useful.

Prawn culture or shrimp farming as it is called in commercial parlance, has attained great importance in the recent years because of the very high unit value of prawns. Among these, the 'naran chemmeen' *Penaeus indicus* and 'kara chemmeen' *Penaeus monodon* are the prize species, because of their fast growth, large size and high economic value. Other prawn species of importance for culture are *P. semisulcatus, P. merguiensis, Metapenaeus dobsoni, M. monoceros, M. affinis, M. brevicornis* and *Parapenaeopsis stylifera*. The recent results on

culture of spiny lobsters *Panulirus homarus*, have shown that it is possible to rear the puerulus stage to marketable size in 18 months' time. Similarly, among the crabs, the green crab,*Scylla serrata* has a good potential.

The edible molluscs at present support only sustenance fisheries at several centres along the coastline. Paradoxically, they are harvested more for their shells than for their meat. However, with the accent on diversification in the fishing industry and the emerging export potential, changes are already visible. The culture of mussels, *Perna virids* and *P. indica* by rafts in the open sea has shown their high production potential. The oysters *Crassostrea madrasensis* and *C. gryphoides* and clams of genera *Meretrix, Katelysia, Paphia* and *Villorita* which have an extensive distribution are the major resources for culture in brackishwater areas. The blood clam *Anadara*, although it has a restricted distribution, is another cultivable species. Among the culture of molluscs which have predominant industrial uses, pearl culture has a good scope. Besides *Pinctada fucata*, the most important species of pearl oyster on the mainland, the blacklip *P. margarifera* occurring in the Andaman and Nicobar Islands has a moderate potential. Culture of window-pane oyster, *Placuna placenta* for the shells and seed pearls could form a minor activity. Other molluscs suitable for culture are the abalone. *Haliotis* and the cuttlefishes.

Culture of seaweeds could meet the growing demands for the raw material for the production of agar and algin. The agar-yielding *Gracilaria edulis, G. corticata* and *Gelidiella acerosa* and the algin-yielding *Sargassum cinctum, S. wightii* and *Turbinaria* spp. form the major species of cultivate seaweeds.

There is also scope for culture of ancillary marine resources such as holothurians (*Holothuria* spp. and *Stychopus* spp.) and sponges (*Spongia officianalis* var. *Ceylonensis*).

Water resources

India with a 6100 km long coastline and varied ecosystems has immense water resources suitable for culture of a multitude of organisms. The potential inshore area (within 18 m depth) available for open sea farming has been estimated to be about 9 million hectares. The open sea is subject to the influence of the two monsoon systems and sea conditions remain rough for certain periods of the year. But, seasonal culture practices could be adopted for the fast growing species so that harvesting could be completed before the onset of monsoon. Sheltered natural bays with purely marine conditions are found mostly in the Andaman and Nicobar Islands and the Lakshadweep Archipelago. The paucity of calm bays along the coastline is greatly compensated by the extensive brackishwater areas present at the numerous river mouths. It has been estimated that along the Indian coast about 2 million hectares of brackishwater area including estuaries, backwaters, mangrove fields and lagoons are available. Of these, the currently used area for traditional culture practices is barely 30,000 hectares mainly in West Bengal, Kerala and Karnataka. Gujarat with 0.376 million hectares of brackishwater area is hardly using 100 ha for fish culture. In Maharashtra (with 0.081 million ha), Tamil Nadu (0.080 million ha) and Andhra Pradesh (0.200 million ha), there is practically no utilisation of the brackishwater resources for culture purposes. Thus there is vast potential of water resources for taking up coastal aquaculture in the country

Technical knowhow

Although it is only about five years since India started research programmes in mariculture in some of the laboratories, notably at Central Marine Fisheries Research Institute, the results obtained are impressive. Several species of marine penaeid prawns have been bred and their larvae reared in the laboratory/ ponds to marketable size. Indigenous techniques have been developed for pearl oyster culture and production of pearls of good quality. Culture techniques for mussels in the open sea and in sheltered bay have been established Techniques for the collection of oyster spat and growing them in the estuaries and tidal creeks have been developed. Elvers of eel have been grown to commercial size in running fresh water system. Vegetative farming techniques have been developed to increase production of seaweeds. Other areas where some encouraging results have been obtained are *Sillago* culture, crab culture, lobster culture and clam culture. Culture of milkfish, mullet, pearl spot and 'bhekti' at different centres has given valuable results. Food organisms required for the

different growth stages of fishes, crustaceans and molluscs have broadly been identified and some success has been achieved in mass culture of plankton components. Extensive surveys have been and are being conducted for locating the seed grounds and estimating the abundance of seed of fishes, prawns and molluscs in space and time.

The areas which require further research inputs have been identified. These relate to development of hatchery systems for mass production of seed under controlled conditions, nutrition of cultivable species, fish diseases and control, reproductive physiology, genetic resources and upgradation of stocks and coastal farm engineering. These programme have already been started.

Transfer technology

A good system for effecting transfer of technology is essential for the development of coastal aquaculture industry in India. It has to be done at different levels to suit the specific needs of the industry. The Central Marine Fisheries Research Institute which has the technologies for prawn culture, pearl culture, mussel culture, oyster culture, seaweed culture and eel culture has been seized of its obligations for transferring them to the end-users.

The technology transfer is effected through (i) training programmes; (ii) deputation of competent scientific and technical personnel, (iii) demonstrations, (iv) Summer Institutes in specicfic topics, (v) Consultancy Service and (vi) the courses of Krishi Vigyan Kendra, Traininig courses are conducted both in advanced and operative levels. The maritime States, Agricultural Universities and private entrepreneurs get their nominees trained under these programmes. The Krishi Vigyan Kendra trains actual fish farmers, both men and women. A Trainers Training Centre is also shortly to be added to these facilities. Besides imparting practical training, the Institute provides follow-up monitoring and advisory services wherever necessary. Thus, we already have some infrastructure for effectively passing on the technical knowhow in coastal aquaculture to the developmental agencies and industry.

PROSPECTS

Production potential

The recent developments in the culture of many of the organisms have shown their high growth rate and production potential. The prawns grow very fast in culture fields and reach marketable size in 3-4 months. By intensive culture of prawns a production rate between 1000-1500 kg/ha/annum could be realised. The mussels could give perhaps the highest yield in sea farming. The production rate as derived from experimental work is 150 tonnes/ha/year for the brown mussel and 235 tonnes/ha/5 months for the green mussel. In pearl culture, the rate of production is 60-70% and multiple implantation enhances it further by three times. Oysters grow to marketable size within 10 months and the estimated production rate is about 100 tonnes/ha/annum. Eel culture has given a production rate of 3.8 tonnes ha/2 years. *Sillago* grows to about 20 cm in seven months. In seaweed culture the growth obtained is 4-5 kg from an initial 1 kg of seed material within 80 days.

Some of the production rates reported from experimental culture farms at different centres are as follows: 1054.81 kg/ha/year and 514.7 kg/ha/70 days for *P. monodon*: 595 kg/ha/105 days for *P. indicus;* 871.75 kg/ha/320 days in mixed culture of prawns; 2759.5 kg/ha/240 days for 'bhekti'; 710 kg/ha/for milkfish; 2238.4 kg/ha/510 days for mullet (*L. tade*) 1100 kg/ha/6 months in mixed culture of fishes; and 2579.8 kg/ha/9 months for polyculture of prawns and fishes.

The reported present yield per hectare per year under the traditional coastal aquaculture system is 35.5 kg in Gujarat, 258 kg in Karnataka, 300 kg in West Bengal, 500 kg in Goa and 700 kg in Kerala. Compared to these low yields, production under controlled culture conditions is far greater and the species used are those of high unit value. The total production under traditional systems in India is around 12,000 tonnes a year in an area of about 30,000 hectares. Even if 10% area of the total 2 million hectares is brought under culture by scientific methods the production can be increased considerably.

Economics of culture

Intensive prawn culture has proved to give one of the best returns in brackishwater culture. In the demonstrations conducted by the Central Marine Fisheries Research Institute in the farmers' fields good returns have been obtained. Under the Cooperative Intensive Prawn Farming project, a net profit of Rs. 7478 was realised in a

perennial field of one hectare area in 105 days on a total expenditure of Rs. 7016. Such demonstrations have created a great interest in the coastal areas of Kerala with many farmers coming forward to take up prawn culture. At other centres, monoculture of *P monodon* in one hectare area has yielded a net profit of Rs. 17,400 per annum for 2 crops and culture of *P. indicus* has yielded Rs. 8,000 per annum for 2 crops.

In the culture of many organisms the economic viability is being worked out under pilot projects. Mussel culture, with very high yields, is bound to give good returns. The profitability in oyster culture would largely depend upon creating an increase in demand both in the urban and rural areas and also establishing export markets. Pearl culture is one of the areas with potential for high returns. In fish as well as prawn culture, the major factor that would contribute to economic success is the availability of quality seed in adequate quantities at reasonable cost. In the case of nonconventional products such as the mussels, oysters and clams the determining factor would be marketability. Culture of sea weed would yield high returns when coupled with post-harvest technology.

Employment potential

The country has an excellent scientific and technical manpower which has made the recent technological breakthrough in the field of coastal aquaculture and this would form the nucleus for further developments. Since the technical problems in future will be greater and more complex, the present teams will have to be adequately strengthened and personnel from the component disciplines should be involved.

There is already a need for managerial personnel and at present some *ad-hoc* arrangements are made to manage the farms of some of the private concerns. In the near future the demand for managerial and supervisory personnel will be greater as more and more entrepreneurs come to this field.

It has been realised that the existing extension services in the country are inadequate even to serve the current development programmes relating to capture fisheries. This has necessitated the scientific and technical community to directly engage themselves in extension programmes. Coastal aquaculture would need competent extension personnel to effectively spread the technologies and assist the farming communities as in the case of agricultural extension service.

The major area for employment potential would be at the primary level of culture operatives and skilled workers. The youth of the fishing communities in the coastal zone with training at the required levels, could form the source of this base.

In the capture fisheries sector, in spite of well established training programmes, the shortage of operative personnel is keenly felt to meet the needs of the current development programmes. It is, therefore, necesary to develop adequate training facilities for coastal aquaculture as a part of the programme for the development of this sector. The establishment of a Krishi Vigyan Kendra for Mariculture at the Central Marine Fisheries Research Institute has been a timely action and much programmes need strengthening and expansion.

The rural base of coastal aquaculture

Coastal aquaculture should form an integral part of rural development for the coastal sector. In inland areas, the need of integration of agriculture with aquaculture has been well recognised. An FAO case-study in Thailand has shown that a famrer's income can be increased 21 times by combining aquaculture with agriculture. In the coastal areas similar integration of aquaculture with traditional fisheries has good possibilities. The fishermen have plenty of leisure time during off seasons and this is being frittered away. They have an intimate knowledge of the sea and its resources and their life base is sea. Thus, logically and ethically, the benefits of coastal aquaculture must accrue first to the small fishermen. The aquaculture system for combining with traditional fisheries must be selected on consideration of several factors relating to the technical aspects of culture as well as socio-economic aspects of the fishermen community of the region. Such integration wolud necessitate identification of talents among fishermen and imparting basic training. Effective monitoring and consultancy services will have to be provided by the aquaculture extension workers.

It is worth mentioning here that the Central Marine Fisheries Research Institute, under the

auspices of the Golden Jubilee Celebrations of the Indian Council of Agricultural Research, has taken up programmes for the release of new technologies in coastal aquaculture and demonstrations in farmers' fields with the specific objective of providing a new means for uplifting the economy of some coastal rural families.

Strategies

An over-view of the prospects for coastal aquaculture in India has been attempted in the foregoing sections. The country is rich in water resource and species resource for coastal aquaculture. The technical knowhow for the culture of presently valuable species has already been developed and it is under constant improvement. Interest among the fishermen and commercial enterprencurs is not lacking. Training systems in ceastal aquaculture have also been developed. In the initial stages subsidies and loans will have to be provided as was done in the case of mechanised fishing when the vessels were introduced. The marketing potential is already good for the conventional species. In the case of non-conventional products there is need for finding new channels both in the internal and external markets. With the realisation of its potential, it is urgent that coastal aquaculture is taken up on priority basis not only from the standpoint of increasing production but also for its strategic importance as means of employment and as one of the tools for the development of the coastal sector.