CHAPTER 11

Fish and Shelfish Production Through Aquaculture in the Brackish Waters of India

E.G. Silas and P. Vedavyasa Rao

1. INTRODUCTION

Brackish water fish farming, as an emperical practice, has been known in India for a long time. However, it received the emphasis as a means for augmenting the fish production of the country only since the past decade, and the total effort involved, both in research and development, has, therefore been limited. In several regions of the world, fish farming in brackish waters is expanding rapidly and the production is increasing with the application of scientific methods and innovative technologies. An attempt is made here to present the information available on the production of farmed brackish water organisms in India, efforts made to improve the production during the past decade, constraints encountered and the prospects available.

2. CURRENT PRACTICE AND PRODUCTION TREND

Fish farming in the brackish waters practised at present in India can be broadly classified into three categories on the basis of the prevailing farming systems.

1. Paddy cultivation during the rainy season (June-September), followed by fish and prawn farming in the fair season (October -April) in the low-lying earthen fields adjacent to estuaries and backwaters, this system is principally concentrated in Central Kerala, along the northern coastal waters of Karnataka, Goa and to certain extent in West Bengal.

---

* Both Dr. E.G. Silas and Mr. P. Vedavyasa Rao are from the central Marine Fisheries Research Institute, Cochin.

2. Fish and prawn farming in relatively larger and deeper earthen fields throughout the year as seen in certain areas of Central Kerala and in the large 'Bheries' of West Bengal.

3. Paddy and fish raised together in the rainy season as practised chiefly in the fields of West Bengal and in some areas in Goa.

In the former two categories, the basic technology of fish farming is similar. The stocking of the field is accomplished by the seed brought in by the incoming tides. The seed thus entering the field is allowed to grow for a short period by feeding on the natural food available in the field, and the stock is harvested periodically. This system does not involve fertilisation of the field, supplimentary feeding of the impounded stock and control over competition and predation. The present brackish water fish farming in the country, by and large, follows this practice. In the paddy-cum-fish farming, the seed is introduced after sowing the paddy seedlings in July-August and the fish is harvested in October-November.

The practice extent of area involved in each of the above categories of farming systems and the total production realised are not available. The total area under brackish water fish farming in the country is estimated differently by different agencies and vaaries from 26,270 ha to 30,000 ha. Similarly, the total fish and prawn production from this area is again estimated to be between 10,000 tonnes and 15,000 tonnes.

In the early seventies, the Central Marine Fisheries Research Institute evaluated the efficiency of management and productivity traditional brackish water farming practice of Central Kerala and pointed out three chief defects in the systems. These are : (a) indiscriminate and uncontrolled stocking of organisms that come along with the tide, (b) short-time allowed to grow the seed before harvesting, and (c) lack of eradication or control of predatory and competitive species in the field. Realising that these defects could be remedied with a little extra effort on the part of the fish farmers, the institute suggested and advocated for the first time to improve the system by eradication of undesirable organisms from the culture base and its preparation appropriately before stocking, stocking with species that grow fast and command good price and demand, and allowing the stocked species to grow to marketable size. This improved system, which offers production of quality fish and prawns of higher unit value, was demonstrated to fish farmers in their own fields for adoption and this paved the way

to transform the traditional practice to an improved system. This is now rapidly spreading and gaining importance in the country.

Following this, and the increasing awareness of the importance of brackish water fish farming as well as the priority assigned for its development in the national and state fisheries programmes, surveys on availability and abundance of seed of cultivable species in different estuaries and brackish waters, and several field experiments on the culture of fishes and prawns have been conducted. Information on the biological and physical inputs required to improve the system and the production, are also being feathered. There endeavours made in different regions of the country during the past 10 years are summarised below.

West Bengal :

The total estimated estuaries and brackish water area of the state is about 0.405 million ha. of this, the total area utilised for brackish water fish farming at prsent is estimated differently as 12,530 ha to 20,000 ha. Similarly, the production of fishes and prawns from 'bheries' is found to vary from 113.5 to 2,323 kg/ha/year. The principal species constituting the catch are penaeus monodon, P. indicus, P. semisulcatus, Metapenaeus brevicornis M. monoceros, palaemon styliferus, p. tenuipes, among prawns, the green crab, soylla serrata, and mullets, milkfish, Lates calcarifer among the fishes. In the paddy-cum-fish culture, the yield is reported to be about 100 to 300 kg/ha/year comprising of mullets, Lates calcarifer and Mystus gulio and prawns such as macrobrachium spp., Metapenaeus monoceros, M. brevicornis and P. monodon.

The Central Inland Fisheries Research Institute (CIFRI) has carried out extensive surveys on the prawn and fish seed of cultivable species in the Hooghly-Matlah estuarine complex and has gathered a wealth of information on the distribution pattern, seasonal availability, colection and transportation procedures and economics of seed collection. The CIFRI is also carrying out a series of field experiments on the monoculture of candidate species, P. monodon, Liza parsia L. tade and Lates calcarifer, mixed culture of P. monodon, P. indicus and Metapenaeus spp. and that of fishes such as milkfish, mullets and pearlspot and poluculture of mullets, milkfish and prawns, in different stocking densities and different strategies of fertilisation and feed application. Although the results of the experimental culture have shown wide fluctuation in the production realised, it has been found possible to raise about 1185 kg/ha

of P. monodon in monoculture in 3 crops during a year at a stocking density varying from 20,000 to 50,000 seed/ha and to realise a net profit of Rs.37,800 on the operational cost. In the polyculture of fish and prawn in the brackish water ponds, an yield of 1000 kg of P. monodon and 2000 kg mullets per ha. per year with 191.2% and 26.1% of returns over paid out costs respectively has been reported. In the mixed culture of five species of prawns (P. indicus, P. monodon, M. monoceros and M. brevicornis and P. styliferus) over 1180 kg/ha/year have been obtained.

Orissa:

About 0.299 million ha of estuarine and brackish water resources are available in the state. Although there is no large-scale brackish water farming activities in the state at present, it is reported that the fish farmers of Balasore District have been traditionally practising fish culture in the impounded earthen fields. During 1982-83, brackish water prawn culture has been taken up in an area of over 275 ha in Ganjan, Puri and Balasore Districts. The important cultivable species available in this region are P. indicus, P. semisulctus, M, monoceros, Scylla serrata, mullets and milkfish. The seed availability of these species in the Subarbarikha, pahchapara - Burrabalanga, Baitarari - Bramharni Mahanadi and Rushikulya-Bahuda estuaries and in the Chilka has now been surveyed. An experiment conducted on the culture of PI monodon in a tank of 0.32 ha area at a stocking density of 7000-8000 seed with fertilisation of the tank water and supplementary feeding for 102, 100 and 126 days showed a production of 86.15 kg, 75.60 kg and 64.80 kg respectively, indicating an average production rate of 683.6 kg/ha/year. In the monoculture of milkfish at a stocking density of 4000 seed/ha, an yield of 902.5 kg/ha in 7 months of culture duration was obtained. During culture, the fish was fed with an artificial feed made up of groundnut oil cake, rice bran and prawn head waste at 3% of body weight of the fish. In the experimental mixed and polyculture of fishes and prawns, over 1000 kg/ha/year production has also been achieved.

With increasing emphasis on brackish water farming, a collaborative project between Orissa Maritime and Chilka Area Development Corporation Limited (OMCAD) and M/s Oil Mills Co. has been initiated in the Chilka lake area, involving about 500 ha.

Andhra Pradesh :

The total estimated estuarine and brackish water area of the state is 0.2 million ha. The total area estimated as suitable

for brackish water fish farming in the 9 coastal districts of the state is found to be about 17,000 ha. While no large-scale commercial brackish water fish farming is in vogue at present in the state, a few fish farmers have in recent years started culture of P. monodon in earthen ponds. As a result about 117 ha area under private sector and about 255 ha under public sector are now utilised for brackish water fish/prawn farming. The principal cultivable species available in the state are P. monodon, P. indicus, P. merguiensis, Metapenaeus monoceros, such as mullets and milifish. Several surveys carried out on the distribution and abundance of seed of cultivable species has provided data on the peak periods of their availability in the Godavary estuarine complex, in the estuaries of Srikakulam District and in and around Kakinada during April-June for the fry and fingerlings of milkfish, November-December for mullets, April-May and September-October for Later calcarifer, and May-October for penaeid prawn seed. In the field culture expriments carried out in the brackish water fish farm of the Central Institute of Fisheries Education (CLFE) an annual production of 1956 kg of fish and 264 kg of prawns per ha per year has been reported. In the monoculture of PI monodon, the production was found to vary from 150 kg to 250 kg/ha/6 months while that of Chanos chanos, 565 kg/ha/6 months with supplementary feeding. In the polyculture of mullets, milkfish, PI monodon and PI indicus (Fish:prawn - 1 : 4) with supplementary feeding the production was found to be over 1000 kg/ha/10 months culture operation.

The development organisations such as the Bay of Bengal Project (BOBP) and the Marine Products Export Development Authority (MPEDA) are also actively involved in propagating brackish water fish and prawn culture in the state. The farmer demonstrated the feasibility of prawn culture in pens, while the latter has shown the viability of prawn culture in brackish water ponds at Machalipatnam. Following this, several fish farmers of this area have now evinced keen interest to entering the field in large scale. The CMFRI, though an experimental culture showed the possibilities of seasonal culture of P.monodon in the salt pans at Neilerravu about 75 south of Kakinada.

The saline ground water with salinity varying between 28.54 and 30.0 ppt, found in the Gurujanapalli-pengundu belt, located at about 8 to 10 km from Kakinada has been found to be suitable for aquaculture of prawns and fishes. The results of farming carried out by a fish farmer in two ponds of 0.22 and 0.25 ha area, one stocked with the juveniles of PI monodon at a stocking density rate of 20,000 seed/ha and the other with milkfish at 5000/ha and cultured for 135 days with supplementary

feeding showed a net production of 198 kg/ha of Pl monodon and 216 kg/ha of milk fish. This endeavour has opened up a potential ecosystem for brackish water aquaculture in the state.

Tamil Nadu :

The state possesses an estimated brackish water resource of 0.08 million ha. Besides 1,20,000 ha of salt pans, coastal lagoons and low-lying coastal areas are also available. About 27,000 ha of brackish waters are reported to be available for immediate utilisation. Although attempts to culture fishes in the coastal waters was made as early as 1920, it was only during the past decade renewed and directed interest was evinced in this field. Following a series of demonstrations carried out by the State Fisheries Department, several fish farmers and entrepreneurs showed interest and about 75 farms varying in size from 0.3 to 10.5 ha, covering a total area of 95 ha in the 6 coastal districts of the state were constructed during 1978 and 1979 and operated for prawn culture. The production of prawn in these farms was found to vary from 200 to 400 kg/ha/crop and income from Rs.3000 to 10,500. About 300 more farms are reported to be under construction. The important species available for culture in the state are P. indicus, P.semisucatus, P. monodon, P. japonicus M. monoceros, mullets and milkfish. The R & D efforts carried out for the promotion of aquaculture in the brackish waters have enabled to gather valuable information or. distribution of seed in all the major estuaries of the state and on the production and economics of culture operations in different systems. A series of experiments on the monoculture of P. monodon, P. indicus, milk fish and mullets in eastern ponds have been carried out. In the experimental culture of P. monodon in earthen ponds without suplementary feeding a production of 496.6 kg and 521.2 kg/ha/3 months at a stocking density of 40,000/ha and 50,000/ha respectively was obtained. Further it was observed that higher growth rate was achieved at a relatively low stocking density of 20,000/ha and with fertilisation of pond an yield of 500 ha/kg of P. monodon (30-35 gm) could be obtained in 3-4 months of culture operation. In the case of P. indicus a production rate of 704.4 kg/ha was obtained in 70 days of culture. In the mixed culture, the lowest yield was 680.4 kg/ha/yr and the highest, 2986.2 kg/ha/yr with a stocking density varying from 3333-11,111/ha for milkfish, nil to 6800/ha for mullets and 16,666-37,777/ha for P. indicus. In the nylon net cages, from the experiments carried out, it was observed that production of 271 gm/m^2/crop of 96-100 days at a stocking density of 11.25/m^2 for p. monodon and 206.7 g/m^2 at a stocking density of 20/m^2 for p. indicus could be obtained.

Experimental culture of prawns in pens constructed with nylon webbings reinforced with the webbing of HDPE, coir rope and casurina poles and erected in brackish waters was carried out in Kovalam, and recently in the Killai backwaters in South Arcot District under the auspices of the Bay of Bengal Project. The cost of 0.5 ha pen was estimated at Rs.10,000. The production has been reported to be about 200 - 600 kg.ha/crop of 80 - 120 days at a stocking density of 40,000 to 50,000 seed/ha for P. indicus and 20,000 to 30,000/ha for P. monodon. A formulated feed compound of squid meal (60%), ground nut oil cake (10%), rice bran (20%), tapioca flour (7%), and maida flour (3%) was given to the prawns in the grow-out pens.

The salt pan reservoirs available in the state are also found to be suitable for prawn and fish culture. The results of experiments carried out on the culture of milk fish in salt pan areas have shown a production rate of 857.5 kg/ha/yr. Recently, P. indicus seed produced at the CMFRI hatchery at Narakkal and transported to Tuticorin and cultured in a salt pan of 1.5 ha stocked with 40,000 seed, and another salt pan reservoir of 0.3 ha stocked with 4200 seed, and another salt pan reservoir of 0.3 ha stocked with 4200 juvenile prawns for 5 months yielded a production of 120 kg and 167 kg/ha respectively. Although, the results of the experiments were not encouraging, from the point of view of production, it was indicated the possibility of culture of P. indicus in such high saline ares.

Pondicherry :

The Union Territory of Pondicherry has about 840 ha of estimated brackish water area. Recently, a fisherman conducted prawn farming in a natural small pond of one acre area formed by the tidal effect, about 21 km south of Pondicherry. In addition to the natural stocking of seed by letting in water from the adjacent river during high tide, 5000 prawn seed of P. semisulcatus, P. indicus and P. monodon were also collected and stocked in the pond. After 80 days of culture, 330 kg of prawns, 200 kg of fishes and 80 kg of crabs were harvested. Expenditure on the cost of seed, manure, labour and harvesting amounted to Rs.1540, value realised from the harvest, Rs.12,400 and net profit, Rs.10,860. The experiment being the first of its kind carried out in Pondicherry has created significant interest and several of the adjacent areas are now being brought under prawn and fish culture.

Kerala :

The extent of estuaries and brackishwaters in Kerala is

estimated at about 0.243 million ha. At present, prawn culture is being practised only in 7100 ha in Central Kerala following the traditional practice of filtration. The average annual yield of fishes and prawns from this system is found to be about 1070 kg to 1570 kg/ha/season. The prawns M. dobsoni, P. indicus, P. monodon M. monoceros and M. affinis constitute about 33.3% of the harvest and the remaining is contributed by the fishes such as mullets, pearl spot, Tilapia and catfishes and crabs scylla serrata. The operational expenditure including the lease amount of the land is found to vary from about Rs.6237 to 7425/ha, and the income from the produce about Rs.6888 - 7626/ha.

During the past ten years, several experimental culture and demonstrations of farming of selected species of prawns such as P. indicus and P. monodon with different stocking and feeding strategies for a period varying from 49 days to 120 days were carried out by the organisations such as CMFRI. The Marine Products Export Development Authority (MPEDA), Regional Centre of the National Institute of Oceanography, Kerala Agricultural University and State Fisheries Department. Although the production in these demonstrations has been found to vary from as low as 112 kg/ha to as high as 875 kg/ha/3 months, several of the successful demonstrations showed an average yield of 500 kg/ha/3-4 months. The economics of these culture operations are also found to vary from a net profit of about Rs.2,500 to 12,000/ha/one crop and depend on the type of culture operation, location of the field and management inputs.

Besides the demonstration of farming of selected species of prawns and fishes, all the major estuarine brackish water systems of the state were surveyed for prawn and fish seed resources and assessments of the availability of seed of candidate species were made.

The noteworthy developments in the brackish water fish farming activities in the state in recent years are the establishment of a Regional Shrimp Hatchery by the Fisheries Department to meet the increasing demand for prawn seed, extension of farming activities to the northern and southern coastal districts of the state, and utilisation of brackish water canals in the coconut grooves prawn/fish culture.

Karnataka :

The State possess about 4000 ha of potential estuaries and brackish waters for fish farming. Most of these areas are distributed in Uttara Kannada District. In the traditional fish/prawn

farming carried out in about 1100 ha consisting of about 30 "Gazam" fields a total production of 390 tonnes of prawns were realised in 1977-78. The average prawn and fish production from the current operation is reported to be about 375 kg/ha season. The profit from the traditional farming undertaken in a field of 81 ha extent during 11976-77 though 1978-79 has been found to vary from Rs.2,852 to 6,600/ha/season. The chief cultivable species available in the states are P. indicus, P. monodon, P. merguiensis, M. monoceros, mullets, milkfish, Etroplus and Sillago sihama. The information on the availability of seed of these species in all the major estuarine system has been gathered. Recent experiments on the culture of prawns and fishes carried out in Dakshina Kannada District have shown encouraging results indicating the prospects of polyculture of fishes such as mullets, milk fish and Sillago sihama and the prawn P. indicus. The culture fields are also found to be very productive.

Goa :

The estuarine and brackish water resources of Goa is estimated to be about 0.019 million ha. Traditionally brackish water prawns and fishes are being cultured in "Kazan" lands. While seasonal paddy and fish culture is practised in certain "Kazan" fields, in certain areas the fields are not utilized for fish culture after paddy cultivation, but their outer water drainage canals are used. Paddy-cum-fish culture is also practised to a small extent during Khariff season. The important cultivable species available in Goa, are P. Monodon, P. indicus, M. monoceros, Mullets, Etroplus, Lates and milkfish. Through the survey conducted on the fish seed resources, the season and seed grounds of mullets, milkfish and prawns in the region have been established. Recent field experiments on the culture of prawns and fishes carried out by CIFRI has indicated the production rate of 500-580 kg/ha/3-4 months.

Maharashtra :

Although there are 0.081 million ha of esturine and brackish water resources, fish farming is not practised at present in these waters. However, as early as 1946, the Department of Fisheries carried out experiments on the culture of Mugil cephalus and this was later followed by a Fisheries Cooperative Society in Thane. The farm was stocked with mullets and prawns and about 800 kg of fish was harvested. Subsequently, the Society gave up fish culture and converted the farm into salt pan as production of salt was found to be more remunerative. At

present the Marine Biological Research station are at Ratnagiri, Konkan and Krishi Vidyapeeth. The Central Institute of Fisheries Education, Bombay and the State Fisheries Department are engaged in experimental demonstration of culture of prawns and fishes for wider propagation. The chief cultivable species available in the state are P. merguiensis, M. monoceros M. brevicernis and mullets. The recent survey carried out in Thane, Bombay, Raigad, Ratnagiri and Sindhudurg districts has indicated the availability of about 14,455 ha of brackish water areas suitable for prawn/fish culture.

Gujarat :

Along the coast of Gujarat there are 2 gulfs and a large number of creeks, low-lying marshes, mangrove swamps and brackish water areas, the extent of which is estimated as 3,76,000 ha. However, there has been no fish farming activities in these waters till recently. With the increasing importance given to aquaculture in coastal waters, surveys on the fish and prawn seed at Sartampur and in the gulf of Kutch have been made. Since 1973, M/s. Tata Oil Mills Ltd., has carried out prawn and fish culture in about 88 ha in Mithapur, Jamnagar Districts. The production details of this farm are not available. The Fisheries Department of the state has started pilot schemes for site selection and culture of brackish water prawns and fishes in the Saurashtra region. P. merguiensis, M. kuthensis, M. brevicornis, P. peniculatus, mullets and milkfish are the important cultivable species in the state.

From the information presented above, the following observation could be made :

1. In all the maritime states there is an increasing awareness of the role of brackish water fish farming as a definite means for augmenting fish production both among the development promotion agencies and fish farmers ;

2. Base-line information on the growth under captivity and on the availability and abundance of seed of candidate species of fishes and prawns in different estuaries and brackish waters of the states is now available. The data gathered on seed resources have shown that adequate quantities of seed could be collected from the natural source for immediate culture purpose ;

3. Although there are vast potential brackish water resources, information on the sites suitable for aquaculture in different states is meagre ;

4. The rate of production of prawns/fishes in the traditional practise is comparable to those obtained in experimental/ semi-commercial monoculture or poly-culture of selected species of prawns and fishes. However, in the former yield is composed of mainly smaller species of prawns, relatively smaller size of the larger species and consequently, the unit value realised is comparatively less. On the other hand, in the culture of selected species of prawns, the unit production per ha is found to be over 500 kg for a culture duration of 3-4 months at a stocking rate of 2000 - 25000 seed per ha in the case of P. monodon and 40000-50000/ha P. indicus. In the case of fishes such as mullets, milkfish, Etroplus and Lates calcarifer the production is found to be 1200 - 1500 kg/ha/yr at a stocking density of 4000 - 6000 seed/ha.

5. Base-line information on the economics of selected species culture of prawns is meagre and those available are found to differ from state to state and from operation to operation followed, farm size and its location, species selected for culture, facilities available and skill of management. Nevertheless, due to the higher unit value realised for the production in the farming of selected species, the rate of net profit is found to be about 3-5 times more over those obtained from traditional culture.

6. In the traditional farming practice followed in the country, no supplementary feeding is given to the stocked prawns/ fishes. Most of the experimental culture carried out have been mainly using groundnut oil cake, rice or wheat bran and fish meal or prawn head powder at the rate of 3 to 10% of body weight of the stocked species. There is very little information on the use of pellet feed in the grow out system.

7. Although increasing information on pond ecology relating to factors such as the physico-chemical parameters of pond water, soil characteristics and biological productivity are being gathered, the effects of fertiliser and manurial treatments in the tide fed ponds are little understood. Most of the fertilizers used at present are inorganic fertilizers.

At this point, it may not be out of context to consider briefly the advancements made on the production front in the grow out systems on the culture of prawns in other countries. There are 300 ha of commercial prawn farms in Japan. Following an intensive culture system which involves high stocking density,

control of water supply and its quality, aeration and feeding with compounded diets, P. japonicus is cultivated in circular concrete tanks of 36 m diameter containing 2.5 m water depth. Stocking density is about 160-200 juveniles/m^2. The prawns are fed once after sun set every day. The production obtained from this system varies from 4.5 to 24 tonnes/ha/yr. The highest production/unit area reported in this intensive culture system is 35 tonnes/ha.

In Taiwan, where P. monodon is cultured is ponds of 0.2 0.5 ha, with a stocking density of 20-30 juveniles/m^2, a total harvest of 1.4 - 9.6 tonnes/ha is taken in 2 crops. The highest recorded production is 12 t/ha.

In Philippines, P. monodon is cultured in earthern ponds following traditional practice without feeding or in semi-intensive culture with feeding. In the traditional practise, the yield is about 200-700 kg/ha. In the semi-intensive culture, the production is found to vary with stocking density as follows :

Stocking density (No./m^2)	Production/ha (kg)
2.5	1264
5	970
10	860
20	584

In polyculture of P. monodon and milkfish, the stocking density varies from 4000-8000/prawns/ha and 2000 fry of the latter per ha.

In Thailand, both extensive and semi-intensive systems of culture are followed. In the extensive system, the size of the pond varies from 2 to 80 ha and the production of P. monodon from 25 to 80 ha and the production of P. monodon from 25 to 625 kg/ha/yr. with an average yield of 338.7 kg/ha/yr. In the semi-intensive culture involving feeding with trash fish or moist-based diets, the production upto 5100 kg in 225 days of culture of 2544 kh in 165 days is reported.

In Eucador, where extensive culture of P. Stylirostris and P. Vannamei is developed since the past decade, large ponds of more than 20 ha area are used. The fields are stocked with seed collected from nature at a rate of 1-2 juveniles/m^2 and farmed without feeding the stocked prawns. Production is found

to be limited to about 0.1 - 0.3 tonnes/ha. Over the last five years a two phase system, incorporating a nursery stage where post-larvae are cultured for 30-45 days and then transferred as juveniles to grow-out ponds is also followed. In this system, feeding commences as the shrimps attain 5 g.

In most of the above countries, the stocked prawns/fishes are fed with compounded diets having 30-50 % crude protein. The cost of seed and feed forms the major items of the total annual operating cost. The cost of these items ranges from 50-72% and the labour costs 9 to 22%. The annual rate of return on operating costs is found to range from 11% to 118% before tax.

3. PRODUCTION REQUIREMENTS

The production of fish/prawn through aquaculture requires certain inputs. These includes :

1. A suitable physical environment
2. A suitable economic environment
3. An equitable regulatory environment
4. Incentive (Profit)
5. Land
6. Water
7. Capital
8. Labour
9. Seed
10. Feed and fertiliser
11. Tools and equipments
12. Trained personnel
13. Management
14. Market
15. Information(research, extension, demonstration)

The most promising production is achieved when all the required inputs are made available in adequate quantity at the proper time. The lack of a single input of its non-supply at the appropriate time would result in little or no production.

In developing facilities for farming and realisation of better production, the major factors to be considered are the location of the farm, its design and water supply, The choice of a suitable location is extremely important, as large amount of money has often been wasted because of poor selection of sites. Further, most of the problems associated with fish farming are location-specific. In our context, it is well-known that the physical environment and conditions relating to soil, water supply and

its quality, climate, and other infrastructural facilities differe from state to state. Because of these differences, the production problems in different regions of the country are dissimilar and non-comparable. For example, the location of farm site, its design and characteristics differ greately in Gujarat from those in Kerala or Tamil Nadu and the practical problems to be faced by the fish farmers in Gujarat would have limited application for the farmers in Kerala.

The total fish production from individual farms depends greatly on the type of farming system taken up by the fish farmers. This in turn influences the designing of the farm, determination of its type, size and lay-out. The excensive system of farming requires large farms to make it viable, whereas the semi-intensive and intensive system may be carried out in relatively smaller farms with better production rates. From this point, the policy of land distribution and sharing of waters assume great importance and need critical consideration. What should be the strategy in the distribution of land small holdings or larger extensive areas ? What should be the farming characteristics in these situations ? A careful consideration of these factors form essential pre-requistics in fish production through farming.

Once the site of the farm is selected and its design and layout decided, the next question which comes up from the point of view of production and economics is what species to be taken for culture and whether the culture of species is to be carried out in monoculture of polyculture. In India, today, penaeid prawns that grow to larger size are preferred over fishes and other organisms because of value realisation and their demand in export market. Here too, most of the farmers prefer P. monodon. However, with the large-range objective in view, it would be more prudent to introduce and propagate the culture of other species of prawns and fishes that are equally suitable for culture and are in good demand. In fact, in several parts of the South-East Asian countries, farmers now believe that P. indicus and better farming prospects in view of its relatively easier and seed production, faster rate of growth and shorter duration of culture in the grow-out ponds. Similarly, in recent years there has been considerable interest in the culture of compatible species in combination to achieve higher production and to utilise more efficiently the pond ecology for the growth of the stocked animals.

The availability of seed is another problem encountered by the fish farmers. Although information on the distribution pattern and abundance of seed of different cultivable species

from nature is now available, often fish farmers fail to procure them as and when required for culture. Further, continued collection of seed in large quantities from nature would also affect the capture fisheries. To overcome this constraint, the need for establishment of hatcheries has already been realised and the technologies for hatchery production of seed of penaeid prawns are now available in the country. However, there is urgent need to develop technologies for seed production of candidate fishes suitable for culture in salt waters, and the research institutions in the country are working towards this front.

The size of seed to be stocked and the rate of stocking in the grow-out pond are crucial to achieve increased production and quality fishes/prawns. It is observed that raising of post-larvae to stockable size in hatcheries with limited space and facilities is not cost effective, and a nursery phase is necessary. It is further observed that in most of the countries where semi-intensive or intensive culture system is followed, a nursery phase where postlarvae are raised further for 30-45 days is followed. In certain cases three phase system has been introduced, where an intermediate culture between the nursery phase and before stocking in grow-out ponds is also followed.

The stocking densities in the pond depends on the type of farming, species cultured, pond size, inlet and outlet water system, carrying capacity of the pond water, aeration and feeding strategies used. Although several experiments on stocking density have been carried out during the past few years the results are still inconsistant and show wide difference. However majorty of observation indicate that the stocking rate of penaeid prawns in monoculture may be from 20,000 - 50,000 seed/ha without feeding, in the case of fishes (Mullets, milkfish) it is 4000 - 6000/ha. Further information on this aspect is essential for different regions and different species.

One of the major requirements to enhance production in grow-out fields is the availability of suitable feed in adequate quality to the stocked population. This could be achieved in two ways : (1) by increasing the natural productivity of the field by fertiliser and/or manurial treatments and (2) by providing suitable balanced artificial compounded diet. At present our knowledge on both these aspects is meagre. The farmer requires an understanding of the various factors of pond ecology, soil characteristics and dynamics of water exchange and energy flux of the pond. It is also known that improper use of fertilisers often results in negative influence on the natural productivity of the field or in the bioproductivity resulting in undesirable

blooms causing mortality of stocked animals. Formulation and development of suitable artificial feed has been greatly handicapped by the inadequate data available on the total nutritional requirements of cultivable species. There is also little information at present on the feeding of stocked prawns/fishes with appropriate dosage of suitable feed in the dynamic pond ecosystem. Nevertheless, in the context of our endeavour to propogate large scale culture in brackish water, the strategy to feed the stocked population in the grow-out systems has assumed great significance and needs immediate attention. In fact, non-availability of suitable feed has become a greater constrain than the availability of seed.

Another technical requirements to enhance the production in the grow-out system is the proper water management in the pond. Water exchange rate, water quality, siltation and deposition problem play key role in providing optimum conditions for growth and production of stocked fishes/prawns. These factors differ from state and our present knowledge in this aspect is inadequate.

In recent years, considerable attention is being given to bring derelict acid sulfate soils under productive use of aquaculture. In our country acid surfate soils occur on both the coasts, particularly in Orissa, Kerala, Karnataka and Goa. A great deal of research is now progressing on the controlled use of nutrients from decomposing organic matter for fish production in ponds, and some of the successful culture system are based to a large extent on microbial-detrital production. The preliminary studies undertaken on the application of microbial ecology to understand the pond productivity and management have indicated significant and encouraging results. Similarly, efforts are also now being made to utilise the agricultural wastes (rice straw wastes, cellulose waste, trash vegetation and aquatic weeds, banana wastes, sugarcane bagasse) as supplementary detritus to reduce the inputs of quality feeds for aquaculture.

The other factors which influence production in the grow-out ponds are the diseases and parasites affecting the farmed animals, predation and competitors limitations of managing dense population and physical features such as damages caused by storms, cyclones and heavy rain fall affecting the water quality.

The development of brackish water fish farming needs finance not only to establish the farms and corollary infrastructures, but also to meet the operational cost. Although there is considerable awareness of the potentials and prospects available

in the field among entreprenuers and farmers, financial agencies are hesitant to enter into the field and promote the venture due to lack of adequate proven economics of culture. During the past decade there have been several efforts to demonstrate the techno-economical feasibility of culture, particularly on the farming of penaeid prawns. In several instances, it has also been shown that farming is a profitable business and could be well compared with any of the land-based animal production industries or the capture fisheries in the sea. Brushing aside the aquaculture as not feasible merely due to lack of reliable data on the economic feasibility would greatly hamper the development of the field. Food production is not only the primary base of wealth of nation, but also is the basis of survival. Encouragement, therefore, should be provided for adequate flow of finance and incentives through simplified procedural formalities.

Lack of trained personnel to execute and manage the culture projects and skilled labourers to operate the sysstem has been pointed out as one of the reasons for the slow pace of development and lower production rate. Management of brackish water farming not only requires knowledge of principles of management but also an understanding of the biological characteristics of the cultivable species, dynamics of pond ecosystem, technology of culture, financial and marketing management and capability to face unpredictable changes and to take up appropriate remedial measures. Several organizations in the country are now offering different training courses at various levels to meet the manpower requirement for coastal aquaculture. Similarly, efforts are also being made to transfer the technologies developed and to dissiminate the information to the fish farmers. However, this aspect needs further strengthening to accelerate the process of development and wider propagation of brackish water fish farming.

The main reasons for the success of penaeid prawn culture in several countries today relate to their demand and market avenues. One could expect several marketing constraints when large quantities are produced or changes in consumer preference which determines the species of culture. As a long range programme, it is essential to develop an effective system of distribution and marketing of produce, so that the producers are ensured of profits of the business and or the use of diversified resources available in the country to the maximum advantage.

Lastly, there are several positive attributes and constraints to food production through brackish water fish farming, which are beyond the realm of the technology research. These relate

to the policies, guidelines and priorities assigned to the field, land and water use strategies, economic strength of the society, investment and acceptance of the venture, structure of organisations which provide development/management support to the field, changes which play an important role in the private, cooperative and corporate activities, labour structure, poaching from aquaculture and local conventions. Nevertheless, given the proper management and a climate, bringing in the resources, technologies, finance and skill available with us, there is little doubt that this country would be one of the major food producing nations in the world through aquaculture of fishes and shellfishes in the coastal salt waters.