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48 Shrimp farming - a status review

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ABSTRACT

The ever increasing demand for shrimp and the resultant pressure on the fishery has led to stagnation or fluctuation in the yield in recent years. Research and development activities carried out by the Central Marine Fisheries Research Institute aimed at improving shrimp production, harnessing both capture and culture fisheries, have yielded wealth of information over the past decades. The finding that the yield from the traditional practices of shrimp farming prevalent in India is only a fraction of what is actually possible from such fields has led to the proposition of the improved technology of selective farming of only the commercially more important species of shrimps ensuring improvement in the quality, quantity and profitability. Research undertaken by the CMFRI on culture system, shrimp seed resources inlcuding hatchery production of seed, shrimp feed formulation and farming trials have been helpful in developing suitable package of practices for the sustainable farming of shrimps. Extension machinery including publications, training programmes at operator, trainer level and field level extension programmes have been instrumental in taking the know how to the user community. Assessment of the prospects and problems of shrimp culture development has also been accomplished.

Introduction

Virtually every country in the world with a sea-coast has a commercial shrimp fishery. The continuous increase in the demand for shrimps world wide, has put an ever increasing pressure on producer countries to increase their supply. This has resulted in the intensification of capture fisheries activities expanding the size of trawler fleets as well as small vessels; paving way for the over exploitation of this very important marine resource. Most of the major shrimp fisheries are at present being harvested to full or nearful capacity. World production of shrimps through capture fishery has been fluctuating between

1869 and 2009 thousand metric tonnes/live weight over the years 1990 to 1995 (World Shrimp Farming: 1996). Production of shrimps through capture fishery along Indian coasts has been stagnating around 2 lakh tonnes inspite of increased effort. Fluctuation or decline in the production trend will have detrimental effect on the national economy. In view of this the last two decades have witnessed a multi directional strategy for improving the production of shrimps harnessing both capture and culture fishery with Government and non-government entrepreneurial support.

The usage of the terms, prawns and shrimps has been much confusing. At the Prawn Symposium of the Indo-Pacific Fisheries Council held at Tokyo in 1955 it was decided that the term prawn should be applied to the Penaeids, Pandalids and Palaemonids, while the use of the term shrimp should be restricted to the smaller forms belonging to other families. According to this definition most of the forms of economic importance are to be termed as prawns. Later on at the 1967 world Conference on the Biology and Culture of Shrimps and Prawns held in Mexico City it was agreed that the term prawn will be reserved for freshwater creatures only, and their marine/brackishwater relatives will be called shrimp.However, in this article both the terms are used analogously to refer to marine/brackishwater forms only.

Compared to the capital intensive and relatively less economic proposition of searching prawns in the deeper areas of the sea or in the already exploited coastal zones, selective farming of commercially important species of prawns which ensure both quality and quantity has been widely accepted as a suitable means of increasing prawn production in recent years. A major share of worlds farm-raised shrimps is produced in the Southeast Asia which offers a favourable site for shrimp aquaculture expansion, in view of the vast brackishwater areas available for farming, ideal climatic conditions, lower labour costs and the Asian aquaculture tradition. Out of the world shrimp production of 26,07,000 metric tonnes in 1995, India's contribution occupying the third position, was 2,70,000 tonnes formed or 78% from capture and 22% from culture fishery. During the year 1994-'95 we could gain foreign exchange worth Rs.2,516.6 crores by exporting 1,06,857 tonnes of shrimps, of which 83,000 was contributed by aquaculture.

Conventional practices of shrimp farming in India

It has been frequently pointed out that countries which have the greatest success with aquaculture generally are those which have a long history and

tradition associated with some form of aquaculture or related fishing activities. In India the traditional system of shrimp farming popularly described as 'trapping and holding' has been prevalent in the low-lying brackishwater impoundments adjoining the Vembanad Lake in Kerala known as 'Pokkali fields' and in the Sunderban mangrove swamps of West Bengal, known as 'Bheries', since decades. The system followed in Kerala, popularly known as prawn filtration was described as early as 1937 by Panikkar (1937) and later on redescribed by other workers (Menon, 1954; George et al., 1968; George, 1974). As per the data collected by Menon (1954) the practice was prevalent in about 4,400 ha. These fields varying in size from less than 0.5 ha to more than 10 ha (George, 1983) and lying along the coastal villages of Trichur, Ernakulam, Alleppey and Kottayam districts are confluent with the Vembanad Lake through canals and are subjected to tidal influence.

The paddy field prawn filtration practised in Kerala is a seasonal operation done during the pre-monsoon period, November-April when the water is saline. During the remaining period when the water is almost salt free due to the southwest monsoon these fields are used for the cultivation of a special variety of salt resistant paddy locally known as 'Pokkali'.

In addition to the seasonal fields there are relatively deeper brackishwater impoundments which are not suitable for growing paddy. These fields ranging in size from 2 to 75 ha (George, 1983) used for prawn filtration throughout the year are known as perennial fields. The prawn filtration fields distributed over different districts include 4000 ha in Ernakulam, 590.8 ha in Trichur, 352.67 ha in Alleppey and 167.43 ha in Kottayam, a total of 5110.9 ha (Rao, 1981a).

As reported by Menon (1954) the approximate average yield of prawns from filtration fields during the 1951-'52 season (November-April) was 972 lbs/acre or 1,089 Kg/ha composing of different species. George (1978, 1980) has estimated the percentage composition in the yield of different species of prawns as *Metapenaeous dobsoni* 53-57% *Penaeus indicus* 36-43%, *M. monoceras* 3.5-6% and *P. monodon* 0.7-1%. The average prawn production was 903.3 Kg/ha/season in the seasonal fields and 838.6 Kg/ha/year in the perennial fields during the period 1969-'72 indicating that, though the total expenditure to run the seasonal fields is higher than that of the perennial fields, the net income realized from the seasonal field was better in general (George, 1974).

The 'bheries' of West Bengal extend to a total area of 32,930 ha spread over the low saline (9,844 ha), medium saline (15,613 ha) and high saline (7,472

ha) zones in the spill area of Bidyadhari river near Calcutta city and 24 Parganas district in brackishwater tidal wet lands including mud flats, swamps, marshes, paddy fields etc. (Saha *et al.*, 1986). In the seasonal 'bheries', both prawn/fish and paddy are raised in the same unit either simultaneously or sequentially and the fields are dried during November-December. In the perennial 'bheries' prawn and fish are raised almost throughout the year. The average production rate is about 775 Kg/ha/annum, with 18.75% contribution by *P. monodon* (Saha et at., 1986).

Prawn farming practices in traditional lines similar to these have been spread to certain other maritime States of the country also in due course (Alagarswami, 1990). Trapping and holding practices are carried out in about 2500 ha of 'Khar' lands (gazani farms) in the Aghanashini, Kali and Sharavathi estuarine systems in Karnataka during the saline period, December-April alternating with paddy crop during the period of southwest monsoon as followed in Kerala State. The yield is about 400 Kg/ha/year of which prawns constitute about 85%.

In the 'Khazan' lands of Goa, about 500 ha of brackishwater areas are used for the traditional type of shrimp farming alternating with paddy crop yielding an average production of 350 Kg/ha/year (Alagarswami, 1990).

Nearly 900 ha of fields in Orissa forming part of Panchapara Budhabalanga estuarine zone and Jumboo-paradeep (Rajnagar) area are under the traditional practice of shrimp farming with an average yield of 633.29 Kg/ ha/year of which prawns form 19.4% (Mohapatra, 1988; Mohanty, 1988).

Evolution of scientific shrimp farming in India

Menon (1954) who has done pioneering work on the traditional shrimp filtration system in kerala had opined that the practice was, in reality, simply a device for large scale prawn fishing which does not allow any time for the prawns to grow within the fields. However, he has indicated that the actual process of shrimp farming was in vogue even before the dawn of the present century in certain localities like Narakkal in Ernakulam district and that the current practice is a later development. After allowing prawns to enter the fields in the traditional way for some days, the sluices were finally closed and the prawns were left in the completely enclosed fields for 2-3 months after which they were fished. In two such experiments Menon (1954) got promising result and a yield of about 400 lbs per acre was obtained which suggested the possibility of 2 crops of prawns during the period November to May.

In view of the fact that commercially more important and fast-growing species of shrimps are represented only by low proportions in the yield from traditional practice, Menon (1954) remarked as early as 1954 that unless prawn is grown for an improvement in production, it has little chance of being adopted by those engaged in the industry. He also suggested that improvement could be effected if the proportion of *P. indicus* could be appreciably raised, or if they could be made to grow larger than at present within the fields.

Regarding the suitability of the traditional filtration fields for introducing culture operations, experiments conducted by George et al., (1968) have shown that these fields provide an active and suitable biological environment for the life and growth of prawns. During the study it was observed that prawns are not passively transported in and out of the field by the flow of tide, instead majority of the juveniles enter into the field and seek shelters at the bottom before the flow of tide reverses and hence are not moving out during the subsequent outgoing tide, pointing towards the possibility that they settle down in the new habitat for a period of 5 to 6 weeks.

Though the yield from the traditional practice is only a fraction of what is possible from such fields the traditional prawn farmers must be appreciated for evolving such a system of rotation of crops of paddy and prawn appropriately exploiting the ecological cycle taking place in these brackishwater fields. While evaluating the merits and demerits, and ecological and techno-economic aspects of the traditional practices, Muthu (1978) has highlighted the scope for improving the culture practices and production trend by way of propagating the selective farming of shrimps at semi-intensive and intensive levels.

In this context, the Central Marine Fisheries Research Institute has been able to develop indigenous low-cost techniques for the culture of marine penaeid prawns during the Fifth Five Year Plan (Silas and Rao, 1978). Different agencies including the Central Marine Fisheries Research Institute, The National Institute of Oceanography, Central Institute of Fisheries Education, the Konkan Krishi Vidyapeeth, some Universities and the All India Co-ordinated Research Project on "Brackishwater prawn and fish culture" have devoted much of their attention in this line of research (Rao, 1981). Among the different species of commercially important shrimps, *P. indicus and P. mondon* are the prize species, because of their fast growth, large size and high economic value (Alagarswami, 1981). The package of practices of the improved technology tested and proved at the Institute which involves the exclusive stocking of the seeds of commercially more important species of shrimps such as *P. indicus* and *P. mondon* proportionate to

the area and productivity of the fields and growing them for definite periods to achieve good quality and maximum quantity of prawns for more profitability than the conventional prawn filtration system has been presented by Unnithan (1985; 1996). Apart from the seasonal and perennial fields under the traditional practice, other backwater and estuarine areas including the shallow brackishwater canals in coconut groves, the derelict water bodies in salt pan areas along the coastline etc. can be made use of for shrimp farming. The Central Marine Fisheries Research Institute has published detailed gudelines for selection of site and construction and maintenance of shrimp farms (Ramamurthy, 1978; Kartha and Nair, 1980; Unnithan, 1985).

Culture system studies

Primary productivity and related hydrographic parameters, the epifauna, benthic fauna and chemical constituents of the bottom soil of the prawn culture fields adjacement to the Vembanad lake, the largest in Kerala State have been studied in detail by Gopinathan *et al*, (1982) and on the basis of the observations on the promary production the fields have been classified as highly productive (> 1500 mg C/m^3/day), low productive (<500 mg C/m^3/day) and moderately productive (500-1500 mg C/m^3/day). The organic carbon content of the bottom soil of the three brackishwater shrimp culture systems in Cochin region, namely, the seasonal fields, perennial fields and canal systems in coconut groves has been reported to be 4.44%, 2.37% and 1.67% respectively, indicating the order of the fertility standard of the three systems (Easwara Prasad, 1982). Suseelan, (1978) has suggested the environmental parameters conducive for the culture of marine prawns. Following the method developed by Pillai and Boyd (1985) Joseph Gilbert and Pillai (1987) have estimated the lime requirement of different seasonal and perennial shrimp culture ponds around the Cochin backwaters forming part of the Vembanad lake, for premonsoon and monsoon seasons, based on exchange and potential acidity of the bottom soil. Sivakami (1988) has demonstrated the beneficial effects of fertilizer and feed application on the growth of *P. indicus* in marine microcosms.

Shrimp seed resources

The success of shrimp culture depends largely on the availability of adequate quantity of the seeds of desired species at the appropriate time. Shrimp seed requirements are met either by the natural wild resources of through hatchery production.

Natural resources of prawn seeds

Estuaries and backwaters are the important sources of prawn seed in nature as most of the cultivable species of prawns spend their juvenile phase in these environments. (Menon and Raman, 1961; George, 1962; Mohamed and Rao, 1971). They are encountered there almost throughout the year. However, October-May is found to be the peak season in the brackishwater areas of the west coast and south east coast, while it is January-April and August-December in the estuaries of the middle and northern regions of the east coast (George and Suseelan, 1982). Suseelan and Kathirvel (1982) have presented a consolidated monthly picture of the seed availability of 13 species of panaeid prawn in Cochin backwaters. Ramamurthy (1982) has done a survey of the juvenile prawn resources of three estuaries, at Kasaragod, Mangalore and Mulki along the Karnataka coast during 1969-'72. The magnitude of the seed resource, the species and size-wise composition and the seasons of availability have been presented.

The magnitude of seed resources decreased from south to north along the Kasaragod-Mulki coast, Kasaragod estuary being the most potential and Mulki the least. The prawn seed resources of Karnataka and Kerala had a multiple species composition with *P. indicus, P. mondon, P. semisulcatus, P. merguiensis, M. dobsoni, M. monoceros*, and *M. affinis* of which *P. Indicus* and *M. dobsoni*, formed the major portion (Rao, 1980). Silas *et al* (1989) have documented considerable information on the prawn seed resources along the Kerala and Tamilnadu coasts. Mathew *et al*, (1982) have developed a simple device for the quantitative assessment of prawn seed resources in the estuarine areas, consisting of an aluminium foldable cage of size, 100 x 75 cm lined with nylon netting and a square scoop net of 95 x 95 cm almost fitting into the cage. Simple methods of collection, sorting, counting and transportation have been described by Selvaraj *et al*, (1980) and Unnithan (1985). Muthu (1978) has given the identification characters of post larvae of penaeid prawns found in brackishwater areas.

Hatchery production of prawn seeds

For large scale farming operations, shrimp seed available in the natural environments like coastal lagoons, estuaries, and other brackishwater areas cannot be considered as a dependable source since there will be wide fluctuation in their distribution, abundance and species composition. For the successful farming of prawns, steady availability of quality seeds at required time is of

utmost importance. During the early phase of scientific brackishwater shrimp farming in India in late 1970's and early eightees farmers were fully depending on the wild prawn seeds. The rapid and widespread expansion of shrimp farming along the east and west coasts of India necessitated large scale production of seeds of commercially important species. It was in these corcumstances that the Narakkal Prawn hatchery laboratory, the first of its kind in the country was established under the Central Marine Fisheries Research Institute in 1974 to undertake prawn hatchery research and development programmes. In this laboratory it was possible to achieve significant break through in breeding and rearing the seeds of different species of shrimps including *P. indicus, P. monodon, M. dobsoni, M. monoceros, M. affinis, Parapenaeopsis acclivirostris, P. stylifera* and *M. brevicornis* (Mohamed *et al.*, 1978; Muthu, 1982; Silas and Muthu, 1977; Thomas *et al.*, 1975, 1976a, 1976b, 1977). Muthu and Lakshminarayana (1981) developed the techniques of induced maturation of *P. indicus* and *P. monodon* by eyestalk ablation and water quality maintenance.

Shrimp feed production

Large scale development of shrimp farming all over the world in recent years has necessitated elaborate studies on the nutritional requirements of shrimps and the formulation and manufacture of nutritionally well balanced diets on commercial scale. Though the significance of artificial feeds in shrimp culture practices has been fully realised and research projects already undertaken in many of the advanced countries of the world pretty earlier, in India, studies in this line were initiated in 1972 at the Central Marine Fisheries Research Institute and as a result considerable information have been acquired on the nutritional requirements of Indian prawns. Nineteen feeds have been compounded with different proportions of the ingredients and these have been tried on different species of Indian penaeid prawns under laboratory conditions. The effects of increase and decrease of protein and carbohydrate have also been investigated on post-larvae and juveniles. It has been found that protein content much less (23%) than those recommended by Japanese workers (40-60%) was sufficient for good growth in our species under local conditions (Thomas. 1978). Studies conducted in the erstwhile Narakkal Prawn Culture Laboratory (NPCL) of CMFRI on *Penaeus indicus* (Ahamad Ali, 1982) have shown that the optimum protein level lies between 35 and 40%. At NPCL, several feeds were prepared with protein contents ranging from 30 to 60% using clam meat, groundnut cake, fishmeal, mantis shrimp, trash fish, yeast and cassava for feeding post-larvae of *P. indicus* at the nursery stage. Among them the feed NPCL/117

consisting of mantis shrimp 20%, prawn waste 20%, ground nut cake 30%, fish meal 10% and cassava 20% with a protein content of 36.8% was evolved as the most suitable feed for rearing post-larvae (Ahamad Ali and Sivadas, 1983). Another formula feed, NPCL/222 contained prawn waste 35%, mantis shrimp 25%, groundnut cake 20% and cassava 20% with a crude protein content of 33% (Ahamad Ali and Mohamed, 1982) tested in growout ponds has recorded faster growth and increased yields of *P. indicus* and was also possible to increase the stocking density upto one lakh seeds per hectare.

Studies made on the nutritional evaluation of some imported and indigenous shrimp feeds have revealed that the imported feeds are better in physical characteristics such as compactness, uniformity in size and shape and colour, in biochemical composition and in biological performance, calling for improvement in local feed formulation, feed mill equipment and design (Manpal Sridhar and Pereira, 1996). The overall effective nutrient composition of the low cost prawn feed formulated at CMFRI and produced under the brand name 'Mahima' in 1994, takes care of the nutritional requirement of the postlarvae, juveniles and adults of both P. indicus and *P. monodon* (Manpal *et al*, 1995).

Farming trials and production profile

The Central Marine Fisheries Research Institute has successfully demonstrated the proven technology of selective farming of commercially important species of prawns such as *P. indicus* and *P. monodon* under different ecological environments, over the past two decades. Suseelan (1975) has given a report of his observations made on the culture of *P. indicus* during January-December 1973 in three reservoirs of the salt pans adjoining Manakkudy estuary in Kanyakumari district. Every year shrimp culture is done in two seasons, February to May and June to December in these areas utilising the wild collection of *P. indicus* seeds. As per the present observation, a production of 625 Kg/ha was realised out of the first crop (27th February-30th May) with a survival rate of 82% and 509 Kg/ha out of the second crop (7th June-31st December) with a survival rate of 71%, total production being 1,134 Kg/ha/year. The average stocking density was estimated to be between 38,000 and 50,000/ha. Feeding was not done. George (1980) has obtained a production of 521 Kg of *P. indicus*/ha within a period of 105 days without feeding, in a brackishwater pond at Narakkal in Kerala. Wild collection of juveniles @40,000 numbers per hectar were stocked. The recovery of prawn was about 75%. Culture of *P. indicus* during 1978-'79 @ 5/m^2 in the coastal ponds at Mandapam, Tamilnadu, fed with clam meat and trash fish has shown a growth of 121 mm/11.5 g in 158

days recording a survival of 44.05% and a total yield of 231.53 Kg/ha/5 months. (Nandakumar, 1982). *P. indicus* juveniles cultured in polythylene lined beach ponds at Calicut attained the highest mean size of 124.3 mm/13.3 g in 115 days (Lazarus and Nandakumaran, 1986). Culture of *P. indicus* in newly developed ponds adjacent to the salt pan areas along the Kallar river at Veppalodai, north of Tuticorin in Tamilnadu under high stocking density of 1.2-1.5 lakh/ha yielded production upto 1604 Kg/ha/224 days with a survival of 95.4% (Marichamy and Motha, 1986). Poultry manure @ 750 Kg/ha was applied at the bottom at the preparation stage of the pond and later the optimum productivity was maintained by applying organic manure @ 20 Kg/ha and inorganic fertilizers like urea and superphosphate, each @ 5 Kg/ha, whenever required. The prawns were fed with pelletised feed twice a day @ 7-10% of body weight. Lipton (1995) has reported a production of 4-5 tonnes of *P. monodon*/ha/crop, under a stocking density of 1.4-1.5 lakh/ha with Taiwanese feed and paddle wheel aeration in a private semi-internsive farm at Kanjiramkudi in Ramanathapuram district of Tamilnadu.

Shrimp culture extension

Simultaneous with carrying out productive and problem oriented research in the field of shrimp farming, the Central Marine Fisheries Research Institute has been giving priority for the speedy and continuous flow of economically viable technology from the laboratory to the end users (Anon, 1980). This mission is accomplished through different means of information dissemination systems including publication of literature, organising training courses both at trainer and operator level, undertaking operational research projects, demonstration projects, implementing lab-to-land and sheduled caste and scheduled tribe programmes, village adoption, rural empowerment and entrepreneurship development schemes.

Publications

The Indian Journal of Fisheries, CMFRI Special Publications, CMFRI Bulletins, Marine Fisheries Information Service-Technical and Extension series, CMFRI Newsletter, Annual Reports and other special scientific reports on sponsored projects, Krishi Vigyan Patrika Mariculture series etc. are some of the major publications of CMFRI which carry shrimp farming technologies apart from the proceedings of Seminars, Symposia, Workshops, Summer Institutes etc. Success stories on shrimp farming activities undertaken by entrepreneurs at different regions have been instrumental in brining about country-wide

awareness on the prospects of shrimp farming development. The first ever attempt of supplementary stocking by a fisherman in a traditionally operated brackishwater pond of 0.4 ha area in Pondicherry which yielded 300 Kg of prawns including *P. Semisulcatus*, *P. indicus* and *P. monodon*, 200 Kg of fishes and 50 Kg of crabs is reported to have created much awareness in bringing more areas under shrimp farming in the locality (Chidambaram, 1980). The compilation of the package of practices adopted in the case of *P. indicus* farming (Unnithan, 1985) has been effective in providing the guidelines to new entrepreneurs. Results of the pioneering experiment carried out in a farmers pond in the salt pan area at Tuticorin has lead to the establishment of its techno-economic feasibility along the coastal area in Tamilnadu (Marichamy and Motha, 1986) Unnithan *et al*, 1984) have narrated the success story of shrimp farming by the technique of intermittant harvesting and stocking in the canal systems in coconut groves, carried out by a farm labourer trained by the CMFRI. The maiden attempt of selective farming of *P. indicus* in such canal systems has been presented as an innovative approach (Anon, 1978).

Dissemination of technology related to homestead shrimp farming is one among the extensive programmes launched by CMFRI, under the Project 'Planned change in a coastal village-a model for first line extension programme at Kandakkadavu, Chellanam Panchayat, Cochin. Narating one of such successful attempts made by a housewife, Jancy Gupta and Unnithan (1993) have highlighted the role of women in managing small scale shrimp farming operations in homestead canals in coastal areas, which offers great scope for self employment and supplementary source of income for the economically weaker sections of the rural society.

Publication of the results of the field trials of compounded feed formulated by CMFRI (Manpal *et al*, 1983) (recording a conversion ratio of 0.9:1) has helped much in popularising the feed among the local farmers.

Training programmes

Training programmes of CMFRI on shrimp farming are organised mainly at its Krishi Vigyan Kendra at Narakkal and Trainers' Training Centre at Cochin. The Krishi Vigyan Kendra (KVK) established in December, 1976, is an innovative and grassroot level agency imparting skill-oriented training in mariculture and other rural farm-based technology by the principle of 'Learning by doing' (Balakrishnan, 1981, Thomas *et al*, 1988) and Martin and Unnithan (1994) have presented the aims and objectives. Transfer of Technology programmes and

achievements of the Krishi Vigyan Kendra. As on March 1996, the KVK has trained more than five thousand villagers including small and marginal farmers, fishermen, farm labourers, unemployed youth and school drop-outs including women. Apart from organising training courses, the Kendra also conduct other extension programmes such as publication of Krishi vigyan Patrika in local language, TV and radio programmes including talks, discussions and interviews, farmers day, film shows, Lab-to-Land programme, scheduled caste/scheduled tribe development programmes etc. There are also programmes for gathering feed back information from the trained villagers regularly. The KVK maintains close linkage with various development agencies including State and Central Government Organisations, Non-Government Organisations and voluntary agencies.

Higher level training courses meant for inservice personnel including trainers deputed from the maritime regions of the country are organised at the Trainers' Training Centre (TTC) of CMFRI established in 1983. As on March 1996 the TTC has organised 34 training courses on shrimp farming including hatchery production of prawn seeds.

In addition to the regular training courses organised through the KVK and TTC the Institute has also conducted summer institutes on hatchery production of shrimp seeds and farming of shrimps (Annon, 1978; 1983).

Field level extension programmes

Lab-to-Land Programme: The Lab-to-Land Programme "launched in 1979 in conjunction with and in commemoration of ICAR Golden Jubilee (1929-'79) celebrations has been the largest and the most intensive unified development effort in any third world country.

The CMFRI started the implementation of the programme in January 1979 by adopting 350 families belonging to the low-income group at different centres-Cochin, Quilon and Calicut in Kerala and Tuticorin, Mandapam, Muthukkadu and Karikkattukuppam in Tamilnadu. All the farmers were imparted training in method of mariculture, relevant to the localities and critical inputs were provided. Shrimp farming programmes integrated with allied agriculture enterprises were implemented at Cochin, Quilon and Muthukkadu. In a mid-term appraisal workshop held in July, 1979, the Institute could gather invaluable feed back information from the beneficiaries (Silas, 1979). Since 1986 the programmes

are implemented through the KVK of the Institute at Narakkal and are being continued in a phased manner.

Operational Research Projects: The Operational Research Project on blending sea farming with traditional capture fisheries started by CMFRI in April 1979 at Kovalam, a fishing village 35 km south of Madras as per the guidelines of ICAR was the first of its kind in the marine fisheries sector (Rajan, 1981). The Project envisaged establishing the possibilities of supplementing traditional fishing with marine culture by demonstration with beneficiaries' participation in order to increase production and improve the socio-economic conditions of the fisherfolk. Establishment and development of prawn seed trade based on wild resources among the fishermen was one of the focal themes of the Project.

Through another extension programme of the Institute namely the Demonstration Project, the CMFRI could successfully demonstrate the techno-economic feasibility of selective farming of *P. indicus* in a seasonal field of 1 ha area at Narakkal during 1978-'79.

Entrepreneurship development programme: The launching of an enterpreneurial programme on small-scale on-farm production of low-cost prawn feed (Rs.25/-kg) under the brand name 'Mahima' in 1994 in a coastal village in Ernakulam district was a landmark in the field of nutritional research and extension of the Institute. The programme has been unique in the sense that it has been probably the first ever attempt in the country to bring down the technology of prawn feed production to the rural level where the enterprise is managed by a group of women (Manpal *et al*, 1995).

Prospects and problems of shrimp culture development

In a country like India with lot of socio-economic and population problems, prospects of development must be sought giving due consideration for the overall development of the rural sector. In this context, action plan, ultimately leading to the development of the country through area development, employment generation and uplift of the rural economy should be implemented. At one side, due consideration must be given for improving small subsistence level operations to meet the immediate local needs. At the other side, suitable strategies must be adopted for promoting large scale industry level farming operations aimed at increased production for export.

It is estimated that there are about 12 lakh hecares of brackishwater area distributed in the maritime States of India. Out of this only about 1 lakh

hectare are under shrimp farming now. The present (1994-'95) production of shrimps through culture is only about 83,000 tonnes (source of figure: the Marine Products Export Development Authrity, Cochin). The current production could be increased to many fold by implementing proper development strategies. Engineering expertise and technical knowhow for the development of land and water areas and also the enormous labour force required for the purpose are available in India. We have also developed the technology for the mass production of prawn seed and feed. Extension and financing services for shrimp farming are also available with different organisations.

Side by side with the fast and intensive expansion of shrimp farming activities, various problems also are cropping up. Environmental problems like pollution, localised problems of socio-economic nature and the recent disease problems in hatcheries and farms alike call for serious attention. Nair (1981) has discussed the situations leading to pollution in aquaculture systems and brought together the available information on the common pollutants and their tolerance level in the cultivated aquatic organisms.

The CMFRI has been devoting much attention to the investigations on the problems of disease among shrimps eversince serious pathological conditions are encountered in the culture systems including hatcheries often leading to mass mortality of the stock. The workshop on "Approaches to finfish and shellfish pathology investigations organised by CMFRI during 10th-11th February 1983 at Cochin outlined the guidelines for the identification of the problems and the rational approaches to be made to tackle the same (Anon, 1983a). Pillai (1984) has described the various types of diseases encountered in brackishwater and marine environment, matters relating to defense against infection, prophylaxis and disease check-up, sampling techniques for disease diagnosis, classification of pathogens, screening of bacteria for identification and methods to be adopted for despatch of diseased specimens for study. Rao (1983) has made a comprehensive review of the investigations made on shrimp diseases in India and abroad supplementing with his own observations. Various diseases caused by viruses, bacteria, fungi, protozoa, trematodes, cestodes, nematodes, leaches, and parasitic crustacea and also those caused by nutritional deficiencies, pollution, environmental stress, toxic algal blooms etc., and their remedial measures have been dealt with. Adoption of suitable strategies and package of practices aimed at sustainable level of production alone can ensure a healthy growth of shrimp farming industry.

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