CENTRE OF ADVANCED STUDIES
IN
MARICULTURE

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
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CENTRE OF ADVANCED STUDIES IN MARICULTURE

INTRODUCTION

During the last three decades marine fisheries in India has shown a steady growth from an annual yield of about 0.5 million tonnes to 1.4 million tonnes. The emphasis had been on capture fisheries, particularly for prawns and shrimps which form the main-stay of the export oriented fishing industry. However, during the last few years, the researches on stocks on prawns carried out by the CENTRAL MARINE FISHERIES RESEARCH INSTITUTE has shown that the exploitation has reached a stabilisation level in some areas along the west coast, while in others there are indications of heavy exploitation of stocks.

To augment marine fish production, considerable emphasis has been given to mariculture including coastal aquaculture in recent years. It is also now realised that mariculture could help considerably in the integrated rural development of coastal areas, provide job opportunities, and help to use underutilised or unutilised inshore and coastal derelict waters. In view of this, mariculture is now given top priority in the National Development Programmes.

The term mariculture is used here to denote the culture of cultivable marine organisms in the inshore waters and adjoining estuarine and brackish waters as opposed to inland fish culture in the fresh water realm. In the early fifties, the Central Marine Fisheries Research Institute had programmes on mariculture, particularly the culture of milk-fish. As coastal aquaculture had a very low priority at that time, the Institute had to programme its research to find answers to more pressing problems relating to fishery resources and their exploitation, fish stock assessment and discovery of new fishing grounds and new resources in the continental shelf waters. However, during the last five years a major thrust has been given for the development of mariculture of fishes, prawns, mussels, edible oysters, pearl oysters, pearl production, seaweeds

and so on. The techno-economic feasibility of culture of some of these organisms has been studied and the Institute is now taking up large pilot projects to demonstrate the economic viability for establishing commercial culture practices.

The further development of mariculture in the country is greatly hampered by the serious lag in research and teaching. Although the Institute has taken up research projects on mariculture and developed some expertise, considerable strengthening of this research base combined with that of teaching at the post-graduate level is imperative for the future development of mariculture at the national level. It is in the light of this background that the CENTRE OF ADVANCED STUDIES IN MARICULTURE was established at this Institute. This booklet gives briefly the background information about the Institute, its activities and the salient features of the Centre of Advanced Studies in Mariculture.

MARINE FISHERIES OF INDIA

Capture Fisheries

India has a coastline of 6,100 km. Scattered along the coast, there are 1913 fishing villages, where over 1.4 million fishermen live. About 0.3 million fishermen are actively engaged in marine fishing, employing 0.1 million indigenous crafts, 12,000 mechanised fishing vessels and about 0.7 million gears of assorted types. Besides, infrastructural facilities such as ice plants, freezing and other processing plants, frozen and cold storages, boat building yards and shipyards, factories for fishing gear and marine diesel engine manufacture, and for transportation and marketing of fish, are available.

The present annual marine fish production of India is of the order of 1.4 million tonnes realised mainly from the inner half of the continental shelf. The exploited capture fishery resources comprise mainly of oil-sardine, lesser-sardines, anchovies, mackerel, ribbonfishes, perches, sciaenids, cat-fishes, polynemids, flatfishes, pomfrets, eels, elasmobranchs, Bombay-duck, silverbellies, prawns, shrimps, lobsters, crabs, and molluscs such as chank, oysters, clams, squids and cephalopods. The fishery resources in the

outer half of the continental shelf and beyond in the extended Exclusive Economic Zone upto 200 miles, are by and large unexploited.

Besides the capture fisheries in the sea, estuaries and brackish waters support a fishery of considerable magnitude. Sub-adults of littoral penaeid prawns of the genera *Penaeus* and *Metapenaeus*, Palaemonid prawns, clupeoids, gobids, mullets, polynemids and molluscs (oysters and clams) contribute to the fishery in this region.

Marine products constitute one of the principal commodities exported from the country. The current export of marine products from India surpasses Rs. 2,000 million.

Culture Fisheries

Culture fisheries in the coastal zone, practised at present in a small scale, is prevalent in the enclosed areas of backwaters and is largely confined to Kerala and West Bengal. The fishery is based on the traditional method of trapping the juveniles of prawns and fishes brought in by the tidal currents and cultivating them in the fields. The total area now utilised under this system of culture is estimated to be about 25,000 ha. The production rate of fishes and prawns is found to vary from 0.5 to 1.2 tonnes/ha/year.

Fisheries Research and Education

At the Central level, fisheries research and education are the responsibilities of the Indian Council of Agricultural Research and the Department of Agricultural Research and Education. At the State level, Department of Fisheries, Agricultural Universities and in certain cases, the Universities share as well, these responsibilities.

Indian Council of Agricultural Research (ICAR)

The ICAR, a registered Society, is an apex body in the country responsible for co-ordinating research and education activities in agricultural, livestock and fisheries. 30 Research Institutes, two National buraeux, 51 All-India Co-ordinated Research projects, 5 Project Directorates and a National Academy for Agricultural

Research Management are functioning under its control. Besides, it fosters and supports the growth and development of 21 Agricultural Universities in the country acting as "Agricultural Universities Grant Commission."

Fisheries research at the national level is carried out by the Central Fisheries Research Institutes, namely, the Central Marine Fisheries Research Institute, Cochin, the Central Inland Fisheries Research Institute, Barrackpore and the Central Institute of Fisheries Technology, Cochin. Recently the Central Institute of Fisheries Education, was also brought under the control of the Council.

The Central Marine Fisheries Research Institute

The Central Marine Fisheries Research Institute was established in 1947 by the Ministry of Agriculture and Irrigation. It came under the control of the ICAR in 1967. The headquarters of the Institute is at Cochin. The Institute has a Regional Centre at Mandapam Camp, Tamil Nadu, 11 Research Centres and 29 Field Centres on both the coasts. The overall objectives of the Institute are to coduct short-term and long-term multidisciplinary researches on the marine capture and culture fisheries of the country in order to provide RESEARCH support for the rational exploitation, conservation and management of the marine and brackishwater resources for stepping up production from the coastal water areas and the Exclusive Economic Zone, and DEVELOPMENT support for growth with stability of the industrial, artisanal and culture fisheries through transfer of technology, dissemination of information, and education, training and extension. These objectives are being achieved through the following functions:

— Estimation and monitoring of the exploited fishery resources;

— Assessment of untapped conventional and unconventional resources of the Exclusive Economic Zone by exploratory, acoustic and aerial surveys;

— Preparation of synoptic fishery maps;

— Studies on the population and biological characteristics of the commercial fishery resources;

— Monitoring of fishery environmental factors and developing a fishery environmental service;

— Marine pollution in relation to protection of living resources;

— Fisheries forecast;

— Survey of seed resources and location of suitable areas for coastal aquaculture;

— Development of low-cost technology for intensive culture of suitable organisms in different ecological systems;

— Crop-livestock-fish culture integration;

— Improvement of rural economy through blending of capture and culture fisheries;

— Studies on the economics of operation of the capture and culture fisheries;

— Strengthening of the Fishery Data Centre for collection and rapid dissemination of Integrated Fishery Data;

— Undertaking Operational Research Projects, pilot projects and National Demonstration Programmes for the propagation and establishment of mariculture enterprises;

— Transfer of technology through regular education and training programmes; and

— Fishery extension and consultancy service.

The Research programmes of the Institute are presently implemented by the following five divisions.

1. *Fishery Resources Assessment Division*

Responsible for carrying out the estimation of total species-wise, gear-wise and State-wise marine fish production and the fishing effort; assessing the fish stocks; conducting quinquennial inventory surveys and running the Fishery Data Centre.

2. *Fishery Biology Division*

Undertakes investigations on the resource characteristics of fisheries; especially of the major fisheries such as that of oil-sardine, mackerel and Bombay-duck; unit stocks; population parameters for stock assessment; recruitment; forecasting of fisheries; mark-recovery studies for growth, migration and other population characteristics and preparation of fishery atlases.

3. *Crustacean Fisheries Division*

Carries out researches on prawn, crab and lobster resources; their characteristics, and on the culture of these organisms in the coastal waters.

4. *Molluscan Fisheries Division*

Monitors molluscan resources of the country; conducts surveys for the assessment of resources of oysters, mussels, clams and cephalopods along both the coasts and carries out researches on the culture of edible oysters, pearl oyster and pearl, mussels, clams and cockles.

5. *Fishery Environment Management Division*

Conducts investigations on fisheries oceanography, primary and secondary production, fish eggs and larvae, seaweeds, ecological energetics, mass culture of plankton, marine pollution and ancillary marine resources.

The Institute also undertakes several Inter-Divisional and Inter-Institutional Projects, and an Operational Research Project and National Demonstration Programmes. *Ad-hoc* training courses on prawn and fish culture, pearl culture, fishery statistics and fishery biology are also offered.

Realising the need to transfer the Technology developed by the Institute to the field, and to meet the trained man-power requirements, a Krishi Vigyan Kendra (Farm Science Centre) has been established under the Institute in 1976. The Centre at present

trains the local fish farmers by providing need-based training courses in different fields of mariculture. This centre will be upgraded to Trainers' Training Centre.

The Institute has been recognised by the Inter-University Board of India as a Centre to carry out research leading to M. Sc., Ph. D. and D. Sc. degrees. The Universities of Bombay, Dharwar, Karnataka, Calicut, Cochin, Kerala, Madurai, Andhra, Utkal, Rajasthan, Pilani, Banaras, Aligarh and Punjab have also recognised the Institute for research in marine science leading to the Doctoral degrees.

During the VIth plan period, (1978-'79 to 1982-'83) the R&D activities of the Institute would be considerably strengthened and expanded. Greater emphasis would be given for the research, education and extension programmes on mariculture. Taking stock of the results achieved so far and identifying the priority areas, the research programmes of the Institute will be organised under the following divisions in the ensuing years.

1. Fisheries Resources Assessment Division
2. Pelagic Fisheries Division
3. Demersal Fisheries Division
4. Crustacean Fisheries Division
5. Molluscan Fisheries Division
6. Fishery Environment Management Division
7. Physiology, Nutrition and Pathology Division
8. Extension and Fishery Economics Division
9. Library and Documentation Division.

Staff : The Institute has a sanctioned staff strength of 945. Of those, 177 members are Scientists, 369 are Technical personnel,

136 are Administrative and Accounts Staff and the remaining are Supporting Staff. All the Scientific staff possess a minimum qualification of M. Sc. degree or its equivalent.

Infra-structure Facilities available at the Institute

Library: The present holdings of the library of the Institute include over 50,000 volumes of books and periodicals. Due to lack of space, the main library is housed at the Regional Centre of the Institute at Mandapam Camp. Besides, at each of the Research Centres and at Headquarters there is a sectional library to meet the immediate requirements. Arrangements are available for quick retrieval of books/journals from the main library. The library has documentation and reprography facilities.

Laboratory: The Institute has adequate laboratory facilities for undertaking researches on the biology, ecology and physiology of marine organisms; fishery oceanography studies; for analysis of water quality, pollution and soils; and for studies on primary and secondary productivity. A running water marine aquarium is available at the Regional Centre at Mandapam Camp.

Facilities for field data collection: There are 22 vehicles, one staff car and 4 minibus for transportation of Scientists to the field. By January 1980 Seven smaller Research vessels (13 m and 15 m) will be available for the collection of biological and oceanographical data and for carrying out experimental fishing. Besides several wooden and fibreglass dinghies are used in the shallow water areas. One 33.3m Research Vessel being constructed indigenously, will also join this fleet by February 1980. During the VIth plan period, it is proposed to add 9 more smaller research vessels, 8 vehicles, one Minibus and one Mobile Laboratory for field data collection.

Field Experimental stations: The Institute has established field experimental laboratories for prawn and fish culture investigations at Narakkal; for prawn, lobster and mussel culture at Kovalam near Madras; for edible oyster, pearl oyster, pearl production and crab culture at Tuticorin; for finfish and seaweed culture at Mandapam; and for open-sea farming of mussels at Calicut and Vizhinjam. The Stations at Narakkal, Mandapam Camp and Tuticorin have attached farms for experimental studies. Experimental

hatcheries are also being established at these Stations. It is proposed to establish fairly large farms at Karwar, Cochin, Mandapam Camp, Tuticorin, Madras and Waltair for intensive studies on various aspects of coastal aquaculture and mariculture.

Publications

The Institute is publishing the "Indian Journal of Fisheries" since 1954; Bulletins on special scientific topics; "Special publications," a monthly "Marine Fisheries Information Service and a Newsletter. Over 1500 Scientific papers have so far been published by the staff of the Institute in various journals in India and abroad.

The headquarters of the Marine Biological Association of India is also located in the Institute.

ACHIEVEMENTS

Capture Fisheries

The Central Marine Fisheries Research Institute during the past three decades, had undertaken pioneering researches in the fields of marine fisheries of the country. At the time the Institute started functioning, an overall picture of the state of the marine fisheries wealth was wanting. As against such a background, the Institute formulated an inventory survey of the marine fisheries and research programmes to study the biology and fishery of the commercially important fishes supporting the traditional fisheries. In the succeeding years more and more detailed works in certain identified areas were taken up along with continuing research schemes that monitored the background data. A sampling design to estimate the seasonal and annual marine fish production on an all India basis was evolved by the Institute, which provided the much-needed basic data for the fisheries developmental programmes in the country. The location of productive fishing grounds in the inshore waters helped the introduction of mechanised fishing vessels which not only gave an impetus for increasing the fish production but also for exploiting the valuable prawn resources.

The programmes of the Institute in the sixties were strengthened considerably. A multistage stratified random sampling system was introduced for estimating marine fish production. The population characteristics of the major fisheries, such as oil-sardine, mackerel, Bombay-duck and prawns, were studied. Equally significant were the investigations in the planktonology and fisheries oceanography along and off the east and west coasts of India. The Institute also participated in the exploratory research cruises in the Indian Ocean area.

In the more recent years the Institute has strived to get a comprehensive picture of the inshore fishery resources and causes for their fluctuations. New resources of fishes, prawns and lobsters in the continental shelf edge and slope have been located. The productivity studies and exploratory data have helped in the estimation of the Nation's potential marine fishery resources. The data thus collected and disseminated by the Institute have enabled to achieve a marine fish production of over one million tonnes and foreign exchange earnings of about Rs. 2,000 million. They also formed the basis for formulating developmental programmes involving the strengthening of the fleet of small mechanised boats, introduction of larger fishing vessels, planning and establishment of infrastructure facilities such as fishing harbours and ancillary industries.

A Fishery Data Centre which has been strengthened for computor analysis, at the Institute processes all relevant information on marine fisheries and supplies such information to the public and private sector agencies concerned with the development of fisheries. Under the consultancy service, the entrepreneurs are provided with information, necessary guidance and adv ice for establishing commercial projects in marine fisheries.

Culture Fisheries

The interest in the development of mariculture and coastal aquaculture is of recent origin. However, it soon assumed greater importance, particularly in the context of the urgent need for

accelerating fish production to meet the over-increasing protein food requirements, and in the context of dwindling catch returns in the marine capture fishery.

Realising this the Central Marine Fisheries Research Institute, initiated a series of research projects on the culture of marine finfishes, prawns, mussels, oysters, pearl oyster, pearls and seaweeds. The highlights of the research results recorded so far are given below:

Culture of finfishes: Valuable data have been collected on quantitative abundance of seed of cultivable species of finfishes in different seasons along the east and southwest coasts on India. Culture experiments on milkfish in saline lagoons and in saline ponds have indicated a production rate of about 860 kg per ha/yr. *Chanos chanos* cultivated along with the penaeid prawns in the experimental fields at Narakkal, showed a faster rate of growth and attained a size of 450 mm from the stocking size of 45–53 mm during a period of about 4½ to 5 months. The Institute has developed methods of culturing the eel, *Anguilla bicolor* in running water. Another species of fish *Sillago sihama* is also being successfully cultured at the research centre at Mangalore. The species grows to about 200 mm in 7 months.

The current research projects are directed on induced spawning of *Mugil cephalus, Chanos chanos, Etroplus suratensis,* eel and on their intensive culture.

Marine Prawn Culture: Commercial penaeid prawns such as *Penaeus indicus, P. monodon, P. semisulcatus, Metapenaeus monoceros, M. affinis, M. dobsoni* and *Parapenaeopsis stylifera* have been spawned in the laboratory and their larvae reared through different stages upto the stocking size under controlled conditions based on indigenous techniques. One of the marine species, *M. dobsoni* has been successfully domesticated as the stocked juveniles grown in the brackishwater medium liberated viable eggs which have been further reared through different larval stages to stocking size in the same medium. Induced maturation and spawning by eye-stalk ablation technique have been achieved in *P. monodon* and *P. indicus.*

Field experiments carried out on intensive culture of selected species of prawns (*P. indicus*/*P. monodon*, 25–30 mm size) have indicated that the prawns grow very fast in the culture fields and reach marketable size in 3 to 4 months after stocking; a production of 1000–1500 kg/ha/year could be harvested; encouraging production could be obtained by culture of prawns in the derelict brackishwater canals in the coconut groves and in salt pans with simple management procedures and better yields can be raised by culturing prawns along with other campatible fishes such as *Chanos chanos*, mullets and *Etroplus*.

Along with the culture experiments on prawns, techniques of mass culture of several species of diatoms, rotifers, *Artemia salina* and zooplankters which form the food of the larvae and postlarvae have also been developed.

The on-going projects include researches on hatchery production of seed and connected problems, induced breeding of prawns, mass culture of live food organisms, nutritional requirements, and on large scale culture of monospecies and polyculture of prawns and fishes.

Mussel culture

Experiments on mussel culture were initiated in 1971 at Vizhinjam near Trivandrum and culture of brown mussels was taken up by following the suspended or raft culture method using ropes. The seeds of mussel were collected from the natural beds and transplanted to the ropes. The results of the experiments have shown that the seed mussels in the open-sea raft culture grow at a rate of 5 mm per month and an yield of 12 kg per metre of rope could be realised. In 1975, culture of green mussel in the open sea at Kozhikode employing the raft culture techniques was taken up. In the experiments conducted at this centre, the seed mussel of average length of 26.7 mm and live weight of 1.48 g transplanted in December grew to a size of 80 mm weighing 28.7 g in April. The production rate amounted to 235 tonnes/ha/5 months It is also observed that the growth of mussels in the farm is very rapid (12 mm per month) as compared to those in the natural beds (8 mm per month). The results of these experiments

indicate great prospects for seasonal culture of mussels in the inshore waters of our coast. Culture of green mussel on rafts in the open sea at Kovalam near Madras is progressing. Further intensive investigations on the culture operation are in progress.

Culture of edible oysters

Investigations on the culture of edible oyster, *Crassostrea madrasensis* have been taken up at Tuticorin. Different methods of capture of spat on lime coated tiles, oyster shells strung on glavanised iron wire, empty coconut shells and rubberised coir mats are evolved. The best time of the year for spat collection, locality, fluctuation in relation to temperature, salinity, and tide are studied. Investigations are also being carried out to develop hatchery technology, and on induced breeding of oysters under controlled conditions. Investigations have shown that the growth of cultured oysters is relatively faster than those in the natural beds. A production rate of 150 tonnes/ha has been obtained in the oyster farm.

Pearl culture

The techniques of production of cultured pearls and farming of pearl oysters were developed indigenously at CMFRI. The experiments were carried out in the field laboratory and open sea oyster farm at Veppalodai near Tuticorin. Raft culture was introduced to rear the pearl oysters. The surgery is performed in the shore laboratory after conditioning oysters. The average production rate of pearls is about 60–70%. Multiple production of pearls in individual oysters has been achieved. Since the rate of deposition of nacre is high in the tropical seas, the duration of post-operative culture operation is reduced requiring 3 to 18 months for the range of 3 mm–8 mm pearls for maturity. Baesd on the techno-economic feasibility studies carried out by the Institute, a Pilot Project on pearal culture has been established at Vizhinjam. Large scale commercial projects would be coming up soon.

Culture of seaweeds

The cultivable seaweeds are agar yielding plants like *Gracilaria* spp. and *Gelidiella* spp. and algin yielding

plants such as *Sargassum* and *Turbinaria*. Seaweed culture has been done by introducing fragments of the seaweeds in the twist of the coir ropes, which are fabricated in the form of frames tied to wooden poles fixed in the coastal waters. The experimental operation on *G. edulis* has revealed that the ideal time for planting is June–July and that 3 harvests could be obtained in a year. In the case of *Sargassum* a duration of about 9-10 months was required for it to settle on artificial substrata after which rapid growth was observed. A growth of 37 to 52 cm from an initial height of 10 cm in *S. cinctum* was reported within 40 days. With *G. edulis*, 4-5 kg of production per sq.m from an initial weight of 1 kg seed material was obtained within a span of 80 days. In *S. wightii*, an average growth of 15.5 cm from an initial average height of 7.67 cm within 60 days has been recorded. An alternate method for the culture of seaweeds by rearing the spores in suitable substrata has also been attempted.

Operational Research Projects

During the last few years, the Central Marine Fisheries Research Institute has been carrying out intensive research work on coastal aquaculture of fishes, prawns, pearl oysters and pearl production, edible oysters, mussels and seaweeds. Projects for testing techno-economic feasibility of large-scale culture are also being taken up. In the endeavour of the Institute in introducing these new opportunities to the fish farmers and the coastal rural population,a new concept of integrating the culture and capture fisheries has been developed and an Operational Research Project blending culture and capture fisheries, has been initiated recently at a fishing village near Madras. This project envisages to establish the possibilities of supplementing traditional fishing with sea farming in order to increase production; to demonstrate the feasibility of culture of different organisms and the scope for improvement of socio-economic conditions of the rural areas. In the Plan period, it is proposed to take up additional Operational Research Projects, in selected fishing villeges on both the coasts of India on similar lines.

Training programmes for Transfer of Technology

Besides the research efforts on various aspects of culture of marine organisms, the Institute is also imparting training on different aspects of mariculture at various levels. Under the Krishi Vigyan Kendra (Farm Science Centre) established at Narakkal, regular courses on mariculture of prawns, fishes, mussels, etc. are being carried out for the benefits of the farmers. Over 500 farmers including farm women have so far been trained on marine prawn/fish culture.

For research workers, scholars and teachers, training courses are conducted under the programmes of Summer Institute sponsored by the ICAR and under special training programmes organised by the Institute. Besides Symposia, Seminars, Workshops and Discussion Meetings are held periodically to discuss and exchange views on various aspects of mariculture.

Scope for the future

Distributed along the coast, there are a large number of gulfs and bays, innumerable creeks, lagoons, estuaries, backwaters and mangrove swamps. The extent of estuarine and brackish water areas in the country is estimated to be about 2 million ha. Most of these areas, though suitable for culture, are lying almost fallow and unutilised at present. India is endowed with a variety of finfishes such as mullets, milkfish, pearl spot, perches, and groupers; crustaceans like prawns, lobsters and crabs; molluscs such as mussels, oysters, pearl oysters, and clams and seaweeds ideally suitable for culture. These assets and the recent R & D efforts made by the Institute have definitely shown the immense prospects of mariculture/coastal aquaculture and the vital role it could play in the national and rural economy. However, the essential pre-requisites for a rational development of the field which is multi-disciplinary in nature are a strong research base, trained personnel and an integrated approach combining research, education/training, development and extension. These requirements can be met only through special programmes exclusively devoted for the purpose.

CENTRE OF ADVANCED STUDIES FOR POST-GRADUATE AGRICULTURAL EDUCATION AND RESEARCH

While appreciable progress has been made in agricultural education, research and extension services in the country over the years, the need for enhancing the quality and standards, particularly by strengthening post-graduate teaching and research, was recognised in 1966 and accordingly, the Government requested the UNDP to provide assistance for the purpose of:

(1) strengthening and developing selected post-graduate departments at certain universities and research institutes for advanced training and research in agriculture in areas closely related to planned production programmes;

(ii) encouraging the pursuit of excellence and collaboration amongst scientists of outstanding ability engaged in programmes of agricultural education and research, and thus to accelerate attainment of the highest international standards in specific fields; and

(iii) improving the competence of teaching and research faculties and keeping them up-to-date with modern scientific developments, thereby raising the standards of education and research.

Following this,the UNDP established six Centres of Advanced Studies in the following subjects in collaboration with ICAR under the project IND/73/020:

(i) Plant Protection at the University of Agricultural Sciences, Bangalore,

(ii) Dairy Sciences at the National Dairy Research Institute, Karnal,

(iii) Poultry Production at the Indian Veterinary Research Institute, Izatnagar,

(iv) Soil and Water Management at the Haryana Agricultural University, Hissar,

(v) Agricultural Engineering at the Punjab Agricultural University, Ludhiana, and

(vi) Agricultural Economics at the Indian Agricultural Research Institute, New Delhi.

Reviewing the seven years of operation of the above Centres of Advanced Studies,the UNESCO/FAO Advisory Mission of 1978, recommended phasing out of UNDP assistance to the first three of the above Centres, by June 1979; extension of the remaining three Centres at the Indian Agricultural Research Institute, Haryana Agricultural University, and the Punjab Agricultural University for another three years from June 1979; and establishment of the following six new Centres under the Phase III of the Project:

(i) Agricultural Microbiology at the Tamil Nadu Agricultural University, Coimbatore,

(ii) Tropical Horticulture at the Indian Institute of Horticultural Research, Bangalore, in collaboration with University of Agricultural Sciences, Bangalore,

(iii) Temperate Horticulture at the Himachal Pradesh Agricultural University, Solan,

(iv) Mariculture at the Central Marine Fisheries Research Institute, Cochin,

(v) Plant Physiology at the Indian Agricultural Research Institute, New Delhi, and

(vi) Dairy Processing at the National Dairy Research Institute, Karnal.

Each of the above Centres is for a total duration of 7 years with UNDP assistance of roughly $ 700,000 and ICAR contribution of Rs. 3.5 million.

CENTRE OF ADVANCED STUDIES IN MARICULTURE

In pursuance of the UNESCO/FAO Advisory Mission recommendations and approval by the Project Committee as well as of the Project Document, the "Centre of Advanced Studies on Mariculture" was established at the Central Marine Fisheries Research Institute with effect from 1st June 1979.

Development objectives

The main development objective of this Centre is to support the nation's food production efforts by establishing the Centre of Advanced Studies for post-graduate teaching and research in mariculture. This will help in enhancing the competence of professional staff and augmenting facilities for high quality research, both applied and mission-oriented, and to tackle problems coming in the way of increased fish production in the country. The development of such Centre of Advanced Studies within the country would also reduce dependence on foreign countries for post-graduate education.

Immediate objectives

The Centre has the following immediate objectives:

(i) To improve the quality of post-graduate education through advanced training of teachers, provision of scientific equipment, latest literature and other modern physical facilities and thus to produce highly specialised and competent professionals required to plan, execute and co-ordinate relevant programmes of mariculture education, research and development in the country.

(ii) To develop and execute research programmes of strategic importance in the selected disciplines and to encourage the utilisation of the worthwhile results by the Extension Wings of the Universities/Institutions through the integrated teaching, research and extension programmes. The main thrust of the research programmes would be to do mission-oriented research to resolve the constraints on realising production potentials.

(iii) To establish linkages between the Indian institutions and overseas institutions of outstanding accomplishments in the subject-matter area with a view to arrange the exchange

of visiting specialists between the foreign institutions and Indian Centres, and exchange of scientific and technical knowhow.

(iv) To provide advanced training in India and abroad for Indian personnel having high level of competence and proficiency primarily at the collaborating foreign institutions so as to bring them up-to-date with the latest developments in the field of their specialisations and to train them in latest scientific techniques.

(v) To develop close collaboration between the Centres and other sister Institutions/Universities in the country engaged in mariculture and to foster an interdisciplinary approach in mariculture research and teaching.

(vi) To organise short-term specialised courses, workshops and seminars on an all-India basis to enhance professional competence of teachers, researchers, and other specialists of sister institutions and Universities in the country in this field, and to disseminate research findings and teaching innovations at the national level.

Project operation

The Centre of Advanced Studies in Mariculture, as in the case of other similar Centres, would be operated at three levels, namely at the UNDP, ICAR and Institute levels.

Project operation at the UNDP level

The UNDP through its Executing Agency (UNESCO/FAO) arranges and issues contract for consultancy services from collaborating overseas institutions, advanced training of Indian scientists in sister-institutions abroad, and procurement of equipments not indigenously available. For this purpose, the following methodology has been evolved.

(a) Identifying those overseas institutions where eminent expertise exists, where relevant research is in progress, and in

which certain scientists can be identified who have a significant contribution to make to research problems in India, who are willing to spend 3–4 months as consultants to the Centre. This identification process is effected by means of study tours undertaken by senior professors who visit the overseas institutions and discuss mutual problems with the staff;

(b) Designating, for each such identified overseas scientist, a local scientist who will act as contact point with the scientist, following up on the preliminary contact through correspondence in order that the scientist, when he visits the centre in a consultative capacity, will be fully briefed as to the nature of the institution, the research in progress, and the contribution expected of him;

(c) Visits of such scientists to the Centre, in a consultative capacity, to work in collaboration with their counterparts, conduct seminars at both local and national level, participate in post-graduate teaching, advise on teaching curricula, research programmes and policies, and also on research laboratory facilities and particular needs;

(d) Visits by counterparts to work in the overseas institution, preferably under or in collaboration with the consultant, the period of this fellowship depending on the subject matter and seniority of the counterpart;

(e) Building up of adequate research facilities and equipment at the Centre, on the advice of the consultant and the counterpart, and in relation to the demands of the subject matter;

(f) Dissemination of research findings and experience at a national level through the conduct of national seminars and conferences; and

(g) Return visits of consultants after an interval of 2–3 years, with further fellowships at the consultant's institution in order to consolidate the linkage.

Project operation at the ICAR level

The United Nations Development Programme makes available the foreign exchange component of the project. It does not manage these inputs directly, but transfers this responsibility to some of the Specialised Agencies of the UN, like Food and Agricultural Organisation of the United Nations (FAO), and United Nations Educational, Scientific and Cultural Organisation (UNESCO), which are designated as the Executing Agencies of this project. Normally, a Project Manager is assigned to the project to act on behalf of the Executing Agency concerned, but in respect of this project, responsibility for execution has been entrusted to the Indian Council of Agricultural Research, and Dr. O. P. Gautam (ICAR) has been recognised as the National Director who is assisted by the Project Unit comprising Dr. O. P. Bhatnagar, Scientist (CAS), ICAR, and Mr. V. Kumar, Administrative Officer. A project Working Committee constituted by representatives from concerned International Agencies, ICAR, Department of Economic Affairs, Planning Commission, and participating Institution, meets once a year to review the project and recommend any measures for its improvement. A UNESCO/FAO Technical Advisory Mission also visits the project periodically for assessment and advice on future planning.

Project operation at the Institute level

To co-ordinate the activities of the Centre, a Sub-Project Co-ordinator is nominated who is usally of the rank of a Dean/Director or Head of Department, with suitable experience and qualifications, and is considered to be the key person for successful operation of the sub-project. He functions under the authority of the Head of the Institution, but deals directly with the ICAR Project Unit, Heads of Departments and other staff forming part of the Centre, and maintains necessary contacts with collaborating sister institutions within and outside the country. The Centre constitutes an Advisory Committee with one or two specialits from outside for guidance in orienting the programme of the Centre. Dr. E. G. Silas, Director, Central Marine Fisheries Research Institute is the Sub-Project Co-ordinatior of the Centre of Advanced Studies in Mariculture.

Project inputs

The ICAR finances under this project are provided for filling up certain gaps, such as additional support in the form of staff, grant of fellowships to post-graduate, doctoral and post-doctoral students, provision for holding all-India workshops, seminars and short courses, and development grants for purchase of equipment, chemicals and other supplies. Specific approval of the ICAR for transfer of funds will be issued and procedure laid down for utilisation of these funds will be followed by the Centre. For award of fellowships, an Expert Committee with a representative from ICAR would meet when necessary and make recommendations.

UNDP finances are provided for arranging consultancy services from collaborating overseas institutions, advanced training of Indian scientists in sister-institutions abroad, procurement of equipment not indigenously available.

Project activities

The activities of the Centre would be based on a work-plan prepared for the purpose and approved by the Project Working Committee. The important activities of the project include:

(i) regular post-graduate education on mariculture leading to M. Sc. and Ph. D. degrees.

(ii) Advanced research (Post-doctoral Fellowship) on selected topics, and

(iii) Organisation and conduct of Seminars/Workshops/Symposia on subjects of topical interest in mariculture.

The M. Sc. course would be of two years duration under four semesters, following a recognised graduate course in natural science, and would include the subjects such as basic science, research methodology, marine biology, oceanography, physiology of marine animals, fisheries, fish and fishery biology, finfish culture, culture of crustacea, culture of mollusca, culture

of seaweeds, integrated farming, fish farm engineering technology, management of mariculture farms and dissertation on selected topics.

The Ph. D. Course will be carried out through course work and thesis under the guidance and supervision of recognised teachers attached to the Centre. The subject of research may be basic as well as applied aspects on mariculture. However, the problems which attract the immediate needs of current developmental progress would be given priority. It is envisaged that the Ph. D. course would be completed in three years.

The degrees (M. Sc. and Ph. D.) would be awarded by the University of Cochin.

The Centre would provide adequate opportunities and facilities to undertake research of high standard. For this purpose, the research programmes on marine prawn culture, finfish culture, mussel culture, oyster culture, seaweed culture, culture of live food organisms and fish nutrition have been identified. Besides, certain areas such as farm engineering and engineering technologies for developing sea farming, marine finfish and shellfish genetics, hatchery production of seed of cultivable species, finfish and shellfish diseases, reproductive biology and endocrinology where there is insufficient expertise in the country would be developed. For this and other critical areas, consultant services for 45 man-months have been provided.

For overseas training programme of Indian scientists the following areas have been identified:

		man-months
(i)	Nutrition physiology	12
(ii)	Reproductive physiology	12
(iii)	Endocrinology	6
(iv)	Marine genetics	6
(v)	Disease control	6
(vi)	Marine prawn culture	6
(vii)	Lobster culture	6
(viii)	Crab culture	6
(ix)	Mussel culture	6

(x)	Edible oyster culture	6
(xi)	Pearl oyster culture	6
(xii)	Seaweed culture	6
(xiii)	Ecology of weeds and their control	6
(xiv)	Milkfish culture	6
(xv)	Mullet culture	6
(xvi)	Eel culture	6
(xvii)	Open sea farm engineering	6
(xviii)	Mariculture system analysis	6
(xix)	Mariculture management	6
(xx)	Extension education/training	6
(xxi)	Resources economics	6
(xxii)	Fisheries Statistics	6
(xxiii)	Marine pollution	6
	Total man-months	150

Project outputs

The output of the project would be:

(i) Approximately 50 Ph. D., 80 Master's Degree holders and 80 B. Sc. Degree holders will be trained at the Centre, under regular academic programmes, which would include course work and research for thesis. It will utilise the specialised training in improvement of teaching and research standards of other sister institutions in the country, and create a multiplier effect.

(ii) A cadre of highly competent professional scientists will be created through advanced level training in India and abroad in association with the visiting consultants. These scientists would in turn be expected to train fisheries graduates who are posted in the field to man the various production programmes.

(iii) The technical reports of the consultants from overseas collaborating institutions, and the fellows getting specialised training abroad, will reflect their findings and recommendations for distinct improvement in teaching and

research programmes at the Centre relevant to the practical problems faced in the development of subject matter areas concerned.

(iv) The research results emanating from the Centre will be disseminated on an all-India basis through national seminars, workshops, and short courses, to be organised periodically at the Centre, and through regular publication of results in widely distributed scientific journals.

(v) The Centre will utilise extension service attached to the Institute/University for transfer of research results and new technology to actual users (farmers, fishermen) These extension wings will also serve as feedback mechanism to identify and bring back field problems to laboratories.

(vi) In the long range, the Centre would build up excellent physical facilities and a group of scientists and teachers in mariculture, so that the country would become self-sufficient in this respect. As a result of advanced level research, training and extension education, each Institution would promote greater utilisation of cultivable area, which in turn would help to augment production, provide greater income to producers, accelerate rural development and its economy, and to provide large-scale employment.

Monitoring, evaluation and reports

The project would be subject to evaluation in accordance with the policies and procedures established for this purpose by the UNDP. Periodic Project Committee meetings would be held, and reviews would be undertaken from time to time with mutual arrangements between the ICAR, UNDP and the Agency concerned. Progress reports on the project would be prepared by the Project Director at an interval of six months. Terminal report would be prepared at the end of the project.