

About CMFRI

The Central Marine Fisheries Research Institute is one of the eight Research Organisations in the network of Central Fisheries Research Institutes under the Indian Council of Agricultural Research devoted to Research, Education, Training and Transfer of Technologies in support of development of Fisheries in India. CMFRI's mandate is to conduct researches on exploited, under- and unexploited marine fisheries resources and fisheries oceanography, to advise on rational exploitation and make forecast of abundance, development and upgradation of technologies for maximising production through mariculture and conducting teaching, training and extension programmes for development of human resources in fisheries.

The Institute with its Headquarters at Cochin and Research and Field centres all along the Indian coastline, conducts mission-oriented researches in important areas of marine capture and culture fisheries on all-India basis as well as regional basis in addition to making district-wise, species-wise and gear-wise production estimates. Besides, the CMFRI also conducts researches on short-term but frontier areas of marine fisheries through ad hoc projects funded by different agencies.

CMFRI

Research Highlights

1996-'97



CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
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प्रस्तावना

भारतीय समुद्री मात्स्यिकी बढ़ती हुई मानव जनसंख्या को प्रोटीन युक्त समुद्री खाद्य एवं रोज़गार प्रदान करने और विदेशी मुद्रा कमाने में महत्वपूर्ण दायित्व निभाता है. संग्रहण और संग्रहणोत्तर क्षेत्रों, घरेलू और निर्यात क्षेत्रों में स्वतंत्रता प्राप्ति से लेकर पंचवर्षीय योजनाओं द्वारा प्राप्त उल्लेखनीय प्रगति के फलस्वरूप इस सेक्टर को बड़ा औद्योगिक परिवेश प्राप्त हुआ है। मछली उत्पादों जिनमें समुद्री मात्स्यिकी उत्पाद प्रमुख है का निर्यात देश के कुल कृषि निर्यात का 29% आकलित किया जाता है. वर्ष 1996 के दौरान प्रग्रहण क्षेत्र से हुआ समुद्री मछली उत्पादन 2.41 मिलियन टन तक पहुँच गया है. यह उत्पादन उपतटीय समुद्र से आकलित 2.2 मि टन शक्य प्राप्ति से अधिक है और यह उपतटीय मत्स्यन धरातल की बाहरी सीमा 50 मी समगभीरता रेखा के परे मत्स्यन बढ़ाने की साध्यताओं को व्यक्त कर देता है. अपतटीय मत्स्यन क्षेत्रों की 1.7 मि टन आकलित शक्यता के विदोहन के लिए अतिरिक्त प्रयासों द्वारा उत्पादन बढ़ाये जाने की आशा करते वक्त अपतटीय मत्स्यन के लिए उचित वेडों के प्रयोग की तुरंत आवश्यकता भी उभर आता है. सी एम एफ आर आइ अपने अनुसंधान और विकास उपलब्धियों द्वारा इस लक्ष्य की प्राप्ति केलिए महत्वपूर्ण भाग निभाता है। वर्ष 1996-97 के दौरान भी विभिन्न नियमित और प्रायोजित परियोजनाओं द्वारा ये प्रयास जारी रखे जाते हैं. विदोहन किए गए मछली स्टॉक, पारिस्थितिक विशेषताओं और मछुआ लोगों की समाज - आर्थिकता पर आंकड़ों को क्रमिक रूप से संग्रहण और विश्लेषण करके विभिन्न निर्णयात्मक कार्यों के लिए उपयुक्त किया जाता है.

तटीय समुद्री संवर्धन और समुद्र कृषि द्वारा समुद्री मछली उत्पादन बढ़ाने की आवश्यकता मानते हुए संस्थान समुद्री संवर्धन तकनोलजियों के विकास, उन्नयन और स्थानांतरण केलिए अपनी अचसंरचनाओं को प्रबल बनाता रहता है. इसको ध्यान में रखते हुये बहुउद्देश्य स्फुटनशालाएं, पालन-पोषण की व्यवस्थाएं, समुद्री जलजीवशाला और ऊतक संवर्धन प्रयोगशालाओं की स्थापना की गई है.

वर्ष के दौरान संस्थान में 74 नियमित और 9 प्रायोजित परियोजनाओं का कार्यान्वयन किया है और किए गए कार्यों का मुख्य अंश इस प्रकाशन में प्रस्तुत किया जाता है.

कोचीन-14
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एम. देवराज
निदेशक

FOREWORD

The Indian marine fisheries sector, with its vast infrastructure and manpower, has been playing a significant role in supplying protein-rich seafood to the growing human population, employment generation and foreign exchange earning. With the significant advancements made through the successive five year plan periods since independence in the harvest and postharvest areas and in the domestic and export trade in marine products, the sector has grown to the status of a large industry. Export earnings from fish products (of which marine fishery products constitute the major component) account for 29% of the total agri-exports from the country. Marine fish production from the capture sector reached 2.41 million tonnes (mt) during 1996. This production is in excess of the estimated potential yield of 2.2 mt from the inshore waters, indicating thereby the expansion of fishing beyond the outer limit (50 m isobath) of the inshore grounds. While there is scope for increasing production from the offshore grounds (> 50 m isobath) through the introduction of additional effort for exploiting the estimated potential of 1.7 mt, there is urgent need to deploy appropriate fleets for offshore fishing. The CMFRI has been playing very vital roles over the years towards this objective through its R&D initiatives. These efforts were continued during the year 1996-97 through the various regular and sponsored research projects. All the required data on the exploited fish stocks, environmental characteristics and socioeconomics of fisherfolk have been collected systematically, analysed and used for various decision-making processes.

Recognising the need for supplementing marine fish production through coastal mariculture and seafarming, the Institute is fast strength-

ening its infrastructure for the development, upgradation and transfer of mariculture technologies. Additional infrastructure facilities including multipurpose hatcheries, growout systems, marine aquaria and tissue culture laboratories are being created for this purpose.

During the year, the Institute implemented 74 regular and 9 sponsored projects and the highlights of the work done are presented in this publication.

*Cochin-14
August 1997*

M. DEVARAJ
Director

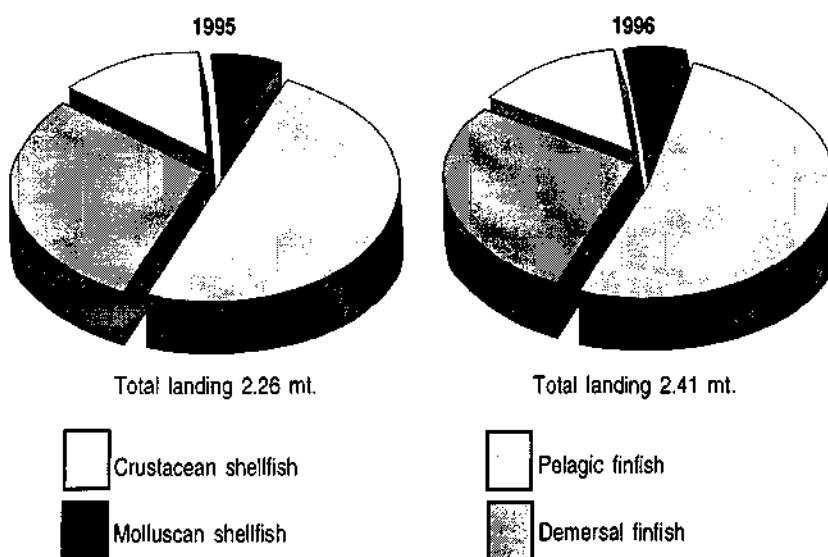
HIGHLIGHTS OF THE WORK DONE

Estimating Fish Production

Collection of marine fisheries statistics and making gear-wise, species-wise production estimates is one of the principal tasks of CMFRI. Besides being useful for various developmental and planning purposes, this information serves as an essential input for research in marine capture fisheries and enable formulation of strategies for sustaining production. The marine fish production in India during 1996 registered an increase of 6.9% over 1995 with the estimated production at 2.41 million tonnes (mt).

The mechanised and motorised units together contributed to 87.3% of the total production and the traditional units the rest. Pelagic finfish accounted for about 52% of the total marine fish production and the rest by demersal finfish and shellfish. Oil sardine fishery started

Composition of marine fish landings in India



showing a sign of revival during this year. The mackerel landings registered an increase of about 1 lakh t over those of the previous year. The production of penaeid prawns, nonpenaeid prawns and ribbonfish also registered increase in their landings. However, the landings of elasmobranchs, lesser sardines, whitebait, carangids and seerfishes registered a decline. The production of cephalopods also registered a decline of about 10,000 t over that of the previous year with the estimated landings during the year at 1.07 lakh t.

The northwest coast comprising Maharashtra and Gujarat contributed to the bulk of the production (34.9% of total in the country) followed by southwest coast (Kerala, Karnataka and Goa) (32.8%), southeast coast (Andhra Pradesh, Tamil Nadu and Pondicherry) (25.6%), northeast coast (West Bengal and Orissa) (5.3%) and Lakshadweep & Andamans (1.4%).

The mechanised sector (trawl, purseseine and gillnet) along the northwest coast accounted for 46% of the total production by this sector in the country and the motorised sector in the southwest coast 69%.

In the forecasting of marine fish production using ARIMA models the predicted value of 23.7 lakh t for 1996, deviated from the estimated value of 24.1 lakh t by about 2%.

Studying Fishery and Resource Characteristics

The marine fish production as is well-known, is stagnating around 2.3 mt during the past few years and is close to the level of potential yield of 2.2 mt in the currently exploited grounds. The situation warrants close monitoring of the exploitation and develop suitable strategies for sustaining the yields on an economic level using the advise emanating from the results of research. The research projects in the capture sector are implemented to meet this requirement.

Pelagic finfish: Data on the resource characteristics of sardines were collected from both the coasts. The length range at recruitment of oil sardine was 50-100 mm at Mangalore and Cochin in the purseseine. In the ringseine at Calicut and Cochin the dominant length range in the catch was 90-120 mm. In the gillnet landings of oil sardine at Visakhapatnam, the length range in the catch was 110-205 mm with 130-150 mm and 180-190 mm groups supporting the fishery. At Mangalore, gravid and partially spent oil sardine was dominant in the catches during August-November and young fish during November-March. At Calicut, juveniles were dominant during April-June. At Visakhapatnam, spent and spent recovered adults were abundant during January-March.

Stolephorus bataviensis was the dominant species at Cochin in the trawlnet whereas *S. devisi* was dominant in ringseine at Mangalore and Malpe. The length range of *S. devisi* was 50-100 mm in trawl and 65-95 mm in purseseine. In *S. bataviensis* the size range was 60-105 mm in the trawl and 80-105 mm in purseseine.

Data on seerfish exploitation were collected from 9 centres; fishing was done by drift gillnet and bottom trawl besides hooks and lines along the east coast. Drift gillnet contributed 66.4% of the total catch followed by bottom trawl (26%), hooks and lines (7.7%), artisanal gear (1.1%) and purseseine (0.3%) at these centres. *Scomberomorus commerson* and *S. guttatus* were the principal species in the fishery. Stock assessment studies suggest that seerfish resource is exploited around MSY level off Orissa and Karnataka, beyond that level off West Bengal and Kerala and below it in other regions.

The resource characteristics of tunas were investigated at 8 centres along the mainland coast and at Minicoy. *Euthynnus affinis* was the dominant species along the mainland centres and *Katsuwonus pelamis* was the dominant species in the pole and line fishery at

Minicoy. In *K. pelamis*, mature fishes were available only beyond 50 cm length and partially spawned adults were dominant. Stock assessment studies on *E. affinis* and *A. thazard* at Tuticorin from *Paruvalai* showed the exploitation rate (U) at 0.71 and 0.58 respectively. At Mangalore the exploitation ratios of *E. affinis*, *T. tonggol* and *A. thazard* were estimated as 0.05, 0.48 and 0.26 respectively suggesting that these species are underexploited. At Bombay, the exploitation ratio of *E. affinis* was estimated as 0.79 suggesting the level of exploitation to be closed to the optimum level.

The mackerel landings were monitored at 8 Centres. At all India level this species registered an increase of about 1 lakh t over the previous year. Purseseine and ringseine together were responsible for major landings of the species along the west coast. At Calicut, mature adults occurred during October-March and fishes in spawning condition during March-June. Along the east coast, drift gillnets, trawlnets and boatseines landed mackerel. At Tuticorin, the exploitation rate of mackerel was estimated as 0.82 from landings of drift gillnet and 0.73 from those of trawl.

Bombay duck landings were monitored at Bombay and Veraval. The length range of this species in the catch along Gujarat and Maharashtra was 30-314 mm; recruitment took place during February-June at a length of 30 mm. Along Gujarat coast two spawnings, one during pre-monsoon and another during winter were observed. In the ribbonfish, investigations were carried out at 8 Centres. At all these centres except Vizhinjam major landings took place from trawl. *Trichiurus lepturus* was the most dominant species. The lengths at recruitment in the trawl at different centres were 8 cm at Kakinada, 16 cm at Visakhapatnam, 20 cm at Veraval, 30 cm at Mangalore, 32 cm at Cochin and 40 cm at Bombay. At Cochin the spawning period was found to be November to June. The exploitation ratio in the landings at Bombay was estimated as 0.85 and 0.32 at Mangalore.

In the programme of fishery forecasting in the Malabar upwelling zone, significant correlation between oil sardine landings and total rainfall was observed.

Demersal Finfish: The exploitation of elasmobranch catches was monitored at 4 centres and at all these centres major catch came from trawlers. At Bombay, the size range of *Scoliodon laticaudus* was 160-640 mm and pregnant sharks were recorded during April and December-March.

The resource characteristics of major perches were studied at 5 centres. *Epinephelus diacanthus* with the length range of 10-52 cm was dominant at Bombay and 10-37 cm at Cochin from the trawlers. In hooks and lines the length range of the catch of the species was 23-50 cm at Cochin. At Vizhinjam maximum catch was obtained during May-July and *Lethrinus lentjan* was in the length range of 180-730 mm and *L. nebulosus* in 140-440 mm. At Tuticorin *L. nebulosus* was in the length range of 100-660 mm and *E. undulosus* in 330-580 mm.

The catfish resources were studied from 3 centres. *Tachysurus dussumieri* and *O. militaris* were the dominant species. The exploitation ratio was estimated as 0.74 in the case of *O. militaris*. At Cochin, bulk of the catch came from gillnets during July-November. It was estimated that 280 kg of eggs and embryos of *T. serratus* were landed on 2 days by purse seine in October. At Visakhapatnam *T. tenuispinis* formed 50% of the catch.

Threadfin bream resources were monitored from 9 centres. At almost all the centres *N. japonicus* and *N. mesoprion* together constituted the bulk of the catch. At Bombay, the MSY of these 2 species was estimated as 315 t and 1551 t. In the case of *N. japonicus* in Karnataka, the MSY was estimated as 3410 t which is close to the present annual average catch. At Tuticorin, *N. delagoae* was the principal species in the catch. At Madras the MSY of *N. japonicus* and *N. mesoprion* was estimated as 1075 t and 1410 t respectively; these values suggest scope for increasing production.

The silverbelly landings were also monitored from 9 centres. Of about 20 species known from India, *Leiognathus bindus* and *Secutor insidiator* were the principal species in the landings at Mangalore, Madras, Kakinada and Visakhapatnam. However, along the southeast coast of India particularly in the Palk Bay, *L. brevirostris*, *L. jonesi* and *L. dussumieri* were found to be the most dominant species. At Madras, the MSY of *L. bindus* was estimated as 1285 t against the average annual yield of 1045 t.

The sciaenid resources were monitored from 9 centres. The number of species contributed to the fishery was 18 at Kakinada, 16 at Veraval, 15 at Madras, 10 at Visakhapatnam, 7 at Calicut and 2 to 4 at Karwar, Cochin and Tuticorin. *Otolithus cuvieri* was dominant at Veraval, Bombay and Karwar in the trawl catches. The larger sciaenid species *P. diacanthus* and *O. biauritus* were exploited by trawl off Veraval. Mature adults of *J. sina* were recorded in October and February-March at Bombay.

In the lizardfish, 2 species were dominant at different centres and *Saurida tumbil* in 100-440 mm length range was caught by trawl at Bombay and 180-450 mm at Mangrol, 100-329 mm at Calicut and 240-440 mm at Cochin. Mature adults of this species were recorded during October-November at Bombay and January at Calicut. In *S. undosquamis* gravid adults occurred in trawl catches during October-November off Madras.

Among flatfishes which were predominantly exploited by trawlers, *Cynoglossus macrostomus* was the dominant species with the length range of 5-17 cm. At Mangalore, peak spawning occurred in this species during November-January.

In the whitefish the length range of the catch was 8-20 cm with major spawning occurring during November-March off Mangalore.

In the ornamental fish survey conducted, 68 species belonging to 17 families were collected at Vizhinjam of which butterfly fish, damsel

fish and surgeon fish were most abundant. In the Lakshadweep, a total of 89 species of 16 families were collected of which wrasses, parrot fish, damsel fish, surgeon fish, squirrel fish, goat fish and butterfly fish were most abundant. Of the total of 164 species collected so far, about 60 species are abundant in the lagoons round the year.

Crustacean shellfish: With a total landings of 1.88 lakh tonnes, penaeid prawns contibuted to 7.8% of the country's annual marine fish landings. Along the west coast, trawlers accounted for 77% of the penaeid prawn landings. At Cochin and Sakthikulangara the landings of *Parapenaeopsis styliifera* during monsoon period were estimated at 1210 t and 5603 t respectively registering a 28% increase at Cochin and 51% decline at Sakthikulangara over 1995. At different centres along the west coast the length range of *P. styliifera* was 60-125 mm, *Metapenaeus dobsoni* 56-120 mm and *M. monoceros* 96-150 mm. Along the Karnataka and Kerala, monsoon period was the peak period of landing of penaeid prawns by artisanal gear. *M. dobsoni* was the most dominant species forming 87% of the prawn landings in the artisanal sector in this region.

Minitrawls in Kerala landed *P. styliifera* and *M. dobsoni* at a catch rate of 27.2 kg/unit. This gear with a mesh of 10-12 mm operating in the nearshore waters removed large quantities (60% of the catch by this gear) of undersized prawns.

Along the east coast of India penaeid prawn landings were estimated at 50,383 t registering a decline of 1.3% over the prepvious year. Tamilnadu contributed maximum quantity. In the trawli fishery along the east coast *Parapenaeopsis* spp formed 42% of penaeid prawn landings at Paradeep, *M. dobsoni* 37% at Visakhapatnam, 40% at Kakinada and 21% at Madras and *P. semisulcatus* 44% at Mandapam, 36% at Pamban and 67% at Tuticorin. The catches of penaeid prawns in this region suggest that smaller species such as *Parapenaeopsis* spp and *M. dobsoni* became dominant in recent years

replacing larger species like *Penaeus* spp. and *M. monoceros* along the northeast coast and *M. stridulans* and *P. maxillipedo* gained importance in the landings from Palk Bay and Gulf of Mannar regions respectively. Similarly the extension of fishing to deeper waters by larger vessels, the nonconventional species: *Metapenaeopsis* spp. and *Trachypenaeus* spp. were caught in considerable quantities along the Chennai coast. At Kakinada the trawlers exploited large quantities of juveniles of *M. monoceros*: nearly 70% of catch of this species measured less than 100 mm.

At Tuticorin the landing of deep sea prawns showed a decline of 71% over 1995; *Heterocarpus* spp. and *Plesionika* sp. were the dominant components. Near Kakinada, a total of 269 t of juvenile prawns were landed by stake nets from the nursery grounds with *M. monoceros*, *M. dobsoni* and *P. indicus* contributing over 80% of the catch.

The nonpenaeid prawn landings in India were estimated at about 1.04 lakh tonnes with Gujarat accounting for 64.4% of the total and Maharashtra 27.1%. In both the regions the production increased over that of the previous year. Trawlers contributed to 77% of the landings in Gujarat and trawl net to 89% in Maharashtra. At Veraval, 98% of the nonpenaeid prawn catch composed of *Acetes* spp whereas at Mumbai *Nematopalaemon tenuipes* formed over 90%.

The lobsters registered an increase of 36.7% in the production over the previous year. Gujarat and Maharashtra together accounted for 86% of the lobster catch in India followed by Tamilnadu (9.5%) and Kerala (4.2%). There was a threefold increase in the catch in Maharashtra but there was a decline of 7% in Gujarat when compared to the landings of previous year and trawlers contributed to over 80% of the lobster production along the northwest coast, 62% in Kerala. In Tamilnadu however, the artisanal sector contributed 67% of the lobster

catch. *Thenus orientalis* reappeared in the catches at Mumbai after its continuous absence for 3 years.

The production of crabs registered a decline of 5.4% over the previous year with an estimated landing of 29,000 t in 1996. Tamilnadu, Gujarat, Kerala and Andhra Pradesh together contributed to about 95% of the crab landings. *Charybdis feriatus* was the dominant species at Mumbai, Mangalore, Calicut and Cochin, *C. lucifera* at Veraval, *Portunus pelagicus* at Karwar and Mandapam and *P. sanguinolentus* at Malpe, Chennai and Kakinada.

At Vizhinjam 35 fish reefs and 40 lobster reefs were installed at depths of 20-25 m and 10 m respectively. These reefs are expected to mature by September-October 1997. Concentration of fishes was observed near the reef sight.

Molluscan shellfish: Cephalopods were landed by trawl at almost all the centres along both the coasts and boatseines and hooks and lines at Vizhinjam. The CPUE was 242 kg by trawlers at Mumbai. *Loligo duvauceli* and *Sepia aculeata* were the dominant species. Peak spawning was observed during monsoon and post monsoon periods along west coast and during October-December along east coast. The stock assessment studies on *L. duvauceli* reveal that the trawling effort in Karnataka needs to be reduced to obtain MSY. An estimated 5390 t of green mussel was landed from Challiyam and Koduvally in Kerala and 2040 t of brown mussel from off southwest coast. The total catch of the black clam *Villorita cyprinoides* was estimated at about 37,000 t from the Vembanad lake. The total standing stock of clams was estimated at 61,000 t from Ashtamudi of which *Paphia malabarica* accounted for 12,000 t. In the Karwar Bay the total bivalve landing was estimated at 28 t. In the Kakinada bay, the bivalves formed 46% and gastropods 54% of the molluscan catch of 3467 t. An estimated 6465 t of clams were landed in December 1996 from the Mulki estuary.

Monitoring the Fishery Environment

Seatruth data collected during premonsoon, southwest monsoon and postmonsoon seasons confirmed the presence of upwelling in the area between Mangalore and Kasargod during southwest monsoon season.

Studies on zooplankton components of the EEZ of India led to estimating the average zooplankton biomass in the EEZ at 88.3 ml per 100 m³ of water and the Arabian sea was found to be two times more productive than the Bay of Bengal. The planktonic cephalopods were more abundant during night time. High density of Ichthyoplankton off the Andaman & Nicobar seas was found in the shelf waters with maximum abundance during November. The seasonal abundance of zooplankton along the northeast coast was found to be during January in the Chilka-Paradeep regions and during November and April off Visakhapatnam; fish eggs were predominant during February-May and larvae in July and January-February.

At Cochin, higher levels of Ammonia (79.31 µg/l) were recorded in the estuary which decreased to 39.6 µg/l in the inshore waters. Heavy-metal levels in fish, prawn and bivalves were found to be within the range recommended for seafood. At Ennore (Chennai) the phosphate levels were high (0.5 ppm) during January-March. Lead levels were also found to be higher (0.1 ppm) during August-October period.

Remote Sensing and Potential Fishing Zones (PFZs)

The validation of PFZ forecasts in the Minicoy region yielded positive results with higher yield of skipjack tuna in the pole and line fishery. Off Kerala coast relatively higher catches by purseseine fishing and gillnetting suggest reliability of PFZ forecast through satellite imageries.

Mariculture Technologies

In the seed production of *Portunus pelagicus*, 14 breeders produced 87 lakh zoeae of which 14.8 lakh were reared through 5 zoeal

stages, megalopa and first instar. The survival ranged from 0 to 16% and a total of 13,277 were produced of which 1148 were stocked for growout. Experiments were also conducted on the broodstock maintenance and induced maturation of *Scylla oceanica*. Of the 12 females maintained in a pool, 9 matured and got 'berry'; repeated spawnings were observed with successive spawnings at intervals of 30-35 days and incubation period of 10-15 days.

In the experiments on fattening of *S. tranquebarica* in a pond of 0.1 ha at Narakkal, 292 water-crabs were stocked and fed with salted trash fish. The experiments suggest a great potential for fattening of water-crabs.

In the fattening of the lobster *Panulirus homarus* in 1.2 t FRP tanks at Vizhinjam, it was found that a 25 g lobster became 600 g in about 1½ years.

A total of 21 spawning experiments were conducted on edible oyster and spat produced were utilised for rearing; 640 strings with hatchery spat were transferred to nursery; from nursery 808 strings with oysters of 25 mm and above were transferred to the farm.

In the pearl oyster, 7.72 lakh spat were produced in the hatchery at Tuticorin and supplied to the different research stations of CMFRI and also to entrepreneurs.

Broodstock maintenance of *Villorita cyprinoides* was carried out under captivity at salinities ranging from 10 ppt to 34 ppt; maximum survival was observed in 15 ppt. In April, 30% of the clams were in maturing stage, 10% in mature stage and the remaining in spent stage.

The eggs of *Sepioteuthis lessoniana* collected from the wild were maintained in FRP tanks and a total of 458 hatchlings were obtained.

In the programme of onshore pearl culture, 1700 oysters were implanted with 3 mm and 4 mm nuclei at Madras. A total of 272 pearls were obtained.

revenue from Rs 3,000 to 19,700. In the demonstration of mussel culture in estuaries at Dharmadam, a fixed rack was established in December. In about 5 months, 1300 kg of mussels were harvested with an average production of 12 kg mussels per meter rope.

The Govt. of Kerala has approved the implementation of edible oyster farming in 4 districts. 15 groups with a total of 125 women and farmers will adopt this technology with financial assistance from BFFDA. Similarly a total of 67 women adopted mussel farming in Padanna, under DWCRA/IRDP programme in a farm area of 800 sq.m.

In an intensive stake culture of mussel using the Institute's technology and assistance, a farmer in Padanna harvested about 2.5 t of mussels from an area of 5 acres.

Improving mariculture technologies

Nutrition: The protein content of dry *Cassava* chips fermented using fungi (*Beauveria* sp.) increased from 1.6% to 10.8%. Similarly the fermented (using fungi) and dried cashew fruit showed increase in protein from 2.44% to 13.08%. The materials thus enriched are being incorporated into the feeds of postlarvae of *Penaeus indicus*. The mudcrab accepted pellets of 5 mm diameter better than other sizes. The experiments on protein requirement of *P. semisulcatus* revealed that this species requires 35% of protein in the diet. In shrimps, soyabean flour gave highest digestibility and growth at 30% level of incorporation and mantis shrimp meal at 20%.

Physiology: The edible oyster and clam subjected to different salinities for 45 days showed that the highest survival rate of *Crassostrea madrasensis* of 85% could be obtained at 20 and 25 ppt salinity. In *Meretrix casta* the maximum survival of 75% and maximum weight gain of 7.18% were at 20 ppt.

Pathology: Histopathological study of white spot disease syndrome (WSS) in *P. monodon* revealed intranuclear inclusion bodies on

mesodermal and epidermal tissues. For the first time a protozoan was reported in the inter and intra tubular spaces of hepatopancreas of *P. monodon* severely affected with WSS.

Two fish pathogens, *Vibrio parahaemolyticus* and *V. harveyi* were cultured and protocols for the isolation of both nuclear DNA and plasmid DNA from them were standardised.

Genetics: Studies on *Rastrelliger kanagurta* and *Sardinella longiceps* revealed that muscle proteins of former species and MIDNA of both the species are potential genetic markers for evaluation of intraspecific genetic variability.

Studying Fisheries Economics

At Cochin the average operational cost of the trawler operating every day was estimated as Rs 3500 per trip and that of the one operating for several days at Rs 7700. Fuel and wages were the major operating expenses. The average gross earning was estimated as Rs 6000/- per trip for single day operation and Rs 13,200 per trip for multiday fishing unit.

Transferring Technologies

The extension activities were extended to Kandakadavu, Valappu and Nayarambalam. The group farming programme was also extended, bringing a total of 90 farmers operating in an area of 150 acres. Training in *Mahima* feed production was given to 3 women groups in Kerala. A number of fishermen-industry-institution meets (11) were arranged and programmes of interest to the community were discussed and suitable assistance given.

At Mangalore, mudcrab culture was demonstrated successfully and a harvest of 349 kg of *S. tranquebarica* was achieved out of 500 kg of soft crabs stocked in an area of 800 sq.m. and a net profit of Rs 36,000. At Vizhinjam, a good response from the farmers for using

PROVIDING CONSULTANCIES AND R&D SUPPORT

MOUs SIGNED DURING 1996-97/TO BE SIGNED

<i>Sl. No.</i>	<i>Name of the Entrepreneur</i>	<i>Location & activity</i>	<i>Amount (Rs)</i>
1.	M/s N.C.C. Bluewater Products Ltd.	Chandanada (A.P.) Pearl Culture	84,000
2.	M/s Balaji Bio-Tech Ltd., Nellore	Thupilipalem Pearl Culture	1,66,250
3.	M/s Aqua Prime International (India) Ltd.	Nellore Pearl Culture	2,01,350
4.	M/s Gem Holiday Resorts Ltd.	Madras Pearl Culture	4,30,750
5.	M/s Sterling Shrimpex (P) Ltd.	Chirala (A.P.) Pearl Culture	
6.	M/s Kalinga Aquatics Ltd.	Bhubaneswar (Orissa) Crab Farming	
7.	M/s Pink Gold British Exports Ltd.	Raigarh (Maharashtra) Crab Farming	1,94,000
8.	M/s Mangalore Refineries & Petrochemicals	Mangalore Pollution Monitoring	3,60,000
9.	M/s Kudremukh Iron Ore Co. Ltd. (KIOCL)	Mangalore Pollution Monitoring	3,80,000
10.	M/s Master Pearls Ltd.	Hyderabad Pearl Culture	6,71,250

Publishing the Research Results

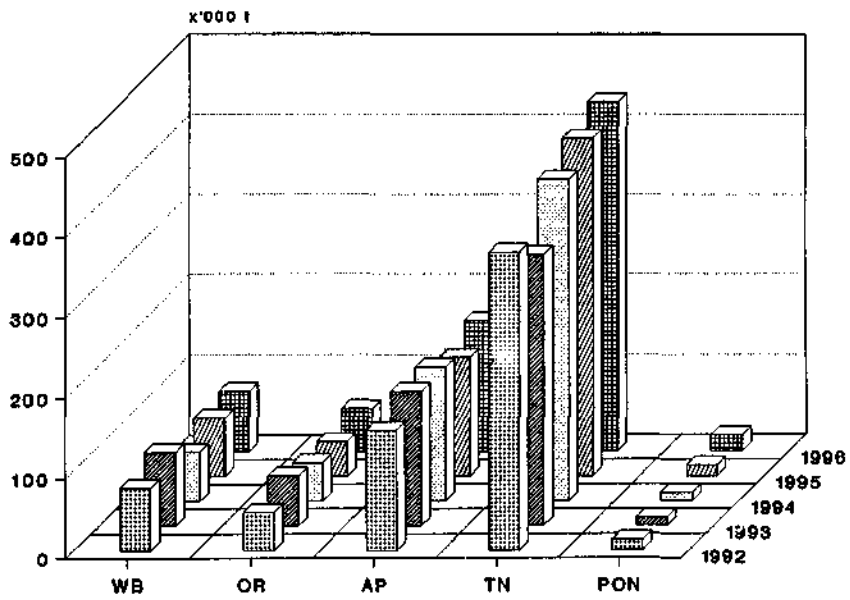
The publication of scientific papers continued this year and a total of 105 were published by the staff of CMFRI; the Institute also released the following publications:

1. *Indian Journal of Fisheries* Vol. 43 Nos 1-3
2. *CMFRI Special Publication* No. 65
3. *Marine Fisheries Information Service* T. & E. Ser. Nos. 140-145
4. *CMFRI Newsletter* Nos. 68-69, 70-71
5. *CMFRI Annual Report* 1995-96
6. *Research Highlights* 1995-96
7. CMFRI Brochure (Reprint)
8. Vision-2020, CMFRI Perspective Plan





Cultured mussel ready for harvest from Chettuva farm, Kerala



Marine fish landings along the east coast of India during 1992-96

