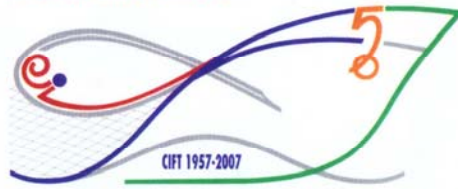


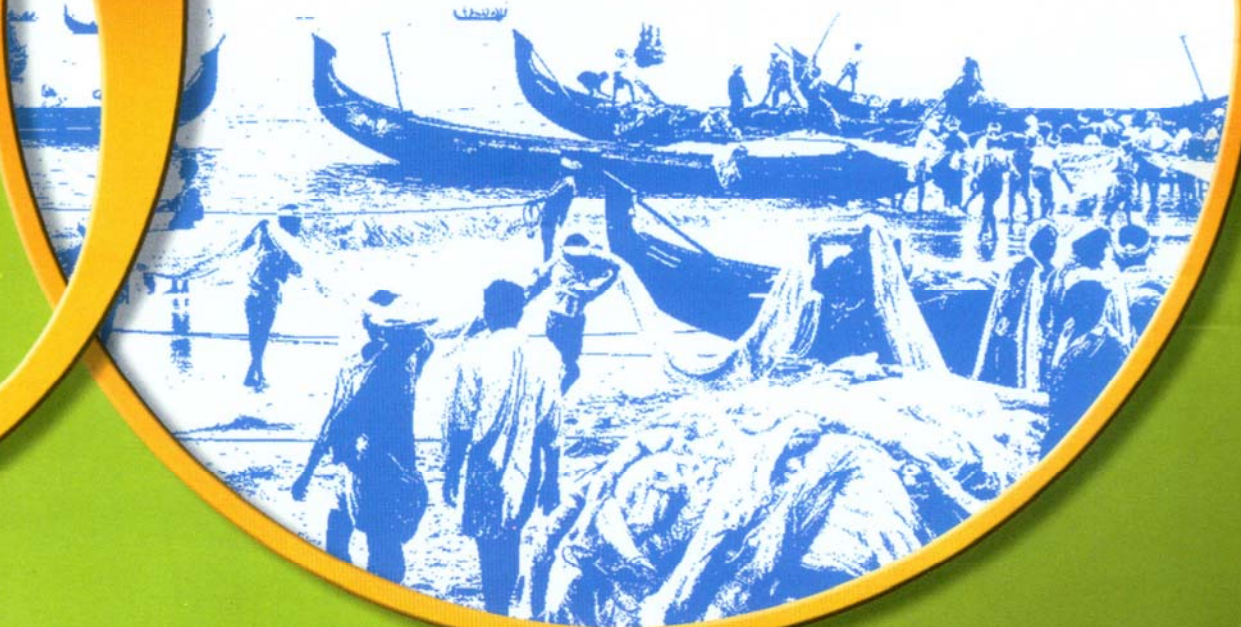
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FISH FOR HEALTH, WEALTH & EMPLOYMENT

GOLDEN JUBILEE YEAR
CENTRAL INSTITUTE OF FISHERIES TECHNOLOGY

CIFT : Fifty Glorious Years of service to fishing and fish processing industries (1957-2007)



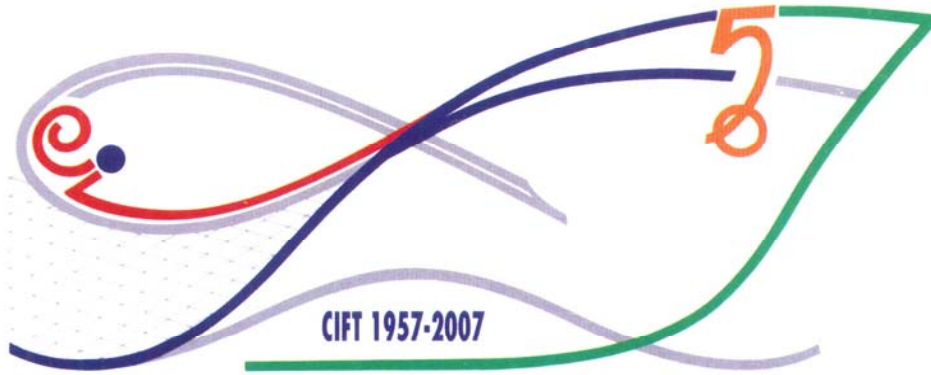
SOUVENIR



Central Institute of Fisheries Technology
(Indian Council of Agricultural Research)
Matsyapuri P. O., Cochin - 682 029, India



मछली तन के लिए, धन के लिए, काम के लिए



FISH FOR HEALTH, WEALTH & EMPLOYMENT

GOLDEN JUBILEE YEAR

CIFT - 50

*Years of Glorious Service to Fishing
and Fish Processing Industries of India
(1957-2007)*

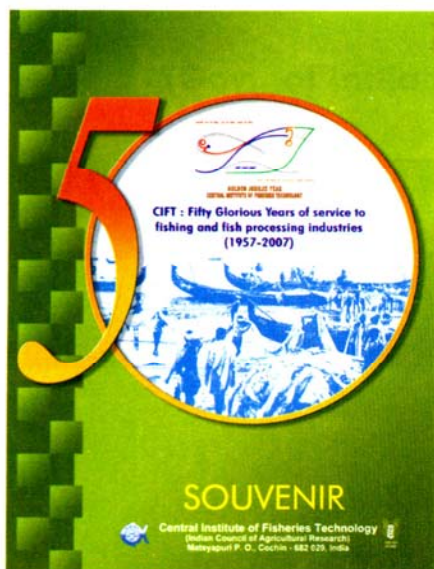
SOUVENIR



Central Institute of Fisheries Technology

(Indian Council of Agricultural Research)

Matsyapuri P.O., Cochin - 682 029



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Director, CIFT
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S.R.M. Road, Cochin - 18
- December 2007**





**President
Republic of India**

MESSAGE

I am delighted to learn that the Central Institute of Fisheries Technology, Cochin, a National Institute under the Indian Council of Agricultural Research (ICAR) is celebrating its Golden Jubilee this year.

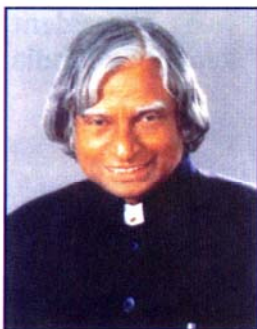
The Central Institute of Fisheries Technology is one of the institutes involved in research in all aspects of fishing and fish processing technologies. I am happy to note the role played by the Institute in making India one of the world leaders in fishing and fish processing industries.

I extend my greetings and felicitations to the Institute and wish the Golden Jubilee every success.

New Delhi
November 5, 2007

A handwritten signature in black ink that reads "P. Patil". The signature is written in a cursive style with a horizontal line underneath the name.

(PRATIBHA DEVISINGH PATIL)



Press Secretary to the President

President's Secretariat
Rashtrapati Bhavan
New Delhi - 110 004

05 March, 2007

MESSAGE

The President of India, Dr. A.P.J. Abdul Kalam, is happy to know that the Central Institute of Fisheries Technology, Cochin is celebrating its Golden Jubilee in April, 2007.

The President extends his warm greetings and felicitations to all those associated with the Institute and wishes the Celebrations all success.

PRESS SECRETARY TO THE PRESIDENT



Dr. Manmohan Singh
Prime Minister

16 July, 2007

MESSAGE

I am very happy to know that the Central Institute of Fisheries Technology, the pre-eminent institution under the Indian Council of Agricultural Research working in the fisheries sector in India is celebrating fifty years of service to the nation.

Fisheries is an extremely important sector for our economy both in terms of the valuable foreign exchange it earns and in improving the livelihoods of a large number of fish workers. The Central Institute of Fisheries Technology has over the years, played an important role in research in disciplines relating to fisheries and fish processing. We still have considerable untapped potential in this sector and I hope, the CIFT will break new ground in harnessing this potential for the benefit of the economy and some of the most vulnerable sections of our people.

I wish the fifty year celebration all success.

A handwritten signature in black ink that reads "Manmohan Singh".

(MANMOHAN SINGH)



Sharad Pawar

Minister of Agriculture
& Consumer Affairs,
Food and Public Distribution
Government of India
Room No.120, Krishi Bhawan
New Delhi - 110 001

07 November, 2006

MESSAGE

I am glad to know that Central Institute of Fisheries Technology, under the Indian Council of Agricultural Research is celebrating its Golden Jubilee in the year 2007. The Institute, I understand, has done commendable work in the past and has developed many new technologies for our fishing and fish processing industries. Fisheries has to play an important role in the national economy in the years to come. I am sure the Institute will continue to play its critical role in this. On this occasion, I wish to compliment the Institute for its valuable contributions and wish them all success in their future endeavours.

A handwritten signature in black ink, appearing to read 'S.P.' followed by a flourish.

(SHARAD PAWAR)



Dr. Akhilesh Prasad Singh

Minister of State for
Agriculture, Consumer Affairs,
Food and Public Distribution
Government of India
New Delhi - 110 001

06 November, 2006

MESSAGE

I am pleased to know that **Central Institute of Fisheries Technology (CIFT)** is celebrating 2007 as Golden Jubilee year of the Institute. I appreciate the efforts of CIFT which will give wide recognition and support for what has been achieved and encourage others to emulate them.

I wish the Central Institute of Fisheries Technology all success in the years to come in the service of the fisheries sector.


(Dr. Akhilesh Prasad Singh)

6.11.06



Kanti Lal Bhuria
Minister of State for Agriculture,
Consumer Affairs,
Food and Public Distribution
Government of India
New Delhi - 110 001

25 October, 2007

MESSAGE

I am extremely happy to learn that the Central Institute of Fisheries Technology (CIFT), Kochi is celebrating its Golden Jubilee. This premier institution in the country dealing with harvest and post harvest technology of fish, only one of its kind, has immensely contributed to the development of fisheries sector. The efforts of this Institute have enriched both livelihoods and exports in the segment. The Institute has rightly been conferred the 'ICAR Best Institute Award' twice during the last ten years.

I compliment the Director and Staff members of CIFT, Kochi for their contributions and wish all the best in their future endeavors.


(Kanti Lal Bhuria)



R.L. Bhatia

Governor of Kerala
Kerala Raj Bhavan
Thiruvananthapuram - 695 099

01 November 2006

MESSAGE

I am happy to know that Central Institute of Fisheries Technology, Cochin, is celebrating its Golden Jubilee in April 2007 and that a Souvenir is being brought out on the occasion.

The series of scientific seminars and other programmes that are scheduled as part of the celebrations, I am sure, will have fruitful discussions on the different aspects of fishery technology in the wake of modern advancements in the field.

I wish the significant venture all success.

Sd/
(R.L. BHATIA)



V.S. Achuthanandan
Chief Minister of Kerala

Phone { Office : 2333812
: 2333682
Fax : 0471-2333489

05.12.2006

MESSAGE

I am glad to know that the Central Institute of Fisheries Technology is bringing out a Souvenir in connection with its Golden Jubilee Celebrations.

The Souvenir, I am sure, will carry articles from learned and eminent personalities in the field of fisheries and it will be a true mirror of the activities and achievements of the Institute during the last 50 years.

I wish to offer my warm felicitation for the success of this venture.

A handwritten signature in black ink, appearing to read 'V.S. Achuthanandan', written in a cursive style.

(V.S. ACHUTHANANDAN)



S. Sharma

Minister for Fisheries and Registration

Phone { Office : 0471-2332700
0471-2333059
Fax : 0471-2333059
Res : 0471-2315520
0471-2725006

Thiruvananthapuram

MESSAGE

I came to learn that CIFT is completing 50 years of glorious service in the realm of fisheries research in the country. On the occasion of the Golden Jubilee Celebrations, it is known that a series of activities are planned including conduct of seminars and exhibitions in different disciplines in fisheries sector. The institute has also planned to bring out a souvenir carrying articles of eminent fisheries scientists. I hope that the occasion would be useful to take stock of the contributions the institute has made for the growth of fisheries sector of the country and plan for the future research and development in a responsible manner so that fish for all is ensured and the socio-economic conditions of fisher folk are improved.

I wish the souvenir all success.

(S. SHARMA)



Dr. Mangala Rai

Secretary
Department of Agricultural Research & Education
& Director General
Indian Council of Agricultural Research
Ministry of Agriculture
Government of India
Krishi Bhavan, New Delhi - 110 001

MESSAGE

I am glad to know that the Central Institute of Fisheries Technology (CIFT), Kochi is celebrating its Golden Jubilee in the year 2007.

On this historic occasion, I congratulate all the scientists and staff members, past and present of the Institute who have worked hard to ensure 50 glorious years of its fruitful existence. The technologies developed in this Institute have played a vital role in making India a major exporter of processed fish and fish products. I am sure the Institute will continue to play its role with a missionary zeal in the years to come and make the fisheries even more profitable and employment generating sector.

I wish the Institute all success in its future endeavours.

Dated the 2nd November, 2006
New Delhi

(MANGALA RAI)



Dr. S. Ayyappan
Deputy Director General (Fisheries)
Indian Council of Agricultural Research
Krishi Anusandhan Bhavan-II
Pusa, New Delhi - 110 012

MESSAGE

It is indeed a matter of pleasure to greet all my colleagues in the Central Institute of Fisheries Technology, on the occasion of its golden Jubilee. When the Institute was established in 1957, Indian fisheries was in its infancy confined to fishing in coastal and inland waters, using primitive craft and gear. In the past 50 years the fisheries scenario has undergone a sea change and today we are the third biggest fishing nation in the world. The Institute has played a vital role in this transformation, developing and successfully commercializing many new technologies in fishing, fish processing, product development, by products and fishery waste utilization. Its pioneering work in the improvement of quality of our fishery products for export is internationally recognized and in the year 2000, the institute was selected for prestigious Sardar Patel Award for the best ICAR Institute. It has received many other national and international awards also. My congratulations and best wishes to the Institute for greater success in the years to come.

(S. AYYAPPAN)

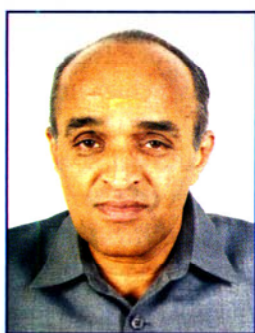


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Foreword



It is my proud and pleasant privilege to greet all fellow Scientists, fisheries policy makers, fishermen, aqua farmers, fish processors and exporters, researchers, students and academicians on this happy occasion when

the Central Institute of Fisheries Technology is celebrating its Golden Jubilee. I had the privilege of actively associating with all the activities of this Institute for the last 41 years out of its 50 years' glorious existence. For the same reason, this is a matter of personal happiness for me. Looking back, we in CIFT, feel proud of our achievements during the 50 years that passed by, witnessing the growth of our fishing and fish processing industries as well as the Institute. The history of fishing and fish processing industries in India is inseparably intertwined with the history of CIFT, right from the day the first ever consignment of frozen shrimp was exported to the U.S. The Institute played an important part in introducing motorized and mechanized fishing boats and modern synthetic fishing gear materials and gear designs in the country. Riverine and reservoir fishing were also developed by appropriate interventions. Trawling as a method of fishing was popularized in different parts of the country by the Institute. From the traditional primitive methods of fish curing, the processing industry also was brought to the high tech era. In the formative years of the industry, the Institute laid down the sanitary and hygienic

standards as well as microbial and biochemical quality parameters which served as the basis for the pre-shipment quality control inspection and certification. This certification was initially done by the Institute till procedures and regulations were standardized, after which the duty was handed over to the concerned agencies of the Ministry of Commerce. Fuel efficient designs of fishing boats, improved fishing gear and fishing methods for responsible and conservational fishing, diversification and value addition in processed fishery products, technologies for the production of high tech convenience foods from low value as well as quality fish from fresh water, marine and farmed sectors, utilization of fishery by products, wastes and improved packaging methods for fishery products, quality assurance of fishery products, basic studies on the biochemistry, microbiology and nutritive value of fresh fish and processed fishery products, were all areas where the Institute could make significant contributions. Bioactive compounds and products of pharmaceutical importance from fisheries sources is another area where CIFT's contributions have been recognized. The Institute also made many instruments, implements and machineries for fishing and fish processing industries and have popularized driers using non conventional energy sources like solar energy. Regional Centres in different parts of the country attended to location specific problems and helped the local industry. In the chequered history of the marine products export industry of the country, there were occasions of crisis due to rejection and ban on our products by importing countries. On all



Cife Golden Jubilee 1957-2007

such occasions the Institute came to the rescue of the industry and helped them to tide over the crisis. On occasions of national disasters like the Tsunami also, the Institute rose to the occasion and did its best to help fishermen and fish processors. The Institutes contributions in human resource development by way of training technologists, processors etc. and by conducting post graduate and doctoral degree courses in fish processing technology are also wellknown. As a result of these creditable activities it has been designated as a referral lab in fishery technology and is today recognized internationally as a leading research Institution in the field. It is also accredited by National Accreditation Board for Laboratories. The Institute was adjudged as the best Institute in the ICAR system twice in the years 2000 and 2006. Scientists of the Institute received many national and international awards also in the recent past. Trainees and visiting

scientists from developing and developed nations of the world come to the Institute for pursuing their studies. The Institute was able to conduct extensive training programmes in all backward areas like the North Eastern Hilly regions, islands like the Lakshadweep and Andamans and also interior states of the country. We remember with gratitude all pioneers who guided the destiny of the Institute and thank all who helped us in our activities in the past. We earnestly request them to continue their support to us in the years to come also. The Institute feels grateful to the Indian Council of Agricultural Research for its support, and guidance in all its activities. While feeling proud of our achievements during the past 50 years, we realize that much greater challenges are awaiting us and we take this opportunity for rededicating ourselves to work for the all round development of our fishing and fish processing industries in the country.

Cochin

04 January, 2008

(K. DEVADASAN)



The Central Institute of Fisheries Technology

Dr. K. Gopakumar

(Former Director, CIFT and Former Deputy Director General (Fisheries) ICAR, New Delhi
28/863, Cheruparambathu Road, Kadavanthra, Cochin - 682 020)

Historical

An event which became a land mark in the history of Indian fisheries was the promulgation of Indian Fisheries Act in 1897 by the then Imperial British Government. The most outstanding contribution to Indian fisheries was given by a veterinary surgeon in the Royal British Army, Dr. Francis Dey. Dr. Dey was fascinated by the diversity of Indian fisheries. Soon he resigned from his job, travelled extensively throughout the length and breadth of the country and along its long coast line. He went on to classify the Indian species of fish, both marine and fresh water, and brought out a publication 'Fishes of India'. This book, even after the lapse of a century since its first publication, remains as the Bible in scientific classification of fishes of India.

However, the need for establishing fisheries institutes in India was first pointed out to the British government by Sir Frederick Nicholson, an Indianised ICS Officer. The credit for starting fish processing in India should also be given to Sir Nicholson. He started his activities in the then Madras Presidency. He also organised, for the first time in India, a Department of Fisheries in the then Madras Presidency. The need for setting fisheries research institutes in India was raised to the British Administration in 1943 by Dr. Bani Prasad, who was the Director of the Zoological Survey of India. It was this "Report of the First Sub Committee of Policy No. 5 on Agriculture, Forestry and Fisheries" dated 18th

January 1945 that led to the creation of fisheries institutes in India. Dr. Bani Prasad in 1944 became the first Indian Fisheries Development Adviser to the Government of India under British rule.

But it should be remembered that it was Dr. N.K. Panicker, a world renowned oceanographer and biologist, who created a chain of fisheries institutes in India like the Central Institute of Fisheries Technology, Indo Norwegian Project (now, Integrated Fisheries Project), Central Institute of Fish Nautical Engineering and Technology (earlier Central Institute of Fisheries Operations) and National Institute of Oceanography.

Central Institute of Fisheries Technology (CIFT)

The Central Institute of Fisheries Technology came into existence based on the recommendation of a high power committee appointed by the Ministry of Food and Agriculture in 1954. The Chairman of the Committee was Dr. B.N. Chopra, who was the Fisheries Development Advisor to Govt. of India. The Committee observed in their report that "Technological research, to be of real value, should be planned on a broad all India basis and carried out in an intensive manner. It should include Craft and Gear Technology and by products. We further recommended that the Fisheries Division of the Food and Agriculture Organisation be approached for advice of their Chief Technologist in planning the station and the initial programme of



work". This recommendation was accepted by the Government of India and thus gave birth to "Central Fisheries Technological Research Station" on 29th April 1957. The head quarters of the Station was in an old rented building at Kochangadi (Cochin). It was a humble birth but a noble one destined to create history in the annals of fisheries technological research in India and perhaps in the whole of Asia. The Station was later rechristened as Central Institute of Fisheries Technology in April 1961.

Genesis

The Station started with an Assistant Director (Gear) in a grade equivalent to that of present "Scientist" in the ICAR system. Immediately FAO of UN posted Dr. Hideaki Miyamoto (till then Chief of Fishing Gear Station of the Tokai Regional Fisheries Laboratory, Tokyo, Japan) as FAO expert under its "Expanded Technical Assistance Programme". Soon a small core group of technical staff was recruited for conducting research on fishing craft and gear. The working place was taken on lease from the office place of the off-shore Fishing Station (presently Fisheries Survey of India known by another name at that time as Exploratory Fisheries Project). Both departments were, however, under the Ministry of Food and Agriculture of the Govt. of India and they worked in harmony.

Fish Processing Technology

The organisation of this faculty was slightly delayed as FAO experienced some difficulty in getting a suitable expert. In 1958 the services of Dr. Ernest Hess, Chief of the Technology Division of FAO was made available for conducting an on-the-spot study of the prevailing status of Fish Processing Technology in India. In May 1958, he submitted his report on the organization and setting up of a Central Fish Processing Laboratory including Quality Control, Inspection and Extension Service to the existing Institute. An Assistant Director (Processing) was appointed in June 1958 and the processing technology research cell consisting of about half-a-dozen scientists was transferred from the Central Marine Fisheries Research Station functioning at

Mandapam in Tamil Nadu. This wing gave birth to fish processing research in India.

Organizational Development

An Assistant Director (Craft) took position in October 1958 and Assistant Director (Craft Design) in March 1959. The Quality Control and Extension Section came into existence with the appointment of Quality Control Officer (October 1960) and Extension Officer in March 1961.

In 1962 Govt of India took a major decision to rename the Station as an institute and head of the Station as Director. The new name was established as Central Institute of Fisheries Technology. The Institute staff strength grew with developments under Five Year Plans. At the end of the Second Five Year Plan, the staff strength was 148 and at the Third Five Year Plan it was doubled to 314. At the end of VII plan the Institute had 140 scientist and a total staff of 520. Soon laboratories were established and several boats were also added to the facilities. However, after taking over by ICAR, the scientific staff strength was drastically reduced. The Institute which had a major Engineering Division took the toll of this decision and virtually became non functional with only one or two engineers. The present scientific manpower strength is 62. The present staff strength of the Institute is given below:

Staff position as on 31 December, 2008

Category	Sanctioned	Filled
Scientific	101	62
Technical	140	125
Administrative	90	81
Supporting	85	73
Auxiliary	6	6
Total	422	347

Establishment of Regional Centres

Bombay Research Centre

The Bombay Centre of CIFT came into existence in 1958 by transferring an existing Demonstration-cum-production unit of Fish Meal Plant under the



Ministry of Food and Agriculture of the Government of India. The Centre soon started research on fish processing technology on problems related to local fish species at Sassoon Docks, in Colaba, Mumbai.

In 1996, the Centre was shifted to a permanent building purchased by ICAR at Vashi, in New Bombay, where most of the fish processing factories are located.

Veraval Research Centre

In 1962 a Centre at Veraval in Gujarat was started for conducting research in problems related to fisheries of that region. Subsequently this Center was developed as a major Research Centre with all modern facilities for advanced research in Fisheries Technology, both craft and gear and Fish Processing. The Centre was responsible for introducing mechanized boats, trawling and modern freezing and canning plants in Gujarat where fisheries was a low priority subject, due to the predominately vegetarian food habits of the local people. Soon under the leadership of the Agriculture Ministry, Govt. of India and ICAR, the highly productive Gujarat coast became a major production centre and a leader in fishing and fish processing technology in the country.

Kakinada Research Centre

In the same year (1962) a Centre for dealing craft and gear technology research for east coast of India was started at Kakinada. In 1972, a processing wing was added to this Centre. This Centre was also shifted to a permanent building at Visakhapatnam later. In terms of man power and facilities it is the largest Station now under CIFT dealing with aspects of Fishery Technology. With the advent of scientific aquaculture, Andhra Pradesh has taken over the leadership in fisheries and the Centre is extending all help and guidance to fishing and fish processing industries in that region.

Nangal in Himachal Pradesh

In 1964 a Craft and Gear unit of the Institute was set up at Nangal, near Govindsagar reservoir in Himachal Pradesh. The creation of this facility was

to solve issues of reservoir fisheries one after another in Northern parts of the country. It was well delineated in the objectives of CIFT that this unit had only temporary existence and should be shifted to another reservoir.

Keeping this mandate, the Centre at Nangal was closed in 1970, after successfully completing the work assigned to it and submitting the necessary recommendations for implementation to the State Government.

Orissa Unit

Based on the same principle, a Centre for doing reservoir fisheries in Orissa was started in 1963 near Hirakud Reservoir. After completion of the research issues of the region, the Centre was recommended to be closed by the IInd Quinquennial Review Team of the ICAR (QRT – revised) and a decision was taken to shift the Centre to some unexplored reservoir. But later this decision was reversed by ICAR and we saw the reorganisation of the Centre with the addition of a Processing Wing in 1972. Subsequent QRT Teams of ICAR (3rd and 4th) also recommended the closure of the Centre and the Agriculture Minister took a decision to close the Centre in 1998 and shifted the Center to Hoshangabad in Madhya Pradesh to do research on the reservoirs in Madhya Pradesh as this state is blessed with a large number of reservoirs. However, the shifting and closure of Burla Centre could not be accomplished due to political consideration and the new Centre started at Hoshangabad in Madhya Pradesh was finally closed in 2005. Finally the Burla Centre was also closed by July 2007.

Goa Centre

A Centre for doing research on Craft and Gear was started at Panaji in Goa in 1962. After accomplishing the task and submitting the report, the Centre was closed by ICAR.

Calicut Research Centre

A Centre of CIFT was established at Calicut in 1962 to do research on fish curing as this facility was not available at Cochin, the head quarters of CIFT. This



Centre shared the building with CMFRI Regional Centre at Calicut. This region of the Kerala was the most important place in the production of cured fish which was one reason for locating this Centre at Calicut. However, as a part of the policy decision taken by ICAR to reduce Regional Stations of Institutes, the Centre was closed in 2006.

Chennai Centre

For a brief period the Institute had a small nucleus Centre at Chennai in the sixties which gave necessary recommendations to the State Government and then closed in operation.

Scientists and technicians of the Institute travelled extensively to all parts of the country and helped the fishing and fish processing industry, from the NEH regions to Andaman and Lakshadweep Islands and to interior states including Sikkim.

Permanent Building of CIFT

A permanent building with all modern facilities was a dream cherished by all Scientists of CIFT. The new (the first) Director of CIFT, Dr. A.N. Bose realized this and decided to get a permanent building constructed for CIFT. In 1962 he submitted a proposal in this regard to the Union Agriculture Ministry. In 1963, the Central Public Works Department (CPWD) submitted a design for the building with an estimate cost of Rs. 4.35 million. The necessary land for the building was leased in Willington Island from the Port Trust of Kochi. The place has a natural scenic beauty as well as commercial importance. It is facing the back water, the Vembanad Lake on one side and the National High Way No. 47 passing along the other side. The Cochin Port and the Railway Harbour Terminal Station and the Mattanchery Halt station as well as the earlier Air Port (now shifted to Nedumbassry in Angamaly) are very close. The budget for the building was revised to Rs. 5.8 million and orders issued for construction in 1971. But due to Bangla Desh war the construction was delayed further. However, the construction was completed in 1976 and the building was declared open on 2nd June 1976 by the then Union Minister for Food and Agriculture Dr. Jagjivan Ram.

Initially to start with, the CIFT had six wings with an approximate area of 5800 square meters in two floors. But subsequent Five Plans saw massive institutional build up in terms of area and facilities.

CIFT under ICAR

The administrative control of this Institute as well as the sister fishery research institutions under Ministry of Agriculture, Govt. of India were taken over by the Indian Council of Agricultural Research in 1967 which gave a good amount of functional autonomy to these institutes. Later, the all India Agricultural Research Service (ARS) was introduced by the ICAR for the Scientists which saw further improvements in serving conditions and pay structure. The Technical Services introduced subsequently by the ICAR gave considerable benefits to the technical personnels also. Regional Centres got permanent buildings and all laboratories were provided with state of the art equipments as well as trained scientists and technicians. A number of scientists were trained abroad in all relevant fields. As a result, CIFT today is recognized as a referral lab in fishery technological research and is a well-known name around the World in the field. In the course of the past 50 years the Institute received many national and international awards also, raising its status and prestige in scientific circles. Presently, the Institute has three Centres (Mumbai, Veraval and Vizakhapatnam). It functions under seven Divisions viz; Fishing Technology, Fish Processing, Biochemistry and Nutrition, Microbiology, Fermentation and Biotechnology, Quality Assurance and Management, Engineering, and Extension, Information and Statistics Division.

Impact of CIFT on Fishing, Seafood Processing and Quality Control in Indian Fisheries Sector

Right from its inception, CIFT has been maintaining close relations with the fishing and fish processing industries and has helped and guided them in all hours of crisis. The Institute laid down the standards for products meant for export and was responsible for the pre-shipment quality control inspection of fishery products exported from the

country until 1969. Later this function was transferred to the Export Inspection Agency. In fact, a major portion of Quality Control Division was transferred to EIA. In its chequered history the export industry faced many crises when importing countries rejected our products due to quality problems. On all such occasions, the Institute came to the rescue of the industry and has guided the industry to overcome such problems. Today, processed fishery products is by-far the largest single foreign exchange earning industry in the agricultural sector, earning more than Rs. 7000 crores (US \$ 1.4 billion) in foreign exchange and providing nutritious food and direct and indirect employment to millions of rural poor especially women. The Institute played a key-role in diversification and value addition in our processed fishery product industry and has successfully developed and commercialized many new technologies for this purpose.

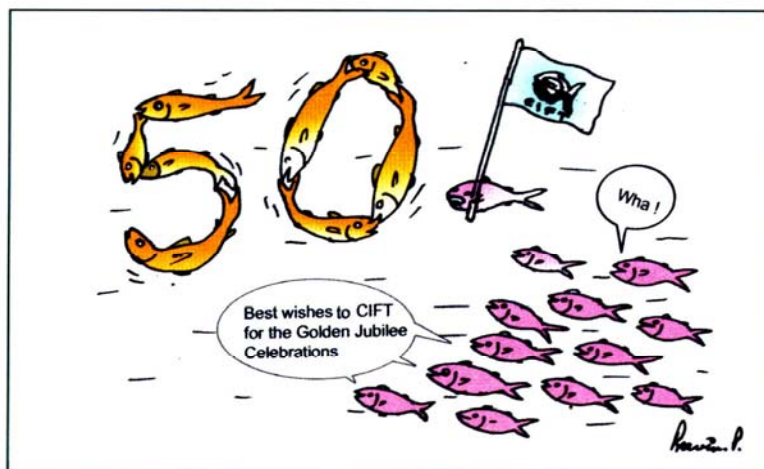
On the fishing side also the Institute gave notable contribution by designing and constructing fuel efficient boats. Many newer fishing craft and gear material and responsible fishing methods for optimum utilization of the available resources were also developed and popularized. Environmental safety, fishery byproducts, waste utilization, packaging etc. were other areas which received careful attention. Brief details of these are given elsewhere. The Institute is offering training to technologists of the industry and has conducted extensive education and extension programmes. An

M.F.Sc. and Ph.D. programme in Fish Post Harvest Technology are offered by the Institute currently in association with CIFE, Mumbai, a Deemed University under ICAR.

The Institute rose to the occasion and gave all necessary help in times of natural disasters like the Tsunami also. National Co-ordinated projects of the ICAR, the World Bank, National Agricultural Technology Programme (NATP) as well as various other externally funded projects helped the Institute in acquiring latest facilities and training manpower. The Agricultural Technology Infrastructure established under the NATP acts as a link between the scientist and the end users of the technologies developed by them. The Regional Centres attend specific problems to offer guidance and assistance to the local fish processing industries and extend facilities to fishers in fishing operation and training.

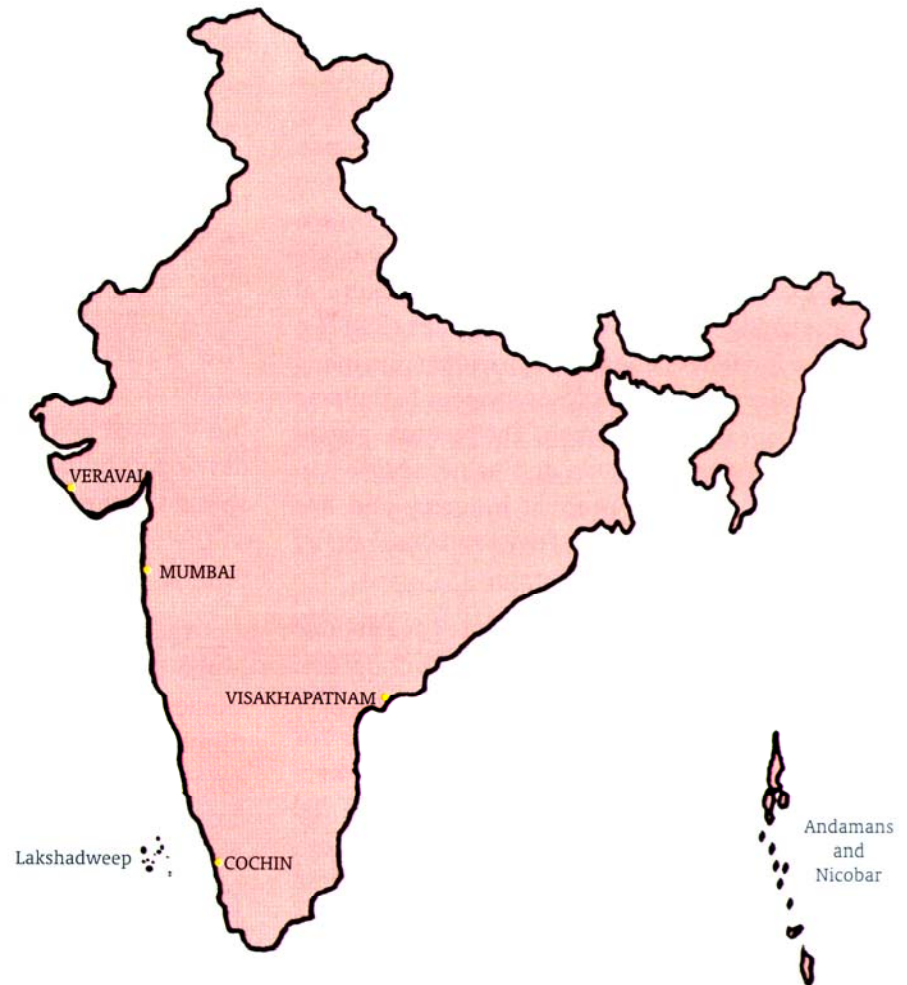
Organised aquaculture is now changing the face of the industry fast and the Institute has taken up studies on the quality problems special to farmed fishery products. Concepts of Hazard Analysis Critical Control Point (HACCP) right from onboard vessels and farms have been popularized. At present CIFT is a member of the HACCP audit committee constituted by the Ministry of Commerce, Govt. of India for inspecting seafood plants.

The salient achievements of the Institute during the last 50 years appears elsewhere.





Addresses of Headquarters and Research Centres



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FAO Experts who Assisted in Building up the Institute



Dr. Hideaki Miyamoto
Fishing Gear Expert



Mr. Paul B. Ziener
Naval Architect



Mr. Peter Gurtner
Naval Architect



Mr. A. Sutherland
Marine Engineer



Mr. E. Kvaran
Marine Engineer



Capt. M. Nakai
Shrimp Trawl Expert



Dr. S.A. Beaty
Fish Processing Expert



Mr. C.G. Tucker
Freeze Drying Expert



Former Directors of CIFT



Dr. A.N. Bose



Dr. V.K. Pillai



Dr. S.Z. Qasim



Dr. R.V. Nair



Shri G.K. Kuriyan



Dr. C.C. Panduranga Rao



Shri M.R. Nair



Dr. K. Gopakumar



Dr. K. Ravindran

Memorable Dignitary Visits



His Excellency V.V. Giri, Governor of Kerala (1962)



Shri C. Achutha Menon
Hon'ble Chief Minister of Kerala (1971)



Dr. M.S. Swaminathan
Director General, ICAR (1972)



Cift Golden Jubilee 1957-2007



Dr. Jagjivan Ram
Hon'ble Minister for Agriculture and Irrigation,
Govt. of India (1976)



Rashtrapathi Giani Zail Singh
(1982)



His Excellency Hammer de Robert
President, Republic of Nauru (1982)



His Excellency Abdul Gayoom
President, Maldives (1983)



Dr. N.S. Randhawa
Director General, ICAR (1985)



Sri Yogendra Makwana
Union Minister of State for Agriculture (1985)



Shri Rajiv Gandhi
Hon'ble Prime Minister (1982)



Shri Rajiv Gandhi & Shri K. Karunakaran
Hon'ble Chief Minister, Govt. of Kerala (1982)



His Excellency ATI George Sokomanu
President, Republic of Vanuata (1987)



Shri T.K. Ramakrishnan
Minister for Fisheries & Co-operation, Govt. of Kerala (1987)



Shri V.V. Raghavan
Minister for Agriculture, Govt. of Kerala (1988)



Shri Hari Krishna Shastri
Union Minister of State for Agriculture (1988)



Cifs Golden Jubilee 1957-2007



Smt. M.T. Padma
Minister for Fisheries, Rural Development & Registration,
Govt. of Kerala (1992)



Shri K.C. Lenka
Union Minister of State for Agriculture (1993)



Shri S. Krishnakumar, IAS
Union Minister of State for Agriculture
& Non Conventional Energy (1994)



Shri Sylvius Condpan
Minister for Fisheries Employment, Govt. of Assam (1995)



Dr. Bal Ram Jhaker
Union Minister for Agriculture at Visakhapatnam Centre (1995)



Shri Chathuranan Mishra
Union Minister for Food & Agriculture (1997)



Dr. R.S. Paroda
Director General, ICAR (1998)



Shri Hukumdeo Narayan Yadav
Minister of State for Agriculture (2000)



Shri Babubhai Bokharia
Minister of State for Fisheries, Govt. of Gujarat (2000)



Shri Debendra Pradhan
Union Minister of State for Agriculture at Burla Research Centre
(2000)



Shri Abdulla Kamaludeen
Minister of Fisheries & Agriculture, Maldives (2006)



Shri Jamuna Nishad
Minister for Fisheries, Uttar Pradesh (2007)



Mandate and Objectives of the Institution

Present Mandate

1. To evolve innovative, cost-effective technologies for fish harvest.
 2. To develop and standardize various aspects of post-harvest technologies.
 3. To develop technologies for extraction of biomedical, pharmaceutical and industrial products from aquatic organisms.
 4. To act as a repository of information on harvest and post-harvest technologies with a systematic data base.
 5. To conduct transfer of technology through training, education and extension education programmes.
 6. To provide consultancy services and to popularize the innovations for the overall development of fishery industry.
5. To do advanced research in food safety in fish and fishery products.
 6. To provide training and consultancy services in fishing and fish processing.

Objectives of the Institute

- Conducting research in fish harvest technologies for developing and evolving suitable fishing techniques for marine and inland sectors for ensuring sustainable production.
- Development of improved post-harvest processing technologies for fish and fishery products with emphasis on value addition, by-products utilization and waste management.
- Isolation, characterization and utilization of pharmacologically important bioactive substances from aquatic sources.
- Developing technologies and standards to ensure food safety through quality assurance.
- Development of new generation fuel efficient fishing vessels and engineering equipments for fisheries.
- Microbiological and Biotechnological applications in fisheries for risk assessment and surveillance, bio-remediation, isolation of microbial enzymes and molecular mapping of aquatic microbes.
- Statistical applications and economic evaluation in fisheries.
- Transfer of Technology through extension activities and organizing extension research for technology assessment, diffusion and adoption among clients.

Revised Mandate

1. To conduct basic, strategic and applied research in fishing and fish processing.
2. To develop designs for fuel efficient fishing vessels and fishing gear for responsible fishing.
3. To develop technologies for commercial isolation of bioactive compounds and industrially important products from fish and fishery wastes.
4. To design innovative implements and machineries for fishing and fish processing and pilot plants for facilitating commercialization of technologies developed.



Upgradation of Fisheries Technologies: CIFT's Contributions

Dr. K. Devadasan

Director, Central Institute of Fisheries Technology, Matsyapuri P.O., Cochin - 682 029

Introduction

Central Institute of Fisheries Technology (CIFT) is a multidisciplinary research organization established by the government of India in 1957 and its administrative control was brought under the Indian Council of Agricultural Research (ICAR) from 1st October 1967. The Institute has been entrusted with the responsibility of devising suitable technologies for the scientific exploitation and utilization of the vast fish resources of India. The development of the Institute over the years is through research investigations in the areas of fishing craft and gear suited to regional fishing conditions, storage, preservation, transportation and processing of the landed fish.

Since its inception, the Institute has taken up and successfully completed studies on various important aspects of fishing and fish processing techniques. Several new technologies have been developed and existing technologies were improved for the construction and maintenance of fishing craft, fabrication, operation and maintenance of fishing gear, processing and preservation of fish and shellfish and fabrication of instruments and accessories to be used in fishing and fish processing. Some of the significant and commercially viable technologies recently developed by the Institute are briefly described below.

Fuel-efficient fishing vessel

The Institute has developed 12 standard designs

of mechanized wooden fishing boats in the size range 7.67 m to 15.24 m during its early days and most of the wooden fishing boats plying in the Indian waters are built to CIFT designs.

A 15.5 m steel fishing vessel, christened 'Sagarkripa', far more fuel efficient than comparable vessels of its size, has been designed and fabricated by the Institute, and dedicated to the nation on 17th September, 1999. This vessel has a hydrodynamically efficient hull fitted with advanced propulsion system perfected at CIFT. This vessel is expected to achieve about 17% fuel saving compared to similar vessels against comparable operational parameters. It is estimated that this vessel can save about 16,000 litres of fuel during one year of operation. The vessel is fitted with Leyland ALM 412, 125 hp and 2000 rpm engine. The speed of the vessel during free



Operation from Sagarkripa



running will be 9.5 knots and 4 knots while trawling. For locating fish shoals, the vessel has 50/2000 dual frequency SIMRAD fish finder and Garmin 128 GPS navigators. The vessel also features better accommodation standards; more fish hold volume (30 m^3), higher winch capacity, large fishing deck area and reduced motion in seaway. These features will help the vessel to achieve higher endurance and to carry out deeper water operations. It is expected that this vessel will revolutionise the fishing industry, as 70% of the operational costs of this type are accounted for fuel alone and fuel saving will be a boon to the fishing industry.

A trawler cum gillnetter cum long liner designed and constructed by CIFT is also operating successfully along the east coast and has attracted the attention of the local fishers at Visakhapatnam.

FRP canoes for traditional fishermen

Fibreglass Reinforced Plastic (FRP) is an industrially important construction material. Strength, light weight and long life are the special advantages of this material. As such it is a convenient and suitable material for building fishing boats, especially for those meant for fishing near shore and in backwaters. Taking these facts into consideration, CIFT has designed FRP fishing canoes for traditional fishermen. Twenty three such boats have been built for the SC/ST Co-operative Society, Chellanam Village under the Special Component Plan of the



FRP boat for backwater fishing

Government of India. The CIFT designed canoe has a length of 5.78 m, breadth of 0.82 m and height of 0.385 m. The cost of construction comes to Rs. 22,500/-. Ten persons were trained in the construction of such fishing boats.

Aluminium-alloy sheathing for wooden fishing vessels

Most of the fishing vessels constructed and operated in our country are made of wood. Unprotected wooden hulls of fishing vessels get damaged by marine borers and fouling organisms. The traditional method of protecting the hull is by giving copper sheathing which is very costly.

In place of costly copper, CIFT has recommended cheap aluminium-magnesium alloy for sheathing wooden hulls along with G.I. fastenings, cast iron fittings and aluminium alloy tacks and screws. The alloy is light, resistant to seawater corrosion and cheap in price. Fouling on metallic surface can be eliminated through the use of a specific painting schedule recommended by the Institute.



Aluminium alloy boat

Cathodic protection of fishing boats

Marine metallic structures are constantly subjected to very severe corrosion resulting in huge economic loss. Properly designed cathodic protection system is not only technically feasible but also



economically viable. Presently, zinc and ternary aluminium anodes are used for cathodic protection.

A galvanic anode free from mercury has been developed for use in cathodic protection of fishing boats and metallic marine structures. The life of these anodes is three times that of zinc anodes. As these anodes are mercury free unlike its commercial counterparts, pollution of the aquatic environment by mercury does not occur. Specifications were laid down for cathodic protection of steel trawlers and metallic sheathed wooden boats, and standards were worked out on the quality, quantity and geometrical disposition of the anodes on the hull.

Dual preservative treated rubber wood canoe for traditional sector

Rubber wood treated with a dual preservative showed maximum increase in compression stress and least reduction in strength even after exposure for nearly three years in seawater. The Institute has successfully completed construction of a few canoes from treated rubber wood subjected to a combination treatment technology developed at the Institute for marine and backwater fishing. The cost of the canoe is 35 – 40% less than a canoe of same size built of 'anjili', the usually used wood. This saves the depleting forest wealth, helps the rubber farmer to get a better price for his under utilized wood and gives a durable, maintenance free boat at affordable



Dual preservative treated rubber wood canoe

cost to the poor fisherman especially of the South West and North East coasts of India.

FRP sheathed rubber wood canoe for artisanal sector

Fibreglass Re-inforced plastic (FRP) sheathed, untreated rubber wood canoes were constructed and given for experimental fishing to artisanal fishermen. Both, the preservative treated rubber wood canoe and FRP sheathed un-treated rubber wood canoe, were found to be in sound condition even after 26 and 16 months field operations respectively.



FRP sheathed rubber wood canoe for artisanal sector

Chemical wood preservatives

Traditional fishing contributes to the major part of fish landings in India. 'Kattamaram' and built-in or dug-out canoes are used for traditional fishing. These wooden crafts deteriorate rapidly due to weathering and also in contact with seawater containing various organisms, which destroy wood. Fishermen are using indigenous preservatives like cashew nut shell liquid, fish oils etc. to protect their fishing craft. But studies have shown that these preservatives have very little toxic properties. They merely act as water repellents.

Considering the financial loss incurred by the traditional sector, CIFT has developed some chemical wood preservatives viz., Arsenic Creosote, Copper



Creosote and Creoscor. Creosote is a coal tar distillation product. Fortification of Creosote with copper or arsenic makes it more toxic and consequently prolongs the efficiency of the preservatives. Fortified Creosote not only imparts toxicity to wood against bacteria, fungi and termites, but also retards the formation of cracks on the wood due to weathering.

Creoscor is a high efficiency oil borne wood preservative which is prepared by heating together heavy Creosote oil, copper compound and plant resins. The treatment consists of giving two or three liberal coats of Copper Creosote or Arsenic Creosote on all parts of the boat. The hull portion is then coated with Creoscor, which not only protects the craft but also provides a smooth surface, reducing the frictional resistance to motion of the craft in water. The new treatment costs much less than the traditional treatment.

Specialised gears

With the advent of mechanized fishing, the Institute made notable contribution by developing suitable fishing gear for operation from boats of varying sizes. Designing of nets for operation from traditional craft was also given equal importance. Some of the important types of gear developed are:

- Long wing trawl
- Double rig shrimp trawl
- Shrimp trawl for traditional motorized craft
- Bulged belly trawl
- High opening trawl
- Large mesh trawl
- High speed demersal trawl
- Midwater trawl
- Rope trawl
- Purse-seine
- Mini purse-seine
- Large lines
- Troll lines

Gill nets for marine and reservoir fisheries

Gill nets are selective gear, the efficiency of which

depends upon the choice of proper twine size and mesh size. The twine size and mesh size for gill nets and trammel nets have been standardised for common marine fishes like seer, pomfret, hilsa, lobsters, prawns etc.

Likewise, gill nets including trammel net and frame net have also been developed and introduced in reservoirs for the capture of catla, rohu, mrigal, catfish and other miscellaneous fishes.

Otter boards

The Institute has developed a number of designs of otter board of different shapes and sizes for operation with different sizes of trawl from different size groups of vessels. V-Form steel otter boards of the following sizes are recommended for different size trawlers:

Dimensions	1	2	3
Length in mm	1500	1370	1050
Breadth in mm	890	820	620
Weight in kg in air	125	70-90	50-55
Size of trawler	14-15 / 15-17.5 m OAL	12-14 m OAL	10-11 m OAL
B.H.P.	125-160/ 165-300	70-120	50-65

Combination wire ropes for deep sea trawling

Combination wire ropes are specialised wire ropes used as head and foot ropes of heavy demersal mid water and pelagic trawls. Materials like steel wire and synthetic fibre having divergent qualities are combined together to form the combination rope. The synthetic fibre provides insulation for the highly corrosive steel from the hostile marine conditions.



India had been importing combination wire ropes from other countries. The indigenous production of combination ropes will help in not only meeting the country's increasing demand but can also be an item of export in the near future.

Turtle Excluder Device to prevent incidental mortality of marine turtles, during trawling

Marine turtles are endangered species which are protected under Indian Wildlife Protection Act. Incidental catch of marine turtles are known to occur during commercial trawling operations, particularly along the coast of West Bengal, Orissa, Andhra Pradesh, Tamil Nadu and southern parts of Kerala. Turtle mortality during shrimp trawling was also linked with import embargo of Indian wild-caught shrimp by USA, in the recent past. Turtle Excluder Device (TED) is a special equipment that greatly reduces the incidental death of turtles caught in trawl nets, by facilitating their safe escape during the tow.

CIFT has developed CIFT-TED which is a top exiting, single grid, hard TED of 1000 x 800 mm size, for use by small mechanized trawlers which predominate in Indian waters. Field trials of the CIFT-TED have been carried out off Cochin (Kerala), Visakhapatnam (Andhra Pradesh) and Paradeep (Orissa). Demonstration of fabrication and operation of CIFT-TED was carried out in Orissa, during the mass nesting season of Olive Ridley turtles (*Lepidochelys olivacea*) in February, 2001. CIFT-TED



CIFT-TED showing turtle escapement

permitted 100% escapement of turtles while keeping escapement of shrimp as low as 0.62%. Popularization of CIFT-TED is being carried out in maritime states which are affected by fishing induced turtle mortality, in collaboration with MPEDA and respective State Fisheries Departments.

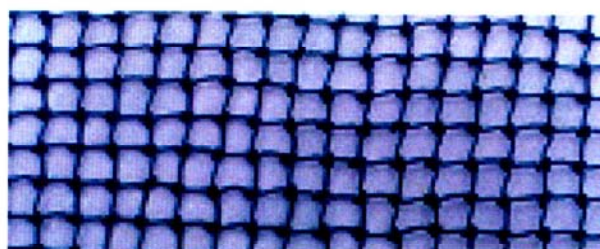
By-catch Reduction Devices (BRDs)

Incidental catches of non-target species and size groups during trawling operations is an important issue which is linked with conservation of resources and biodiversity. Juveniles and sub-adults of commercially important fin fishes form a significant proportion of trawl by-catch. CIFT has conducted investigations on several by-catch reduction devices such as Radial Escapement Device, Fish Eye and Rigid single grid separator devices, which facilitate the escape of non-target species and juveniles from trawls. Square mesh panels have been developed in order to improve the selectivity of trawl cod ends and protect the juveniles.

A Juvenile Fish escaping and Shrimp Sorting Device (JFSSD) in fishing nets designed by the Institute recently won an international award from World Wildlife Fund against stiff competition from 17 developed and developing nations active in the field of fisheries.

Square mesh panels

The operations of trawl with conventional diamond mesh cod end results in mortality of juveniles, as the mesh lumen tend to close under tension, preventing their release. CIFT has developed



Square mesh cod end panel



square mesh panels for trawl cod ends, incorporating square meshes, which do not close under tension, and facilitates escapement of juveniles and sub-adults.

Improved lobster trap

Spiny lobsters constitute an important item of marine products exported from India fetching foreign exchange for the country. Thousands of traditional fishermen are dependent on this fishery for their livelihood. The traditional traps used by them for exploiting spiny lobsters are made of easily biodegradable vegetable fibres. These traps are crude in shape, less efficient and last only for 2-3 weeks. CIFT has developed a new trap which is 70 x 55 x 40 cm in size and is fabricated out of M.S. rod frame and mounted with 2.5 cm square welded mesh. Corrosion being the greatest drawback for iron materials in seawater, a complete coating of plastic is provided to the trap as a measure of preservation which makes the iron material completely impervious to seawater. The trap lasts for 3-4 seasons and is 2.5 times more efficient than the traditional trap in terms of catch and is economically advantageous in the long run. These traps have become highly popular among traditional fishermen of south west coast of India.

Studies on baits for lobsters revealed that diesel oil can be successfully used as bait to attract lobsters to the traps.



Collapsible lobster trap

Freezing of fish and shellfish

CIFT has developed a number of processes for freezing almost all important varieties of fish, both marine and fresh water and shellfish available in the country. This includes freezing of prawns, squid and cuttle fish, lobster tails, pomfrets, seer, mackerel, sardines, crab, clam, mussel, oyster meat, major carps and milk fish.

Canning of fish and shellfish

Canning is a form of preservation of food materials. Fresh foods normally carry organisms which will cause spoilage if their activity is not restricted. The basis of canning process rests on the destruction of these organisms by heat and prevention of the entry of others. Enzymatic action will also be restricted by heat treatment. Methods have been developed for canning almost all varieties of fish and shellfish in different forms and media.

Canning of prawn, tuna meat, sardines in different media, clam meat, mussel meat, crab meat, edible oyster meat etc. are some of the examples worthy of mention. But due to the prohibitive cost of the cans, the canning industry had a major set back and now attempts are being made for alternate methods for the heat processing of fish and fishery products.

Tin free steel cans have been popularised as a



Canned fish and shellfish

viable and satisfactory alternative to tin cans by CIFT and this is now running canning industry in the country.

Ready to serve fish curry in flexible pouches

Value addition and diversification to satisfy the ever changing and diverse demands from the importing countries as well as urban consumers at home are some of the major challenges faced by the Indian fish processing industry. Value addition is the most talked about word in the fish processing industry these days because of the increased realization of foreign exchange and high unit value of such products. One such value added product developed at CIFT is fish curry processed in flexible pouches.

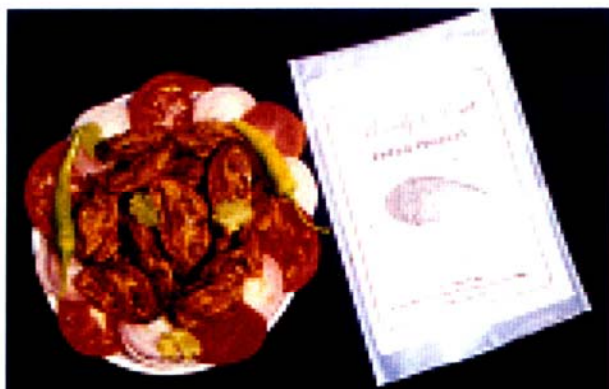
The earlier attempts on popularising a ready-to-serve fish curry could not meet with success because of the above limitations imposed by the metal containers. Now CIFT has successfully developed a suitable three-layer configuration of flexible pouches which can perform the packaging function equally well as metal cans, and is free from the disadvantages met with them. This is a retortable flexible pouch based on Polyester/Aluminium foil/Cast polypropylene. Now flexible pouches are manufactured in India employing the configuration developed by CIFT and this opened the way for commercialisation of heat processed fish curry in flexible pouches. CIFT has standardised the process for the production of fish curry in these pouches using over pressure autoclave and the curry processed in them has remained without any change for over a year at room temperature.



Mughlai fish curry from UP



Fish curry from NEH



Fried mussel

CIFT has a research/pilot model of autoclave with full provisions for monitoring all functions associated with thermal processing of flexible pouches and allied infrastructural facilities.

CIFT can offer state-of-the-art technical consultancy services on heat processing of food products in flexible condition.

Improved method of fish curing

The present method of fish curing is somewhat crude and unhygienic. The fish after salting is sun dried on the open beach or ground by which process

it gets contaminated with a lot of sand and mud. Fish cured in this way often shows contamination with red halophilic bacteria and fungus and these products cannot be stored for more than two months.

A method has been standardised for preparing good quality cured fish. In this improved method, the fish, after proper evisceration and cleaning, is salted in specified way and kept in clean cement containers for about 24 hrs. The salted fish is dipped in saturated brine containing 5% Calcium propionate for 2-5 mts. followed by drying. The dried fish is then packed in polythene bags for retail marketing and in synthetic woven sacks for bulk marketing. The preservation traced dry fish has a shelf life of more than Six months.

Solar drier

A sophisticated fish tunnel dryer using solar energy, with LPG back up for operations during monsoon season, was developed. The dryer uses forced convection system and is superior to natural convection type dryers due to reduced risk of spoilage and increased capacity. The manifold advantages of this dryer are hygienic drying conditions, protection against dust, insects, birds, rodents and climatic conditions, reduction of drying time, minimum mass loss, operation without fuel consumption, improved quality of the product, low operation cost etc. This model is being popularized



Solar drier for drying fish using solar panels

in collaboration with MPEDA. This will be useful for entrepreneurs.

Apart from this, a variety of implements and machineries used in fishing and fish processing and electronic instruments for use in these fields have also been developed by the Institute.

Freeze dried fish products

Freeze drying has become an accepted method of food preservation and is gaining more popularity because of its several advantages. In this technique, the material is frozen and the ice is directly converted to vapour (by sublimation) and is removed. The dried, porous material can be well re-hydrated when required. As the moisture content of the freeze dried product is 1-3%, the material has to be packed in air tight containers and stored at ambient temperature. CIFT has developed techniques for processing several freeze dried fish products including ready-to-serve soup mixes, salads etc.

Dehydrated jelly fish

Jelly fish is a marine species abundant in the east and west coasts of India. It has hitherto been unutilised, although some of the species are said to be edible. CIFT has now worked out a suitable method for processing jelly fish. As it is highly susceptible to spoilage under tropical conditions, it has to be processed immediately after catch or kept for a short period in iced condition.

In the process developed, the umbrella portion alone is taken, trimmed, cleaned, washed well and then treated in four solutions of salt and alum of different concentrations and drained till the moisture content is reduced to less than 60%. It is then graded, packed and stored in chilled condition at around 0°C.

Beche-de-mer

Beche-de-mer is the commercial name for cured Holothurians commonly known as sea cucumbers.



This is a high unit value dry fish item almost entirely exported. Beche-de-mer is known to have a unique place in Chinese diet probably due to its reputation as an aphrodisiac and for treatment in high blood pressure. An improved technique has been evolved for processing Beche-de-mer. The process involves evisceration of fresh sea cucumbers, cooking in boiling water, drying and packing in gunny bags.

Improved method of preparation of 'masmin'/ 'masmin' flakes

'Masmin' is a traditional fish product of Lakshadweep prepared from tuna fish which is an abundant catch of the island. Traditional 'masmin' is crude and poor in quality fetching a very low price. Improvement in quality is sure to fetch the product a better price leading to the betterment of the island's economy.

An improved method has been developed for preparing 'masmin'. The fillets from tuna are cut into steaks, brined, steamed, partially dried, smoked and finally dried followed by packing. 'Masmin' is usually made into shavings or flakes before preparing food dishes. The hardness of the dried product makes the preparation of flakes very difficult. Hence, process has now been developed to convert the cooked product into flakes before smoking and drying.

Fish wafers and soup powder

These are a protein rich food products prepared from miscellaneous fish. Fishwafer is prepared out of fish meat, starch powder, salt etc. The cooked meat is first homogenised with water. To this, corn flour, tapioca starch and salt are added and the whole mass blended for about an hour. The homogenised slurry is then spread uniformly in trays in layers of 3-4 mm thickness and cooked in steam. The cooked material is then cooled and the layers cut into desired shapes and dried. For consumption, it is fried in oil and used as a side dish. Soup powder is another type of protein rich food formulated by CIFT. Cooked fish

meat is mixed with fried onion and other ingredients and ground thoroughly till it becomes a fine paste. The pasty mass is spread in trays, dried and powdered. The fine powder is mixed thoroughly with the required quantity of milk powder and stored in bottles or laminated paper bags. The product is a rich source of animal protein and other nutrients and stores well for 16-18 months at room temperature. For consumption, one part of the powder is boiled in 20 parts of water for five minutes.

Battered and breaded products

These items form an important class of value added fish products. The battering and breading process increases the bulk of the product, thus reducing the cost element. The basic fish products prepared after preliminary processing are battered



Fish balls - A battered and breaded product



Battered and breaded fish nuggets



and breaded to obtain the final products which can be stored in frozen condition for future use. CIFT has developed methods for preparation of several types of battered and breaded fish/shellfish products. Important among them are fish fingers, fish sticks, fish cutlets, fish patties (burgers), prawn products like peeled and deveined, cooked and peeled, fan tail (butterfly) and round tail-on, squid rings, stuffed squids, mussel, clam and oyster, cuttlefish fillets, fish fillets etc.

Pickles from fish and shellfish

Fish pickles have got wide acceptance in the internal markets. They are likely to get regular foreign markets particularly in gulf countries. The meat from fish/shellfish is prepared as per specific methods, mixed with salt, kept aside for some time, fried and mixed with lightly fried chilli powder, turmeric, mustard seed, garlic and ginger. After cooling, vinegar is added and the product stored in clean bottles. Pickle prepared by this method keeps well for 8-10 months. Pickles can be prepared from fish, prawns, mussel meat, clam meat, oyster meat etc.

Fish byproducts

There are a number of byproducts obtained from fish and shellfish during the course of their processing. These byproducts are commercially important materials finding application in several fields. The more important of such byproducts for which technologies have been perfected by the Institute are given below.

Chitin, Chitosan and Glucosamine hydrochloride from prawn shell waste

More than 1,00,000 tonnes of prawn and other crustacean shell waste is available annually from prawn processing centres in India. This is not properly utilised at present. CIFT has developed a process for preparation of Chitin from prawn shell waste. Chitin can be incorporated in the diet for broiler chicks. The diet with Chitin was found to

improve the feed efficiency, resulting in about 10-12% weight gain in the birds compared to a Chitin free diet. Use of Chitin for the production of Glucosamine hydrochloride which finds application in antibiotics and baby food formulations is also popularised. Chitin is also a raw material for preparation of Chitosan. Chitosan is a valuable chemical substance finding use in several fields. Process has been developed for preparing Chitosan from crustacean shell wastes.

Chitosan can be used as sizing material for textiles. It can be used as a water/wine clarifying agent and also in the preparation of cosmetics, pharmaceuticals etc. Recent studies have shown the effectiveness of Chitosan (in the form of microfinned powder) impregnated gauze and film for treatment of chronic wounds and external ulcers and to arrest/minimise bleeding in brain surgery. Chitosan film can also be used as artificial skin and kidney membrane, and as contact lens. Incorporation of Chitosan during mixing and homogenisation of shrimp and fish feeds for pelletisation and granulation of the feed imparts very good water stability to the feed without the use of sophisticated machinery.

Fish feed

With the advancement of scientific fish/prawn farming in India, need for good quality feed was also felt. The indigenous feed used by farmers does not meet the nutritional requirements of the fish. Other types of feed available in the market are very costly. Formulation have been worked out at CIFT for preparation of fish/prawn feed at reasonable cost by incorporating miscellaneous fish and fishery wastes like prawn shell and squilla, ground nut cake, ground nut oil, starch and salt mixture in specified proportion. This feed can be prepared by the skilled farmers with minimum facilities.

Surgical sutures

Absorbable surgical sutures are an essential requirement for wound healing after a surgery. Of the various materials tried, cheap gut is found most



acceptable and is the most popular material now used all over the world. But it has its own drawbacks and is also very costly.

CIFT has been examining the possibility of using processed fish guts as surgical sutures thus providing a relatively cheaper suture material and at the same time ensuring utilization of the presently wasted fish guts. Absorbable extra fine sutures are prepared from the fish gut collagen by cross linking and polymer coating and has been found suitable for retinal and other microsurgery. It is comparable to the commercial products in properties like thickness, uniformity, breaking strength etc. and is free from abnormal tissue reactions.

Collagen - Chitin film

This film is prepared from collagen and Chitosan obtained from fishery wastes and can be used as artificial skin. It is used for covering wounds/burns to prevent moisture loss and microbial invasion.

Purified air bladder is partially dissolved in a hydrophilic solvent. Viscous suspension obtained is spread on clean glass surface and evaporated to give a thin film of collagen. Reformed Chitin matrix is deposited on this exposed surface to give strengthened collagen film.

Shark cartilage

The skeleton of shark is made of cartilaginous bones, which is about 10-15% of the body weight. Until recently, only very small quantity of these bones was made use of, that too from the small shark, for making buttons and necklaces. The cartilage is rich in Chondroitin sulphate which has got application in medicine for treatment of arterosclerosis, blood vessel thrombosis and also to prevent infections. Now there is very good demand from Europe, USA and Australia for processed shark bones.

The head and vertebral column of the shark collected are to be processed to a presentable and

stable form before export. A procedure has been developed for the processing of the cartilage into a clean, dry, white, attractive material without any characteristic smell. The products are well accepted by the overseas buyers.

Squalene from shark liver oil

Squalene is a hydrocarbon found in the liver oil of some species of deep sea shark. It is isolated by fractional distillation under vacuum. An improved method has been developed to extract squalene from shark liver oil. This has been commercialised.

Squalene is used in the preparation of steroid hormones, treatment of wounds and liver diseases and as anti-cancer agent and as a bactericide.

Hydrogenated squalene (Squalane) is used in the preparation of cosmetics, perfumes and aromatics and as anti-aging agent and lubricant in finishing silk and wool.



Squalene in pharmaceuticals

Shark fin rays

Shark fin rays are valuable products of export from India. Formerly, only shark fins were being exported. But now, even fin rays are exported. CIFT has developed a technique for extracting rays from shark fins.

The dried fins are soaked in dilute acetic acid for sufficient time to get the muscle and skin softened. The skin is then scraped off and the fins further



treated with dilute Acetic acid when separation of the rays in clusters becomes easy. The rays are then dried and packed in polythene bags.

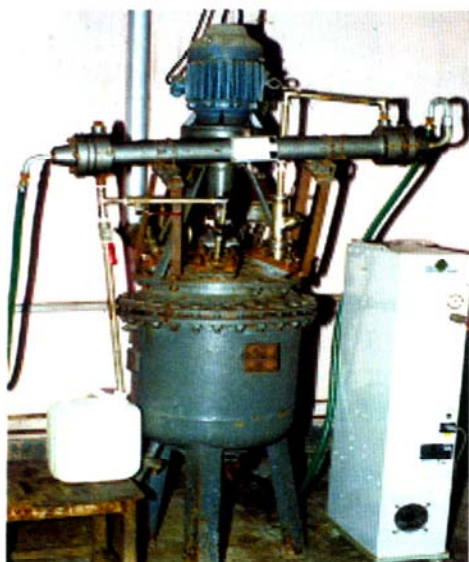
The rays are utilised in the preparation of soup in many foreign countries. There is good internal demand also for shark fin rays especially in major star hotels.

Isinglass

Fish maws are carefully washed and dried air bladder of fish. Air bladders are taken mainly from dara fish, jew fish, cat fish, eels etc. Fish maws are mainly used for making isinglass. Fresh air bladder is taken out, the internal membrane is removed, and the bladder is well cleaned and dried. Fish maws have great demand in foreign markets.

Concentrated PUFA from fish oil

Poly Unsaturated Fatty Acids (PUFA) have therapeutic value as they have the power to lower the cholesterol level. A method has been worked out and perfected by the Institute to increase the PUFA content in the oil by suitable methods of concentration.



Pilot plant for PUFA extraction

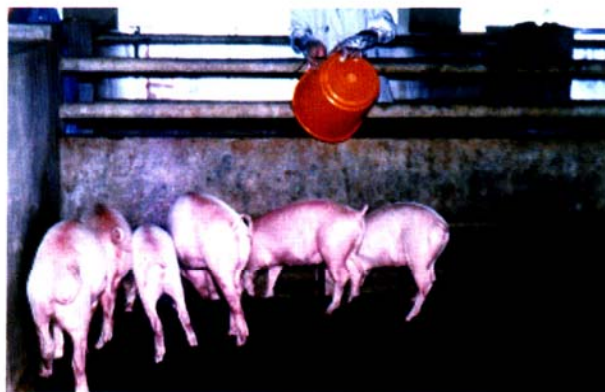
Agar and agarose from sea weeds

Sea weeds are important organic renewable resources of the sea, used for a variety of purposes like preparation of agar, agarose, carrageenan etc.

CIFT has developed a process for producing good quality agar with high gel strength by alkali treatment instead of the conventional acid treatment method. Dried sea weeds are soaked in water, agitated to remove foreign particles, drained, treated with Sodium carbonate solution and heated. It is then washed repeatedly to free it of the alkali and the agar extracted by boiling with dilute Hydrochloric acid. The extracted gel is frozen and then thawed and the thaw water is drained off. The gel obtained is bleached, washed with water, drained and dried. It is then powdered and stored in plastic bags.

Fish ensilage

A method for the preparation of good quality cattle/ piggery/ poultry feed supplement by ensiling fishery waste has been popularized by CIFT. This has solved the environmental problem caused by the decaying waste by converting it into a useful product of high nutritive value with an agreeable smell.



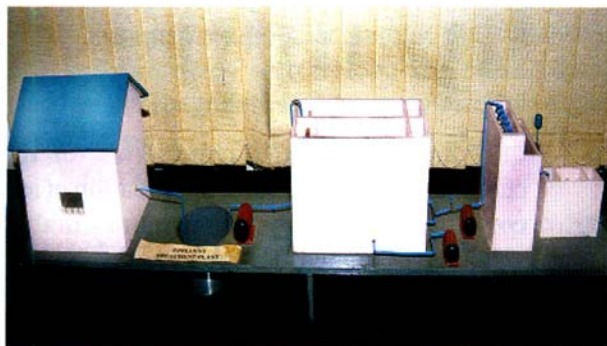
Feeding trials of ensilage based feed

Effluent treatment system

A simple effluent treatment system was designed to meet the standards of the Pollution Control Board.



This system installed in a leading exporter's factory on a consultancy basis has attracted the attention of all exporters. For an industry consuming enormous quantity of water, this innovative design, ensuring disinfection and clarification of the effluent will be a big boon. It will avoid wastage of precious water also.



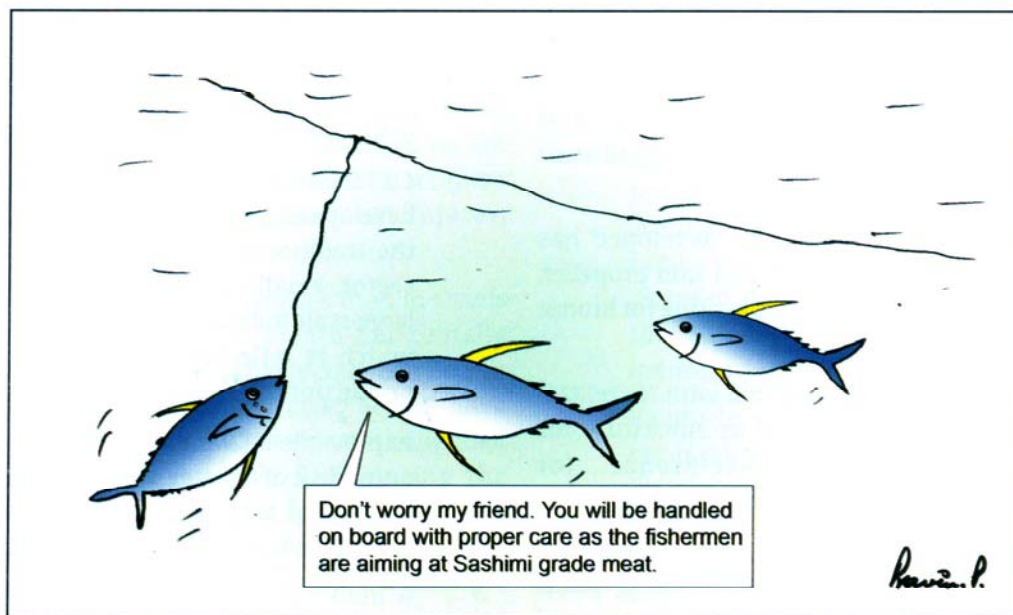
Model of the effluent treatment plant

Basic Studies

In addition to these, extensive basic studies on the biochemistry of fish spoilage, nutritional value of fish and fishery products and changes during processing and preservation have been taken up which have yielded valuable information.

Conclusion

CIFT has developed a number of technologies for the benefit of fishermen and for the fish industry and has tried best to transfer the technologies to the actual end users. With the untiring efforts of CIFT, the country has earned the name as one of the best countries exporting fish and shellfish, earning maximum foreign exchange.





A Quick Glance at Past Research Achievements

- CIFT has developed and introduced 12 standard designs of mechanized wooden fishing boats in the size range of 7.67 to 15.2 m LOA for coastal and intermediate range. It is estimated that over 80% of the nearly 54,000 mechanized wooden fishing crafts in the Indian fishing fleet confirm to the popular CIFT designs or its later adaptations.
- Hull maintenance of the fishing vessels is important for increasing its service life. CIFT has developed a package of technologies for protection against bio-deterioration, fouling and corrosion for increasing the life span, substantially reducing maintenance cost of fishing vessels.
- Aluminium-Magnesium alloy sheathing with cathodic protection and prescribed coating system was developed as a cost-effective substitute for Copper sheathing for wooden hulls as protection against marine borers. This technology is widely used in the small-scale mechanized vessels.
- Epoxy resin based coating developed has improved the life span of cast iron propeller, making it a cost-effective substitute for Bronze propeller in fishing boats.
- Spheroidal graphite cast Iron with Nickel (21-24%) was recommended as substitute for conventional Manganese-Bronze for propellers of fishing boats, resulting in cost savings of 25-30%.
- Superior cost-effective antifouling paint formulations incorporating Cuprous oxide and modified indigenous resins were developed for protection against fouling in fishing boats.
- CIFT has developed technologies for the chemical preservation and upgradation of low cost timbers to make them more durable. These have extended the service life of fishing crafts and contributed towards the efforts against deforestation.
- Technology was evolved for upgradation of cheaper secondary species of wood as substitute for boat scantling, by impregnation with styrene-polyester monomers, fortification with Creosote/Tributyl tin oxide and polymerization with gamma irradiation.
- CIFT has made immense contribution towards the standardization of the netting, netting yarn and netting twine used for fishery purposes. These developments have led to an increase in the productivity of the fishing gear and increase in net profits due to low maintenance and long service life of the nets.
- CIFT has made significant contributions in the development of fishing gear and methods for the traditional sector, traditional motorized sector, small-scale mechanized sector and large-scale industrial sector in Indian fisheries, which is reflected in the increase in fish production.
- Improvements were made in the design and durability of lobster traps as substitute for traditional traps of short life span and low efficiency, for harvesting of spiny lobster.
- A mini-trawl for operation from traditional crafts powered by outboard motors of 8-15 hp,



for shallow water shrimp trawling was introduced.

- The purse seine was introduced and popularized for operation from traditional plank built canoes (Thangu vallom) powered by outboard motors, for efficient harvesting of pelagic shoaling fishes. Since its introduction, the mini-purse seine has become very popular among the fishermen of motorized sector along the coast line of Kerala, contributing significantly to the landings of pelagic resources such as sardines, mackerels and anchovies.
- Specially designed trawl for shrimp trawling with vertical opening and extra long wings on either side was found effective for sweeping of wider horizontal area along the sea bed resulting in increased shrimp catch.
- Bulged belly trawl with relatively high opening was designed to improve the catch of fin fishes without compromising on shrimp catch.
- In high opening trawls, vertical opening of the trawl is increased by innovative design improvements, facilitating capture of demersal as well as off-bottom resources.
- Large mesh trawl with relatively large meshes in the front portion resulted in significant reduction in trawl resistance, making use of the herding effect of large meshes on fin fishes. These designs have been well accepted by the trawler fishermen of Gujarat, Karnataka and Kerala.
- Otter boards are sheer devices used in trawls for keeping the trawl mouth horizontally open. Different sizes of flat rectangular boards and vertically cambered otter boards have been introduced by CIFT for the benefit of small-scale mechanized fleet, during the course of its development. V-form otter boards with high stability, better hydrodynamic efficiency, low maintenance cost and longer service life is now replacing the flat rectangular boards in the small-scale mechanized sector. Overall savings by adoption of V-form otter boards in place of flat rectangular boards is about 15%.
- Purse seines for catching pelagic fishes such as sardine and mackerel, from small mechanized vessel has been developed.
- Long lines for sharks using indigenous hooks has been developed as a low energy resource-specific alternative to energy intensive, less selective fishing methods such as trawling.
- Troll lines for predatory fishes such as Spanish mackerel and barracuda using buffalo horn, stainless steel spoon and fish head jigs were developed.
- Marine gill net optimized for catching sardine, mackerel, Spanish mackerel, pomfret and hilsa, in terms of material and mesh size were introduced for the benefit of non-motorized and mechanized segments of the industry.
- Gear systems have improved the capture fishery production from the inland open water resources significantly over the years. Trammel nets and monolines were also introduced in reservoir systems.
- Technology for the extraction of Chitin from shrimp shell and conversion to Chitosan has successfully addressed a very serious environmental threat due to the careless disposal of the waste. Eight parties have already taken this technology and started production and marketing. Nearly 20% of the available shell waste is being used by these industries for conversion to Chitin and Chitosan. In addition to creating employment, this has become a highly remunerative industry.
- Ready-to-serve fish curry products in retortable pouches can be stored at ambient temperature. This revolutionary technology has been given to more than a dozen parties who have already started production and marketing. This technology has long term impact in terms of value addition.



- Isinglass is a product that has got application as a clarifying agent in breweries, mainly in the beer industry. The technology was transferred to an industry for commercialization. This has resulted in the production of a value added product which has got demand in domestic and foreign market.
- The technology for extraction of Poly Unsaturated Fatty Acids (PUFA) from fish oil is a very important contribution towards nutritional security by providing a vital nutritional component. Many multinational companies are importing PUFA-enriched products and this technology will lead to import substitution. This value-added product will help in increasing the income of the fishermen.
- Collagen-Chitosan film has wide applications as a wound dressing and in dental surgery. It replaces the imported Teflon membrane used in dental surgery and the cost will be only a small fraction of that of the imported material. The raw material is fish air bladder, which does not find any use now. This technology can utilize the industrial waste and thus can enhance the income of the fishermen.
- Database on biochemical composition of fish serves as the major source of data for product formulation and nutrition labeling.
- A single step microbiological assay was perfected for detecting residues of eight antibiotics in seafood, viz. Chloramphenicol, Oxolinic acid, Tetracycline, Oxytetracycline, Furazolidine, Nalidixic acid, Neomycin and Trimethoprim which are commonly found used in aquaculture farms in India. The method can detect the antibiotic residues to a level of 0.1 ppm. About 65 seafood factories in Andhra Pradesh, Tamil Nadu, Kerala, Karnataka, Maharashtra and Gujarat exporting seafood to EU and US are direct beneficiaries of this technology.
- A two step nested PCR method for the detection of White Spot Syndrome Virus in shrimps was developed, standardized, assessed and introduced for commercial use. This method will detect the presence of as small as 10 virions per host larvae. The technology is being used for regular testing of post larvae before introduction to the farms.
- A RT-PCR method to test the presence of the devastating Yellow Head Virus in shrimp farms was developed, assessed and commercialized. This is the only test method for YHV now available in India. The method is being currently used for screening frozen shrimp for YHV, being exported to the US, to meet the phytosanitary regulations of the WTO.
- An improved ELISA method for detection of residues of Chloramphenicol, a 'zero tolerant' antibiotic, in processed seafood for export to EU, US and Japan was evolved. This improved method was assessed and commercialized in 2003. It is now regularly used to monitor Chloramphenicol level in farmed and processed shrimps. Hundreds of shrimp farmers and seafood exporters have gained by the technology.
- The 'Chloritest paper' developed for detection of ppm levels of Chlorine in process water, an essential requirement to implement sanitation and hygiene practice in food processing industry, was transferred to M/S Glaxo Laboratories. This has resulted in the non-rejection of seafood/food items on the basis of contamination with pathogens significantly, resulting in substantial savings of foreign exchange to the country.
- Suitable programmes were organized for implementation of HACCP in the seafood industry. A software and multimedia CD was also developed for HACCP.
- Throughout India the effluent treatment system attached to seafood processing units is a neglected area resulting in serious environmental problems. To alleviate this problem of pollution by the seafood industry,



an efficient effluent treatment plant was designed to treat the effluents conforming to the Pollution Control Board standards.

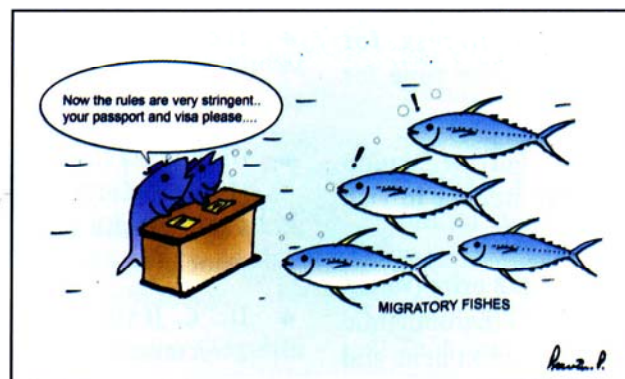
■ The following engineering equipment have been developed by CIFT for use in fishing and fish processing:

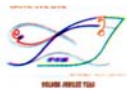
- ◆ SS Tilting Kettle
- ◆ Oil fryer for battered and breaded products
- ◆ Tunnel Dryer
- ◆ 15.5 m fuel efficient steel fishing vessel
- ◆ Fibreglass canoes
- ◆ Environmental data acquisition system
- ◆ Temperature-Salinity meter
- ◆ Ship borne data acquisition system
- ◆ Speed and distance log
- ◆ Trawl depth meter

■ The following aspects having management and policy level implications in fisheries have been studied by the Institute:

- ◆ Idle capacity in fish processing plants in India
- ◆ Price analysis of Indian seafood in the export market
- ◆ Economics of artisanal fisheries
- ◆ Economics of operation of fishing vessels on both West and East coast of India
- ◆ Price spread in domestic fish markets of Kerala and Gujarat

- ◆ Fuel utilization pattern by the fishing industry in India
- ◆ Assessment of harvest and post harvest losses in fisheries
- ◆ Estimation of inland fish landings in reservoirs
- The Institute also undertakes research studies which provide feedback to technology development and transfer. The following are some of the works undertaken:
 - ◆ Socio-economic profile of fisherfolk in different parts of the country and development of socio-economic status scale.
 - ◆ The areas and extent of participation of women in fisheries related activities.
 - ◆ The types and activities of co-operatives and other organizations in fisheries and the role played by them in small scale fisheries.
 - ◆ Adoption behaviour including extent of adoption, communication, decision making, response to technological gaps of fishermen in traditional, mechanized and motorized sectors and fish curers in relation to technology transfer by the Institute.
 - ◆ Evaluation of the training and extension programmes taken up by the Institute in terms of gain in knowledge, awareness, practices and constraints.
 - ◆ Studies on ban on monsoon trawling, coastal zone management and socio-legal issues.





Awards and Recognitions

- ◆ Dr. T.S.G. Iyer (1970) – Invention Promotion Award for ‘Humane method for cutting frog legs’
- ◆ Dr. T.K. Sivadas (1971) – Invention Promotion Award for ‘Operational depth telemeter instrument’
- ◆ Shri A.P. Valsan (1973) – Invention Promotion Award for ‘Improved method for preservation of cured fish’
- ◆ Shri M. Velu (1974) – Invention Promotion Award for ‘Mechanical weeding equipment’
- ◆ Dr. T.K. Sivadas (1976) – Invention Promotion Award for ‘Warp tension measuring instrument’
- ◆ Dr. P.G. Viswanathan Nair (1983) – Jawaharlal Nehru Award (ICAR) for best Ph.D. thesis
- ◆ Dr. K.G. Ramachandran Nair (1986) – Jawaharlal Nehru Award (ICAR) for best Ph.D. thesis
- ◆ Dr. A. Ramachandran (1987) – Young Scientist Award of Asian Fisheries Society for best scientific paper
- ◆ Dr. B. Meenakumari (1989) – Young Scientist Award of Kerala Science Congress for Development of combination wire rope for import substitution
- ◆ Shri H. Krishna Iyer (1989) – Port of London Authority (U.K.) prize for best student in Fish marketing
- ◆ Dr. B. Meenakumari (1989) – 5th JRB prize (Young Scientist Award) of Academy of Environmental Biology for work on aquatic environment and fisheries
- ◆ Shri V. Vijayan, Shri T. Joseph Mathai, Shri H.N. Mhalathkar and Shri M. Syed Abbas (1993) – Best Scientific paper Award of Society of Fisheries Technologists (India)
- ◆ The Institute (1994) – TOLIC Award for best performance in Hindi implementation
- ◆ The Institute (1995) – TOLIC Award for best performance in Hindi implementation
- ◆ Dr. K. Gopakumar, Shri P.V. Prabhu, Shri P. Madhavan and Dr. K.G. Ramachandran Nair (1995) – ICAR Award for team research for 1991-93 on fishery waste by product utilization for food and industrial purposes
- ◆ Shri M. Baiju (1995) – Outstanding trainee award from South East Asian Fisheries Development Centre (SEAFDEC), Thailand
- ◆ Shri C.R. Gokulan (1996) – Outstanding trainee award from South East Asian Fisheries Development Centre (SEAFDEC), Thailand
- ◆ Dr. K. Gopakumar (1996) – Rafi Ahmed Kidwai Award for 1993-1995 (ICAR) for outstanding contribution in fishery science
- ◆ The Institute (1996) – III position rolling award of TOLIC for best performance in Hindi implementation
- ◆ Dr. C.N. Ravishankar and Dr. K. Ashok Kumar (1997) – Certificates from Royal Institute of Public Health and Hygiene, London on HACCP principles
- ◆ Dr. C. Jessy Joseph (1999) – Central Hindi Directorate Award for literary contribution in Hindi from non-Hindi speaking areas



- ◆ Dr. Krishna Srinath (2000) – National Award of Department of Science and Technology for Women's development through application of science and technology
- ◆ Dr. Leela Edwin (2000) – Jawaharlal Nehru Award (ICAR) for best Ph.D. thesis
- ◆ The Institute (2000) – Sardar Patel Outstanding ICAR Institution Award for 2000
- ◆ The Institute (2001) – Rajarshi Tandon Rajbhasha Puraskar 2000-2001 for best implementation of official language among ICAR Institutes in 'C' region
- ◆ Dr. B. Madhusudana Rao (2001) – Dr. S. Vancheeswara Iyer Memorial Award of Indian Veterinary Association for best article in Indian Veterinary Journal
- ◆ Dr. M.K. Mukundan (2001) – Approvals as National Accreditation Board for Laboratories (NABL) assessor
- ◆ Dr. T.K. Srinivasa Gopal, Shri T.S. Unnikrishnan Nair, Shri P.K. Vijayan and Dr. C.N. Ravishankar (2002) – ICAR award for team research in the field of fisheries research for the biennium 1999-2000
- ◆ The Institute (2002) – Rajarshi Tandon Rajbhasha Puraskar 2001-2002 for best implementation of official language among ICAR Institutes in 'C' region
- ◆ Dr. B. Meenakumari (2003) – Panjab Rao Deshmukh Woman Agricultural Scientist Award – 2002 (ICAR)
- ◆ Dr. M.K. Mukundan and Dr. K. Ashok Kumar (2003) – Certification as ISO 1400 Lead Auditors by BIS and Marsdon International, U.K. for auditing industrial units
- ◆ Dr. B. Madhusudana Rao and Dr. P.K. Surendran (2004) – Best Scientific paper award – 2003 of SOFT(I) published in Fishery Technology
- ◆ The Institute (2005) – Ganesh Sankar Vidyarthi Agricultural Journal in Hindi Award (ICAR)
- ◆ Dr. M.R. Boopendranath, Dr. P. Prawin, Shri T.R. Gibin Kumar and Shri S. Sabu (2005) – International Smart Gear Award -2005 of World Wildlife Fund (WWF) under the category other non target species (including fish) for the development of a fishing device that provides facilities for escapement of juvenile fish and shrimp sorting in bottom operated commercial shrimp trawl nets
- ◆ Dr. Saly N. Thomas (2005) – Jawaharlal Nehru Award (ICAR) for best Ph.D. thesis
- ◆ Dr. T.K. Srinivasa Gopal, Dr. C.N. Ravishankar and Smt J. Bindu (2006) – K. Chidambaram memorial award – 2005 for outstanding work done on development of value added fishery products
- ◆ The Institute (2006) – Rajarshi Tandon Award 2005-2006 for the best official language implementation among ICAR Institutes in 'C' region
- ◆ Dr. P.N. Joshi (2006) – Kerala State Energy Conservation Commendation Certificate – 2006 in the category Research and Innovation for 'An energy efficient eco-friendly solar fish dryer with LPG backup'
- ◆ Dr. Leela Edwin, Dr. Saly N. Thomas and Dr. B. Meenakumari (2006) – Best Scientific paper award – 2005 of SOFT(I) published in Fishery Technology
- ◆ The Institute (2007) – Sardar Patel outstanding ICAR Institution Award for 2006
- ◆ The Institute (2007) – NABL accreditation as per ISO 17025 by National Accreditation Board for Testing and Calibration Laboratories, New Delhi
- ◆ The Institute (2007) – Rajarshi Tandon Rajbhasha Puraskar 2006-2007 for best implementation of official language among ICAR Institutes in 'C' region
- ◆ Dr. B. Meena Kumari (2007) - Women and Technological Innovation National Award (Triennial) by Bharathiya Stree Sakthi, Mumbai



ICAR Outstanding Institution Awards



Dr. K. Devadasan, Director receiving the Sardar Patel Award - 2000 from Shri Nitish Kumar, Hon'ble Union Minister for Agriculture in the presence of Dr. R.S. Paroda, DG, ICAR



Receiving the Sardar Patel Award - 2006 from Shri Sharad Pawar, Hon'ble Union Minister for Agriculture in the presence of Shri Kantilal Bhuria, Minister of State for Agriculture and Dr. Mangala Rai, DG, ICAR



INDIAN COUNCIL OF AGRICULTURAL RESEARCH

**SARDAR PATEL OUTSTANDING
ICAR INSTITUTION AWARD**

2000

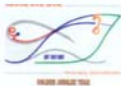
CITATION

The Sardar Patel Outstanding ICAR Institution Award for the year 2000 is bestowed upon the **Central Institute of Fisheries Technology, Kochi**, for its notable research work in fisheries.

The Central Institute of Fisheries Technology, Cochin, is the premier research Institute in India in the field of fishing and fish processing technology. Established in 1957 as the Central Fisheries Technological Research Station, it was given the status of an Institute in 1962 and an ICAR Research Institute in 1967. It has two major regional research centres, one at Varaval (Gujarat) on north west coast and the other at Vishakhapatnam on the east coast.

The Institute is responsible for leading the industry from its traditional ways of fishing to the most modern and technologically advanced levels, combining indigenous technical knowledge with international requirements. The responsible fishing methods and seafood quality assurance techniques are the hallmarks of its achievements. The methods developed at the Institute have helped both the large and small scale processors in better utilization of fish catch.

The major contributions include human resources development in the fisheries sector through well designed training programmes for in-service personnel, technicians and fishermen. A post-graduate degree programme in Post-harvest Technology has been introduced in the Institute and is affiliated to the Central Institute of Fisheries Education, Mumbai. The Central Institute of Fisheries Technology has played a very important role in bringing India into the fisheries map of the world. The pioneering contributions and extensive research work done at this leading research Institute has brought the country to the 8th rank in the world with other developed nations in fishing as well as in fish processing technologies.



Cift Golden Jubilee 1957-2007



INDIAN COUNCIL OF AGRICULTURAL RESEARCH

SARDAR PATEL OUTSTANDING ICAR INSTITUTION AWARD

2006

CITATION

Among the National Institutes, the Sardar Patel Outstanding ICAR Institution Award, 2006 is bestowed upon the Central Institute of Fisheries Technology (CIFT), Cochin, for its outstanding work in fisheries technology.

The Central Institute of Fisheries Technologies was the proud recipient of the International Smart Gear Award instituted by the WWF, in addition to several other National Awards. The Institute is responsible for leading the industry from its traditional ways of functioning to the most modern and technologically advanced levels combining indigenous technical knowledge with international requirements. It has placed the country to a coveted position in the global fish market. The responsible fishing methods and seafood quality assurance techniques are the hallmarks of its achievements. The processing methods developed by the CIFT have helped both large scale and small-scale processors in better utilization of fish catch.



Technologies Assessed and Transferred

- Designs of wooden fishing vessels in the size range of 7.6 m – 15.2 m
- Development and popularization of designs of steel fishing vessels of size 15.5 m LOA, 20 m LOA and fuel efficient vessel of 18 m LOA
- Design of Aluminium craft for inshore waters and FRP pole and line fishing vessels for Lakshadweep
- Substitution of wooden boats by FRP canoes and treated rubber wood canoes for use in backwaters and near-shore waters
- Dual preservative treatment for low valued species of timbers for boat construction
- Painting schedules for Aluminium-Magnesium alloy and FRP sheathing for underwater hulls of fishing vessels
- Antifouling and anticorrosive paints for protection of fishing craft
- Mercury free anodes for cathodic protection of fishing craft
- Protective coating for cast iron propeller
- Specifications for different types of synthetic materials for fabrication of different types of fishing gear
- Designs of different types of fishing gear such as trawls for demersal, pelagic and semi-pelagic applications, gill nets, purse seines and traps for exploitation of the different fishery resources
- Otter boards of different sizes and designs to suit demersal trawl fishing operations and variable depth fishing
- V-form steel otter boards for demersal trawls
- Combination wire rope for deep sea fishing
- By-catch Reduction Devices (BRD) such as square mesh codend and fish eye for reducing catch of juveniles and young ones, in shrimp trawls
- Turtle Excluder Device (TED) for conservation of marine turtles
- Designs of dryers such as tunnel dryer, rotary fish meal dryer, electrical fish dryer and solar dryer with LPG/electrical back up
- Designs of deep fat fryer and cutlet moulding machine
- Fuel efficient propeller for fishing vessels and other fuel saving devices such as propeller nozzle
- Stainless steel tilting kettle for processing plants
- Oil fryer for battered and breaded products
- Meat bone separator for removal of bone including pin bones from rohu
- Electronic instruments for application in fishing technology, fish processing technology, aquaculture, marine environmental monitoring, agricultural investigations etc.
- Improved methods for freezing, freeze drying, canning, drying and curing of different types of fish and shellfish
- An improved method for production of dried prawns
- Methods for production of quality dried fish



- products with attractive appearance and long storage life
- Hygienic drying of anchoviella
- Method for economic utilization of low grade fish and conversion of fish wastes into useful by-products
- Methods for production of value added products such as wafers, pickles and soup powder from fish/shellfish
- Methods for the production of value added products such as fish balls, ready-to-cook and fry products, battered and breaded products from marine and fresh water fishes
- Ready-to-use isinglass from fish maws
- Methods for extraction of Chitin/Chitosan from prawn shell waste and their application in textile and poultry industry and in the medical field
- Pilot plant for production of Chitosan
- Method for extraction of shark fin rays and processing shark cartilage
- High gel strength agar from sea weeds
- Method for isolation of squalene from shark liver oil for use in cosmetics
- Improved packaging materials for transportation and storage of fish
- Production of retort pouch packed fish products
- Specific requirements in setting up fish processing plants
- Cleaning schedules for fish processing establishments and boat decks and preparation of deodorant and antiseptic ointment
- Chlorine level indicator paper for instant reading of chlorine level in water used in fish processing plants
- Specifications for various types of seafood, process water and ice
- Procedure for implementation of HACCP
- Design of energy efficient treatment plant for effluent water from processing plants
- Collagen - Chitosan film from fish skin, bone and air bladder for treatment of burns and as a barrier material in Guided Tissue Regeneration (GTR) in dentistry
- Fine grade absorbable surgical sutures from fish gut
- Method for preparation of n-3 Poly Un-saturated Fatty Acid (PUFA) concentrates from fish oils
- An 18 h depuration method to eradicate pathogenic bacteria and grit from bivalves, especially clams and mussels
- Bacteriological culture media for 1) direct detection and enumeration of the potent spoiler bacterium *Alteromonas putrefaciens*, and 2) estimation of total plate count of cured/semi-preserved/salted fishery products by preventing swarming of *Bacillus* sp.
- Device for drawing uniform samples from frozen fish blocks for microbiological evaluation
- Polymerase Chain Reaction (PCR) technique for detection of white spot disease syndrome in farmed shrimp



Technologies Commercialized

Designs of fishing craft and gear

Designs of more than 12 wooden fishing vessels in the size range 7.6 m – 15.2 m, Aluminium craft for inshore waters and FRP pole and line fishing vessels for Lakshadweep waters were developed. Designs for various types of fishing gear like trawls, gill nets, purse seines, lines and traps for exploitation of the fishery resources were also developed and popularized. Most of the craft/gear now in operation are built to these designs. Transferred on consultancy basis to; Govt. Fisheries Training Centre, Thane, Ministry of Agriculture, Govt. of India, Oriental High Seas Fisheries Ltd., Visakhapatnam, Pondicherry State Fishermen Co-operative Federation Ltd., PWD, Mechanical Division, Govt. of Kerala and Yedugiri Seafood Ltd., Visakhapatnam.

The mini purse seine, which was developed for operation from traditional fishing craft, is extensively used by fishermen in the motorized sector.

Designs of steel fishing vessels

A 15.5 m multipurpose fuel efficient steel fishing vessel named Sagar Kripa was developed and successful trials carried out. Business enquiries are coming in from different agencies. Transferred on consultancy basis to; Fishing Boat Operators Co-operative Society, Munambam and Ministry of Agriculture, Govt. of India.

Combination wire rope

An important substitution developed by the Institute for deep sea fishing. Commercialized

through M/s. Usha Martin (P) Ltd., Calcutta and used by large class vessels. Technology transferred to; South India Wire Ropes Ltd., Always.

V-form otter boards

These have replaced wooden otter boards in a number of fishing boats at Cochin and Veraval. They are more durable and hydro dynamically more efficient.

Quality standards for fish net twines and gear accessories

Standards of quality were laid down for cotton and synthetic fish net twines and other gear accessories. These have been adopted by the Bureau of Indian Standards for issue as national quality standards.

Fibreglass Reinforced Plastic canoe for backwater fishing

Strength, durability and light weight are the advantages of FRP. Hence it is suitable for the construction of fishing vessels, especially for use in backwaters and near-shore waters. Transferred on consultancy basis to; Chellanam Village SC/ST Service Co-operative Society, Munambam.

Several FRP canoes have so far been constructed for the Society. The technology has also been transferred successfully to the NEH region.

Painting schedules for Aluminium-Magnesium alloy for sheathing

For under water hulls of fishing vessels,



antifouling and anticorrosive paints for protection of fishing craft have been developed. Mercury free anodes (CIFTAL) made of Al, Sn and Zn have also been made for cathodic protection of fishing craft. Several parties have adopted these technologies and many of the vessels are now following the technical know-how given by CIFT.

Fabrication and popularization of Turtle Excluder Device (TED)

There is great potential for commercialization of this technology. MPEDA has already fabricated about 2000 TEDs based on CIFT know-how for distribution to interested parties.

Improved fish processing methods

Formulated for freezing, canning, freeze drying, drying/curing and smoking different types of fish and shellfish. The processes adopted by the fish processing industry are based on the technologies developed at the Institute.

Cleaning schedules for fish processing establishments and boat decks and preparation of deodorant and antiseptic ointment

These technologies have been adopted on a large scale by the fishery industry. Efficient cleaning schedules worked out for fishing boat decks, fish containers, utensils and equipment used in peeling sheds and processing plants have helped to bring down the total bacterial count and destruction of pathogenic organisms.

The deodorant developed for use in prawn peeling sheds and processing factories serve to remove objectionable odours.

The antiseptic ointment has helped to heal the lesions seen on palms of workers engaged in prawn peeling and other processing works thereby serving to avoid contamination of the processed products.

Designs of dryers

Design of driers like tunnel dryer, rotary fish meal

dryer, electrical fish dryer for cottage scale operation and pre-processing plants. Dryers as per CIFT design have been set up in many centres. Transferred on consultancy basis to; Jardine Marine Products (P) Ltd., Mumbai and Invicta Foods, Cochin.

Fuel efficient propeller for fishing vessels

The technology promises significant reduction in consumption of fuel.

Electronic instruments for agriculture and marine sciences

Several of the instruments are being used for agriculture investigations related to hydro meteorology, water management, agro-climatology etc. Transferred on consultancy basis to; Central Institute of Agricultural Engineering, Bhopal and College of Veterinary and Animal Sciences, KAU, Mannuthy, Trichur.

Production of fish meal

Processes have also been developed and transferred for production of fish meal and extraction of fish oil from the less important species of fish. Transferred on consultancy basis to; Prismack Biotechnics Ltd., Eluru (P.O.), Andhra Pradesh.

Design of a cost-effective effluent treatment plant for the seafood industry

A simple design was developed of a cost-effective effluent treatment plant for the seafood industry. Plants of this design constructed by a factory have attracted a lot of attention. Transferred on consultancy basis to; Inegrated Rubian Exports Ltd., Aroor, Southern Seafoods, Chennai, Andaman Fisheries, Andamans, Devi Marine Food Exports Ltd., Chennai and Abad Fisheries (P) Ltd., Cochin.

Economic utilization of low grade fish and conversion of fish wastes into useful by-products

Commercial plants for production of Chitin and



Chitosan have been set up based on consultancy provided by the Institute. Transferred on consultancy basis to; FDC Ltd., Mumbai, Technical Developments, Mumbai, India Seafoods, Cochin, Lapecherie, Veraval and Bureau of Fisheries and Aquatic Resources, Govt. of Philippines, Higashimaru Feeds (India) Ltd, Cochin, SPAMCHE Industries, Cochin, Tripindo Patria, Indonesia, Gadre Marine Exports, Ratnagiri and MATSYAFED, Thiruvananthapuram.

Methods for production of value added products

Products like wafers, pickles, soup etc. from fish/shellfish. Many of these technologies have been transferred to parties and many of them have already started production of these products on a commercial scale. Some have even set up export units.

Process for ready-to-serve fish curry in flexible pouches

The technology was perfected and test marketed in the Gulf countries with the help of the MPEDA. The technology of pouch packing has been extended to other food products as well. Transferred on consultancy basis to; Invicta Food Industries, Cochin, Meat Products India Ltd., Koothattukulam, Kerala, National Research Centre for Mushroom, Himachal Pradesh, Fresh Coconut Products Ltd., Kuduppissery, Trichur, Lakshadweep Administrations, Sara Spices, Kizhakkambalam, Kerala, Forstar Frozen Foods (P) Ltd, Mumbai, Britto Exports, Chennai and Anns House of Sweets, Palai, Kerala.

Improved packaging for fish and fishery products

Transferred on consultancy basis to; Amalgam Foods, Cochin.

Chlorine level indicator paper for instant reading of chlorine level in water used in fish processing plants

The product, 'Cloritest', is marketed by M/s Glaxo Laboratories, Mumbai. The paper is used by the fish

processing industry and other laboratories for various tests. Transferred on consultancy basis to; Rameshwar Cold Storage, Veraval, Kartik Cold Storage, Veraval, Bhavani Seafood, Veraval, Mamta Cold Storage, Veraval, Pinnacle Innovative Technologies (P) Ltd., Cochin, South Indian Federation of Fishermen Societies, Thiruvananthapuram and Tqs International, Cochin.

Method for extraction of shark fin rays

A valuable product of export from India. Transferred on consultancy basis to; Miranda Exports, Nagercoil.

Technology for processing shark cartilage

The technology is gaining popularity and has been transferred to several parties such as Mubarak Enterprises, Edavanakad, Jojo James, Changanacherry, C. Christopher, Cochin, Bluebay Exports (P) Ltd, Cochin, ARK Marine Biopolymers (P) Ltd, Cochin, Koshy Thomas, Cochin, India Seafood, Cochin and M.A. Ummar, Trichur

Specifications for various types of seafood, process water and ice and food processing

The processing establishments are following the specifications laid down by the CIFT.

Squalene from liver oils

Technology for isolation of squalene from liver oils of certain species of sharks.

The technology has been successfully commercialized to Asha Biochem, Badagara, Kerala.

Package of HACCP practices

A package of HACCP practices to be followed at various stages of fish handling and processing was developed by the Institute, which is being implemented by all the fish processing establishments in the country. HACCP on board



fishing vessels was also developed and transferred. Packages of practices based on HACCP for export of fish in chilled condition, HACCP for fish curry and curry powder packaging unit and other food industries were also developed and transferred to the industry. Technical assistance and advice for development of a HACCP software was also imparted to a party. Transferred on consultancy basis to; Yedugiri Seafood, Cochin, Rameshwar Cold Storage, Veraval, Kartik Cold Storage, Veraval, Bhavani Seafoods, Veraval, Mamta Cold Storage, Veraval, South Indian Federation of Fishermen Societies, Thiruvananthapuram, Pinnacle Innovative Technologies (P.) Ltd., Cochin, Sara Spices, Kizhakkambalam, Always and Forstar Instafoods Division of Forstar Frozen Foods, Navi Mumbai.

Collagen – Chitosan film

Derived from collagen of fish air bladder and Chitosan of prawn shell. Found suitable for periodontal Guided Tissue Regeneration (GTR) techniques, the technology is gaining popularity among dentists. Transferred on consultancy basis to; Eucare Pharmaceuticals (P.) Ltd., Chennai.

Fine grade absorbable surgical sutures from fish gut

Comparable to the commercial products in their physical properties – An ideal substitute for the imported product. Many private entrepreneurs have

come forward to commercialize the process. The clinical tests in the Medical Colleges have confirmed their usefulness. Transferred on consultancy basis to; Innovative Sutures, Hyderabad and Sangram Rinoose, Trichur.

PUFA from fish oils

Technology for production of medicinal grade Poly Unsaturated Fatty Acid (PUFA) concentrated from fish oils was developed and released for commercial exploitation. Transferred on consultancy basis to; Strides Arcolab, Bangalore.

High gel strength agar from sea weeds

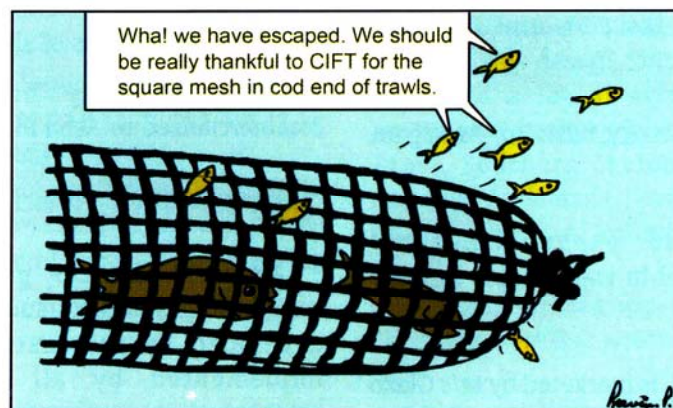
Transferred on consultancy basis to; Marine Chemicals, Cochin.

Technology for production of ready-to-use isinglass from fish maws

Product approved for use as a clarifying agent in brewery. Transferred on consultancy basis to; Brewers Nest, Chennai.

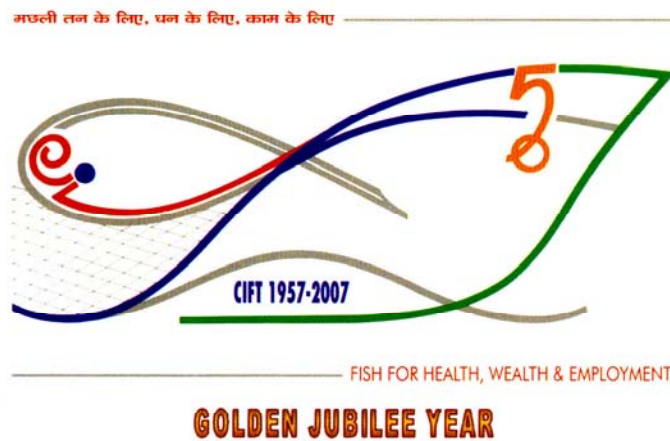
PCR (Polymerase Chain Reaction) technique

For detection of white spot syndrome and yellow head viruses in farmed shrimp. Transferred on consultancy basis to; ADAK, North Parur, Kerala.

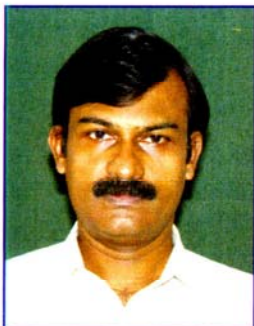




Golden Jubilee Emblem - What it signifies?



- The logo depicts a fish, a net, a boat and a wave, contoured out of the acronym CIFT, in four colours
- The fish represents research in post harvest areas
- The net represents research in harvest sector
- The boat represents technologies for fisheries sector
- The wave represents research in challenging frontier technologies
- The RED colour expresses the highest research temper of the Institute
- The BLUE colour expresses commitment of the Institute towards technological development of fisheries sector
- The GREEN colour expresses eco-friendliness and appropriateness of CIFT technologies
- The neutral GREY colour expresses rational approach of the Institute towards searching for effective and economical solutions to problems faced by fisheries sector



Design conceived by :

Shri M. Nasser

Principal Scientist, CIFT, Cochin



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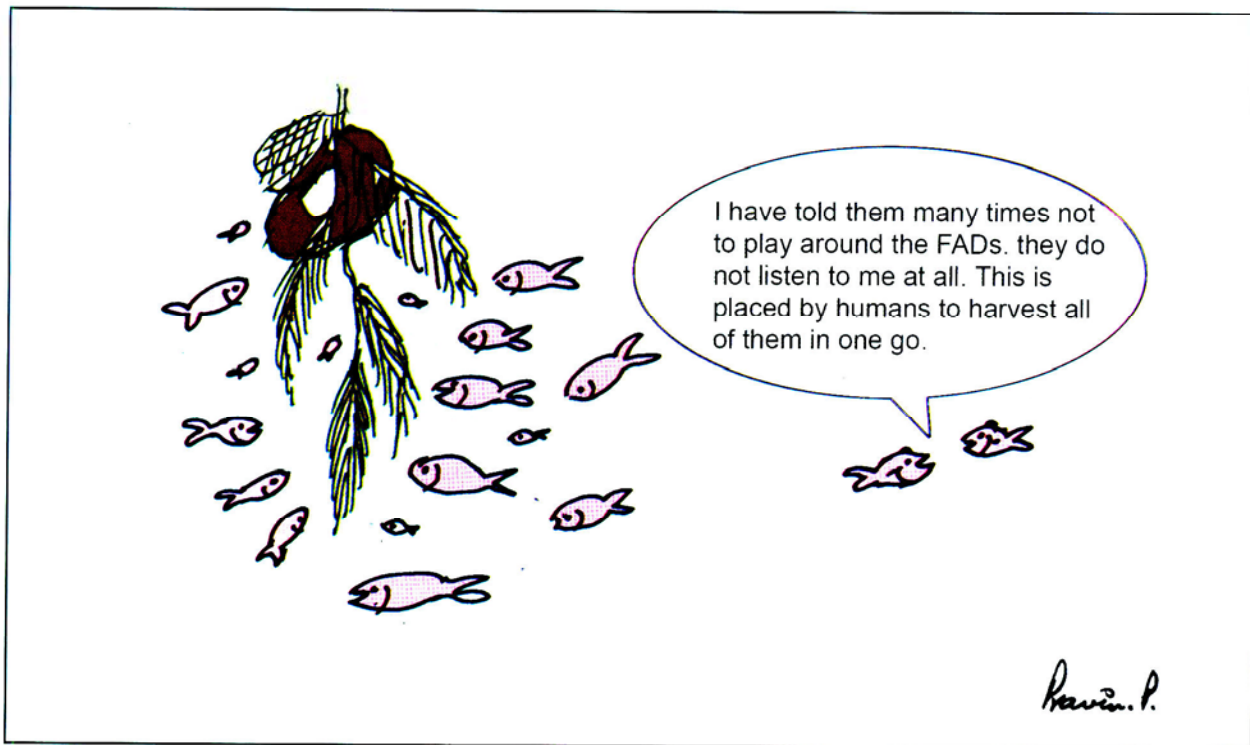
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Shri R. Anil Kumar, AAO

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Golden Jubilee Celebrations in Progress



Prof. Mercy Williams, Mayor of Cochin Corporation speaking after releasing the Golden Jubilee Logo at Cochin



Shri S. Sharma, Kerala Fisheries Minister inaugurates the Golden Jubilee Training and Awareness Programmes at Cochin



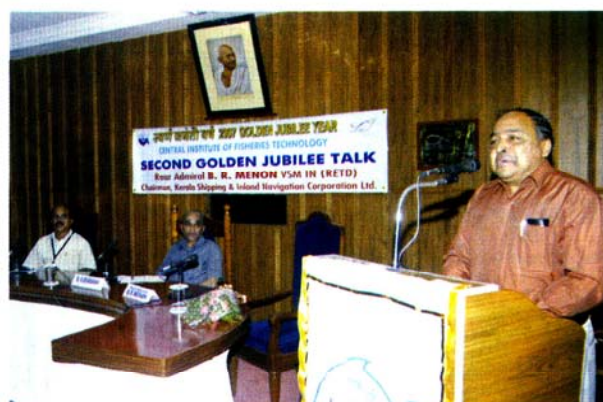
Prof. L. Venugopala Reddy, VC, Andhra University inaugurating the National Seminar on Energy conservation in fisheries at Visakhapatnam



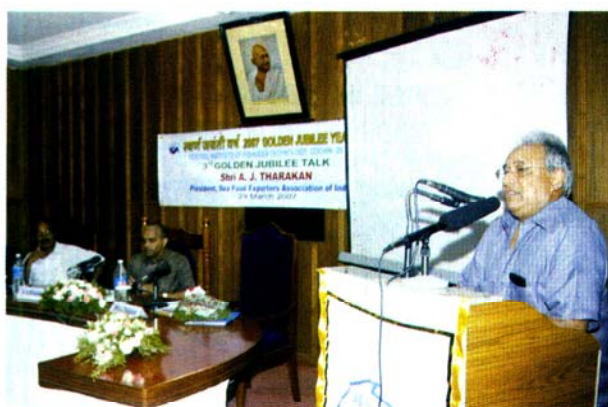
Prof. Mercy Williams, Mayor of Cochin Corporation unveiling the name board at Cochin



Padmabhushan G. Madhavan Nair, Chairman, ISRO, delivering the First Golden Jubilee lecture on 'Indian space programme and its initiatives towards fisheries development' at Cochin



Rear Admiral B.R. Menon, Chairman, Kerala Shipping & Inland Waterways delivering the Second Golden Jubilee lecture on 'Development of inland water ways and minor parts with fish related ancillary industries' at Cochin



Shri A.J. Tharakan, President, Seafood Exporters Association of India delivering the Third Golden Jubilee lecture on 'Problems faced by the seafood industry and possible solutions' at Cochin



Dr. K. Gopakumar, Former DDG (Fy), ICAR, New Delhi delivering the Fourth Golden Jubilee lecture on 'Intellectual property rights and TRIPS agreement' at Cochin



Shri V. Vivekanandan, SIFFS, Thiruvananthapuram delivering the Fifth Golden Jubilee Lecture on 'Fishing technology and social change' at Cochin



Dr. V. Prakash, Director, CFTRI, Mysore delivering the Sixth Golden Jubilee Lecture on 'Can nutrition integrate with food and fish processing?' at Cochin.



Cift Golden Jubilee 1957-2007



Dr. Hosahalli S. Ramaswamy, Professor, McGill University, Canada delivering the Seventh Golden Jubilee Lecture on 'Emerging and novel food processing technologies' at Cochin



Participants and faculty of training on Packaging of fish and fishery products at Imphal, Manipur



Skill upgradation training in Hygienic preparation of smoke cured fish at Burla, Orissa



Awareness programme on Sustainable gillnet fishing in inland waters at Kottakeel, Kerala



Training on Harvest and post harvest technology of fish at Udaipur, Rajasthan



Training and Demonstration on Gillnets and Turtle Excluder Device at Cadalore in Tamil Nadu



Training programme on “Harvest and post harvest technology of fish” at Tripura



Training programme on “Advances in harvest and post harvest technology of fish” at Pant Nagar



Training programme on “Responsible fishing and application of remote sensing in marine fisheries” at Vanakbara, Diu



Training programme on “Value added fishery products” at Dimapur, Nagaland



Shri S.C. Demath, SDO, inaugurating the training programme on Responsible fishing and extension methods at Deomali, Arunachal Pradesh



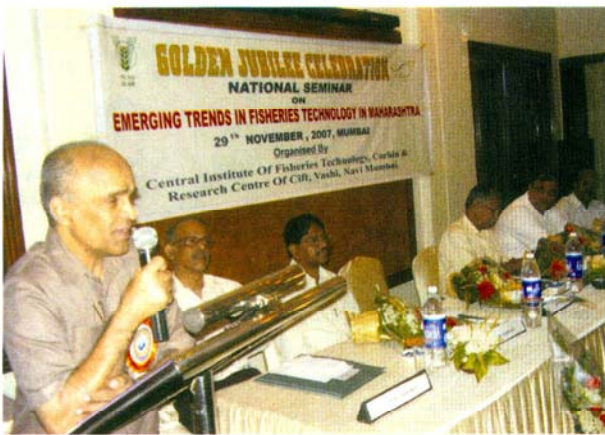
Inauguration of training in Advances in fish processing technologies at Cuttack, Orissa



Seminar on "Emerging trends in fisheries technology" at Veraval



Dr. Sebastian Paul, MP inaugurating the Seminar on "Biomedical application of chitosan" at Cochin



Seminar on "Emerging trends in fisheries technology" at Mumbai



Seminar in Hindi on "Role of Biotechnology in aquaculture and fisheries" at Cochin



Inauguration of Golden Jubilee Trainees Hostel at Cochin by Dr. Mangala Rai, DG, ICAR



Inauguration of Golden Jubilee Model Fish Processing Hall at Cochin by Dr. S. Ayyappan, DDG (Fy) ICAR



Know About Fishes

Dr. R. Badonia

Veraval Research Centre of CIFT, Bhidia Plot, Veraval - 362 269, Gujarat

- Fishes are fascinating animals that come in an amazing variety of shapes and sizes. They are poikilothermic, aquatic chordates with appendages (when present) developed as fins, whose chief respiratory organs are gills and whose body is usually covered with scales. The hagfishes and lampreys lack jaws; the sharks, rays and chimaeras have skeletons made of cartilage; the teleosts have skeletons made of bone.
- A group of fish of the same species is called 'fish'. Two or more species of fish are called 'fishes'.
- About 29400 species of fishes are known so far and many more are expected to be discovered in future.
- About 40% of the fish species inhabit fresh water which form less than 0.01% of the earth's water resources.
- About 2500 species of fishes are found in India, of which 930 are of fresh water origin and about 350 species are commercially important.
- Fishes are cold blooded (poikilothermous) having a temperature approximately the same as their environment; however, some fishes like tuna (Scombridae), billfish (Xiphiidae and Istiophoridae), butterfly mackerel (*Gasterochisma melampus*) and some species of sharks maintain elevated body temperatures to varying degrees (endothermy).
- Although most fish are exclusively aquatic, some fishes such as mudskipper, snakeheads and climbing perch have evolved the capacity to live out of the water for extended periods of time.
- Alimentary system of fishes is often indicative of their feeding habits; it could be elongate (piscivorous), sac like (omnivorous), with more pronounced stomach and shorter gut (carnivorous), or long and coiled (herbivorous).
- Among the fishes of the world, landings of Anchoveta is maximum followed by Alaska Pollack, Skipjack tuna, Capelin, Atlantic herring, Japanese anchovy, Chilean jack mackerel and blue whiting.
- Many pelagic fishes like sardines and herring are having high amount of fat compared to demersal fishes.
- Caviar which is the processed salted roe of various species of fish, most notably sturgeon, is one of the expensive seafood in the world. Iran is the largest exporter of caviar. A can of 100-150 g caviar may cost US\$ 50-70.
- Shark fins are another very expensive seafood item. A kilogram of high grade processed shark fin rays may cost over US\$ 600 in Singapore and Hong Kong markets.
- Omega-3 fatty acid present in fish oil reduces the accumulation of cholesterol in men. The fish eating population is reported to have a



low rate of heart ailments.

- Chitin, Chitosan and Glucosamine prepared from shrimp and crab shell waste are having a number of industrial and therapeutic applications.
- Air bladder occupies up to 7% of body volume in fresh water fishes and 5 % in marine fishes. Isinglass prepared from air bladder (fish maws) are used in clarification of beer.
- Hilsa is a prolific breeder. The egg size is 0.8 mm in diameter and a 20 cm long specimen can lay 0.25 - 1.6 million eggs.
- In South East Asian countries the aquaculture production includes finfish 60%, molluscs 18.2%, sea weed 20.2% and crustaceans 1.6%. Common carp, Chinese carps and Indian major carps constitute 80% of the finfish.
- Finfish contributes about 88%, molluscs 8% and crustaceans 4% in the world landings.
- Most of global aquaculture production of fish, crustaceans and molluscs continues to come from the fresh water environment (57.7% by quantity and 48.4% by value); mariculture contributes 36.5% of production and 35.7% of the total value; brackish-water culture contributes 5.8% by quantity and 15.9% of the total value.
- World Fisheries Day is observed on 21 November every year.
- Colour of fishes and prawns of the same species may vary with different environmental and ecological conditions.
- Some fishes produce strong electric current of 20–600 V. Electric current is generated in cells called electrocytes, which are generally modified muscle cells. Examples include knife fishes (electrophorids) of South America, the elephant fishes (mormyrids) of Africa and the mochokid cat fishes of South America.
- Fishes of the Family Sciaenidae such as Drums and Croakers are known to make underwater sounds.
- Parental care is seen in at least 25% of the fishes. Some fresh water fishes prepare nests with great care. Males are generally more active in the parental care.
- Coral reef fishes like Cardinal fish, Angler, Butterfly, Surgeon, Parrot fish, Damsel and Wrasse are brightly coloured. Generally fishes are darker on upper surface which helps in evading predators.
- In India more than 300 species of exotic fishes have been introduced and most of them are ornamental fishes.
- The fish (Matsya) is one of the incarnations (Avatara) of Lord Vishnu, described in the Bhagavata Purana. The purpose of this incarnation was to save Manu (the first born) and the seven sages from a deluge.
- Mackerel is a Danish word, meaning “dots”, that are present on the fish laterally; Salmon is a Latin word meaning “jumping fish”, because it crosses the stones and boulders in shallow water while swimming; Trout is a Latin word, meaning “hungry fish” due to its active feeding habit.
- The fastest species of fish is the Indo-Pacific Sail fish, *Istiophorus platypterus*. It has been clocked in excess of 110 km/h over short periods (spurt speed). The Indo-Pacific Sail fish grows to over 3.4 m in total length and 100 kg in weight.
- The Whale Shark, *Rhincodon typus*, is the largest of all fishes. Whale Sharks between 4 m to 12 m in length are most often seen, but this species can possibly reach a length of 18 m.
- The Australian coral reef Pygmy goby (*Eviota sigillata*), a tiny coral reef fish, which occurs in tropical inshore and coral reef waters of the Indo-West and Central Pacific is known to be the vertebrate with shortest lifespan of 59 days.
- The world's smallest fish is the Stout Infantfish, *Schindleria brevipinguis*. Females of

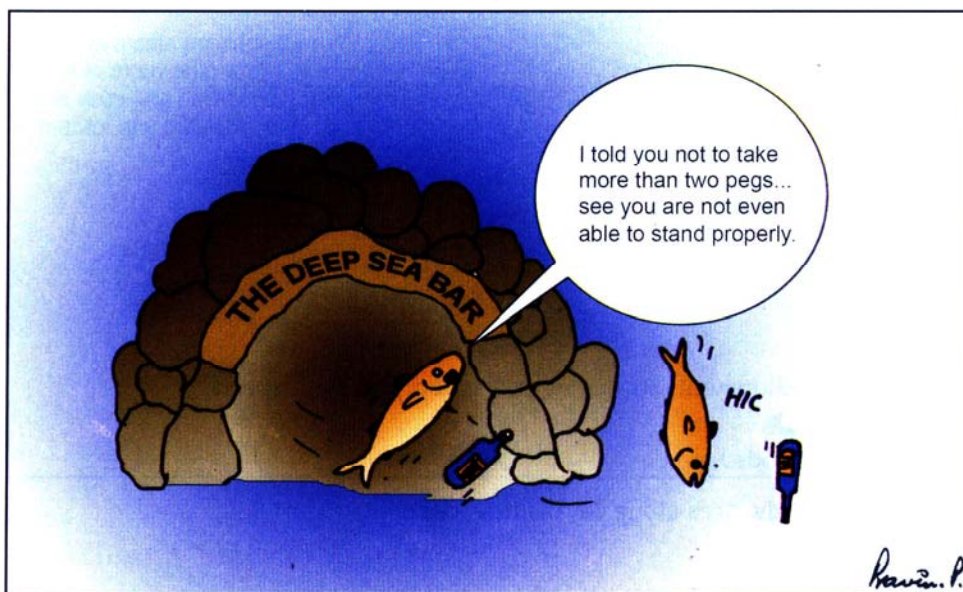


this species, a relative of gobies, which is only known from the Great Barrier Reef, reach sexual maturity by 7 mm to 8 mm in length and males mature by 6.5 mm to 7 mm. The largest specimen known is a gravid female that is 8.4 mm in standard length and about 1 mg in weight.

- The fish that currently holds the record for deepest-living fish is a species of Cuskeel (family Ophidiidae) called *Abyssobrotula galathea*. This 20 cm long fish has been caught from the Puerto Rico Trench at a depth of 8,370 m.
- The Ocean Sunfish (*Mola mola*) is the most massive bony fish in the world (but not the longest one; that honor goes to the Oar Fish). It is a unique pelagic fish, which have been reported to grow up to 3.33 m in length and up to 2,300 kg in weight.
- Oar Fish (*Regalecus glesne*), is reported to be the longest bony fish. It has a ribbon-like body that has been reliably documented to grow to 8 m in length, however specimens up to 17 m in length have been reported.
- Hearing abilities of fishes vary from species to species. Hearing in fishes involves the sensory chambers of the inner ear which is

lined with sensory hair cells and contains an otolith (ear stone). In some fishes the swim bladder aids in hearing by transmitting vibrations to the inner ear.

- The world's largest octopus is the giant octopus (*Octopus dofleini*), that can grow to 5 m in length and 34 kg in weight. They are known to be shy and gentle animals.
- The coelacanth *Latimeria chalumnae*, the "living fossil" fish, pre-dates the dinosaurs by millions of years, and was thought to have become extinct about 70 million years ago. The first live coelacanth known to science was caught by a trawler on 22 December 1938, off Chalumna River mouth, east coast of South Africa.
- The giant squid (*Architeuthis* sp.), lives in the ocean depths and grows up to 19.5 m in length and over 1000 kg in weight. It is one of the largest known living marine invertebrates in the world.
- Ninety percent of all deep-sea species living below 700 m where there is no sunlight are bioluminescent. Many fishes have photophores (light-producing organs) which is used to evade predators, attract prey or to signal to potential mates.

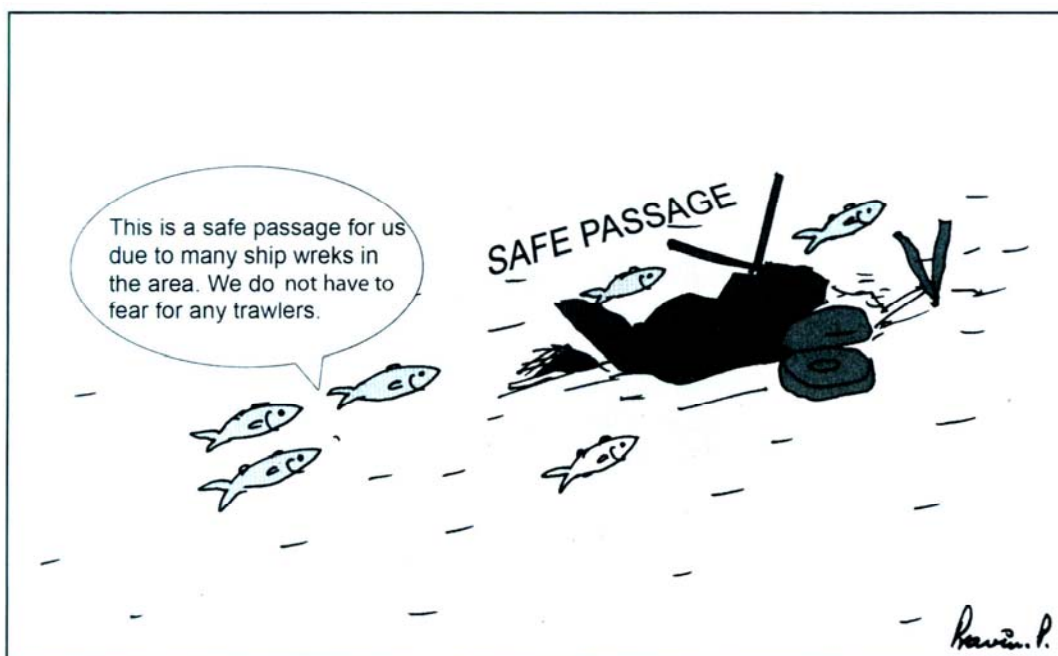




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Major ocean-based industries in India

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There are about four major industries in India related to the ocean sector. Shipping is one of the oldest industries and most important for transportation of men and materials. Fishing is another one of the largest industries in the country. It provides employment and gainful economic activity to millions of people. India stands sixth in the world in fish production and one of the foremost exporters of seafood. Offshore oil and gas industry has come up only during the last four decades. This is most important for the prosperity of the country. Tourism has become another major industry along the sea coast for recreation and holiday-making and provides considerable income and prosperity to places of tourist attraction.

Introductory remarks

This article has been written at the request of Dr. K. Devadasan, Director, Central Institute of Fisheries Technology (CIFT) to be published in a Souvenir by the CIFT on the occasion of its Golden Jubilee Year-2007. Fifty years of highly commendable work on research and development marks a series of important events in the life of an institution and the Golden Jubilee Year is really its landmark because this year will always be remembered for its ceremonial highlights, as well all have short memories of smaller events and people. I have no doubt that the CIFT will continue to move forward

in the same spectacular fashion as it did in the past to achieve its Diamond and Platinum Jubilee in the future with pride and dignity. Since I have been associated with the Institute for a brief period, I still have some happy memories, though outdated, regarding the capabilities and devotion of its staff, which forms the backbone of the Institute.

Major industries related to the ocean sector in India are: (1) shipping, (2) fishing, (3) offshore oil and gas, and (4) tourism. The different types of ocean-based industries can be described as follows:

Shipping

Shipping is one of the most important industries in the economy of a nation. Since ancient times, shipping in some form or the other for the transportation of men and materials flourished from the days of the Mauryas.

During the British period, very little progress was achieved in India in the shipping sector, as the transport of goods and cargo was carried out by foreign ships, largely European, to and from India. In 1862, the British India Steam Navigation Company was founded which soon developed into a large shipping venture. Subsequently, several Indian companies came into existence, the most notable among them was the Scindia Steam Navigation Company. This had a fleet of several vessels. In 1961,



the Shipping Corporation of India (SCI) was formed, and within a short time, it became the leading shipping company of the country. It started with only 15% of the nation's total shipping and reached 51% in 1975. Its growth till today has been phenomenal.

Fishing

Fishing is one of the largest industries in the country. It provides employment or gainful economic activity to nearly 10 million people. There are nearly 34,000 mechanized boats and about 200,000 non-mechanized boats operating along the 7000 km coastline of India. Other infrastructure includes a large number of processing plants, canning factories, ice and refrigeration plants and many other ancillary industries. It contributes to the seafood production, which consists of capture fishery from the sea and culture fishery from the estuarine and enclosed backwaters. In 1974, fish production in India was about 0.4 million tones. In 1979-80, it had increased to 1.4 million tones. Today, our fish production by capture is of the order of 2.5 million tones. India ranks sixth in the list of fish-producing countries. Fish constitutes only about 4% of the world's food production, but in Asia, it supplies about 45% of the total animal protein to the people. During the last few decades, substantial inputs have been provided for sea fisheries in the form of infrastructure, institutional base and manpower. Within the last 30 years, India has also emerged as one of the foremost exporters of seafood in the world. The export of seafood from India has reached more than Rs. 3,500 cores per annum in value.

The fishing industry is constantly getting enlarged and much of the investments in this sector are coming from the private sector. The list of exporters of marine products is increasing rapidly, and with this, inspection and quality control measures are also getting more and more stringent. With the export of new products, such as squids and cuttlefish to Japan and shark fins to several other countries, the possibilities in this sector are immense. However, shrimps form the bulk of the export. Quality food fishes such as pomphrets, kingfish, perches etc. are being exported to Gulf

countries. Similar is the case with by-products and processed food such as fish meal and dehydrated seafood. Expansion of the industry is associated with the enlargement of canning, freezing, refrigeration and transportation industries.

Seaweeds form another resource for industrial development. In the early fifties, dried seaweeds were exported from India. However, when agar-agar, alginate and other products began to be extracted in India, the export of seaweeds was stopped. Factories in Gujarat and Tamil Nadu began to multiply but because of the shortage of seaweeds as raw materials, many factories had to be closed down. Culture of seaweeds in the sea can generate considerable extra resources and the technology for their rope culture has been well demonstrated in India.

Offshore oil and gas

India has mounted a major effort to increase its exploration, exploitation and development capabilities for hydrocarbons and during the next few years, this effort is likely to increase rapidly. The present activities related to offshore production of oil and gas are confined to Bombay High areas on the west coast and the Godavari Basin on the east coast. However, further exploration activities are going on intensively on both the coasts. This is being achieved largely through the efforts of several national organizations. The two agencies, namely, the Oil and Natural Gas Commission (ONGC) and Oil India Ltd (OIL) are largely responsible for the entire oil and gas production. In 1993, the total oil production was 27 million tones against a demand of 58.7 million tones; indigenous production was expected to reach 38.3 million tones in the year 1995-96, because of the onset of production from three new Bombay High oilfields - Neelam, L-11 and L-111 - and from the Godavari Basin. The latest (1996-97) production figures are 35 million tones.

India's own consumption which was about 60 million tones in the year 1993 is expected to rise to 140 million tones by 2010. The Middle East accounts for nearly 65% of the total world oil reserves and at the present rate of depletion, if the reserves of crude



oil are going to last for fifty years, those of natural gas are likely to continue for the entire 21st century.

India has a large petrochemical industry. Indian Petrochemicals Ltd. (IPCL) at Baroda is well known. In addition, there are many other industries in the country producing raw materials, intermediaries, and products such as plastics, polymers, synthetic rubber, synthetic detergents and industrial chemicals which are based on hydrocarbons.

Recreation and tourism

Tourism has become a major industry along the sea coast for recreation and holiday-making. It has made excellent progress during the last decade and many tourist resorts and luxury hotels have come up along the coastline. These provide considerable income and prosperity to places of tourist attraction such as Goa, Cochin, Mumbai, Chennai, etc.

One of the most common uses of the sea all over the world is recreation. People from far away places go near the sea for rest and relaxation. They also enjoy water sports such as diving, surfing, boating and underwater photography. Sea air is known to be fresh and rich in oxygen. In the Maldivian Archipelago, tourism is the major revenue-generating industry. The total combined human population of all the islands is about 200,000. There are 58 tourist resorts that can accommodate about 6000 people. In 1992, more than 200,000 tourists visited the Maldives. The Lakshadweep islands also provide a great potential for tourism. The islands of the Andaman and Nicobar group are also providing some facilities for tourists but tourism on a large scale is yet to come up on these islands.

Successful tourism requires a lot of infrastructure to meet the needs and demands of every class of tourist. The first and most important basic requirement is accessibility to the place by air, rail and road. The second priority is accommodation (hotels, guest-houses, etc.) to the needs of all types of tourists. The third includes facilities for good catering, sight-seeing, recreation, boating, surfing, surf-riding, diving and underwater photography. On most of our islands, such facilities are still very

inadequate. Goa and Cochin perhaps provide the best facilities for tourists in the country. Because of this, special chartered flights are coming directly from London, Frankfurt and other European cities to Goa and Cochin with full tourist packages.

Conclusion

Since 1947, and more intensively since 1960, considerable work has been done in the ocean sector by different agencies and institutions which have laid the foundation of newer and a greater sophistication in industrial growth. However, in the 21st century, new thrust and priorities are needed in the light of global scenario.

Ocean technology cuts across the technologies of almost all sectors because it is at the centre and has direct linkages – both vertical and horizontal – with all other technologies leading to the new industrial revolution in which we have entered now. Moreover, the new regime of the ocean has added 2 million square km of ocean area to India's 3 million square km land area. This is a very large resource at our disposal to be exploited. Therefore, it is very necessary for planners and policy-makers in India to progressively follow and take note of global development and formulate appropriate steps to usher in a new era of marine industries in the country.

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Impact of fishing on marine fisheries

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Importance

Fishing originated as one of man's earliest avocations in search of food to quench his hunger. Over the thousands of years of fishing history, today fishing and related activities present a 100 billion dollar industry across the world. Economy, trade and survival of some countries today depend most on fishing and related activities. Fish is gaining importance as a health food and the requirement for fish has been ever increasing and supplies are short of demands, thus pushing up the price of fish in the international markets. Sea foods are presently cherished items of food in the developed world and demand and prices are ever increasing. There are seafood items which costs hundreds of dollars for one serving. However, in many developing countries, fish and fisheries are livelihood and employment avenues and their role in alleviating poverty has been well recognized.

Although fishing started with hand made tools, today fishing is very well modernized, employing very sophisticated modern craft and gear and technologies including satellite data, remote sensing, sonar, fish finders and the post-harvest technologies available and being innovated are highly sophisticated, automated and modern, confirming

to the strictest of food safety standards on the higher end profile of the industry. However, for many communities, fishing is still a livelihood avocation, a basic food and nutritional security.

What is fishing ?

To understand the impact of fishing, one need to understand what fishing is. There could be many other scientific or well articulated definitions for fishing. However, the simplest and most straightforward definition is that fishing is the removal of fish from the wild population using selective or non-selective gears or mechanisms. From using bare hands for capturing wild fish, man has traveled a long distance and currently he has the advantage of modern technology and science for aiding in his effort for capture of fish. The extent and scope of fishing certainly is beyond the scope of this article. But, it would be interesting to note what happens when fishing is carried out. We all know that fishing could be selective or non-selective. In selective fishing, only a few species or fishes of particular sizes are targeted to be captured and therefore special tools (both craft and gear) are used to achieve the selectivity. In non-selective fishing, all that are accessible in space and time and vulnerable to the specific craft and gear are caught.

* The views expressed here are personal to the author and do not reflect those of the organization represented



It is generally believed that selective fishing is resource friendly while non-selective is not. But this is not true. Both types of fishing have negative impacts and consequences.

Impacts

If we have to understand the impacts of fishing, we need to look closely at what happens when fishing is carried out and what happens to the wild stock after some of the fish is removed. This aspect is mostly neglected as we are always concerned about what is being caught and not what is being left behind. Fish live in communities in a common habitat sharing the water, space and food supply. They have specific community structures, inter-relationships and behavioural patterns. They live as unit stocks or mixed stocks. They have a community structure where there are larvae, fry, fingerlings, juveniles, adults, senile fish, males and females. These communities of various fish species often mix during feeding, breeding, migration as well as daily local movements. They also interact between communities and habitats. When we fish, certain members of this community are removed from amidst the community. How this will impact the community will depend on what has been removed from the mixed population and what were their roles in the community to which they belonged. Such removals, whether they are selective or non-selective, will have their own impacts which need careful study and understanding. Let us examine a few of such impacts under various heads.

Fish stock

Fish stocks are generally confused with fish species. Stock is a lower unit than a species. A stock will have a distinct recruitment, growth and mortality rates and usually behave in similar manner. They will have common feeding and breeding grounds and migration routes. Several such stocks will form a species population in the seas and they all mix during the life activities. When fishing takes place, we remove a certain bulk, say a netful, of fish. This will contain members from many stocks and many species. Members of the same species caught

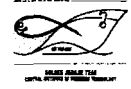
in the net may belong to different stocks of the same species. When these are removed through fishing, such removal impacts the size, basic characteristics and dynamics of the stock. Research is needed to understand its impact on the stock. Selectively removing a part of the stock will have both short and long term impact on the resource health, dynamics and behaviour. It will depend on which part of the stock we removed, whether they are juveniles, sub-adults, adults, spawners, or senile fish. Were they a spawning stock or a migrating stock? Were they a unit stock or a mixed stock? All these can be understood only through analysis of data generated from sampling the populations.

Species ratios

When we fish, we catch many species of fish. All of them are not in the same quantity. Some of them are much more in quantity than the others. There are many reasons for this situation. May be they were present at the place of capture in such a differing proportion. May be the gear was more efficient in catching some species much more easily than the others. In fisheries science, these variabilities are called by terms such as accessibility and vulnerability. Some fish are accessible in space and time to some gears while others are not. Similarly, some fish are vulnerable to certain gears while others are not. The species ratio therefore does not truly represent the species abundance in a place or even the community structure of the fish population at the place of capture. Every fishing operation therefore removes a part of the population and the species removed through capture changes the community structure of the fish in the habitat. Through migration and mixing, much of this imbalance is restored, however, in unit stocks and threatened species assemblages, the imbalance caused by fishing will impact adversely the resource resilience.

Adult-juvenile ratios

Fishing, as already explained, is a resource destructive activity. What is being removed from the community depends on several factors. If the bulk



of the fish caught are senile population, then the impact on the resource is minimal. But if the fishing removes a breeding population, then the impact is very serious. More severe is the impact if the fishing removes the juveniles. Fishing thus upsets the ratio between juveniles and adults. Replenishment capacities of stock are adversely affected if large scale juvenile destruction takes place due to fishing. There are two categories of fishes, one with very high fecundity resulting in millions of juveniles from each spawning while the other category produces only small number of juveniles as their fecundity is low. Generally when the fecundity is high and large number of larvae are produced in each spawning, there operates a mortality between larval hatching and recruitment (entry to the fishery) which is directly proportional to the larval density. This is the density dependent mortality. If the larval density is high, then the mortality rate is also high, thus keeping the recruitment under check. If the larval density is low, then the mortality is also low, keeping the recruitment high. This is the nature's mechanism for balancing population size. Human interferences in the natural process (through fishing) upsets such balances.

Size groups and age groups

Fishing removes bigger individuals first. Thus the larger ones which are also the older ones are removed at the beginning of a fishing cycle/season. As the fishing progresses, the sizes of older ones get reduced. Thus, the number of size groups and age groups in the population are reduced. In a fished population, if all age groups are well represented, then the fishery is at its top health. As the fishing pressures reduce the larger size groups and higher age groups, their representation get reduced indicating the levels of stress. One way of ascertaining the health of the fish population is to look at the relative representation of all available age/size groups in the catch. The same measure can be used to assess the impact of fishing on the fish population also as far as the size-age structure is concerned.

Trophic positioning and food web

We know that the food of fishes vary from species to species and also based on their life histories. In the seas each species occupies a relative position in the food web. These relationships are generally called trophic relationships. Selective removal of certain fishes from this food web will disrupt the existing relationship, thus upsetting the food pyramid and the overall ecological structure. If such removals are too serious, then the food web will collapse and all species in the food web will get affected. So fishing impacts the predator-prey relationships and how serious is the impact of fishing will depend on the level and degree of such selective removals from the community. There are classical examples of collapses of fisheries and ecosystems due to serious impacts from such massive destructions.

Catch and bycatch relationships

Most fishing gears are non specific, resulting in capturing of those fish species which are not the primary targets. They are called bycatch. However, the bycatch also are valuable protein and some of the species in the so called bycatch are valuable species of high grade food quality. However, the problem arises when the bycatches are non-fish biodiversity (eg. bottom fauna), or juveniles or when the non targeted fish are discarded at capture. While it is true that bycatches can not be avoided whatever we do, there are valid arguments and reasons for reduction of bycatches. Technology is being developed for reduction of bycatches and throughout the world, bycatch reduction is a priority agenda in marine fisheries management. Commendable work is being carried out at Central Institute of Fisheries Technology (CIFT) and it is anticipated that the results will be usable and will lead to uptake of the technology for bycatch reduction in trawl and purse seine fishing. This is also an important aspect of the FAO Code of Conduct for Responsible Fisheries.

There are some arguments that bycatches must be effectively utilized by developing edible products from them. This will appear a seemingly logical proposition. However, there are great dangers hidden



in such initiatives. As we all know, large investments are needed for development and commercialization of a new product and the investments made in infrastructure must have long term supply of bycatch in very large quantities to make them economically viable. So on the one hand we are trying to reduce bycatch while on the other we are promoting large scale and long term capture of bycatch by promoting products and industry. This paradoxical approach must stop. Especially when aquaculture is fast developing and the demand for fish meal is steadily increasing, we must find alternatives for fishmeal for supply of the protein in the feed. There is worldwide awareness that development of aquaculture will result in increased pressure on the marine resources, especially the bycatch and juvenile fish, for production of aquaculture feed.

Biodiversity

Fishing destroys biodiversity through targeted and non-targeted means. While this will have serious impacts and compounded long term negative consequences on the marine habitat, in tropical marine habitats, their impacts are much more profound. Our seas are one of the most diverse biodiversity hot spots. A visit to any fish landing centre will reveal the immense destruction caused to the marine biodiversity by our fishing methods. Large quantities of juvenile fish, benthic invertebrates, egg masses, marine algae, mollusks, crustaceans, sponges, echinoderms, etc. belonging to every phylum are present in abundance. All these are dried and transported to fish meal or animal feed factories. Since there is some value for every dried marine life, the indiscriminate destructive activity goes on and on. If an appropriate valuation of biodiversity is carried out, the loss in terms of economic value would be billions of rupees. Such negative impacts will also adversely affect the fisheries resources as many of these are food organisms in the food chain and their destruction will affect the food chain adversely. Further, international trade of our marine products can get adversely affected in course of time because of the biodiversity destruction as the process of

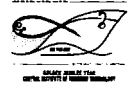
certification of fisheries is becoming *a priori* for exports to many countries.

Recruitment

Best defined as the 'entry of fishes of a year class in to the fishery', recruitment marks the beginning of the fishable life span of a fish. The fish can get caught any time after they enter the fishery. Entry to the fishery is decided by the mesh size in all those fisheries where nets are used for capture. Recruitment generally is indexed not by size, but by age of the fish at recruitment, often denoted by tp' . Thus, the size or age at recruitment is in the hands of the fisheries operatives or fisheries managers. By manipulating the mesh size, the tp' can be increased or decreased. In well-managed fisheries, this is one of the mechanisms for management. When a particular mesh size has been in use for quite some time and if the mesh size is abruptly increased, the fishes in the population will escape through the now bigger mesh and therefore the immediate catches will decline. After this initial decline, the fish will grow and reach a size large enough to be retained by the mesh. At this time the mean size of the fish caught will be much bigger than those caught earlier. Thus, the total yield also will increase (because of the higher mean weights), subject to the natural mortality (M) operating. In most exploited marine fisheries, the M is much smaller than the fishing mortality (F) and therefore, the positive impact of higher yields result. Thus, it is possible to manage the recruitment level by manipulating the mesh size where nets are used for fishing.

Stock replenishment capacities

Fishing affects the stock replenishment capacities of major fish species. If the fish are caught before they have a chance to spawn at least once, then the recruitment to the fishery is seriously affected. If the fish spawns several times in a year, then several batches of recruits will result. In temperate waters the fish has annual breeding and therefore capture before at least one spawning will have serious impacts. However, in tropical seas, the fishes grow fast and most species have early maturity and



protracted spawning, several times in a year. These are to the advantage of the fish stocks. One reason why our fisheries are still surviving in spite of the destructive fishing and severe damages is this unique feature of tropical marine organisms. Many pelagic stocks can suffer serious set backs in recruitments and recover from the adverse impacts. Thus, the relationship between parent stock and subsequent recruitment is complex and diverse. Nevertheless, fishing during breeding season should be avoided to the extent possible and this will be a very resource friendly practice even in our fisheries.

Environment

Impact of fishing on the marine environment is a subject of global interest. As already highlighted, the resource and benthic community has the greatest negative impacts from fishing *per se*. Compounded to this, the way fishing is carried out has several negative impacts on the environment. The bottom trawls and shore seines are the best examples. The constant churning up of the bottom not only removes all living macrobenthos, but also ploughs up the benthic substratum, killing all burrowing organisms and exposing others to predators. It has been shown that if the bottom trawl ploughs up the sea bottom once, it takes over two years for recovery to original position provided the area is not ploughed again. In reality, the sea bottom is ploughed again and again several times and no time is provided for any recovery. Thus, the damage done to the environment is much more than what is currently understood. Ghost fishing is another concern. Broken nets left out in the seas entrap many fishes which eventually die or are predated upon. This indirectly adds on to the damage to the fish stock and the environment.

Coastal livelihoods and poverty

Fishing intensity, patterns, yields, composition of the catch, market demand and dynamics, prices, competition, marginalization etc. all have impacts which feed back to the resource capture (fishing). Classical examples are the trade driven demand for the shrimps which resulted in poor demand for low value fish. A large number of fishers, especially

women, depended on the low value fish not only for food, but also for livelihood through salting, drying and selling hand processed fish. This avocation provided livelihood for lakhs of women along the coastal regions of the country. Then the shrimp mariculture emerged and there was need for the low value fish and bycatch for preparation of fish meal for the aquaculture feed industry. The poor fishers in the coastal region could neither compete nor had access to the low value fish which were landed. Thus, the changing trade demand resulted in the marginalization of the women processors who ended up in denial of livelihood leading to increased pressures of coastal poverty. Thus, fishing can lead to coastal livelihoods as well as result in poverty and distress.

Employment

Change over from a traditional livelihood avocation to a developing industry has resulted in generation of numerous livelihood opportunities in the coastal sector which are in one way or other related to fishing. There are perhaps over a hundred avocations which are related to fisheries. Changing fishing patterns and trade will alter these opportunities. It is necessary to study the trends and address the issue of employment generation in such a way that the coastal poor are weaned away from distressed resources and shown alternate, even non fisheries based, avocations. There is also great scope for involving the coastal people in creating awareness about conservation, disaster management as well as involving them in these activities some of which can create alternate employment in the coastal region. Small-scale livelihood mariculture is also an avenue for employment generation in the coastal region at least in some parts of the country.

Economy, trade, exports, CBD and WTO

In most agricultural commodities there is a strong demand-supply relationship. However, in marine fisheries, the supply is unpredictable and the demand and market fluctuate widely except for high value or exportable fish. There is always a great demand for varieties such as the shrimp which dominate the



export seafood market. Thus, the major focus in marine capture fisheries is to catch shrimp, whatever way possible. This demand driven fishing using many types of gear, mostly bottom trawls, is the bane of marine fisheries. As shrimps are organisms living at or near the bottom, most bottom fishing gears plough the bottom in an effort to catch shrimp and in this process destroy all other bottom biota. Thus, the demand supply scenario has a direct impact on the capture of fish and shellfish from the seas and the process of fishing. Time was when we had a lot of bycatches and low value fish. Today, every species of fish has a value and there are no discards at the landing site, although there are substantial discards at sea. The bycatches have become targeted catches as there are efforts by certain industrial houses and even research organizations to develop byproducts from bycatches, thereby indirectly encouraging capture of bycatch as a targeted catch, negatively impacting resource sustainability and resilience. Many European countries are looking at India as a cheap source of raw material in the form of fish protein from the bycatches for the animal feed/fishmeal industry. The changing demand for some varieties of fish in new markets emerging in the middle east and China are affecting the internal demand, market structure and prices.

The Convention of Biodiversity will play an important role in the marine capture fisheries. While it is mandatory for fishing countries to put in place appropriate legal instruments to prevent loss of non-target biodiversity, such measures are sure to affect our present fishing practices. The future will see certifications as a prerequisite for exports and therefore issues in sustainability and biodiversity are bound to define export trade of seafood from India. The Marine Stewardship Council (MSC) has had discussions already with the India industry on initiating the certification process. Labeling and certification will soon become mandatory for export trade of seafood and unless we are able to put in place such mechanisms for ensuring resource friendly practices, the trade will be adversely affected. The cascading impacts of such fallouts will have a bearing on the coastal economy, livelihood and poverty.

Policy

There are many marine Fisheries Regulatory Acts in the coastal states of the country. However, in most coastal states these are not followed in a way that the benefits are available to the resources or the stakeholders. The marine fisheries policy of the Government of India and the policy guidelines of the government should find full compliance by the stakeholders in letter and spirit. The agenda for more fishing vessels, fishing harbours, new fish meal plants are all to be viewed or shelved in accordance with the resource sustainability issues and therefore, there is a need for fresh look on the policies of the Government in the light of the emerging national and global scenario. On the one hand, capture of juveniles and bycatch is discouraged while on the other, incentives are given for more fishing vessels and procurement of gears which are destructive and even banned. The tendency of developing and promoting byproducts from bycatches should also stop forthwith, as such initiatives will lead to further resource instability. There is an absolute need for developing a real time knowledge based policy outlook for marine capture fisheries encompassing all these issues in order to ensure resource resilience.

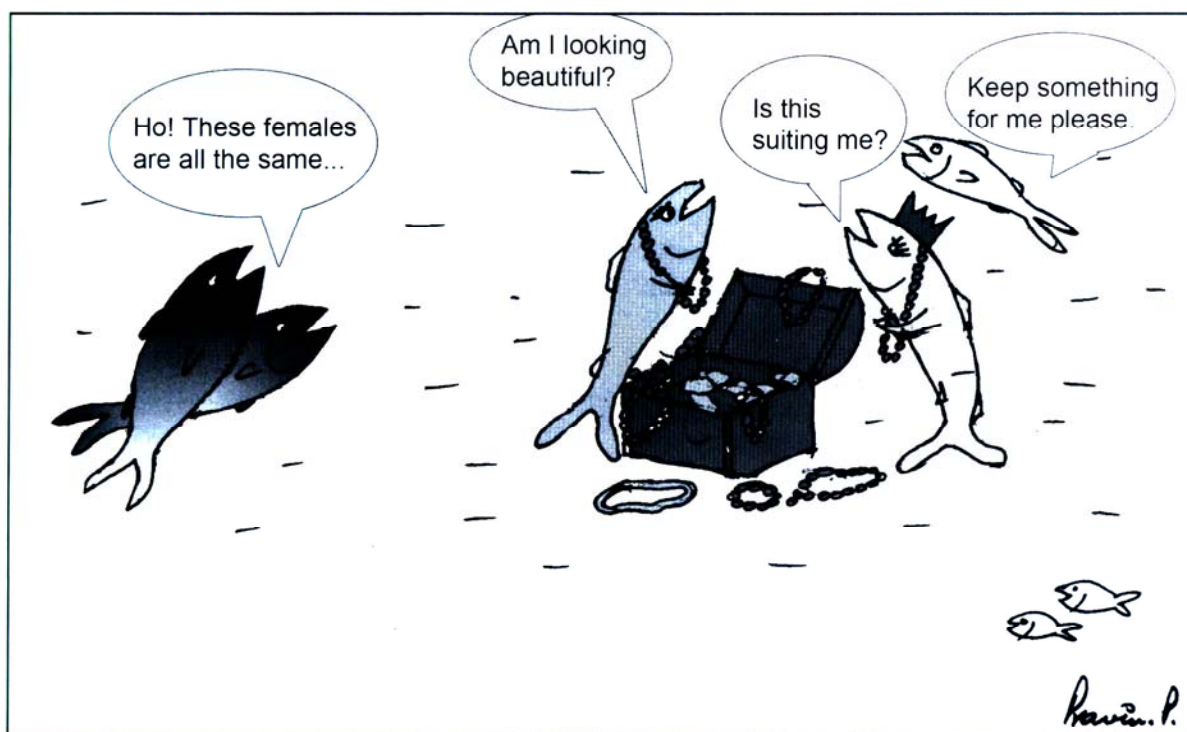
Concerns and emerging issues on fishing which can impact trade and exports

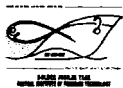
With the advent of the WTO and emerging global concerns about the consumer safety of sea food owing to the HACCP principles, the trade scenario is going to change both in the domestic and export markets. More and more people are aware of the risks in consuming fish that are not safe to eat due to various contaminants including heavy metal accumulations. Coastal waters are getting more and more polluted and time will arrive soon when only certified safe to eat fish will find market at least in urban areas. Therefore, the site of capture is going to play a role in the trade of fish and log books will be mandatory for all fishing vessels. Also, certifications of various kinds would be prerequisites for international markets. Marine Stewardship Council (MSC) has already made consultations with India and the process is on for

getting at least some species groups certified. Eco-labeling and HACCP certifications will be the hallmarks of tomorrow's trade of seafood. In this context, we need to be proactive to develop a marine atlas indicating the distribution of most common commercial species of fish on a GIS platform and to develop and use resource friendly fishing gears which will eliminate capture of non-target species (especially benthic biodiversity). Many more parameters are bound to emerge as regulatory criteria for trade of wild caught fish. Already several importing countries are demanding certifications including not only related to HACCP but also on ecofriendly gears (TED for example) and biodiversity conservation. Thus fishing *per se* is going to emerge as a major factor determining the prospects of our trade of marine fish. In addition to the above, other parameters that would impact are capture of juveniles, capture of breeding stock, capture of undersized fish, bottom trawling (already many countries have banned high seas bottom trawling), use of small mesh size, destructive gears (such as ring seines), destructive fishing practices such as dynamiting, dredging, screen nets, bottom gears, lack of closed seasons etc.

The road ahead and the need for proactive role

From the above it is amply clear that the road ahead is not very bright or smooth. If our marine fisheries have to become profitable and globally competitive, then we have to start acting on a proactive mission mode in the absence of which the industry is bound to collapse. Although some initiatives have been taken by the Government of India, and even certain knowledgeable NGOs, vested interests in the maritime states are thwarting the conservational and management agenda by developing and even legislating negative mechanisms. By such actions, we are moving towards short term gains and long term losses and it is high time that this is realized and scientific and learned advice is listened to rather than the "blind leading the blind" approach adopted in the maritime states. Let us not kill the goose laying the golden eggs, but sustain our resources through responsible fishing. If we are not proactive, the time is not far away when we will be regretful.





Indian fisheries and challenges

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India, indeed the world is in throes of profound changes. The media, transport, communication and Science and Technology revolutions have made the world a smaller place. The economic policies have catapulted India into a highly competitive and globalized world. As we look to the future it becomes necessary to craft and project a new image, which is more reflective of this emerging new India and their fidelity or relevance, as also a critical self examination, and perhaps even a redefinition of ourselves. This would involve identification of positive images that may require reassertion or redefinition, identification of negative images which need to be countered, negated or replaced and the creation of new, often latent images. A fresh look at many of the positive values of Indian civilization itself offers good potential for redefining India's image in a manner not hitherto realized.

Today, the entire world faces grave environmental problems. The continuing deterioration of earth's ecological reserves pose a major threat to sustainable economic development. One of the most pressing and complex challenges faced by generation is to develop a workable synergy between economic and environmental reality. Sustainable development and environmental protection both go hand in hand. For this to happen certain possible changes have to be made and a balance has to be maintained at both the fronts.

Education plays an important role in the creation of an economically and sociologically sustainable environment. Thus there is a need to adopt a holistic approach to education in terms of its content. Of late, the focus of education has been towards scientific and economic development. It has also been observed that there has been an erosion of social and moral value system. The Indian psyche is deeply embedded in spiritual value system drawn from thousands of years of common cultural heritage and an education system devoid of cultural value is not only hollow in its content, but unsustainable as well. Educated systems inter-linked with our cultural heritage on one hand and economic and scientific development on the other is the only viable medium to take us successfully ahead. Man has played with the delicate balance of various constituents of nature in order to meet his ever increasing demands without understanding its ill effects. Time bomb of population is on the verge of explosion. Nature's precious resources are getting scarce because of indiscriminate and unplanned acts of man. Rapid industrialization, mechanization of human life and scientific inventions have made human life comfortable, but at the same time they have created new problems of pollution and many other diseases. In the blind race of development, man has forgotten to take care of side-effects of environmental pollutions.



The relevance of science to the future of society is considerably more far reaching than the influence it has on human affairs in the past. Some of the pressing problems of society are related to the increasing population pressures, rapid decline in the quality of global environment, depletion of natural resources, increasing poverty, hunger, diseases and illiteracy, also the fast deterioration in social values and temperament leading to intolerable society. Solutions based on science and technology is likely to provide remedial measures to some of these pressing problems. With specific relevance to the fisheries sector for which we all are contributing to a great extent, this part of the country, has witnessed a steady growth from the first year plan onwards with the annual fish production from 0.75 million tones in 1950-51 to 5.66 million tones in 2000-02. Starting from a purely traditional activity in the Fifties, fisheries has now been transformed into a commercial enterprise opening enormous potential for employment generation and self employment, contributing to the food and nutritional security of the country, besides huge foreign exchange earning.

The contribution of fisheries sector to the Gross Domestic Product (GDP) has shown almost twenty fold increase from Rs. 921 Crores in 1980-81 to Rs. 22,223 Crores in 1998-99 at current prices. Fisheries sector is one of the fastest growing food sectors in the country with an annual average growth rate of 4.5%. Presently India ranks fourth in the world in total fish production and second in aquaculture production, next only to China. The contribution of inland fisheries during 1950-51 was about 29%, which has now reached about 50%, of total with inland fish production of 2.85 million tones in 2000-01. Such a phenomenal increase was possible because of rapid expansion of aquaculture in the country, contributing now about 36% of total fish production and about 72% of total inland fish production of the nation. Our scientists and farmers deserve appreciation for the development and adoption of improved aquaculture technologies.

Fish production potential for marine and inland fisheries sector of our country is estimated to be 3.9

million tones and 4.5 million tones respectively. Tenth five year plan would aim to effective utilization of fisheries resources of Indian Exclusive Economic Zone (EEZ) of 2.02 million sq. kms. It would require enlarging the present fishing area to offshore waters, as inshore waters have been fully exploited up to optimal level. Deep sea fishing industry would need to be strengthened with trained manpower and modern harvest and post harvest technology.

Though aquaculture has shown tremendous growth, presently only about 30% of the available area is under fresh water aquaculture in the country. In order to harness the full potential of inland fisheries, additional area needs to be brought under culture. Average fresh water aquaculture productivity of Fish Farmers Development Agency (FFDA) supported ponds/tanks in the country is around 2.2 t/ha. This is no doubt a good achievement. But we cannot be satisfied with this level of accomplishment as much more is possible to be achieved in view of advanced technologies available in the country to raise production level. This is evident as certain states like Punjab and Andhra Pradesh have recorded productivity of around 4.74 t/ha and 3.5 t/ha respectively under FFDA ponds/tanks. In order to enhance the fresh water aquaculture production, large number of demonstrations in potential areas are to be organized. Further, intensive fresh water aquaculture on a factory-farm basis with private investment have immense possibilities in certain states like Andhra Pradesh, Haryana, Punjab, West Bengal, Orissa etc. for high production of fish.

Sewage and waste water gushing from urban centers in huge quantities daily need not be viewed merely as a source of pollution for rivers, canals and other water channels. It is indeed a valuable resource, rich in a variety of highly useful nutrients and micro-organisms which can be gainfully utilized to produce edible food in the form of fish, prawns, rice and vegetables. Many countries in West Asia, South-East Asia, Europe and Russia are making full use of the waste water for producing human food. India is also now trying to catch up in this field, thanks to



indigenous technology developed for this purpose by the Waste Water Aquaculture Division of the Central Institute of Freshwater Aquaculture, Bhubaneswar.

Estimates have it that as much as 15,000 million liters of waste water flows out of the country's major cities everyday. Even if a fraction of it is harnessed for fisheries or farming, substantial quantities of additional food can be produced. According to scientists, the low-cost technology now available can help produce upto 3.5 tones of fish from one hectare of sewage fed pond in a year. Besides, techniques have been evolved to use the waste water for irrigating paddy fields which can simultaneously support fish stocks. Such paddy cum fish culture yields between three and five tonne of paddy and nearly one tonne of fish a year. Good harvests of vegetables, fruits or relatively high priced commodities like turmeric, ginger and garlic, have also been successfully raised, using waste water.

The sewage water, a black or grey colored mixture of liquid wastes, contains 99% water enriched with organic and inorganic nutrients and minerals like carbon, nitrogen, phosphorous, sulphur etc. and traces of living objects like bacteria and other microbes. The composition of this liquid is conducive for the emergence and quick growth of living organisms like phytoplankton, zooplankton and bottom biota that serve as nutritious feed for fish.

The waste water ofcourse, needs preliminary treatment to make it fit for fish or crop production. But all that is required for this purpose is sedimentation-allowing water to stagnate for some time to let the solid contaminants settle down at the bottom. Such a treatment is already in use in many metros and big towns where sewage water is either being discharged into fresh water streams or is supplied to vegetable cultivators.

Environmental sustainability has to be achieved by adopting environmentally non-degradable, financially appropriate, economically viable and socially acceptable best farming practices. In many parts of India, the main motive of fish farmers is profit and they neglect the long-term viability of

farming. Surely the Aquaculture Authority of India under Ministry of Agriculture can play an active role in promoting this sector by enacting legislation to regulate the aquaculture in the country. In order to harness the potential of fish culture in brackish water system/salt affected areas, there is a need for diversification for production of fishes, crabs, sea weeds etc. besides enlarging the number of shrimp species to be cultured.

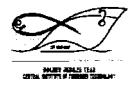
Significant contributions from strategic and applied research are essential for sustained development of fisheries sector. There is a need for intensive research in areas such as genetics and biotechnology, nutrition, pathology, aquaculture engineering, marketing and value addition. Health care or disease control system in fisheries sector is very important. Systematic attempts are needed to go for fish disease surveillance and taking effective timely measures. The movement of live aquatic animals within the country and from across the borders need a regulation to avoid spread of disease and introduction of unwanted exotic species. There is a lack of good quarantine system in the country and this should be taken care of in Eleventh Plan.

It is also feared that our fish produce is affected with antibiotic residues. In order to safe guard our fish exports and to protect our fish eating population, remedial measures need to be urgently taken. Our laboratories should be well equipped to provide scientific back up to solve such problems.

Human resource development for raising a cadre of experts at various levels to support research and sustain the growth of the fisheries sector is critically important.

Reservoirs constitute the single largest fisheries resources in the country. Average production from reservoirs is around 20 kg/ha/yr, which is much lower than that recorded in the countries like Thailand (65 kg/ha/yr), Russia (88 kg/ha/yr) and Sri Lanka (100 kg/ha/yr). Adoption of proper management practices are essential to raise the productions of these water bodies.

Our country is the founder member of World



Trade Organization (WTO). There are many apprehensions on how the unfolding WTO regime will impact Indian agriculture including fisheries. Impact of various provisions of WTO such as removing quantitative restrictions, trade related intellectual property rights, sanitary and phytosanitary measures and reduction in subsidies need to be studied to protect the interest of Indian Fisheries. Former Prime Minister Shri Atal Behari Vajpayee while addressing the conference of Chief Ministers of WTO agreement on Agriculture and Food Management at New Delhi on 21st May 2001 said, "Government approach to WTO and agriculture is based on our conviction that the emerging world trade is both a challenge and an opportunity for India. The challenge arises out of the fact that the WTO bears the birthmarks of a deeply divided world, in which the developed countries have many unfair advantages over the developing countries. India is playing an active role in mobilizing other countries for removing these disadvantages and establishing a truly just, equitable and fair world trading order". He further went on to add that the Government has taken adequate measures to protect the interests of our farmers and our hands are no way tied to prevent us from taking further protective and promotional measures.

Our fisheries education and research should reorient to encompass the cutting edge technologies in the new emerging areas. Certain subjects of teaching and learning such as, "information and communication technology", "biotechnology", "trade and IPR related issues", have become much more important and relevant today. The existing infrastructure and human resource therefore need to suitably redeployed to meet the needs of these emerging areas.

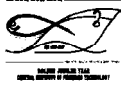
It is important to realize that information is a perishable commodity and possession of information is only of limited value unless one has the ability to transform the information into knowledge. Only then it is possible to relate a single bundle of information to the diverse opportunity for application.

The coming years will offer many exciting challenges, for the new entrants to various professions ranging from arts and humanities to medicine to agriculture and engineering. Emerging inter-dependence among nations is increasing the need for preparation in competitiveness. The competition among professionals as well as among institutions for securing recognition and a place of pride in the national and international context will be enlarged. The sheer size of available talents in various disciplines will demand special capabilities and skills. Those who are constantly alert to the changing pattern of demand and supply for talents and skills will be more successful than others.

The degree earned is symbolic of our capability to achieve a set of goals through a learning process but does not constitute the finality of our knowledge and understanding of any discipline. The total sum of what we have learnt in acquiring this degree is only a tiny fraction of what is available in our particular specialty. Whatever be the occupation one chooses in coming years, one would inevitably recognize that success in real life requires frame of mind to continuously engage in further learning, not only in one's own discipline but a variety of associated fields of knowledge. As the world is rapidly being transformed into knowledge-intensive society, the satisfaction in the performance of your responsibilities will be governed by your abilities to keep pace with the transformation in the context of your knowledge.

We all are aware that biotechnology, the use of biological systems for the production of goods and services, has expanded rapidly in recent years. The explosive growth of modern biotechnology has been fuelled by fundamental breakthrough in the fields of molecular genetics, cell physiology, biochemistry and biochemical engineering.

Much of the current research in aquatic biotechnology seeks a basic understanding of aquatic organisms and biological systems associated with persistent aquatic problems. Areas of research include the biological and biochemical processes of



aquatic biofueling, the metabolic pathways which produce the chemical structures of aquatic toxins, the isolation, identification and physiology of human pathogens of aquatic origin, and the understanding of structures and function of genes in aquatic plants and animals. The potential benefits of advances in aquatic biotechnology are immense. The aquatic sector's contribution to the national economy can be dramatically improved as new products, including pharmaceuticals and specialized chemicals are developed from marine/freshwater organisms.

Biotechnology hold promise for solving the problems of disposal of industrial waste in the aquatic environment. Genetically engineered aquatic, marine and fresh water microbes can detoxify wastes or produce useful compounds from them and is an avenue of great promise.

Chemical structures of many new compounds from marine organisms have been worked out in India and abroad as well. At the Universities of Hawaii and Cornell, researchers have found that Halenquinone, a substance isolated from sponge, is an antibiotic and new chemical structure identified. At the University of California three new compounds were found to inhibit tissue inflammation, analgesic and one inhibits cell division and is important for stopping tumour growth. Similarly two anti-cancer compounds from marine sponges have been isolated and are under test process at Oklahama University.

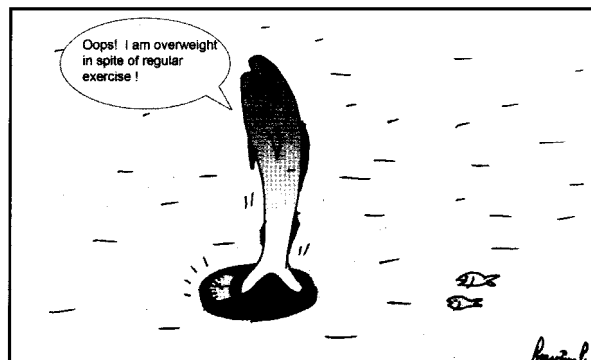
In marine and fresh water biotechnology, as in other fields of biotechnology, basic research is particularly needed to determine the structure,

function and expression of the genes of plants, animals and microbes. Opportunities for significant commercial application through expanded aquatic biotechnology are possible in the fields including:

- Fisheries enhancement, management and protection
- Industrial materials and specialty compounds
- Pharmaceuticals and enzymes
- Management of wastes in aquatic environment
- Environment health
- Methods development and improvement
- Aquaculture of plants and animals

As a member of a relatively small segment of our population holding a College Degree, we would be required to show a high level of maturity in dealing with economic, social and political issues of our times. We will have to confront many issues which will affect us personally as much as rest of the society. Population growth, environmental degradation, depletion of vital life-supporting natural resources like water and land, corruption in public life, violent social conflicts are some of the areas which are likely to draw our serious attention. Our disciplinary knowledge will indeed help us to deal with some of these in a professional and competent manner while others will require our maturity as a graduate.

At the end let us recall the words of Swami Vivekananda, who observed that, "Wisdom lies not in the amount of knowledge acquired, but in the degree of its application".





Framework for fisheries research, education and training, change in mindset of young students to generate excellence in science and leadership in technology and develop knowledge systems and knowledge society

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Education is the key to progress and ensures well being and welfare of individuals and the society. It is globally known that in developed nations the literacy is around 100% and entire society is knowledge centred. The fundamental difference among the developed and developing nations is the major difference levels of education, progress in science and technology and creating a knowledge based society.

Excellency in research and technology to create knowledge society and meet challenges of dynamic aquatic ecosystems

The developed nations are continuously striving to maintain their position and continue to have leadership at the global level. In today's world, the leadership requires excellence in research leading to development of a very broad and effective technology base, which is capable of acquiring and adopting new knowledge and use the same for development. The recent examples are Information Technology and Biotechnology. Information technology has influenced global communication, adoption of modern systems, technologies and accept quick obsolesce of earlier outdated technologies. This creates a dynamic environment

and the society is going through a process of continuous change and develops new knowledge. This change normally results in utilizing latest knowledge and resources effectively, and helps in creating additional assets, development of new products, processes, and services. These products, processes, and services are being continuously tested to see that they do not create any adverse impact on environment, on the society and quality of the life of people.

Whenever technologies and new knowledge is created, it can also have direct or indirect adverse impacts. By continuous monitoring and research, it is improved, updated, modified, and replaced. Thus, research is helping society to grow at an exponential rate, but the progress in knowledge system should be fast enough to combat the adverse impact of population explosion, and meet newly created greater demand for products, processes, and services. To meet this challenge, the education has to be updated by research, evaluation, and demonstrations to increase productivity, production, and ensure conservation of environment. In the past, adverse impacts of development were acid rains, global warming, and deterioration of soil and water due to



excessive use and discharge of wastes and contaminants in rivers and oceans was noticed.

Now at global level, scientists are making efforts to undo the adverse impacts of anthropogenic factors and minimize impact of their damage on the natural ecosystems. These are being achieved by continuous research efforts which are updating education programmes in real time. It is essential to get benefits of science in updating technology, extension and development, and quality education and create well-trained manpower for using new knowledge.

Fisheries is an integral part of aquatic and terrestrial ecosystems and uses water as a medium. The production and growth of fisheries depends upon ensuring good water quality and availability of nutrients for sustainable use. Whenever the anthropogenic factors result in addition of pollutants in the aquatic ecosystem, at a rate faster than the capacity of the nature to degrade, break and recycle them, it results in pollution and deterioration of the environment, and reduction in productivity, production and degradation of the ecosystem. Therefore, for sustainable development, judicious use of new knowledge through production processes is essential. We must ensure that the present generation does not produce adverse impact on the ecosystem. Sustained efforts should be made for judicious and optimum use of natural resources to protect ecosystems so that our children and grand children have the benefit of higher standards of living in pristine aquatic and terrestrial environments.

Change of mindset for young students

Education and research should be targeted to most receptive age groups to change their "mindset". Today young people choose subjects, which give them a scenario of making quick money. Their personal benefits are primary concern and their impacts on society are secondary.

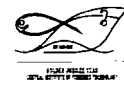
The desire for new knowledge and following life styles in conformity with global environment are the last concerns. To change this mindset we must look at education pattern in the country and introduce impact of science and research at an age when

students are most receptive. The present system caters to students in different age groups; primary school 5-10 years, secondary school 11-18 years, graduate studies 18-23 years, post graduate education 23-30 years. Therefore, awareness about globe, environment, atmosphere, earth, oceans, and *their role should be introduced at school level*. At graduate level they should learn components of nature, universe and environment, use and misuse of resources, renewable and non-renewable resources of energy and their opportunity of the unknown and their impact on human, physical, biological, and atmospheric disciplines. The teaching should attract them towards enquiry and generating excellence and deriving satisfaction in living good quality life which is also useful to others. They should learn analytical systems of the West and synoptic approach of the orient which has helped in conservation and optimum use of nature. The school and college going groups which constitute about 50% students population in India (Ref. State of World Population Report, 2003, UN Population Fund, NY, USA) have longer life span, can get the benefits of fundamental and applied research, education, and technology which can sustain the society. Therefore, modern research should be translated in to a form of education, which can induce change of mindset of school and college students. This is a major task and needs concentrated efforts.

Inland resources in tropical countries provide faster growth

A cursory review of different civilizations across the globe indicates that life originated in water and the ancient man lived along the water edge. The stone age man lived along the rivers and sea shores and hunted for food on land and water. Oceans provided a large base for fish production. Most of the fish, till 1950s, came from different oceans of the world. FAO statistics indicates that during 1950s 85% of the fish landings came from the oceans and the rest 15% came from the fresh water resources.

In large continents like China and India the picture was slightly different. During 1950s in India fresh water accounted for 30% of fish landings and



70% came from the oceans. With the intervention of modern research, the situation has grossly changed. In India the production of fresh water through aquaculture has increased from 30 to 45%, whereas the marine production has come down from 70% to 55%.

This single factor reflects that fisheries education, supported by research through various fisheries research institutes and Universities of India, has helped in enhancing research, which has benefited education, manpower training and production systems. In order to maintain this trend, research should be given paramount importance to develop new knowledge and systems, which are important and can be utilized by student, people, and professionals through fisheries research education and training programmes.

Aquaculture-Nutritional security and fish production

India and China are large continents where aquaculture supported by systems research and biological and biotechnological processes have made very rapid progress. Therefore, in India the priority areas are ensuring nutritional security by increasing food production and generating livelihood for people and enhancing export trade. However, to meet world health standards, food quality and monitoring for food standards are essential considerations. India is very rich in biodiversity both in marine and inland aquatic resources and drugs from the sea and bio-products like shark liver oil, Chitin and fish toxins etc. from other aquatic resources come to occupy an important role. Similarly, culture of single cell protein particularly Spirulina has made changes in providing low cost protein to ever growing population of the country. Spirulina also provides economically viable alternatives to provide live feed to fish, cattle, poultry, and some other culturable animals and plants.

Further, institutes like CIFE, CMFRI, CIFT and Madurai Kamaraj Univeristy have made advances in genetics of fish and prawn. They have succeeded in cloning and other biotechnological interventions for protection of environment and abatement of

pollution. They have also helped in fish culture by adopting technologies developed at CIFA, Bhubaneswar, which can produce 20 tonne fish per ha. per year. With the help of biotechnology at CDRI, Lucknow, a substitute of pituitary hormone, Ovaprim has been made. This has resulted in development of an indigenous product Ovotide, which is cost effective, successful and very popular. DBT has also supported production of feed for prawns and setting up of indigenous feed mills at CIFA, Bhubaneswar and CIAE, Bhopal. These are very successful examples and are being emulated in other parts of the country. Recently, CIFE has set up a fish feed mill at Baba Amte Complex. This has been very useful for lepers, and other weaker sections of the society. CIFE has developed environmentally controlled modern carp fish hatcheries, CIFE D81-85, which ensures 95% hatching rate.

CIFE has also developed and implemented Fish Based Mixed Farming System in water logged lands in Andhra Pradesh where average production is eight tons of fish/Bay. This has ushered in prosperity in East Godavari, West Godavari, Srikakulam and Guntur districts. The Institute has also bred fresh water giant prawn in formulated sea water and established fresh water prawn hatchery in Tripura. Similarly they have made advances in cage culture for production of fingerlings for stock in reservoir and they can also produce table fish in cages.

Similarly CIFT has made important contributions for maintaining health standards and quality control for exports of prawns and other marine products. Their contributions in post harvest technology, developing equipment for drying of fish along sea beach, use of prawn shell waste to develop Chitin and development of products from Chitin, making convenience food products from fish, etc. are spectacular. For reservoir fisheries, exploitation methods backing, preservation and making value added convenience fish products and fast fish foods are excellent and economically useful contributions. Now these should be demonstrated to fishermen through institutional finance. This will make a quantum change. Devices for excluding threatened



species like turtles and mammals from trawl nets have helped conservation measures.

Biotechnology and exponential changes

Fisheries is a part of life science which are in a dynamic state of continuous change. Only the survival of the fittest is ensured as propounded by Darwin. The theory of the survival of the fittest is true even today. Therefore, it is necessary to look at molecular level in the living organisms. This has been happening for more than few hundred years and now we have better genetic understanding and modern tools to modify living organisms including human being for inducing desirable traits. Today this is being done through modern biotechnology. The impact of modern biotechnology is being felt across the globe by better and appropriate use of microbes, plants and animals. The biotechnology is also making impact on fish and fisheries for producing genetically modified species, production of vaccines for control of diseases and making physiological and genetic changes for improved absorption of foods and higher FCR, greater fecundity and faster growth rate and increasing productivity and production of fish, prawns, crabs and even single cell protein "Spirulina". The introduction of environmentally controlled systems is essential. In these systems control of temperature, water flow, oxygen and removal of wastes and metabolites from the environment are ensured.

All these require knowledge of physics, chemistry, engineering, technology and social behaviour. Therefore, fisheries education and research have become multidisciplinary and are used by the beneficiaries starting from fishermen, co-operatives, technicians, supervisors, executive officers, managers, administrators, and scientists in different agroclimatic regions. Therefore, adaptive research is needed in different geographical and ecological areas. It is obvious, in order to cater to the large spectrum of fisheries; conservation of biodiversity, ecosystems, optimum management of single-species and multi-species population (population dynamics), and manpower training and increasing production and introduction of short term crops of 60-90 days

and to ensure continuous improvement in education and research must go hand in hand.

Research and technology approaches for leadership

At higher level and for top management it is very difficult to make an artificial barrier between education and research. However, clear difference exists between science and technology. Science aims at search and understanding of the unknown and quest for new knowledge and components. In technology, given inputs and processes result in desired production at a predetermined cost and in a given time frame. It is easier to teach technology through Hands On Training, field demonstrations, TVN systems but teaching of science for the quest of unknown, for better understanding of nature is more difficult. It is necessary to teach these aspects in simple language and with visuals and models at school stage.

Education for 'sons of soil' and weaker sections

During 1950s, the Govt. of India and FAO, jointly designed fisheries education programme, which was implemented by CIFE and included education for fisheries technicians, operatives, executives, extension workers and officers. This was supported by national and international research programmes, which were operated at CIFE both for marine and inland sector including estuaries, reservoirs, and lakes. The alumni of CIFE was around 1200 people till 1998. They had trained about 100 students and officers from other countries with international financial support and fellowships. It includes students, officers, and research scholars from India, South-East Asia, Asia and Middle-East and African countries. This in-service education system has been discontinued due to reorganization of CIFE. It is therefore, essential to re-start regular courses of operatives, field workers, Jr./Sr. Executives, and officers who are working in different governments, voluntary and other agencies.

Fisheries is a state subject. States continue to recruit local people with available educational qualifications. Forcibly imposing upon them that



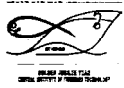
fisheries education institutes and colleges will select, recruit, and train students; and the states should employ only these students does not appear to be very practical. Particularly today when 'sons of the soil' receiving greater preference and attention. Therefore, it is essential to educate personnel from state governments voluntary organizations working in fisheries sector in different states and different agro-climatic regions and different aquatic ecosystems. Later, ICAR also worked in close collaboration with USA, UK, Canada, Australia, Norway, ICLARM, and various research and development programmes were initiated. This resulted in increase in production in some sectors and setting up of aquaculture farms, ice factories, cold storage, fish freezing, and processing plants, which helped in increasing exports. Immediate concerns of research which influence education and development process, need our careful consideration, discussion, evaluation and modernization.

Integrated coastal zone management

Globally coastal zone is the most preferred area. It has attracted attention of the people all over the world. More than 10% world's population lives along the sea coast and generates more than 20% of the global business. Therefore most of the large metropolitan cities and industrial centers have developed along the sea coast. The examples are New York (USA), London (UK), Rotterdam (Holland), Lisbon (Portugal), Rome (Italy), Karachi (Pakistan), Bombay, Chennai, Kolkatta (India), Singapore, Hong Kong, Tokyo (Japan), Mexico, Uruguay (South America), Sydney (Australia). First discussion on coastal zone management in India was organized at CIFE under the auspice of National Workshop on Ocean Management. That became a precursor for starting Coast Guards in India. CIFE has also conducted a training programme for officers of Coast Guard. A special training programme was organized for them in Canada at Halifax University. Later, the first National Workshop on Coastal zone management was organized by Department of Ocean Development at Delhi and was inaugurated by Shri K.R. Narayanan, former President of India. Subsequently, coastal zone

workshops were held at Kolkatta, which was inaugurated by Shri Jyoti Basu, former Chief Minister, West Bengal. Workshop in Tamil Nadu was inaugurated by Dr. M.S. Swaminathan. Similarly, workshop on coastal zone management were also held in Andhra Pradesh and Kerala. As a result of these initiatives, Dept. of Ocean Development started monitoring oil and industrial and sewage pollution all along the Indian coast line and has also made efforts to develop mathematical models for pollution control.

Coastal zone is a dynamic ecosystem where ocean, land and air interaction is continuously taking place. Over a period of millions of years, this zone has developed a dynamic equilibrium but due to changes in environmental factors and influx of pollutants, it is in a stage of continuous change. Consequently, it is the most sensitive ecosystem. However being region of confluence between air, sea and land, it receives nutrients and oxygen both from land and sea and is the most productive ecosystem. Any change in the physical factors viz. air temperature, wind, storm, surges, cyclones, and waste disposal brought about naturally or through anthropogenic factors results in rapid changes and disturbs the ecosystem. This causes pollution and the natural disasters. The example is that due to global warming intensity and number of storms, surges, and cyclones, both have increased in frequency and intensity in the Bay of Bengal and along the East Coast of India and Bangladesh. Change in water discharge due to Farakka Barrage have also influenced occurrence, distribution, and migration of hilsa and prawns. During the last century, pressure has been increasing due to exponential growth in population and disposal of sewage, industrial and city wastes and domestic effluents. When these effluents are discharged along the coast without any treatment or with partial treatment they cause maximum damage and result in irreversible damage to the coastal zone. The beautiful beaches become unfit for recreation, bathing, and boating and the scenic beaches are lost for new generation. This has happened at Chaupati and Juhu beaches at Mumbai during our lifetime. The problem has further



aggravated due to oil pollution caused by shipping. All of us know that Gujarat, Maharashtra, and Konkan beaches were known for good fishes like pomfrets, sardines, mackerels, Bombay duck, and catfishes. Now all these fishes have disappeared from near shore areas.

A careful study of any metropolitan area in the coastal zone indicates that this is an area of multiple variable, multiple interests, which act in harmony but when one of these interest becomes a dominant factor, it disturbs the balance, and the pristine value of coastal zone is lost. The main problem in coastal zone is conflict between multiple factors and domination of single factor interest. Thus, it requires an integrated approach in which physical factors are monitored and assessed, and balance is maintained between multiple and single party interests.

Let us look at this problem, as it exists. In Mumbai large reclamation of the low lying tidal and backwater area and construction of multi storied buildings have taken place in Juhu - Versova area. The money spent per square feet in Versova Juhu area for large scale reclamation and building construction is in the order of Rs. 60 thousand per square ft. (Rs.4000 per square ft. for 15 floors). This is highly profitable for builders. However, the construction of multi-storied buildings creates problems of large-scale generation and disposal of garbage, sewage and domestic waste. The net result is development of slum areas where people live under unhealthy conditions. This results in diseases, misery, loss of life, and property. The discharge of industrial wastes has also resulted in accumulation of heavy metals like Zinc, Cadmium, Lead, Manganese, Iron, etc. in coastal areas up to a depth of 50 cm along the coast of Maharashtra and Gujarat.

The above examples make it clear that coastal zone consists of multiple factors and it is necessary to develop an integrated and balanced approach for sustainable development and optimum use of coastal resources. Efforts should be made that a single factor or agencies interested in only one preferred use of coastal zone should not be allowed to cause adverse impact on other uses. Therefore, analyses of various

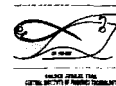
components, which constitute the economic zone is essential. Studies must also be conducted to derive maximum benefits from single uses without disturbing the ecosystem.

Development of new courses and specialization in Universities and develop systems of excellence

Keeping in view, the requirement of fisheries research and education, some important areas which should be considered by teaching faculties are listed here. But, the development and adoption of new courses should depend upon available field facilities, equipment, infrastructure and expertise of manpower. This approach will help in developing desired specialties at post graduate level in different research and education centres and Universities. This will also avoid duplication of research efforts on a large scale but will ensure quality education supported by efficient technologies and promote different specialized courses in different Universities. Systems research and development of excellence in different Universities are also important. This will help in skill development, adoption and implementation of knowledge based tested technologies to create knowledge workers and knowledge systems.

Some topical areas for research and education in fisheries

- Large marine ecosystems and world oceans.
- Large, medium, and small fresh water ecosystems and their dynamics.
- Oceans (near shore and off shore areas and open oceans).
- Coastal ecosystems popularly understood as coastal zone management.
- Pollution (oil pollution, industrial and sewage pollution) and impact on coastal waters. Deposition of heavy metals in soil and their bioleaching.
- Global warming, tides, storms, surges, and cyclones and impact on management of water masses and impact on food chain.



- Biodiversity of oceans, rivers, and lakes; and drugs and bioactive compounds and toxins from the sea.
- Estuaries – Anadromous and catadromous species – Conservation of breeding population.
- Natural lakes and man made reservoirs.
- Benthos - Macro, micro, and meio benthos.
- Degradation of organic matter and recycling of effluents in the oceans, estuaries and lakes.
- Village ponds and 'niskar' tanks - culture in seasonal tanks.
- Coldwater ecosystems including fisheries in Himalayan region from Jammu & Kashmir to Sikkim, Tarai regions of Himalayas and the North-Eastern states for sports fishery, nutrition, and livelihood for hill population.
- Biodiversity and conservation of different ecosystems and study of conservation and migration of different threatened species including sport fish, olive turtles, corals, mollusks and marine mammals and zoogeography.
- Oceanography, limnology and fisheries - Fundamental, considerations and future perspectives.
- Biotechnology, microbiology, immunology and immunogenetics and production of vaccines and other health care products and prophylactics.
- Education and research relevant to problems of different state governments and ecosystems.
- Catfish and fresh water prawn culture, sport fisheries, fish food, pelleted feeds, physico-chemical survey of aquatic ecosystems etc.
- Sport fishery and angling, conservation of masher and other threatened species in sacred sanctuaries.
- Indian Fishery Act and role of Coast Guards, MPEDA, NABARD, DOD, DST, DBT, ICAR and other international funding agencies.
- Post harvest technology for making new products in domestic and export market.

These are indicative suggestions which should be included in fisheries education, research and training programmes. The education programme should be formulated keeping in view field and laboratory facilities, equipment, manpower, and available resources. This should lead to creation of a balanced environment in which education and research are complimentary to each other for bringing about use of biotechnology and other allied sciences for conservation of environment, improving production and production systems, food security, and availability of fast food for rich and young people and white meat fish protein for the masses at an affordable price.

Oceans which provide bulk of fish production need management and conservation of estuaries

Data of world fish landings from 1996 to 2000 indicates that at the global level the landings of the capture fisheries was 93.5 million tones which increased to 94.8 million tones which represents increase of 1.4%. Whereas in aquaculture for the same period, production has increased from 26.7 million tones to 35.6 million tones showing an increase of 33.3%. The figures clearly indicate that at global level, aquaculture is the major thrust area for fisheries research. However, the world oceans occupy 70% of the global surface and are a major resource for supporting development of marine fisheries. Oceans constitute the major production base and provide direct and indirect employment. So far as Indian Ocean is concerned, it is smaller than the Atlantic and the Pacific Oceans and the productivity is also very low. Though Indian Ocean is smaller and least productive, it supports fish production and fishermen population along 8000 km of coastline in India and provides livelihood to more than 20 lakh people. Recent reports indicate that 10% of Indian population lives within 60 km from the coastline. Even metropolitan cities of India like Kolkatta, Bhubaneswar, Visakhapatnam, Chennai, Thiruvananthapuram, Cochin, Mangalore, Panjim and Mumbai are all located along the coastline. Thus, management of coastal ecosystem is vital for Indian economy and for production of food.



Thus, marine and estuarine fisheries are major resource sectors for fish production, which should also receive higher attention. A critical review indicates that stagnation in marine fish production is due to reduction in catch from the coastal areas. From this example students must decide their areas of preference for research.

Pollution and leaching of heavy metals and coastal engineering

During the last decade, the coastal areas have become polluted due to discharge of untreated city waste, sewage, and industrial waste. In other areas due to continuous release of heavy metals, and industrial waste, the accumulation of heavy metals has occurred along the Indian coastline. Heavy deposits of iron, zinc, lead and mercury have been found upto a depth of 0.5 m. This causes major damage to environment and in order to provide clean near-shore areas for coming generations, it is absolutely essential that research on leaching of heavy metals from coastal marine environment should receive our immediate attention. Dredging from coastal areas particularly along Hoogly Estuary has been used to remove sand deposition and ensure navigation. Similarly dredging and reshaping of the coastal areas as done in Zuary Estuary at Goa should also receive attention of research workers. In Zuary Estuary by dredging they have reshaped the coastline and constructed small landing centres for loading, unloading and transport of mineral ore and other marine products. Therefore, coastal management and coastal engineering processes occupy an important role. Thus, protection and conservation of coastal areas is a major sector which will help in providing livelihood and income to a very large number of traditional fishermen who by profession depend on fisheries. The remedial measures should include instruments and large scale engineering systems for researches on treatment of sewage and industrial wastes. They should also make mathematical models to indicate quantity of discharge of treated sewage and wastes, which do not produce any harmful impact on environment. Therefore, hydrodynamics of coastal areas is a

priority area for research. Similarly, studying erosion and accretion processes along Indian coast are important. In India, marine fish are sold in fresh condition, and the bulk of low value fish is dried and stored under unhygienic condition. Therefore, engineers should develop equipment and fish processing machines for post harvest research for development of products from low value fish which can help in producing good quality fish and employ a large number of people. The marketing margins between fresh and processed fish products are of the order of 100-120%. In this area by use of fish processing machines, a large section of fishermen and women can be employed to make and sell semi-processed and ready to eat fish products.

Largest estuarine ecosystem is highly productive

India has large river systems of Ganga and Brahmaputra which make a Gangetic Delta System in India and Bangladesh. This is a highly productive system and constitute a largest estuarine system of the world. Again the estuaries are highly productive, but due to pollution, a major portion of the fishes remain unused. These estuaries and the adjoining coastal areas are very important breeding grounds for a number of species of anadromous and catadromous fishes. Therefore, conservation of biodiversity of the estuarine ecosystem should receive high research priority. It may also be indicated that the coastal lagoons like Chilka Lake in Orissa, Pulikat Lake in Tamil Nadu and Vembanad Lake in Kerala which were once very productive have now become silted and polluted. Therefore, research on silting and eutrophication, ecology, biology, and production system of estuaries and natural lakes is vital.

India has tropical ecosystems, resources and potential for leadership in education and research for tropical countries of Asia, Africa and South America

The data on resources of inland fisheries have been published by Ministry of Agriculture. India has 29000 km of major rivers. They were the resource for biodiversity and providing a genetic base for different species. Some species have disappeared and

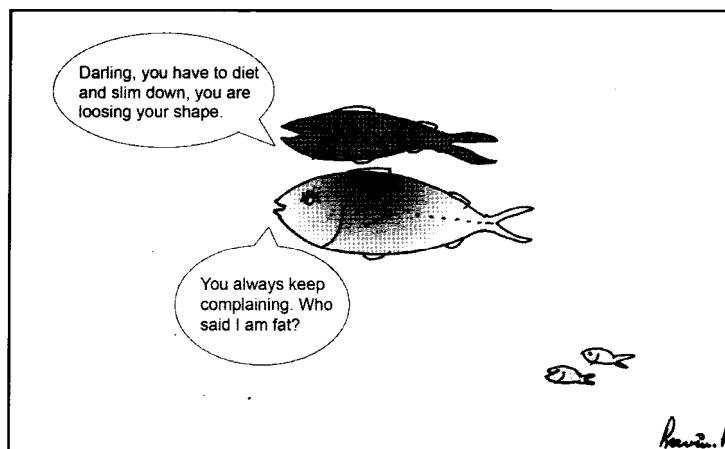
many are in the list of threatened species which need protection and conservation. In Uttar Pradesh, Bihar, and West Bengal, Ganga river system was a major resource for collection of spawn of major carps. This has come to a stand still and has adversely effected the production system. Therefore, conservation of breeding grounds and declaration of sanctuaries including sacred sanctuaries near religious centres should be strengthened. The construction of large irrigation dams across the large river systems have adversely effected migration of fish stock to upper reaches. The example is Godavari Anicut at Dholshwaram, Andhra Pradesh. Therefore, the study of biology of carps, catfishes, and prawns, and construction of fish ladders and fish passes should become important areas for research and education. The major increase in inland fisheries have come from aquaculture. This includes reshaping of land, construction of farms, use of circulatory systems, air blowers, and provision of natural and formulated feed, heavy stocking rates and prophylactic measures for reducing pollution and conservation of environment and are integral part of research and education.

This article is intended to provide a spectrum of problems which Indian fishery is facing and now more specialized groups along with the research and development officers, bankers and industry should decide comparative priorities of research and education to meet national and international requirements and make fisheries an economic industry and to provide delicacies for the rich and

meet food needs and employment generation for masses. With these assets India has resources infrastructure, and trained manpower to become a leader in fisheries for countries, which are located in tropical ecosystem. India can develop research and teaching programmes for students from South-East, Middle-East, Africa, and South American countries, which are located in the tropical region.

Future perspectives and challenges

Since independence, India's fish products and exports have increased. The benefits have gone to industries and organized sector and fisherman have been benefited to a small extent. It is now necessary to train knowledge worker, create knowledge system and knowledge society for benefit of fish farmers and young students. In India personnel employed in Fisheries Departments in States manage aquatic resources. Their regular training should be restarted at CIFE and other Institutes with an objective to manage aquatic resources with trained manpower and adopt state of art technologies. They will also ensure nutritional security, increase sustainable production, ensure pollution abatement in coastal zones and design new processes, products and equipments of export. India should become a knowledge and technology hub. It should also develop a database for research, education, manpower training, and demonstration of new technologies for countries in Central Asia, South East Asia, Africa and Latin American countries in South America.



Recent developments in fishing technology

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Fishing is an ancient occupation. About 200 million people are either directly or indirectly involved in this industry. Fifty million people - of which 12.5 million are fishermen and their family members - directly depend on fishing for their livelihood. An additional 150 million people are involved in shore-based support activities, processing and marketing of fish and fish products. Fishing contributes significantly to foreign exchange earnings of many developing countries. Fishing provides employment and economic benefits to large sections of the society. As a source of food it contributes about 20 percent of animal protein supply. At present the total world capture fishery production is around 95 million tones. About 70 percent of the fish production is directly utilized for human consumption while the balance 30 percent is reduced to fish meal and used in animal feed production.

In the past, technological development of fishing gear and methods were aimed at increasing production, by increasing efficiency of the gear systems. However, in the present situation of over-exploited fish stocks and increased awareness of the environmental and ecological impacts of fishing, progress in fishing technology is focused on the development of responsible fishing systems, with improved size-selective and species-selective properties, decreased impact on the environment and non-target resources, which facilitates

sustainability of fish stocks.

In India, Central Institute of Fisheries Technology (CIFT, Cochin), under Indian Council of Agricultural Research, being the premier research and development organization dealing with harvest technology of fish, has in the last fifty years greatly facilitated improvements in traditional, motorized and mechanized sectors, in fisheries. Its contributions in the harvest sector include standard fishing vessel designs, standardization of netting, netting yarn, netting twine, ropes and combination wire rope for fishing purpose; introduction of modern fishing gear fabrication methods and efficient ecofriendly and fuel saving gear systems for different fishery resources.

Fishing vessels

The world fishing fleet numbered about 3.8 million vessels (1995). About one-third of these were decked vessels, the remaining two-thirds were undecked vessels, generally less than 10 m in length. There is great diversity in fishing vessels operating around the world. Major developments which have taken place in fishing vessels include improvements and recent innovations in:

- (i) Craft materials
- (ii) Hull optimization
- (iii) Engine performance
- (iv) Propulsion systems

- (v) Gear and catch handling equipments
- (vi) Onboard pre-processing, processing, preservation and packaging systems
- (vii) Navigation and communication equipments
- (viii) Vessel safety
- (ix) Energy conservation in vessel operation

Modern fishing vessels have integrated control console, navigational instruments and fish detection instruments, including echosounder, sonar and net monitors, radio communication with GMDSS facility etc.

Fishing gear materials

In earlier years, fishing gears used to be made of natural fibers such as cotton, manila, sisal, jute and coir. As these materials are vulnerable to biodegradation, they have relatively short service life and incur high cost for maintenance. In recent decades major advances have taken place in fibre technology, along with the introduction of other modern materials. With the introduction of man-made synthetic fibres in India in the late 1950s, natural fibres used for the fishing gears have been substituted by these synthetic materials due to their high breaking strength, high resistance to weathering, low maintenance cost, long service life and better uniformity in characteristics. Most important synthetic fibres used in fisheries are polyamide (PA), polyester (PES), polyethylene (PE) and polypropylene (PP). Other synthetic fibres, which are less widely used and generally restricted to Japanese fisheries are polyvinyl alcohol (PVA), polyvinyl chloride (PVC) and polyvinylidene chloride (PVD). Recently, newer materials with better high tensile strength such as 'dyneema', has been introduced. Earlier, netting used to be fabricated manually, which is laborious and time consuming. In recent years, machine made nettings are almost exclusively used in fishing net fabrication.

Fishing gears

A wide array of fishing gears and practices ranging from small-scale artisanal to large-scale industrial systems are used for fish capture. Over

the years, traditional fishing gears have been upgraded and newer more efficient fishing systems have been introduced. Most important among these fishing gears are trawls, purse seines, lines, gillnets and entangling nets and traps. Among the most significant developments which affected the historical evolution of fishing gears are:

- (i) Advances in craft technology and mechanization of propulsion
- (ii) Advances in gear and catch handling equipments
- (iii) Introduction of synthetic gear materials
- (iv) Developments in gear designs based on fish behaviour and requirements for minimization of ecological and environmental impacts
- (v) Advances in acoustic fish detection and satellite-based remote sensing techniques
- (vi) Advances in electronic navigation and position fixing equipment

Fishermen may use several fishing gears and methods appropriate for the species and environmental and ground conditions. Fishing gears whether primitive or sophisticated use five mechanisms in the capture process viz., gilling and tangling (e.g., gill nets and trammel nets), trapping (e.g., traps and pound nets), filtering (e.g., trawls, seines and other net fishing systems), hooking and spearing (e.g., hook and line and harpoons) and pumping (e.g., fish pumps).

Fishing gears are classified based on the principles of capture, design and technical features and operational methods. The main categories of fishing gear are (i) Surrounding nets (including purse seines), (ii) Seine nets (including beach seines and boat, Scottish/Danish seines), (iii) Trawl nets (including bottom beam, otter and pair trawls and midwater trawls: otter and pair trawls), (iv) Dredges, (v) Lift nets, (vi) Falling gears (including cast nets), (vii) Gillnets and entangling nets (including set and drifting gillnets) trammel nets, (viii) Traps (including pots, stow or bag nets and fixed traps), (ix) Hooks and lines (including handlines, pole and lines, set or drifting longlines and trolling lines), (x) Grapping and



wounding gears (including harpoons, spears, arrows etc.), and (xi) Stupefying devices.

Among the great variety of harvesting systems available around the world, the most significant in commercial fisheries are purse seines and trawls, followed by lines, gill nets and entangling nets and traps. Surrounding nets are roughly rectangular walls of netting rigged with floats and sinkers, which after detection of the presence of fish are cast to encircle the fish school. Surrounding nets are generally operated in the surface layers. Purse seines are the predominant type of surrounding nets, in which the bottom of the net is closed after encircling the fish school, by a purse line. Mini purse seine or ring seine used in the traditional motorized sector belong to this category. Seine net is a long wall of netting supported by floats and sinkers, which are operated by surrounding areas of water with potential catch. They are usually operated in the coastal or shallow waters where bottom or surface act as natural barriers. Trawl nets are conical bag nets with two wings and a codend where catch is concentrated, operated by towing from one or two boats. Based on the position in water column where they are operated, trawls are classified into mid water trawls or bottom trawls. Gill nets and entangling nets are rectangular walls of netting kept erect by means of floats and sinkers and positioned in the swimming layer of the target fish, which catch the fish by holding them in the mesh by gilling or entangling.

Acoustic fish detection and satellite – based remote sensing techniques

The most well known and widely used instruments for fish detection are echo sounder and sonar. Technological advances in electronics and research into underwater acoustics have led to

tremendous improvements in echo sounder and sonar and made them more reliable and affordable. Progress in the satellite-based remote sensing techniques, which use sea surface temperature and ocean colour to identify areas of potential fish abundance also greatly reduces the search time, as near-real time information is communicated to the fishermen.

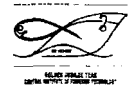
Responsible fishing techniques

Code of Conduct for Responsible Fisheries, was adopted in October 1995 in order to ensure the long-term sustainability of the resources, minimize negative environmental impacts and protect biodiversity. It is voluntary and global in scope. Directions associated with the use and development of fishing gear and practices delineated in the Code focus on:

- (i) Developing selective fishing gear and practices
- (ii) Minimizing environmental impacts of fishing gears
- (iii) Minimizing energy conservation in fishing operations

Conclusions

The Code of Conduct of Responsible Fisheries sets out principles and international standards of behaviour for responsible practices to ensure long-term sustainability of fishery resources. It stresses that fishing capacity should be commensurate with maximum sustainable yield of the resources. Efforts should be taken to rehabilitate the fishery resources, adopting selective and environmentally safe fishing gear. Future of fishing as an economically and ecologically viable method of food production may greatly depend on the implementation of responsible fishing and enhancement of fishery resources.



Value added products and processing of fresh water fish

Dr. S.D. Tripathi

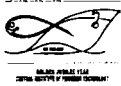
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Unlike the marine fish that are landed in huge quantities at specific and established centres, fresh water fish, in general, constitute a small bulk of the fisher's or farmer's produce at a large number of scattered centres strewn all over inland areas on river or pond banks, mostly so in the remote and rural areas excepting at some major landing centres located on the rivers, reservoirs or urban/city centres. The large quantities are auctioned and dispatched to markets while the small quantities are most often sold, either whole or cut, like hot cakes and there hardly remains a surplus for conversion into value added products or for processing. It is for this reason that no attention has so far been paid to the technological aspects of processing the fresh water fish. Now that fresh water fish production is increasing as a result of enhancement of culture-based capture fisheries and semi-and intensive aquaculture through adoption of a number of different systems, the need has arisen for the utilization of the occasional glut or processing of the surplus in areas where the consumer demand is not so great or where the demand for a specific variety or product does not exist. An increase in the purchasing power of the common man coupled with his interest in 'ready-to-eat' or 'ready-to-cook' products also justifies the need for processing and value addition in fresh water fish.

Though processing of fresh water fish has been in vogue in many areas for a pretty long time, albeit

on a small scale, it is confined to only a few traditional houses, especially in the North-East, where it is preserved through value addition for rainy days. Unfortunately, the products are hygienically poor and often get infested with fungus and insects. However, the demand is high and if hygienic products would be available, these would have a good market. Let it be noted that the fresh water fish, in general, are no less rich in protein content than its marine counter-part. Further, some of the essential nutrients such as omega-3 fatty acids, iron, zinc, calcium, Vitamin A and Vitamin C that are missing in the staple foods or found only in small quantities are present in fish, whether big or small, in relatively higher amounts. The contribution of small fish to food and nutrition security is especially important as these are consumed whole, including bones, providing both calcium and phosphorus, besides large amounts of Vitamin A as Retinol and Anhydroretinol, especially in *Amblypharyngodon mola*, which are readily absorbed and utilized in humans though not so readily from the vegetables.

Though the Indian major carps are the mainstay of aquaculture as well as the dominant product from reservoirs and tanks besides the rivers in the northern half of the country, a wide variety of fresh water fish are popularly consumed in different parts with great relish, some more than others. There are murrels (*Channa* spp.), large perches (*Wallago attu*, *Aorichthys* spp., *Mystus* spp., *Pangasius pangasius*,



Rita rita and others) and small perches (*Clarias batrachus*, *Heteropneustes fossilis*, *Ompok* spp. and others) catfishes, fethrebacks (*Chitala chitala* and *Notopterus notopterus*), a whole lot of minnows and some euryhaline species (*Lates calcarifer* and *Chanos chanos*) that grow well in fresh waters. Of the major carps, rohu (*Labeo rohita*), mrigal (*Cirrhinus mrigala*) and catla (*Catla catla*) are in great demand by the consumers even in the north-western states where they would love to have them but for their spines. Of late, even trout is available in Himachal Pradesh and Jammu & Kashmir from where it is transported to New Delhi. Here now lies a great opportunity for processing and value addition!

Principal consideration for processing

It is the nutritive and technological value of the fish that determines its potential for processing. While the nutritive value of fish meat is almost comparable with that of animals, it is the former which, being a low-calorie, high-energy diet, is always preferred and advised for consumption over the red meat. Moreover, the amino-acid composition of fish proteins being similar to that of hen's egg, consumption of fish together with rice - which is poor in amino-acids like lysine and threonine - not only helps in complete utilization of plant protein but also improves the quality of the diet. Fish is also a valuable source of vitamins and minerals as it contains trace elements such as selenium, molybdenum and cobalt - elements that play a significant role in the physiological processes.

The technological value of fish is determined by the yield of edible parts which not only depends on the species but also on its age, size and maturity and is an important factor in determining the technological value of the fish. The meat yield, in general, ranges from 60% to 70% but during the breeding season it is less than 60% in most of the carps.

Flavour, texture, appearance, size and bone content comprise the quality features of fish meat which determine the consumers' interest and its market demand. In general, fish with high bone

content are not as popular for consumption as those with fewer bones. This shows that for some the technological value of carps is lower than that of murels and catfishes. Again, the taste of fish depends mainly on the quality of their habitat, environment and food. It is well known that carps from dirty and muddy ponds or sewage waters have an unpleasant odour and flavour. Further, large-sized fish are usually preferred over small ones, particularly in view of their bone content so that 1 to 3 kg rohu will be preferred over 250 to 500 g rohu, but much larger fish again have a lower value owing to the fibrous texture of their meat. Lastly, the sanitary and hygienic condition of fish or fish meat that takes into account the presence of parasites and pathogenic micro-organisms also influences its technological value. However, the technological value of fish is based on its freshness which depends on the species, fishing methods and storage conditions following its capture.

Fresh water fish deteriorates fast and its freshness is mainly evaluated by sensory methods such as texture, flavour, appearance, state of abdominal cavity and taste that determine its usefulness as raw material but these properties change during storage and it is difficult to determine the stage at which it is no longer entirely fresh.

It is best to keep the fish alive as long as possible and, when killed, reduce the bacterial action by immediately decapitating and gutting followed by washing and chilling. Unfortunately, this is not the case at many of the landing centres, either on the rivers or reservoirs. The temperatures being high and the markets located at distant places, the fish never reaches in good condition even when sold without processing. Such a product hence does not meet the quality requirements for processing which has to be of a very high standard. An important aspect of fish processing is to have the product in a form that is attractive to the consumer, and has a high quality with a long shelf life e.g., fillets without scales, skin and fins.

A basic approach in modern processing technology which would lead to increased economic



profitability would be to make the maximum use of raw material and leave no wastes. Introduction of mechanization in processing plants and production of value added products appear to be the obvious choice when one thinks of profitability through processing. An assured and regular supply of a minimum quantity of the raw material in good condition and the provision of proper storage during the glut season is a must. Owing to irregular and poor supply of fresh water fish as compared to the huge marine landings, commercial processing of fresh water fish has not developed so far. It needs to be noted that each step from fishing to processing and transportation to sale of the finished product is important and only when followed strictly and responsibly can assure the customer a top quality product.

Common processing techniques

Unfortunately, there is not a single fresh water fish processing plant in India. However, there exist quite a few in the USA and several European countries where fresh water fish, like in India, are cultured and relished. The following account is based on the techniques followed there.

The quality of the raw material for processing is very important which depends on how it is caught and later handled. Too many fish in a single haul result in injuries and damage the fish causing stress that accelerates the processes of spoilage. It is desirable to keep the fish in live condition as far as practicable and select the healthy and uninjured ones from among them for conditioning which could be done in large hapas to evacuate the gut contents, reduce stress and inhibit metabolism. In India, the fish are normally removed from the net, whether gill or drag, and either thrown in the hold on the boat or on land in mud and slush and allowed to struggle that severely impairs its quality, especially when the temperatures are ruling high. The fish should be quickly washed, iced to be transported a long distance, and marked – auctioned or retailed – where the consumer buys it to be processed at home. It is also possible that it is partly processed (scaled and filleted), weighed and kept in sealed packs under cold

storage conditions in the super markets. Channel catfish in the USA and carp, trout and pike perch in European countries are transported live to the processing plants in tankers that are provided with cooling and filtering (activated coal and biological filters) systems.

Preliminary processing of fresh water fish involves the following steps: evisceration, deheading, scaling, cutting of fins and belly flaps, slicing into steaks, filleting, skinning, grinding of skinned fillets or different combinations of the above. These products could be sold as such or further processed to obtain value added products. Unlike the shrimp and other processing plants, most fresh water fish processing plants in the USA and Europe are small with a low level of mechanization owing to limited production, seasonal availability of the raw material and non-availability of inexpensive and efficient mechanical equipment.

Once delivered in the plant, the fish are stunned or killed following a painless method as prolonged agony causes production of lactic acid and other products that affect the quality of the product. This is usually done by passing an electric current through the water holding the fish in the tank. Most catfish plants in the US practice this method but, in some others, the water in fish holds is saturated with Carbon dioxide that kills the fish or makes it unconscious.

The next step of grading the fish by species and size is again a manual process though mechanical graders are highly efficient but enormously expensive. While slime is a natural mechanism of protection, it creates a perfect environment for the growth of micro-organisms and needs to be removed by thorough washing, especially so in the carps. It is best removed by soaking the fish in a 2% solution of baking soda and then washing in a rotating drum washer which is more efficient than manual washing.

Scaling the fresh water species is highly labor-intensive when done manually and carps are particularly difficult to scale manually. Mechanized and power-assisted hand-held scalers are commonly



used in small processing plants in Europe. The scaled fish are washed in vertical drums with potable water to clean and remove the accumulated bacteria.

The head, an inedible part that constitutes 10-20% of the total fish weight, is usually cut off manually as there is no cheap equipment available for an efficient cut. The fishermen in India are experts in removing the head with a minimum loss of flesh by giving a round cut around the operculum. Large fish are deheaded by using a guillotine cutter. The channel catfish being small in size, deheading is rather easy and done with machines without loss of flesh.

Evisceration is again labour-intensive and usually performed by hand to remove internal organs, peritoneum, kidney tissue and blood avoiding damage to the gall bladder. Use of vacuum suction tools employed to clean the body cavity in processing salmonids could be used in case of fresh water fish also.

Manual cutting of the fins is a strenuous and labour-intensive operation, especially with large fishes. Slicing of deheaded whole fish into steaks with a cut perpendicular to the animal's backbone is a very common fish processing method. Larger fish, particularly carps, which have a massive and more solid backbone, need slicing mechanically. Fillets, a piece of meat consisting of the dorsal and abdominal muscles, are the most sought-after fish product in the retail market. Filleting efficiency depends upon fish species, its sex, size and nutritional condition. Manual filleting is highly labour-intensive and largely depends on the skill of the workers. Filleting machines for processing marine fish are quite costly and hence not suitable for fresh water species.

Manual filleting and deboning are time-and labour-consuming procedures and are usually carried out using simple and inexpensive machines. In small processing plants, a machine which separates fillets and bones, is commonly used. Filleting devices are produced in Germany, Poland, Russia and many other countries and are finding increasing applications in

small processing plants. Meat left on the fish's backbone after filleting can be recovered to the extent of 50% using a meat-bone separator.

Skinning of fresh water fish fillets is a recent introduction into processing plants. Manual fillet skinning is labour-intensive and difficult. The simplest and most inexpensive automated tool in use for skinning of fillet consists of an oscillating knife powered with a small electric motor and a system of compression springs operated with a foot pedal. Various fresh water and marine fish species can be processed in this machine, including larger fish. Its use is recommended for small processing plants, fish markets, fishmongers, supermarkets and restaurants. Compared with manual operations, this machine facilitates and speeds up skinning. Some devices are small and can be placed directly on the processing table. Running water and electricity are necessary for their operation. Efficiency varies with the fish species.

In recent years, a new trend has emerged to effectively process raw fish products which result in production of minced meat separated from inedible parts, such as bones, skin and scales. During filleting a considerable amount of meat is usually left along the ribs and backbone (30-50%). The carcasses are a source of minced meat. Minced meat is also produced from less valuable fish species after deheading and cleaning their body cavities along with the kidney tissue. Meat is separated from the bones, skin and scales, in automated devices called separators.

Minced meat has a great value and can be either frozen in cardboard or foil containers, or used immediately to produce fish burgers, fish sticks, canned fish, vegetable mixes and fish dumplings. In Hungary, minced fish meat is made from carps 1-3 kg in weight, dried and later added to fish soups.

Value-added products

Researches conducted at technological institutes are coming out with various recipes for value addition and, of late, a number of value added products have been developed from fresh water fishes. Though yet to pick up on a commercial scale,



these are being locally produced by individuals or a small group of so-called entrepreneurs as a cottage or small-scale industry. Quality assurance and marketing of the new, rather unknown, products will surely take some time for the industry to pick up but, if supported, there exist tremendous possibilities for its development in certain regions.

Fish pickles, like prawn pickles, are equally delicious and have been prepared using the meat of catla, rohu and mrigal. Though wafers, sandwich, papad and chakli have not been prepared using fresh water fish, but any low value fish could be used for that purpose.

Cutlets with high organoleptic properties can be prepared from filleting waste of Mahseer (*Tor khudree*) by cooking the frame to recover the meat, the yield being as high as 37%. The bones are cleaned again, sterilized, dried and powdered and incorporated in curry products to fortify with calcium. Fish calcium has also been obtained from rohu scales, though the yield is low (9.5%).

Smoking is usually practiced in rural areas under unhygienic conditions but quality products have been developed recently using scientific techniques. Fillets from *T. khudree* and common carp are smoked at 70° C for 30 minutes and the product vacuum-packed and stored at 3° C which has a shelf-life of more than four months. The Central Institute of Fisheries Technology (CIFT), Kochi, has developed a Mobile Model of Community Fish Smoking Kiln (CoFiSmKi, better abbreviated as CoFSKi) at its Burla Centre in Orissa with a capacity to smoke 12 kg fish in about two hours. The quality of the product had high scores for the biochemical and bacteriological characteristics of the smoked *Gudusia chapra*, a favourite clupeid of the Bengali palate.

Sausaged and canned rohu in curry medium have also been attempted at CIFT. Mughlai and Punjabi type preparations were made using 'Masheer' steaks and packed in pouches along with the curry, sealed and processed in retort to give ready-to-serve fish product. The shelf-life of the product was more than four months.

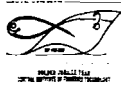
Fish silage is a by-product of great value and can be produced wherever a large quantity of offal is available and its proper disposal causing a problem. In fact, it is a profitable utilization of offal by converting it into the form of a liquid product which is rich in easily assimilated proteins and fatty acids, unaltered vitamins, micro-elements and digestive enzymes and is a known substitute for fish meal in pig and poultry feed. The process of conversion is simple and can be done by setting up a small plant.

Silage or fish hydrolysate can be stored up to six months provided it is stirred periodically and kept at a low temperature of about 15°-20° C. It is a rich product having 15% protein; 6-14% fat depending on the raw material; 2.4% ash; besides micro-elements and vitamins. Experiments have shown that 1 kg of hydrolysate equals 0.3 kg of fish meal.

Collagens have a wide spread use in pharmaceutical, food, healthcare, and cosmetic industry and have so far been isolated from land-based animal skins. Recently, these have been prepared from the skins of silver carp, bighead carp, and grass carp in China with a recovery rate of 79 to 84%. Fish collagens are safe as compared to animal collagens and being a waste product in processing, would be a further fillip to the processing industry. Fish collagens are a good substitute to animal collagens for enhancing food safety.

Food safety and quality assurance

Residues of chemicals and toxins in fish and fish products can be harmful to human beings and at times take an immediate toll of their lives. Heavy metals such as mercury, copper, lead, arsenic and cadmium are deadly. Pesticides, insecticides and herbicides washed from agricultural fields get accumulated in various organs and tissues of the fish and such raw material needs to be discarded totally. Care needs to be taken regarding *E. coli* in fresh and Salmonella in processed products. It is necessary to assure food safety by adopting the principles that are laid down for procuring the raw material and processing too. Sanitation and hygiene at every step from harvesting to transport and final processing



and marketing to the point it reaches the consumer is of prime importance. The CIFT has been conducting training programmes in food safety which may now be taken up in the inland states in collaboration with the State Governments and NGOs at major fresh water fish producing centres.

The CIFT has also developed the Palm Impression Technique (PIT) to popularize hygiene literacy among the fishermen and workers in fish processing plants which may be demonstrated at large to the staff of the Fisheries Departments and the NGOs who should take it up on a massive scale, not only for those who are catching and transporting the fish but also for those who sell it in the markets. No attention is paid to the condition of the markets and in many places these are located by the road side adjacent to the drains where crows, dogs and dust abound besides the filth and smell. It is unfortunate that the role of Sanitary Inspectors of the Municipalities or Corporations is limited to collecting taxes. The video film on sanitation aspects prepared by CIFT needs to be shown at each and every landing centre and in all processing plants and ice factories.

Quality assurance system as developed in the USA covers all aspects of quality – biological, chemical and physical – from fish collection to its consumption that may cause the fish or product to be unsafe for consumption and is called Hazard Analysis and Critical Control Points (HACCP). Strict and accurate monitoring is the very basis of the system that controls the hazards at each and every point for which the tolerance limits are fixed. The system is now adopted by all processing plants where detailed records are maintained for inspection. A beginning needs to be made in the fresh water fish production/processing sector before it is too late.

Scope for establishing a mini-processing plant

Plants for processing oranges, pineapple, guava, apples and other fruits exist in the country but there

is not a single plant for processing fresh water fishery products. The Agro-Food Processing Ministry is supporting the establishment of processing plants for horticultural and other food products. It is time the Ministry of Agriculture takes the lead and establishes a mini fish processing plant in Himachal Pradesh in collaboration with the local government with public-private partnership. A regular supply of 2-3 tones of fish, mainly silver carp is available for about 300 days in a year barring the closed season during the monsoon. The fish with fine bones does not fetch a high price in the market owing its non-acceptability by the consumers in the local markets. However, the finished product in various forms would be easily acceptable to the consumers. Besides the silver carps, the catfishes from Pong reservoir will also be available for processing. All these could be converted into ready-to-cook or ready-to-eat products. Collagen could be prepared from the skin of silver and grass carp and the offal converted into fish silage to be used locally as feed for poultry and pigs. Smoked catfishes, mahseers and other medium-sized fish, besides all sorts of small catfishes and minnows would form a valuable product. Himachal Pradesh also produces trout which could be value added at a later date. Such a diversified assemblage of raw material within a small area may not be available elsewhere and that too with an assured supply. This would not only help in sustainable production from the reservoir but also in improving the economic status of the fishers in the region and contribute to the food and nutritional security of the local populace.

The plan for the Processing Plant could be drawn by the CIFT and all the necessary instruments and equipment development at the Institute installed at this pilot or mini-processing plant and the requirements assessed for further development to give a fillip to the fresh water fish processing industry in the country.



Coral reef-related fisheries of India: Considerations for their exploitation, conservation and management

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The fisheries resources in the seas around India are being continuously exploited for over half a century, mostly concentrating on these in the open coastal waters. Recent research indicated that many of the commercial stocks have been fished at optimum level, some of them exhibiting declining trends. The situation warrants immediate diversification of fishing methods to exploit the under-exploited and unexploited resources in deeper waters. The fishing pressure on coastal shrimp resources has to be reduced. With the proposed expansion of Indian EEZ from the present two million square km to 3.1 million sq. km, greater challenges would be placed for fuller exploitation of the living resources of the sea.

Coral reefs are amongst the most exquisite, spectacular and diverse natural communities on the earth. Numerous animals and plants co-exist in a fragile and delicately balanced web of life. The reefs are composed of myriads of corals, brightly coloured fishes, beautiful shells and other animals and plants of all shapes and colours. The reefs remain in a dynamic equilibrium with prey-predator relationships, complex food webs, shelter and space competition, ever changing environmental parameters and natural enemies destroying the corals themselves. Nature's bounty, offered by the coral reefs in the form of living and non-living

resources may be extracted for the benefit of mankind, but this has to be done very cautiously and in a planned way. At the same time, the reefs have to be protected and managed for the goods and services they render. While natural disturbances and events within the reef can cause destruction of the reefs, human induced activities like overfishing, industry and tourism development causing pollution have to be controlled to maintain the health and wealth of the reefs. The long term effects of such processes may be reflected in depletion of several resources and the very life-cycles of organisms.

Coral reef fishery resources in many parts of the world are exploited by subsistence fishers. Reef fishery and related activities provide food and economic benefits to people. But in India, only traditional methods of fishing and mechanized fishing has been in vogue to exploit the conventional fisheries resources. Only an insignificant portion of the fishery could be said to be reef dependent, though clearly reef fishes are known to be abundant in the Lakshadweep and Andaman and Nicobar islands and to some extent in the Gulf of Mannar. The reasons for the lack of attention to the resources could be the very inaccessibility of the areas, inadequate information on the resources, their abundance and distribution (especially of species of economic importance) as well as a limited



understanding of the basic biology of the species. The present account deals briefly with the reef and reef-related fisheries resources of Indian coral reefs and the problems of their exploitation, conservation and management.

The Indian coral reefs

Major coral reefs in the country are found in the Lakshadweep (Atolls), the Andaman and Nicobar islands, the Gulf of Mannar and Palk Bay and the Gulf of Kutch (Fringing reefs). While the reefs in offshore islands are generally in a healthy condition, those close to human habitation have degraded considerably. Besides dredging and coral mining, destructive fishing methods like blasting, dynamiting and poisoning, operation of unsuitable fishing gear and trampling of reefs have been contributing to the damage of reefs. Sedimentation, oil spills and sewage disposal take a heavy toll of reefs and the living resources.

Lakshadweep is composed of 36 islands, of which 11 are inhabited. Over 100 species of corals, numerous species of fishes, crustaceans, mollusks, echinoderms, other invertebrates, turtles, dolphins and seaweeds are found in and around the islands. The region is famous for pole and line fishing for the skipjack tuna which is dependent on the live-bait fishes caught in the lagoons. The reefs and lagoons harbour several food and ornamental fishes, octopuses, lobsters, ornamental shells, sea cucumbers and seaweeds. Local people take advantage of all the ancillary resources when tuna fishing is at a low ebb due to south-west monsoon. Sea grass beds found in the lagoons provide food and shelter for several juvenile and some adult fish and act as nursery grounds. The economy of local people hinges on the health and riches of the reefs.

The Andaman and Nicobar islands (350 nos. of which, 38 inhabited) have extensive fringing reefs and mangrove slopes. Reefs containing numerous coral species are often covered by mud and sediments. Number of resident and non-resident fishes, crustaceans, mollusks, echinoderms, other invertebrates, turtles, estuarine crocodiles and the dugong inhabit the reefs. Sea grass and seaweed beds

are found along the coastal areas.

The Gulf of Mannar has a chain of 21 islands, with luxuriant growth of corals. The reefs are extensive and richer than those of the Palk Bay. Several species of corals, a wide variety of fishes, crustaceans, mollusks, echinoderms, polychaetes and other invertebrates inhabit the area. Food and ornamental fishes are extensively distributed. Extensive sea grass beds are found between the main coastal land and the islands, providing shelter and grazing grounds for fishes, turtles and the dugong. Occasional large shoal movements of the cow-nose ray are known to feed on oysters and other mollusks in the pearl banks. Seaweeds are found in the rocky and reef areas around the islands.

The reef areas of Palk Bay are inhabited by several economically important fishes, crustaceans, mollusks, echinoderms, polychaetes, etc. While the sea grass beds are limited, Sargassum beds are extensive, harbouring numerous pipe-fishes and juvenile fishes, shrimps and most brilliant and colourful nudibranchs. Occasionally, large schools of huge medusae invade the coastal waters, drifting with currents and winds.

The Gulf of Kutch reefs are characterized by the presence of extensive intertidal mud-flats in close proximity to the reefs. There are about 40 islands, with reefs in a fragmented and degraded condition. About 40 species of corals, several species of algae, fishes, crustaceans, mollusks, sponges, other invertebrates, turtles, dolphins and dugongs inhabit the area.

In addition to the major reefs, isolated coral formations are found on the submerged banks between Bombay and Goa. Corals in the region are mostly massive or encrusting type. There is no information on the associated flora and fauna.

Reef-related fisheries

The resources are chiefly constituted by food fishes, ornamental fishes, crustaceans, mollusks, sea cucumbers and seaweeds. No where in the country extensive use of these resources is on record. However, local communities have been capturing



some of the food fishes in a limited way, for their own sustenance or disposal in local markets. Mollusks have been exploited in different areas, mostly for ornamental purposes. The seacucumbers and seaweeds are traditionally collected and used for industrial purposes, especially along the south-east coast of Tamil Nadu. Intensive exploitation of these two resources in a limited area attracted controls on their collection and export. However, all the reef fisheries, which are almost virgin, need to be evaluated carefully from various angles to make use of them, at least at a small-scale level.

Food fishes

Although skipjack tuna is the main stay of sea fish production in the Lakshadweep, the reef and reef-related finfishes have been found to be abundant. Surveys and research by the Central Marine Fisheries Research Institute (CMFRI) indicated that species belonging to 17 families comprising of sharks, rays, belonids, half-beaks, groupers, lutianids, wahoo, goat fishes, dolphin fishes, jacks, rainbow runner, flying fishes, polynemids, kyphosids, parrot fishes and others are found in the area. While qualitative information is available, stock assessments have not been made. The author's experience of trial angling at night in the reef areas of Lakshadweep (off Bangaram island) in 1986 indicated heavy hooking rates, especially for lethrinids and lutianids in sizes varying between 50 and 80 cm, indicating total lack of exploitation of such valuable fishes. Fishermen also go to uninhabited islands and reefs for fishing. Small coral banks have been found to be good fishing grounds for *Acanthocybium solandri*, *Elagatis bipinnulatus*, *Coryphaena hippurus* and flying fishes. The islands are reported to have good potential for sharks, groupers, carangids but these are caught only in limited numbers. The lagoons of all the islands harbour several food fishes which can be harvested by hooks and lines and gill nets. Sharks and bill fishes can be harvested by long lining and rays by harpoons. Diversification of fishing takes place when sea fishing is suspended during the south-west monsoon period. The fisheries resources are

generally considered a common property and community managed.

The exploited coral reef food fishes in the Andaman and Nicobar islands include snappers, groupers, grunts, parrot fishes, squirrel fishes and goat fishes. It was apprehended that there was large scale poaching of coral reef fishes in the high seas by employing destructive methods of fishing like blasting and poisoning. Several other food fishes are caught in coastal gears like gill nets, cast nets and hooks and lines. Generally, fishing intensity for oceanic fishes in the region is considered to be low and hence fish may be dying of old age or move away from the region. The reefs are not monitored regularly and there is no published information on how the reef resources are used. Local tribes are known to have been using the reef resources at subsistence level.

Continuous fishing activity in the areas of the Gulf of Mannar and Palk Bay adjacement to the islands and reefs yields a wide variety of fishes caught in the shore seines, gill nets, cast nets, hooks and lines, long lines and traps. There are several fishermen in the area who are traditionally dependent on reef fish, mainly using traps to capture fishes, lobsters and crabs. The fish catches from the reefs include *Lethrinus* spp., *Lutianus* spp., *Callyodon ghobban*, *Teuthis marmorata*, *Siganus canaliculatus*, *Epinephelus* spp., *Plectorhynchus* spp., *Diagramma* spp., *Upeneus* spp., *Plotosus* spp., *Psammoperca waigiensis*, *Therapon* spp., *Serranus* spp., *Chaetodon* spp., and *Acanthurus* spp. Over the years, the species composition in the traps was reported to have changed, mainly due to usage of prawn peelings as bait and shifting the area from near shore waters to the nearby islands. The selective nature of the traps (their oval shaped entrance and the length of the entrance) has been considered not favourable for exploitation of certain dominant species like *Lethrinus nebulosus* because of the capture of juveniles and immature fish in large numbers.

Fishing by destructive methods using chemicals and explosives in the reef areas of the Gulf of Kutch was reported to have caused stress on fish



populations and other living resources. Compared to other coral reef regions, fewer species are found in the Gulf of Kutch. The food fishes amongst the reefs include eels, groupers, lethrinids, lutianids, goat fishes and rabbit fishes.

Ornamental fishes

Over 600 species of marine fishes are known from the Lakshadweep, of which over 300 are considered colourful and attractive. They include the wrasses, parrot fishes, damsels, clown fishes, surgeon fishes, goat fishes, squirrel fishes, rock cods, butterfly fish, trigger fish, cardinal fish, box fish, puffer fish, rabbit fish, sand smell, lizard fish, scorpion fish, angel fish, file fish and Moorish idols. There is no directed fishing for these ornamental fishes and hence no data are available on their abundance, seasonal variations, basic biology, stock size of individual species, impact of exploitation on the stocks and the habitat. Recent studies by CMFRI in this direction indicated that the lagoons offer vast scope for developing a sustainable fishery for ornamental fishes to the magnitude of 8.6 million fishes, belonging to 20 families and 165 species, per year. However, indiscriminate exploitation may damage the biodiversity and degrade the reef habitat. Use of traps and collection by divers which are non-destructive methods, are recommended to be the most suitable. Commercial scale exploitation has to be cautious, not exceeding the maximum sustainable yields and strictly adhering to the quotas fixed. Selective fishing for preferred varieties which are scarce has to be avoided. Development of data base, monitoring and regulation, licensing, banning of fishing in lagoons from June to September, development of marine protected areas, brood stock development, and breeding and culture, especially the rarer varieties have been suggested. It is gratifying to note that CMFRI took the first step to evaluate the stocks, determine the maximum sustainable yields and fix quotas for exploiting these valuable resources and also succeeded in breeding a number of them under artificial conditions. This would go a long way to put the marine aquarium fish trade on a strong footing.

The Andaman and Nicobar islands also harbour almost all the families of ornamental fishes as found in the Lakshadweep but the number of species appear to be comparatively less. Here again, the catch statistics, catch-per-unit of effort, size ranges and other population parameters are non-existent. Hence, it is not possible to recommend exploitation until such data are available. The ornamental fishes in the reefs of Gulf of Mannar and Palk Bay and the Gulf of Kutch are in the decreasing order of abundance compared to the Lakshadweep and Andaman and Nicobar islands. Detailed data on population parameters and exploitation in the regions are not available, ruling out any commercial fishing.

Crustaceans

Penaeid prawns, sergestids, Caribbean prawns, crabs, lobsters, hermit crabs and stomatopods are the most important crustaceans found in the reefs and lagoons of Lakshadweep. These resources, however, are not substantial to warrant any commercial exploitation. While penaeid prawn species are few, Caribbean prawns and brachyuran crabs are rich, and may contribute to a sustenance fishery. Three species of lobsters, viz., *Panulirus versicolor*, *P. penicillatur* and *P. homarus* are occasionally caught and used as food. Hermit crabs are plenty in the sandy beaches and intertidal regions of the reef. They are brightly coloured and suitable for use in aquaria. The hard bottom of the lagoons and other environmental conditions have not been found congenial for prawns.

From the Andaman and Nicobar islands 19 species of shrimp, six species of lobsters and three species of portunid crabs were reported. Lobsters and crabs inhabit the rocky and reef areas. Crustaceans are captured in a number of gears.

A number of penaeid and non-penaeid shrimps, lobsters, and crabs are caught from the Gulf of Mannar and Palk Bay regions in a variety of fishing nets and traps. Lobsters and crabs are caught from reef and rocky areas close to the islands. Precise details of crustaceans caught from reef areas of Gulf



of Kutch are not available.

Molluscs

Octopuses, squids, cuttlefishes, cowries, edible gastropods, ornamental gastropods, edible bivalves, pearl oysters and boring bivalves are found in different islands of Lakshadweep. Octopuses are caught and used as food. Cowries are collected for ornamental purposes. Ornamental gastropods are not available in large quantities. Same is the case with edible bivalves. Boring bivalves cause extensive damage to corals. Pearl oysters and octopuses indicate potential for culture.

Of all the molluscan resources of the Andaman and Nicobar islands, Trochus and Turbo are the most important and heavily fished over the years for their ornamental value. Because of their declining populations, restrictions have been imposed on their fishing. Other mollusks fished include the sacred chank, helmet shell, cone shell, five finger chank, pearly nautilus and cowries. Edible oyster, pearl oyster, green mussel and the giant clams also occur in the region.

The Gulf of Mannar and Palk Bay region abounds in a variety of gastropods, bivalves and cephalopods. These are hand picked by divers and also captured in fishing nets. The sacred chank is heavily fished from the area. The reefs are extensively exploited for ornamental shell trade. Molluscs are reported to be collected from the reefs in the Gulf of Kutch.

Sea cucumbers

Sea cucumbers represented by *Holothuria atra*, *H. scabra*, *Actinopyga mauritiana* and *A. echinites* have been found to be the most abundant in Lakshadweep. It is felt, a modest Beche-de-mer industry based on these species could be developed at a suitable location in the islands with the possibility of breeding and sea ranching of valuable species into the lagoon to support the industry. Recently some steps have been taken in this direction.

In the Andaman and Nicobar region, *H. scabra*, *H. atra*, *A. mauritiana* and *Sctinopyga millaris* which

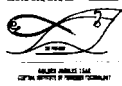
contribute to the Beche-de-mer industry occur in abundance in many mud reef flats. There is a good potential to farm sea cucumbers by collecting the juveniles and rearing them in enclosures in intertidal regions and also breed the most valuable species for ranching.

Several species of Holothurians are found in the Gulf of Mannar and Palk Bay region, of which *H. scabra* is the most important, followed by *H. atra*. They are extensively collected from rocky and reef areas, adjacent to the islands and also from the intertidal mud flats. The Beche-de-mer industry flourishes in the region. Harvesting sea cucumbers is mainly done by skin divers in shallow inshore areas and hand picked at low tides from intertidal areas. Indiscriminate over harvesting lead to decline in the catches over the years attracting ban on export of sea cucumbers below 3" size. No information is available on the availability of sea cucumbers from the Gulf of Kutch.

Seaweeds

In the Lakshadweep, marine algal resources have been found to be sparse and heterogenous. *Gelidella acerosa*, *Gracilaria edulis*, *Gelidium rigidum* and *Gelidiopsis repens* are the major agarophytes. Alginate resources are represented by *Turbinaria* and *Sargassum*. Besides the above, there are other economically important seaweeds. *Halimedia graciles* was found to be most abundant in the lagoon and reef areas. Cottage level production of agar-agar could be based on collection of agarophytes.

Seaweeds are found abundantly in the rocky and reef areas in Andaman and Nicobar islands, but there is no commercial harvesting. Along the Gulf of Mannar and Palk Bay coasts, they are regularly harvested from coastal areas and close to the islands. *Gracilaria edulis* and *Gelidella acerosa* and *Sargassum* are the most common. Quality of raw material is the major constraint for the industry. The seaweeds should be free from epiphytes and other foreign material. Agents who supply the raw material control quality, quantity and price. While



natural resources have been harvested for decades, resource management has received little attention. Trade has been controlled by licensing. Harmful harvesting practices have not been curbed. Seaweed harvesting and production in Gulf of Kutch is negligible.

Seaweeds have been cultured for several years experimentally along the south-east coast of India, targeting vegetative propagation of *Gracilaria edulis* and *Gelidiella acerosa*. Production results have not been consistent and the economics of cultivation have not been proved. However, recent attempts to culture and produce seaweeds at cottage level, especially by women in the same region, are stated to be successful. It appears the industry is yet to be convinced of consistent production and economic viability.

Exploitation

Exploitation of reef and reef-related fisheries resources is quite complex. Predominant reef fishing methods in South Asian region include handling, longlining, trolling, bottom trawling, use of shore seines and traps. In some cases, destructive fishing methods like blasting and poisoning using chemicals are used. Gears used may be selective in terms of size of fish caught, species or a combination of both. Effective management of fishery may be dependent not only on limiting fishing effort but also on mesh sizes, hook sizes or banning certain gears for their selective effects. Tropical reefs show considerable variability as to the multiplicity of species. Often, there is lack of data on population statistics of individual species. Estimates of fishing effort are also not available. Stock abundance may be estimated from visual senses data and hook and line catches. Single species approaches or aggregate single species models may provide adequate information for management purposes, rather than resorting to more complex models that account for species interactions, especially for long lived and slow growing predators like groupers and sharks.

Observed yield is primarily a function of fishing effort. Initially it was thought that the sustainable

yield from tropical reef fisheries was between 4 and 5 t/km²/year. Whether they are sustainable in the long term, is yet to be determined. Handlining on shallow reefs in South Asian region was reported to have yielded 0.5 to 5 Kg/line h. In the Maldives and Chagos archipelago handlining for Lutjanidae, Lethrinidae, Serranidae, Carangidae was in vogue with good results. Deep water benthic sharks were exploited by vertical long lines in 200-600 m/depth on the outer slopes of atolls. However, such demersal fisheries did not present any substantial potential for expansion. Recovery times for such species are believed to be considerable. Marine ornamental fish export involving 200 species from Sri Lanka resulted in the fishery becoming unsustainable because of overfishing and destruction of habitat. Over exploitation and damaging collection practices also have been found to have affected other reef related resources like mollusks and sea cucumbers.

When there is opportunistic nature of exploitation, there would be rapid decline in resources, attracting regulatory measures in the form of bans, licensing and quota systems. Even with such controls, particularly sought after species can be endangered. Catch quotas, minimum size limits etc. may be impractical in multispecies fisheries.

The Indian reef fisheries resources at present should be considered almost virgin. In certain pockets, traditional fishermen have been catching and utilizing them as sustenance fisheries. No large scale fishing has so far been conducted anywhere. The apparent abundance of reef resources would be quite tempting for exploitation. When a virgin resource is fished, the catch rates would be expected to be very high. But soon the catches would be dwindling with increasing fishing pressure. To circumvent such a situation, stock assessment and basic biology of the species concerned have to be studied. All the information so far available in the country about these special resources is only qualitative. Even for the exploited sea cucumbers, seaweeds and some mollusks there are no quantitative data to conduct fishing. It is more than time to make use of these resources by developing a

quantitative data base on population structure of various resources.

Conservation and management

It is essential to conserve and manage the reef resources as they are subjected to exploitation based on quantitative estimates and quotas. Experience of fishing the reef resources in some South Asian countries indicated that unless the fisheries are regulated, they may soon turn out to be unsustainable. Non-resident, migratory species may behave differently from the resident, mostly sedentary species with reference to fishing intensity. Reef fisheries are usually small-scale in nature. Research is needed to establish more accurate levels of sustainable exploitation of reef fisheries. Since most of the reef resources are sensitive, limited and localized, exploitation should go hand in hand with culture of most valuable, vulnerable and endangered species. The ornamental fishes and mollusks and certain species of sea cucumbers qualify for this action. A number of perches found in reefs with quality meat offer possibility of culture and production.

Illegal fishing and employing destructive methods have to be curbed. Community management of resources has to be encouraged. Co-management by fishers and Government would be preferable. Regulations become useless if they are not enforced. Periodic closures and permanent reserves may have greater potential for conservation of fish stocks, especially when local communities are involved. It has also been found, that very small reserves can protect significant fishery stocks by providing high quality habitat and spawning stock since majority of fishes associated with reefs are relatively sedentary, remaining in a small area for most of their lives.

In the country, a Marine National Park in the Gulf of Kutch, a Biosphere reserve in the Gulf of Mannar and the Mahtma Gandhi Marine National Park at Wandoor in Andaman islands have been established. It is time that a protected area is also established in Lakshadweep. Experience elsewhere indicates the benefits of protected areas accrue in about five years.

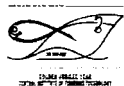
Therefore, periodic verification and review of the ecological functions of such areas should be done. The economic and social costs of marine reserves have to be evaluated. Small reduction in fishing area may not significantly affect the yield since catches vary from year to year. Marine reserves properly located may not impact the livelihoods of fishermen in the face of declining fisheries. However, community support for reserves is essential. Traditional methods of fishing which are non-destructive can be permitted in the designated areas. Depletion of fish stocks and deterioration of the habitats are considerations for permanent or temporary closure of certain areas.

If the living reef resources have to be maintained in a healthy and productive state, the reefs also have to be kept in a healthy condition. The reef is a frame work for many organisms, the food chain starting with the reef itself. When corals die, the skeletons are weakened by other boring animals and make them crumble. The reef is then deserted. Overfishing, damage to reefs by trampling and blasting, industrial and tourism development and associated pollution, felling of mangroves and discharge of sewage from populated areas are potentially disastrous to reefs. Population explosions of prey and predatory organisms and effects on breeding cycles of pollutants cause damage to reefs and their inhabitants. Public co-operation to mitigate the external forces acting on the fragile coral reef ecosystem is essential for their conservation.

The unique, fragile and complex marine ecosystem – the coral reef ecosystem in India – has so far not received the attention it richly deserves, as outlined above. To achieve this purpose, the CMFRI in 1993 has proposed to ICAR for establishment of an exclusive and specialized Institute for coral reef research. At least now, it is hoped, the proposal would see the light of the day.

Conclulsion

The coral reef fisheries resources of India are almost in a virgin state, except for sporadic and insignificant exploitation of some resources like



mollusks, sea cucumers and seaweeds in certain areas. Most of the information available about the reefs and reef-associated fauna and flora is at present only qualitative. For rational exploitation of the resource, a quantitative data base (region-wise, reef-wise and reef-subhabitat-wise) has to be developed. Based on such information, catch quotas and associated rules and regulations have to be imposed. CMFRI has initiated to quantify marine ornamental fishes of Lakshadweep and also succeeded in breeding and culture of a number of aquarium species. Similar studies have to be made in all other coral reef areas to develop small-scale fisheries. Non-destructive and ecofriendly fishing methods only should be permitted. To safeguard the valuable, vulnerable and endangered species, simultaneous methods of culture have to be developed, the species produced under controlled conditions and also sea ranched. Marine protected areas, biosphere, temporary and permanent closures have to be effectively managed by periodic reviews to evaluate the benefits. Community based co-management procedures have to be adopted. Public support for management of protected areas has to be elicited. Just as the resources are managed, the reefs should also be managed to keep them in a healthy condition for posterity. To achieve all these objectives, an exclusive and specialized coral reef research Institute should be established in the country.

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A few key issues for attention in fisheries development

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India is endowed with rich fishery resources with a potential to bring a turnover of nearly Rs.100,000 crores per annum and provide employment to about 50 million people. Such a large potential natural resource was exploited mainly for fishing (hunting) in inshore waters, and for farming in inland areas. All our estimates to assess the potential of Indian fisheries were based on fish landing statistics. The aquaculture potential of our country is yet to be estimated scientifically in terms of biomass production or bioenergy which is capable of providing a nutritional security to a large population of India. The cultivation of seaweeds, mariculture of bivalves and farming of a few finfish species alone can generate enough bioenergy to feed half of the population of India and save them from malnutrition. What are the hurdles that are preventing us from doing it?

Dietary habit

The basic issue is our traditional dietary habit, keeping fish as a non-essential item in our daily menu. This would have happened mainly due to non-availability of fish to the population living in the hinterland throughout the year and restrictions to eat fish on religious grounds. We have to break this ice through media announcing the health benefits repeatedly to the public at national level. The Central Government (Ministry of Agriculture and Ministry of Health) should have an adequate budget

for this publicity every year. At the same time the ICAR Fishery Research and Educational Institutes should gear up with the required technology to enhance aquaculture production and process fin fishes, shellfishes and seaweeds into a variety of edible products, palatable to Indian taste. A strong market promotion of these products in the internal markets should be carried out by the NFDB and State Fisheries Corporations. The per capita fish consumption of the fish eating population should be raised from 8 kg to 16 kg. "Fish for all and Fish for ever" of World Fish Centre's programme should be implemented in the country.

Reasons for negligence of fishery sector

All attempt for fishery development in the past were for enhancing fishing efficiency with modern crafts and gears which led to over-exploitation of inshore fishery resources. The promotion of offshore and deep sea fishing didn't succeed due to various reasons. These two issues gave a wrong signal to planners and they started giving less importance for further development in fisheries. Since the capture fisheries production was stagnating, the focus was shifted to inland fish production. In this process we lost an opportunity to project a very large untapped potential of marine fishery resources for mariculture/sea farming to the planners of our country. It is due to the failure of the concerned fishery research institutes to develop appropriate technology in



mariculture/seafarming despite the fact that it is prevalent in South East Asia, China and Japan for the last few decades. When world mariculture/seafarming production has reached nearly 30 million tones including seaweeds, it is a real shame to count our mariculture production with five thousand tones of mussels. Our fertile sea for mariculture is still unknown to our scientific community. India should be in a position to produce atleast 1 million tone of seaweed and 1 million tone of bivalves and fin fishes.

The recent technology development in Kappaphycus seaweed cultivation has brought to light a few facts. They are:

1. Near shore (shore to 10 m depth) and inshore (10 m to 5 m depth) waters are rich in nutrients and their frequent recycling through monsoon winds, currents and tides in the sun-lit surface water is capable of generating a huge wealth to the nation. Rapid recirculation of nutrients over shallow shelves and seas locally bar the sea's richest fund of life (Scientific American 1970). "Seaweeds are capable of concentrating high amounts of nutrients which can be extracted as liquid fertilizer for the enhancement of growth and yield of terrestrial plants-an excellent source to get nutrients back from the sea to land" (Rengasamy, 2004).
2. There are many unknown fertile grounds in the inshore waters for the culture of green mussel and oysters which are totally unutilized for cultivation. The attachment of mussels and oyster spats in millions in monocline net bags of seaweed cultivated near Chennai (Panaiyur Kuppam) gives a clue that there are such hidden resources for mariculture. There are rich resources of clams in many parts of the intertidal zones and backwaters/coastal lagoons which await the attention of aquaculture production.
3. Potential sites for finfish cage culture are lying idle along the long coast line for want of essential inputs such as seed, feed and technology.

Huge untapped domestic market and partially tapped export market for fish and fishery products to play a key role in the development of Indian fishery

The export of seafood created a momentum for the development of shrimp farming in India. When this single item could contribute a billion dollar, other items are awaiting a major breakthrough in the near future to increase our export earnings several folds. The world market for seafood is expanding fast and India should have a master plan to cash the opportunities by enhancing the production through diversified aquaculture development.

While several potential species await for costal aquaculture and mariculture/seafarming, Kappaphycus seaweed cultivation, Mudcrab farming and Seabass culture have reached take off stage with assured technology and return on investment.

Seaweed cultivation – an untapped potential for food, medicine and biofertilizer

It is estimated by FAO that the world production of sea plants has reached 13 million tones worth of >US\$10.0 billion and China is the world leader followed by Japan, South Korea, Philippines and Indonesia. Seaweeds are also found to provide a strong base for growth promoters of several plants because of their properties such as cytokinin, auxin and gibberellins. Therefore seaweeds will be the major source of raw material for biofertilizer to start organic agriculture revolution in the country. Thus seaweed cultivation in India can be instrumental to start a set of new industries to manufacture Carrageenan, Agar and Algin and several biofertilizer industries. The vast sea with rich nutrients around mainland and islands and with plenty of sunlight throughout the year in tropical climatic conditions are natural gifts to India to produce atleast 1 million tone of seaweeds (dried) and employ nearly 200,00 families with an annual earning of about Rs.10 lakh per family. The annual turnover through Kappaphycus seaweeds cultivation alone can be safely estimated to be Rs. 2,000 crores. Dr. A.P.J. Abdul Kalam, former President of India, is encouraging the Kappaphycus seaweed cultivation for the livelihood support of the coastal poor (Annexure-I). The Executive Council of NAAS-2004 headed by Prof. P.L. Chopra has certified that it is ecologically safe and



recommended that large scale cultivation of *Kappaphycus* can be undertaken in Andaman Islands (NAAS Policy Paper No. 22).

Tamil Nadu is rich in seaweed resources. Wild seaweeds are harvested for Agar and Algin production especially in the area of Gulf of Mannar. Several hundred women depend on wild seaweed collection just to earn their daily bread and they were victims of recent Tsunami with loss of life and properties. If this coastal community could be rehabilitated from wild seaweed collection to scientific farming, it is possible to generate atleast Rs.10,000/- per month for a family. Economics of seaweeds cultivation, in bamboo rafts worked out and approved by State Bank of India is given in the Annexure-II. Seaweed cultivation can also be done in monocline net bags where waves are fairly high with good water motion. Since trials are going on, the actual economics will be known shortly. Meanwhile the economics based on assumption is given in the Annexure-III. What is needed is a favourable water leasing policy for seafarming and awareness creation on potential of seaweed cultivation. Pilot scale operation on seaweed cultivation started for the welfare of fisherwomen in Mandapam, Pampan, Tuticorin, Kanyakumari, Kovalam and Pulicat has shown remarkable results providing it as a profitable venture. Under the Dept. of Biotechnology's financial assistance The Aquaculture Foundation of India has successfully rehabilitated 120 Tsunami affected coastal poor in Mandapam-Rameswarm coast in the first phase and is going to start the second phase in Tanjore coast. All inputs such as seed plant, raft material for cultivation, bank loan and buy-back guarantee of the produce are available. SBI and Pandyan Grama Bank have started financing this project to SHGs. If the cultivation is taken up in Gulf of Mannar, permission is required from the Chief Wildlife Warden. If seaweed cultivation is taken up as a major programme in Tamil Nadu it is possible to rehabilitate atleast 10,000 families of coastal poor with a turnover of Rs.100 crores per annum. After seeing the success, the Govt. of India has taken steps for the rehabilitation of 100,000 families of coastal

communities along the east coast, Andaman & Nicobar Islands and Gujarat. A survey to identify suitable areas will be done shortly.

Advantages of Mudcrab culture

- It is a wide spread large biomass in estuaries of India with high fecundity.
- It is tolerant to wide variations in salinity, temperature and other environmental parameters. If the conditions of the environment goes bad during culture, crabs come out of water and take shelter on the dykes. It is possible for a farmer to see the mistakes in water/soil quality and get a chance to correct them without mass mortality of the crop. In shrimp culture the farmer can loose the entire crop when viral disease breaks out since it is invisible. Partial harvest and premature harvest bring heavy financial loss to the shrimp farmers since he has no remedial measures. Since organic shrimp is gaining momentum in the international market, the prevailing technology with banned chemicals and antibiotics will not be able to help hereafter. *Mud crab culture is organic since there is no need to apply any chemical/antibiotics.*
- The growth is fast to prove the economics of culture more attractive (Annexure -III).
- It is possible to enhance the survival rate upto 80% through nursery rearing, creation of natural hideouts such as *Gracilaria* seaweed in the culture ponds/pens or fume pipes.
- It is ideal for polyculture in the ponds and pens with seaweed, milk fish/mullets and make it cent percent ecofriendly.
- Moulded crabs/soft crabs could be utilized for fattening in floating cages to realize higher price.
- The technology of crab culture is simple and coastal fisherwomen are capable of handling it successfully.
- The world market for live and frozen crab is very lucrative and Chinese pay a fancy price to mud crabs.



Apprehension of crab by shrimp farmers

Since crabs are carriers of virus, there is a strong apprehension against crab farming in the vicinity of shrimp farmers. If this apprehension is really meaningful, the crab biomass present in estuaries would have created the spread of virus since water is drawn from the estuaries. They are found in adjacent water body, in dykes and inside pond water because of crawling and burrowing habit. No crab farm can function successfully without a fence around the pond since crabs have a tendency to escape. Crabs were grown in a pond adjacent to a shrimp culture pond with Tiger shrimps and Scampi in Nellore and all of them were harvested successfully after eight months. If these factors are not convincing, the shrimp farmers can earmark an area exclusively for crab farming and study whether it is beneficial or harmful. As long as there is a threat of white spot virus on Tiger shrimps, the crab farming is considered as an alternative with similar income without any major risks. Therefore while shrimp farming is the main stay in aquaculture, crab farming can form a supplementary activity in the selected areas until it is proved to be safe without harming shrimp farming. A few areas which are worst hit repeatedly in shrimp farming could be tried for crab farming first; e.g. Kakinada to Yanam – a natural abode for mudcrab with > 1000 wild crab collectors. They can start polyculture of crabs in pens in the Godavary estuary. If it is viable and economically attractive, shrimp farmers can think of mudcrab culture in ponds later. When Southeast Asian countries and China are doing both shrimp farming and crab farming, there is no reason for India to avoid it based on rumors/allergy created by a group of shrimp farmers and scientists. A potential resource for coastal aquaculture which is capable of generating a billion dollar export should not be stymied or left out by misinformation.

Seabass culture

CIBA has successfully bred seabass (*Lates calcarifer*) and set up a pilot scale hatchery recently near Chennai. It is upto the aqua hatchery operators to avail the technology and produce seeds/

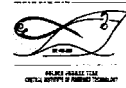
fingerlings for coastal aquaculture as well as sea farming. A series of demonstrations on techno-economic viability is the need of the hour. Technology dissemination to hatchery operators, pilot scale demonstrations in pond culture and cage culture to farmers and feed production by private companies are to be synchronised by agencies like NFDB. It will be really a boon to enhance fish production for internal consumption and export. The coastal ponds which are unutilized in shrimp farming due to viral disease could start seabass culture. Grouper, Snapper and Silver pomfret should join the race soon by borrowing the technology from overseas counters like Kuwait Research Institute, Kuwait, SEAFDEC, Philippines, Gondol Research Institute for Mariculture, Indonesia etc. The overseas training of Indian scientists should be strongly linked with “learning and doing” principle with a specific programme on ground while they return.

Contributions of CIFT

CIFT has made remarkable contribution in the following areas of fishery:

- Ecofriendly fishing
- Fuel saving devices in mechanized fishing
- Protection and maintenance of fishing crafts
- Post harvest fish handling, preservation, transportation and processing of value-added products
- Nutritional value of fish
- Microbiological contamination and quality control
- Installation and maintenance of processing machineries including cold storage and ice plant
- Chitin and Chitosan from shrimp shell waste

The above contributions has laid a strong foundation for fishery development in India especially in the post harvest and processing side. A momentum has been created on quality awareness starting from fishers to fish processors in the country. The export sector has been benefited a lot. The domestic sector also should have achieved desired maximum benefits, provided the technology



(Annexure – I)

**Address By Dr. A.P.J. Abdul Kalam,
former President of India at the Bicentennial
Celebration of the State Bank of India
on 30th May 2006**

**Bio-products from Seaweed : Coastal PURA
employment generator**

developed by CIFT was properly disseminated by the State Fisheries Extension Staffs. The biggest problem in the domestic sector is the slow process in the development of basic infrastructure in post harvest handling, preservation, transport and value-added pre-processing. Waste handling has also become a big issue in fish landed, processing and marketing for want of essential infrastructure. Sufficient portable water for washing is a big issue in many landing centres. Therefore, the microbial contamination in landing entries is a serious problem. The huge invisible loss due to unhygienic handling, delayed preservation, loss of unit value in export and sale of substandard fish through daily distress sale will amount to a few thousand crores of rupees every year. Our administrative system allows such loss instead of arresting it at every stage through proper management and creation of infrastructure. No serious attempt is made to prevent this huge loss of valuable health food.

Since Indian fishery could not project its true image as a multi-billion dollar industry, it is treated as a shadow under Agriculture and Animal Husbandry. Though it is declared as a priority sector from time to time, the tardy implementation by the responsible agencies jeopardize the speed of progress as a result of which the sad state of affairs continue in the over all fisheries development. In places like Kakinada, tones of edible low value fishes are landed and they are unutilized for want to proper preservation and preprocessing facilities, and sold for a song to fish meal manufactures. When a sizeable population is suffering from chronic under-nourishment and starving for fish on one side, it is really tragic to see the wastage of fish protein in tones for want of distribution through quick transportation, pre-processing and preservation with a longer shelf life in the form of ready to cook retail packs. Therefore, the National Fisheries Development Board should set up "Fish Dressing Centres" in all major landing centres to utilize the low value fish for low income population in the hinter land and reduce the malnutrition problem.

Scientists of Central Salt and Marine Chemicals Research Institute (CSMCRI), Bhavnagar have developed an important thickening agent Carrageenan using seaweed called *Kappaphycus alvarezii* that bestows useful properties to many commercial products such as toothpaste, ice cream, pet food and soft capsules. I am happy that SBI is providing loan upto Rs. 50 lakh without collateral security to the women self-help groups in Mandapam region of Tamil Nadu for cultivation of seaweed. The scientists have developed a unique technology of liquefying seaweed without adding any water and thereafter they have separated the solid from the liquid to obtain two products. The solid is the source of Carrageenan and the liquid has been found to be a very useful plant nutrient rich in potassium and organic growth promoting hormones. This sap has been used in a variety of crops such as sugarcane, paddy, maize, pulses and several fruits and vegetables. The productivity increase has been in the range of 20% to 40% in different regions for different plant varieties as per studies conducted by regional institutions. This highly innovative process of producing useful products from the fresh harvest of the seaweed is being done for the first time in the world.

I would suggest seaweed cultivation and value addition should be taken up as a mission mode project of Fishermen Co-operatives and Self-Help Groups of the coastal areas particularly in the PURA (Providing Urban Amenities in Rural Areas) complexes in partnership with scientists, industrialist and SBI. This will enable creation of industries for producing Carrageenan and bio-fertilizers in the PURA itself resulting in substantial amount of revenue increase to the fishermen and farmers.



MODEL SCHEME 1
SEAWEED CULTIVATION IN BAMBOO RAFTS
PER RAFT INFRASTRUCTURE COST

Sl. No.	Particulars / Description	Qty Reqd.	Rate (Rs.)	Cost per Raft (Rs.)
1.	3-4" dia Hallow bamboos of 12' x 4 for main frame + 4'x4 for diagonals (without any natural holes, craks etc.	64'	3.10/ft	200.00
2.	Five-Toothed Iron Anchor of 15 kg each (@ Rs. 35 per kg) – One anchor can hold a cluster of 10 rafts.	1.5kg	40/kg	50.00
3.	3 mm PP twisted rope for plantation – 20 bits of 4.5 m each	0.45kg	110/kg	50.00
4.	Cost of HDPE braider pieces (20 pcs x 20 ropes = 400 pcs of 25 cm each)	0.165kg	120/kg	50.00
5.	Braider twining charges @ Rs.1/20 ties. For one raft 400 ties = Rs.20	20 ropes	1/rope	20.00
6.	Raft framing rope 6 m x 12 ties per raft i.e. 36 mts of 6 mm rope	0.65kg	110/kg	75.00
7.	HDPE Fishing Net to protect the raft bottom (4 m x 4 m size) + labour charges Rs.10	1.13kg	75/kg	85.00
8.	2 mm rope to tie the HDPE net (28 mts)	0.09kg	110/kg	10.00
9.	Anchoring rope of 10 mm thickness (17 m per cluster of 10 rafts)	0.09kg	110/kg	10.00
10.	Raft linking ropes per cluster 10 rafts – 5 mm thick – 2 ties x 3 m x 9 pairs = 54 m length	0.1kg	110/kg	11.00
11.	Transport cost for seed material			25.00
12.	Seed material 150 gm x 400 ties	60kg	0.85/kg	51.00
13.	Raft laying + maintenance cost			75.00
14.	Miscellaneous			3.00
	Total raft cost (Rounded off)			690.00
	For SHG having 20 members		Rs.6,21,000	
	Rs.690/- x 900 rafts		Rs.1,25,000	
	Net Bank Loan		Rs.4,96,000	

**Assumptions:**

- ✓ One SHG has maximum of 20 members; each members to have 45 rafts
- ✓ Culture period - 45 days
- ✓ Hence total no. of rafts to be financed – 900 per group
- ✓ Total cost (900 x Rs.690/-)
 - = Rs.621,000
- ✓ Subsidy from Project Officer, DRDA
 - = Rs.125,000
- ✓ Net Bank loan
 - = Rs.496,000
- ✓ PepsiCo will buy dried seaweed @ Rs.8.50/kg, as per agreement
- ✓ PepsiCo will also supply input materials, rafts etc. as per cost indicated above
- ✓ PepsiCo will route the sale proceeds through the bank
- ✓ There will be no culture in October, November, December on account of North East Monsoon in the East coast and June-August in the West coast. Hence no repayment is fixed during the months.
- ✓ 900 rafts per SHG has been arrived @ 45 rafts/ member. In case, the SHG has less than 20 members or the number of members in a particular group who will to take up seaweed culture is less than 20, the total number of rafts to be financed will be calculated on the basis of 45 rafts per member.

Economics of seaweeds culture

- i. Total yield of seaweed per raft in 45 days
 - 260 kg
- ii. After retaining 60 kg as seed for the next crop, balance available for drying
 - 200 kg
- iii. Dry seaweed available for sale, after 2 days of solar drying (10%)
 - 20 kg

- iv. Estimated yield of dried seaweed available for sale after wastage
 - 18 kg

Income

- a. For one cycle – 18 kg x Rs.8.50 x 900 rafts
 - Rs. 137,700
- For 4 cycles in the I year
 - Rs.550,000
- For 6 cycles in the II and III year
 - Rs.826,200/year
- b. EMI (for 24 months)
 - Rs. 22,385
- c. DSCR
 - 1:4.1

Interest Rate: 7% p.a. (If the SHGs are Tsunami affected, otherwise 8.5%)

Repayment: 3 years including 3 months grace period.

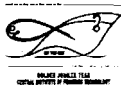
Repayment at monthly intervals except October, November and December

1 year – 4 cycles; II year and III year – 6 cycles each

Note:

- 25% subsidy provided by Project Officer, DRDA
- Where subsidy amount is enhanced / reduced, the loan amount and the EMI should be fixed accordingly.
- Only SHGs sponsored by the DRDA/Govt. department to be financed.
- Documentation and other norms, as applicable to SHG finance.

Note: Instead of having 20 members per SHG a smaller group of 5 members/SHG works better with good coordination. If any NGO is involved with a technical team to assist cultivators for one year their cost has to be included. 500 families or 100 SHG could be covered by one team with an expenditure of Rs. 5 lakh per year.



MODEL SCHEME 2
ECONOMICS OF SEAWEED FARMING THROUGH
MONOLINE BAG TECHNOLOGY IN THE OPEN SEA CONDITIONS

A. Cost of Single Monoline

1. Monoline lead rope 10 mm thickness and 120 m length	Rs.1,000
2. Net bags (0.5 m x 0.5 m) 200 Nos.	Rs. 700
3. Lead rope loop and net bags hanging rope (3 mm) (Rs.4 x 200)	Rs. 800
4. Net bag mending rope 1.25 inch (Rs.1 x 200)	Rs. 200
5. Floats (Rs. 0.5 x 200)	Rs. 100
6. Anchor rope 40 m length (10 mm thickness)	Rs. 200
7. Seed cost	Rs. 140
8. Cost of Anchors: 3 Nos. (Rs. 100 x 3)	Rs. 300
9. Labor cost for rope and net bag preparation and mooring the Monoline in the open sea	Rs. 300
10. Handling and Transport cost	Rs. 60
11. Insurance / Miscellaneous Expenditure	Rs. 500
Total	Rs. 4,300

Capital Investment

1. No. of Monolines required per SHG group (12 members) - 150 Nos.
2. Cost of Monolines (150 x Rs.4300) - Rs. 6,45,000
3. Cost of catamaran 1 no. (Rs.7000) and Tarpaulin sheets (Rs.3000) - Rs. 10,000

Total Project Cost per SHG group
- **Rs. 6,55,000**

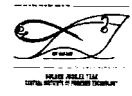
C. Loan amount and subsidy

- DRDA subsidy on project cost @ 25%
- Rs. 1,63,750
- Loan per SHG of 12 members
- Rs. 4,91,250
- R/O - Rs. 4,92,000
- Loan for one SHG member - Rs. 40,937

R/O - Rs. 41,000

D. Income from one Monoline culture of 30 days

- No. of Bags / Monoline - 200 bags
- Quantity of seed placed per bag - 0.5 kg
- Yield = 2.0 kg / bag / mth (growth 1:4)
- For 200 bags - 400 kg
- Less quantity of seaweed retained for seed - 100 kg
- Net Wet weight - 300 kg
- Dry weight (10%) - 30 kg
- Income : 30 kg x Rs. 10 - Rs. 300
- Less harvesting charges - Rs. 25
- Net Income per Monoline - Rs.275
- For 150 Monolines - (Rs. 275 x 150)
- Rs.41,250/ Mth



E. Income per year

1. 9 Cycles in a year (Rs.41250 x 9)
- Rs. 3,71,250
2. Income per operating month / group
- Rs. 41,250
3. Income per operating month / member
- Rs. 3,437
4. Loan amount per group - Rs. 4,92,000
5. Loan amount per member - Rs. 41,000
6. Repayment of loan (per group / month)
- Rs. 20,500
+ interest
7. Repayment of loan (per member / month)
- Rs. 1,710
+ interest
8. DSCR 1 : 2.0

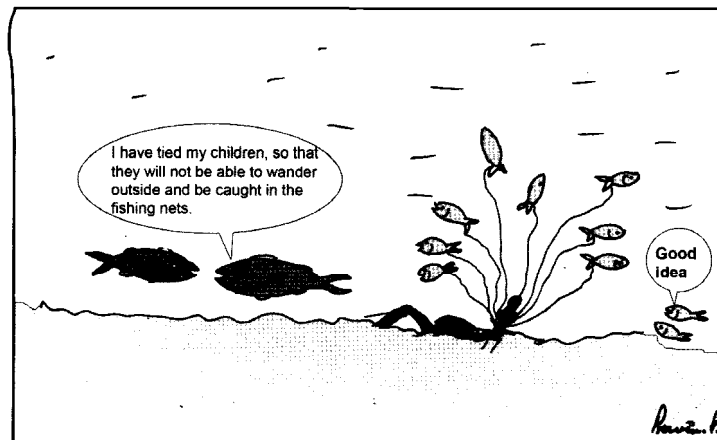
F. Repayment Period

3 years including 3 months Grace period. No repayment in October, November and December as there is no culture on account of North East monsoon.

G. Banking Norms

1. Monoline scheme is suitable for rough seas; in other areas Raft Culture scheme should be considered.
2. Only SHGs sponsored by DRDA/DBT/ Government agencies are eligible for loan.
3. SHG members should have been trained by

- government agencies / NGOs before availing the loan.
4. Subsidy should be received as front end subsidy.
5. In this scheme each SHG is considered to have 12 members. If more members are involved, the group members can be financed subject to SHG norms.
6. As per the MoU signed, the PepsiCo will identify the site and supply the input materials as per invoice.
7. PepsiCo will buy-back the dried seaweed @ Rs.10 kg.
8. The sale proceeds will be routed through the bank.
9. Assets will be insured through New India Assurance Company.
10. The SHG members will be covered under SBI Life Insurance.
11. Repayment period is 3 years including 3 months grace period. Moreover there will not be repayment for 3 months, viz. October, November and December on account of North East monsoon, wherein culture is not done.
12. Rate of interest as applicable to SHG advances.
13. Wherever subsidy is > 50%, the loan amount is determined accordingly.
14. SHG members should be encouraged to maintain Farm records.





Aquaculture and food security

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Sustainable food security depends on the sustainable supply of food, access to that supply and its nutritional adequacy. Fish and shellfish contribute prominently to food supplies. On a global scale, fish and fishery products make up about 16% of animal protein in-take (20% in Asia). The future demand of humankind for protein from the waters of the globe will have to come increasingly from culture practices. The short fall in protein of aquatic source will be considerable in the present century and aquacultural food production would have to be greatly increased. India, South Korea, Indonesia, Thailand and Vietnam during the 20th century have steadily increased their fish productions mainly due to development of and investment in vessel and capturing technology that has permitted them to exploit stocks that were more lightly fished in the past.

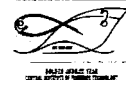
Many of the World's poor and low-income people lack reliable access to enough food to sustain their health and normal daily labours. The absolute numbers of food-insecure people are growing annually, although at a global scale the percentage of people living in poverty is shrinking. In 1993, 1.3 billion people were classified as "the absolute poor", and 800 million people as not having sufficient and regular supplies of food (World Bank statistics, quoted in the Global Governance, 1995).

Fish has made larger gains than any other food over the last four decades. The 1990 per capita level

was approximately 1.7 times the 1961 level for the developing world and 1.5 times the 1961 level for the developed world despite significant increases in population during the period. The increase came largely from natural fisheries resource and only more recently from aquaculture. Now after more than four decades of increase, the contribution of fish to sustainable food security is undergoing a transition to increasing security. The solution will include increased aquaculture production (Williams, 1996). Since the Food and Agriculture Organization of the United Nations (FAO) first started collecting detailed aquaculture statistics in 1984 and until 1982, annual per capita fish supply from aquaculture increased by 67% (FAO, 1995 a). Globally in 1992, aquaculture contributed an average of 2.5 kg of food per capita.

Ninety five nations met in Kyoto (Japan) during December 1995 to consider the issues of the contribution of fish to sustainable food security. The meeting represented a turning point in fisheries affairs as, for the first time, nations officially recognized "a potential short fall by 2010" of supply of fish and fishery products to meet demands from an increased human population which in turn will adversely affect world food security (Kyoto, 1995).

It is complex to predict fish demand. In case of nutritious high-protein food such as fish, demand is increased by economic factors and population growth. During the period 1970 to 1990, population



growth accounted for only half the growth in fish consumption. Factors like greater disposable income, the price of fish as compared to other proteins, trade opportunities and dietary and health preferences all contributed to fish consumption patterns (Westlund, 1995). Most of these factors have acted positively on the demand for fish as well as on its price and tradability, thus putting pressure on all forms of supply and tending to limit access to it by poorer people. This is a break with the past in the developing world, when fish from natural stocks used to be considered as “the poor man’s protein” due to its low price and/or to the fact that the very poor who owned no land or other means of production nevertheless could often exploit open-access fisheries resources as commons.

The 1995 Kyoto Conference projected that aquaculture production in 2010 would be between 27 million and 39 million tones up from a 1993 total of 16 million tones (FAO, 1995b) thus providing the greatest hope for maintaining per capita fish supply. Marine and inland fisheries were predicted to stay steady, decrease or at best increase more modestly than aquaculture (5 million tones each as the most optimistic increases) at an aggregate level, therefore, aquaculture is the major (though not the sole) hope for improving world’s fish production.

Fish and all other aquatic products contribute directly to food security as nutritious human food supplying protein, essential amino acids, iodine, calcium, minerals, some vitamins and other elements (Rogers, 1990). Fish from aquaculture and fisheries supply 19% of total animal protein and just over 5% of all protein in developing countries (FAO, 1995b). Fish also assist food security by providing income for fishers and fish farmers and livelihood for workers in fisheries, aquaculture, fish processing, marketing, and allied supply and service industries like feed, fertilizer, seed, hatcheries etc.

Supply of fish can no longer be left to nature only. Whereas about 85% of total fish or 79% of food fish still comes from natural stocks, the majority of these habitat are threatened with degradation and habitat loss. Encouraging more people to catch fish for food

or profit is no longer an option in most parts of the world. Encouraging people to grow their own fish or participate in artificial stock enhancement schemes are viable options.

Despite great technical advances, modern aquaculture is still a new technology and requires further progress to meet the supply challenges ahead. Most of the current aquaculture is still quite rudimentary relying on natural supplies of seed stock. Feeds are also largely unimproved and the nutritional requirements of most species are not known at all except in general terms from studies of diet and feeding preference.

The majority of aquaculture production occurs in developing countries and production in these countries has been increasing much more rapidly than that in the developed countries due mainly to developments in Asia.

Losses and shortfalls of supply from natural stock are not directly replaced by aquaculture. The species showing the largest increases in aquaculture production are carps, tilapia, shrimps and salmons. The later two satisfy the luxury markets and increasingly lower-price markets in the developed world as cost of production drops (Anonymous, 1996). But no basic food needs. In Asian countries and in some North American export markets tilapias are substituting generic whitefish formerly supplied only by marine demersal species. Carps satisfy a range of low to middle price markets especially in Asia but tend not to replace either marine, fresh or small native fresh fish in markets. There is virtually no market for Carps and are mostly consumed locally.

The greatest supply gap for coastal people will be in marine fish for which in Asia, only 1.2% is presently supplied by aquaculture but for which demand is high (Csavas, 1994).

Aquaculture production will directly assist the supply of fish for food –insecurity people if they grow it themselves or indirectly - if it is grown cheaply enough for them to purchase. Given the wide range of species and types of aquaculture, different types of enterprises and different scales of enterprises will



have different, often location specific impacts on food security. For example, commercial enterprises producing luxury fish or shellfish may have positive impacts on food security though providing some local employment and general economic gain. At the same time, the enterprises may have negative impacts through physically displacing small-scale farmers or fishers who are most likely to be living in poverty. Aquaculture is a direct supplier of food to those who culture fish. Many studies have shown that aquaculture gives direct access to the households that begin to grow their own fish and depending on proximity to markets and quantities of fish produced, also contributes to improving their income. Where producers are close to urban or local community markets, and as the market price appreciates, more fish will be sold for cash, marketing fish and aquatic products becomes fully commercial rather than subsistence. Gupta *et al.* (1992) showed that fish grown by low-income families in Bangladesh increased animal protein consumption, because 70% of fish produced was consumed in the household.

Half of the fish grown in leased ponds by landless people in Bangladesh was eaten in the home and the rest sold at the local market (Gupta and Rab, 1994). Aquaculture improved access to food by direct growing of fish and by improving income to purchase foods and other needs such as housing, education and medical services.

Aquaculture is often more profitable than farming alternate staples such as rice. Fish ponds, therefore, are starting to encroach on existing agricultural land at a time when these lands are at a premium. For example, in China, growing fresh water crabs (*Echiochiera chinensis*) produces 20 times the value of the same land area under paddy (Li and Xu, 1995). Fish farms are reported to be taking over agricultural land, encouraged by government policy "to create wealth from aquaculture" (Tyler, 1995).

Shrimp culture has received prominence because it has been one of the highest remunerative forms of aquaculture in the developing countries. In just over 10 years it has risen from negligible production

to supplying about 8,00,000 metric tones or a third of total world shrimp production in India. Shrimp farms have come to symbolize islands of prosperity in a sea of rural poverty (Jayaraman, 1995). Most of the shrimp produced is exported from the local region often to international markets.

Conflicts between shrimp farming operations and other rural activities have been reported from many localities such as the eastern Indian coast (Jayaraman, 1995), Malaysia (Hilbert, 1995), Philippines (Villaneura, 1994) and Java, Indonesia (Bailly and Malistyani, 1996).

Culture of other value species such as giant clams, some algae and some parts of pearl farming enterprises are feasible for low-income people especially those who hold household community tenure over marine territory. Inputs for these enterprises are inexpensive and therefore within the reach of rural people. The returns on investment are high.

Aquaculture should bring higher income and more animal protein into the household at least for those households that retain their access to the means of production. However, studies on the *commercialization of agriculture in many countries* have shown that increased household income does improve nutrition but more slowly than expected (Kennedy and Boris, 1993). Health, education and sanitation programmes seem necessary for families to benefit fully. Where capture fisheries exist, the nutritional adequacy of fish may depend on whether the fish were traditionally eaten. Culture often focuses on large, fast growing species such as carps and larger tilapias. The traditional fish eaten in much of Africa and parts of Asia are small and eaten whole, often dried. The bones, scales and skin of these fish provide valuable dietary calcium and other minerals (Deelstra *et al.*, 1994) and elements lacking in the muscle of large fishes.

The issues relating to food security and aquaculture indicate that the benefits of increased aquaculture adoption and production (blue revolution) will not be equitably distributed. Some

forms of aquaculture are only accessible to commercial operators and may even disadvantage poorer people. Capital and labour cost, technical skills, and the financial security to bear the risk of a new enterprise restrict many from venturing into some forms of aquaculture.

National Policy objectives are important to the development of aquaculture and can have major impacts on the distribution of benefits. In all countries where aquaculture is judged to be succeeding, national governments have identified it as a priority for national interests be they for export earnings, import substitution, food supply, technological advantage, or national security through decentralizing industries into remote areas (Katz, 1995). Production statistics show that aquacultural development has been very uneven across regions and between the developing and developed world. In 1993 Africa recorded 0.4% of aquaculture production, Asia 85.8%, South America 1.4%, North America 3.5%, Europe 7.3%, the former USSR 1.1% and Oceania 0.4%. Many developing countries have doubled production since 1984 (e.g. China, India and Thailand) or nearly double (e.g. Brazil, Ecuador, Philippines and Vietnam). In Asia, only North Korea has declined as a major producer.

The first and major beneficiaries in Asian aquaculture have been the middle to large-scale commercial farmers and the consumers. Nevertheless, powered by growing industrial economies, the success of technology, strong market demand, the ready availability of many inputs such as fish seed and fingerlings and the popularity of easy-to-grow species such as carps and tilapias, Asia has also produced many small-scale winners and could produce even more. For example, studies in progress in five Asian countries (Bangladesh, China, Philippines, Thailand and Vietnam) show that elasticity of fish demand with price varies across socio-economic groups. In Bangladesh, where fish has traditionally been an important animal protein, lower-income people would eat more fish if the price were lower.

Aquaculture can be integrated into many different

farming systems via use of multipurpose farm ponds and other water sources which result into production of fish, improved recycling, better on-farm natural resource management and the ability to spread financial risk through farm diversification. The best known form of integrated aquaculture-agriculture and one with a long history in parts of Asia is raising fish in rice fields and in ponds on rice farms. Across nine Asian countries (Bangladesh, China, India, Indonesia, Korea, Malaysia, Philippines, Thailand and Vietnam), out of a total of 114.3 million ha of rice-field area, 10.2 million or nearly 10% are thought to be suitable for rice-fish culture which is not, however, fully utilized for the purpose. Through rice-fish culture, a large number of small rural producers are benefiting from aquaculture. The fish produced are either fingerlings for on-growing in other aquacultural systems or table fish for domestic market and household consumption.

Culture of penaeid shrimps, except in some extensive farms integrated with mangroves, has been more of a detriment than a benefit to food security. Likewise, brackish water pond culture of milkfish has had mixed outcomes for food security. Mollusk culture of bivalves has been the dominant form of small scale coastal aquaculture in Asia. Seaweed culture is also becoming more important. Pacific, Indian Ocean, and Caribbean island countries depend largely on seafood.

The needs and approaches to development are changing. Aquaculture is more in demand from more rural communities and its development is now viewed more as part of rural development than as a separate sector or even as a part of the fisheries sector.

To achieve food security, high-value species preferably those that are low on the food chain, are readily processed and are easily transported to distant markets, will be the best (Munro, 1995). Aquaculture should have little or no negative ecological impacts and use affordable technologies so that low-income people can become producers.

The African continent is the most threatened by



rising food insecurity due to steeply increasing population and climate uncertainty. While capture fisheries production has stagnated throughout the continent at about 8 kg per person, aquaculture has continually increased from 50 g per person in 1984 to 100 g per person in 1992 (FAO, 1995). Kapetsky (1994) found that 31% of the area was suitable for warm water subsistence aquaculture and 9% of the land in sub-Saharan Africa is suitable for commercial aquaculture.

Aquaculture production increased by 15% per year in Latin American - Caribbean region between 1984 and 1992 but aquacultural products still represented only 1.86% of the per capita fish supply in 1992 (FAO, 1995). Ecuador and Chile dominated production (36% and 21% respectively) and Mexico, Brazil, Columbia and Cuba each produced more than 20,000 metric tones. A major change in approach would be required in Latin America for aquaculture to have a major food security contribution. As a result of more than 20 year extension effort and good availability of on-farm inputs and fry of several fish species, 10% of 1,70,000 small and middle scale farmers in Santa Catarina Province (Brazil) are engaged in fish farming.

Mass aquaculture production of affordable fish for rural and urban consumers contribute tremendously to food security. Aquaculture, therefore, can make a valuable contribution in improving the lives of the rural poor but its development remains constrained by factors like limited extension services, poverty, poor infrastructure and adequate water which need to be addressed on priority basis.

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Reservoir fisheries development: Strategies and action plan with special reference to Karnataka

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In India, the reservoirs cover an area of 3.15 million ha out of which small reservoirs occupy 1.4 million ha followed by large (1.14 million ha) and medium (0.52 million ha) reservoirs. Madhya Pradesh leads with 14.6 million ha followed by Andhra Pradesh (14.5 million ha), Karnataka (13.8 million ha), and Tamil Nadu (11.3 million ha). The area of small reservoirs is maximum in Tamil Nadu followed by Karnataka and Andhra Pradesh. The small reservoirs are regarded as very important due to high biogenic production potential. The fish average production per hectare is maximum from small reservoirs (50-213 kg) (Tirumoorthy reservoir, Tamil Nadu) followed by medium (13 kg/ha) and large (11 kg/ha) reservoirs. The present estimated production from reservoirs is 93,650 tons as against the potential of 2,45,134 tons.

Resource status in Karnataka

Karnataka state is one of the most important states in the country with regard to water resources. The reservoir resources of the state are vast and varied and stand at 3rd position in the country, next only to Madhya Pradesh and Andhra Pradesh. There are 74 reservoirs covering an area of 2.94 lakh ha, which comprise 46 small reservoirs (<1000ha) with a Water Spread Area of 15, 253 ha. The 16 medium reservoirs have an area of 29,078 ha and 12 large

reservoirs cover an area of 1.8 lakh ha. The small reservoirs are well distributed all over the state and provide a big opportunity for promotion of culture-based fisheries.

Small reservoirs represent water bodies, which are shallow and highly productive. There is enormous scope for enhancing yield from such water bodies. A large number of them are situated in northern plains of Karnataka where temperature is high and fish growth is fast because of higher productivity. Most of these small reservoirs do not offer scope for auto stocking. The reservoirs of Karnataka possess rich Ichthyofauna (biodiversity) especially the species of *Puntius* and *Cirrhinus*. Heavy predatory pressure and failure of natural breeding is responsible for the decline in catches of these fishes.

The fish yields at the present level of management of reservoirs are poor and range from 20-100 kg/ha/year. The reservoir ecosystem being dynamic has a tendency to change its productivity and production rapidly as compared to other aquatic ecosystems. The reservoirs in Karnataka harbor about 83 species of fish with at least 40 species contributing to the commercial fishery mainly comprising peninsular carps such as *Puntius sarana*, *P. dubius*, *P. pulchelus*,



Cirrhinus reba, *Labeo fimbriatus*, *L. kontius*, *L. calbasu*, *L. potail* along with catfishes, murels and minor carps including weed fishes. The introduced fish species particularly Indian Major Carps are still to establish a fishery of commercial importance in reservoirs. This is mainly because of inadequate stoking programmes and stocking with the fingerlings of rohu, mrigal and common carp in less numbers as compared with the productivity of the reservoirs. Excepting one or two reservoirs (Markonahalli and Hemavathi), the fish catch mainly comprise of catfishes and minor carps in most reservoirs.

The sharp level fluctuation and draw down of water have destabilizing effect on the primary productivity. Another limiting factor is the wind-induced turbulence resulting in high turbidity during May-September which severely restricts light penetration and thus affects primary productivity. Frequent water level fluctuation often affects the benthic community. Based on planktonic abundance, the year round reservoir productivity could be categorized into three groups, viz., Productive period (December-April), Retardation period (May-July) and Recovery period (August-November).

Factors of reservoir productivity and production

The factors affecting reservoir productivity and production are:

1. Sharp decline in water level reducing the fishing season and fishing area leading to over exploitation
2. Inadequate stocking resulting in dominance of the unimportant species
3. Use of destructive fishing practices affecting any possible means of auto-stocking and artificial recruitment
4. Destruction of breeding grounds due to short-term fluctuation in the water level
5. Being open water bodies, wind induced turbulence causing year round turbidity of water which indirectly obstructs water productivity.

The catchment area of the reservoirs would help in enriching the nutrient status of the reservoirs. Reservoirs which have forest catchment and located in higher altitudes and characterized by mineral rich soil in the catchment make them less productive as evident in Supa reservoir. Due to heavy accumulation of organic matter at the bottom coupled with low pH and inadequate biological activity for decomposition has led to accumulation of toxic gases like Hydrogen sulphide and ammonia making the reservoir less productive.

Most of the perennial and large reservoirs harbor catfishes, eels and murels, which are predatory and harmful for carps. Some reservoirs which contribute these fishes significantly (Linganamakki) to the total production should be developed for establishing predatory fish populations through maintaining proper predatory-prey ratio. Another alarming situation is increasing contribution of Tilapia to the total fish production of many reservoirs. Some reservoirs (eg. Nelligudda), which receive high organic load, have been contributing significant quantities of Tilapia to the total fish production. Tilapia has entered even large reservoirs like Krishna Raja Sagar and is creating management problems.

Self propagation

Generally the reservoirs, which do not receive sufficient flowing water during south west monsoon, do not offer scope for breeding of gangetic carps. Probably this could be the reason for non-establishment of self-breeding populations of Indian major carps. However, in some reservoirs, common carp does breed naturally and provides opportunity for natural recruitment. The local carp populations have dwindled significantly due to very low water level during years of drought and heavy fishing pressure. Hence the breeding population has terribly reduced leading to depletion of stocks of medium carps. In addition, the hatching survival is at stake due to heavy predation by fish like *Gambusia* (eats larval stages), and juvenile predation by catfishes and murels. Apart from this, the water renewable rate has negative impact on benthic community of the reservoir.



Contribution of Indian Major Carps to fishery

Indian Major Carps and exotic carps are yet to form a fishery of importance in major and medium reservoirs except in Krishna Raja Sagar where common carp contributes fishery of considerable importance (36%). In all the other reservoirs major carps contribute at very low level. In all the reservoirs, the predatory fishes account for 10-30% of the total catch followed by minnows and forage fishes (20-40%). In some reservoirs, Tilapia has gained entry and established well as noticed in Kabini reservoir (8-60% catch) reducing the proportion of medium sized carp (*Cirrhinus reba*), which during 1980s accounted upto 70% of catch. The shallow reservoirs where weed infestation is generally noticed (Vanivilas Sagar) could be stocked with *P. pulchellus* or grass carp so as to control eutrophication of reservoir due to death and decay of aquatic plants.

Seed rearing in pens

Pen rearing of fish seed as was practiced in Tunga Bhadra Dam, has paved way for enhancing stocking density upto 100 advanced fingerling/ha. However, it is better to rear fry to fingerlings rather than rearing spawn to fingerlings in pens for achieving better survival of stocking material. Reservoirs with deep depression are not found to be biologically productive and too shallow reservoirs are also found to be less feasible for improvement of fish production.

Development of small reservoirs

Small reservoirs of area less than 1000 ha (46 Nos.) offer great scope for enhancing fish production even upto 200 kg as being demonstrated in Tamil Nadu (Aliyar and Thirumurthy) as against the average production of less than 50 kg/ha/year. For scientific development of reservoirs, the development should center on concept of productivity indices (Primary and secondary productivity). This would help in scientific planning and adoption of various productivity enhancing practices listed as below:

1. Species selection and their proportion should be decided depending on productivity indices,

morpho-edaphic factors, water depth, rate of water drawn down, etc. Since most of the reservoirs have rich organic matter and benthic biota, the Indian Major Carps and exotic carps could be stocked in suitable proportion. Importance should be given for seed production and stocking of local carps of consumer importance as they are known to perform better than some Indian Major Carps. If commercial water based aquaculture is planned, culture technology for catfishes and murels can be developed.

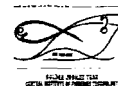
2. Stocking size and density should be based on the productive potential of the reservoirs. For better survival, stocking fish seed of 100-150 mm size is desirable. This also helps to overcome the problem of predation. A stocking density of 500 fish juveniles/ha for large and medium reservoirs and upto 1000 juveniles/ha for small reservoirs is feasible, however, stocking density could be varied depending on the productivity indices.

3. Establishment of an eco-hatchery for *in situ* production of fish seed of good quality and desirable species needs serious consideration.

4. Formulation of vibrant co-operative organizations with well defined objectives and responsibilities for participatory management of reservoirs is important.

5. Capacity building of all the stake holders assumes significance to appraise scientific principles and practices and provide conflict-free management with social and legal security.

6. Adoption of water based seed rearing systems: Fish seed farms do not have sufficient rearing space to provide advanced fingerlings/juveniles for large scale stocking of water bodies like reservoirs. In addition transportation of large sized fish seed poses serious problems of seed handling and resultant mortality. The fish seed (fry) are known to grow much faster in pens/cages as water quality and soil quality will not be limiting factors. It is observed that with in 45-60 days, the fry attain the size of more than 100 mm which could be directly stocked in the reservoir. Enumeration of the nursery seed



harvested becomes easy in cages than in pens but growth of seed will be better in pens.

7. Harvesting of fish from reservoirs is generally done by issuing license to professional fishermen. As such fishing has become an avocation with lot of uncertainties. Proper assessment of the fishable stock, mesh size regulation, banning non-selective gears, indiscriminate and unscientific fishing, fixing fishing season, participatory and profit sharing fishing activity, possible mechanization of fishing etc., would help in overcoming problems of uncertainties in fish harvesting and also provides option for planning proper reservoir management and handling of the harvested catch.

8. Pollution control: The effluents from the industries or the domestic sewage should not be allowed directly to enter the reservoir. It is better to divert the effluents outside the reservoir. This may otherwise cause deterioration of soil and water quality and might result in mass mortality of fish.

9. Post harvest handling and marketing: Proper handling, transportation, processing and marketing is the key issue for proper utilization of the fish produced through aquaculture. Presently, the fish is generally sold at the landing centers or the fishermen/merchants sell in retail markets or through hawking in towns and villages. It is desirable to establish ice production unit in the vicinity of reservoirs for first stage preservation of fish catch. It may become essential to establish hygienic fish dressing centers in places of organized marketing with good display facility to preserve the quality of fish. During periods of heavy catch, the marketing could be linked to the existing cold chain using refrigerated trucks. Low quality small fishes could be properly dried/salt cured/smoked and marketed during off-season.

Chilled storage and transportation of fresh fish at just above its freezing point using ice as medium for chilling by reducing temperatures from 25°C to 1°C is feasible. The fresh fish immediately after capture should be stacked in boxes with intermediate layers of ice. By this method fish could be transported over 24-48 hrs by trucks/trains to the urban fish

markets. Various ready to cook/ready to eat products such as battered and breaded products, coated fish and fishery products such as fish finger, fish blocks, mince based products such as cutlets, burgers, balls etc., can be made. Surumi and surumi based products, kneaded products, fibreized products etc., could be produced during periods of glut. Use of instant quick freezing (IQF) for fish has helped in quality maintenance as compared to block freezing practiced conventionally.

Modified atmospheric packaging in pouches filled with Carbon dioxide/nitrogen/oxygen etc., is another recent method of fish processing. These gases are known to slow down the degradation of meat by microorganisms.

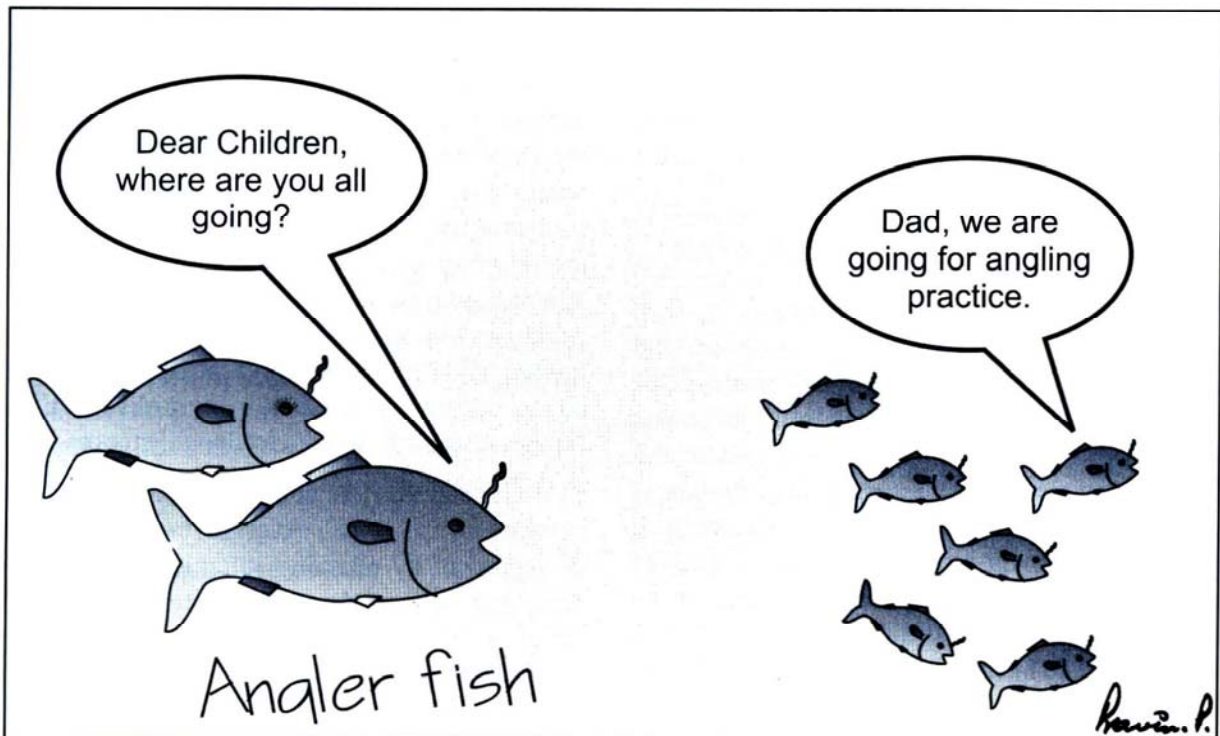
10. Live fish transport: Transportation of live fish is gaining importance in recent years. As is practiced in Thailand and Vietnam, large sized carps (1-3 kg) are maintained live in plastic crates using water recirculatory and sprinkling pumps. Such fish attract better price compared to iced fish. Nowadays transportation of fish in low temperature water media along with tranquilizers is being practiced and this would help in transport of fish in live condition under reduced metabolic rate. The air-breathing fishes such as a few catfishes and murels could be transported live in tanks with low temperature water media for long distances.

11. Policy support: For comprehensive development of reservoirs, it is better to tackle reservoir development by planning suitable strategies. For achieving measurable success, attention should be diverted towards development of small reservoirs, which offer better scope for easy aquaculture management. The research should concentrate on development of productivity indices for all these small reservoirs and simultaneously create data base about nutrient status, type of catchment, physico-chemical qualities of soil and water, species performance etc., which would help in deciding stocking density, species proportion, size of fish seed etc. A suitable leasing policy should be developed for supporting fisheries co-operatives/private entrepreneurs to establish ownerships right with

proactive terms and conditions concerning fisheries development and water management. The whole process calls for proper understanding of institutional arrangement so as to involve all the stakeholders at different levels right from seed production, seed rearing, feed management, culture, security, awareness building, fish harvesting, legal issues, processing, value addition etc. to fish marketing either in domestic or export markets. With carps as the main species, export market may not be a good option, however, species

diversification through import of desirable species for profitable aquaculture should be carefully thought of to avoid any other problems of management and its impact on biodiversity of indigenous fish species.

Meticulous planning and effective implementation of the suggested strategies would certainly pass way for enhancing fish yields considerably from these potential reservoir resources.





Fishery technological advances along Saurashtra coast

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Gujarat is the northern-most state on the west coast of India, situated between 20.01° and 24.07° N latitude and 68.4° and 74.4° E longitude. The present state of Gujarat came into existence on 1st May 1960. The coastline is 1600 km long and is the longest among the coastal states of India. The area of continental shelf is 1,64,000 km², which is 32.54% of the total Indian shelf area and the EEZ off Gujarat is estimated to be around 10.59% of the total Indian EEZ. The potential resource for exploitation is worked out to be around 7.03 lakh tonnes. The annual marine production is in the order of 6.09 lakh tonnes. The export figures are 1.084 lakh tonnes and Rs. 614.41 crores in quantity and value respectively.

The early development

The earlier fishing boats comprised of wooden boats, with sail and gillnetting was the major fishing operation. Cotton gillnets were exclusively used and fishing cruise used to be mostly of one day duration during day hours.

The development of commercial trawl fisheries along Saurashtra started in the year 1964 with the introduction of 10.97 m LOA, 48 hp wooden research vessel, Fish Tech IV by CIFT and commissioning of fishery training and demonstration boats by the State Fisheries Department. Studies and demonstration from these vessels and the dedicated works of technical personnel associated with this gave a real impetus to the ensuing fishery development in Saurashtra.

The state did not have a common fishing policy

and two fishing policies existed for the region i.e., Saurashtra Fisheries rules and Kutch Fisheries rules. This fragmented and often imbricating policies hindered the development of fisheries in this region even after the state was officially formed on linguistic basis in the year 1960. In the mid seventies, due to government directives, some of the provisions in the rules were removed, but the policy continued until 2003, when a common fishery policy, Gujarat Fisheries Act, 2003 was promulgated.

The catches prior to 1970 from this region were predominantly from the gill nets and Pomfret formed the major fish that was marketed to interior places of Gujarat and Mumbai. Almost 90% (15-20 tonnes) of the catches of Pomfret was iced daily and send to Crawford market, Mumbai.

In the period 1964 - 1966, Out Board Motors (OBM) by GMA (Gujarat Marketing Association) and Nylon nets by CIFT, were introduced for the first time in Veraval. This saw a boisterous resistance from the local fishermen stating that the sound of the OBM's may fend off the fishes to deeper waters. The introduction of nylon nets were opposed stating that the blue coloured webbing will be easily visible and will affect the gilling process.

With persuasion from the Scientists and fishery officials, two local vessel owners Shri Kanji Kalidas and Shri Devi Kalidas finally agreed to test the OBM. The quality and quantities of the catches by these vessels were excellent in comparison to the local vessels and this finally started a rush for



popularizing the OBM and nylon gill nets along Saurashtra coast.

In the beginning of the year 1968, there were a total of 14 trawlers, including the research vessel Fish Tech IV operating along Veraval. The vessels were in the size range of 30-39 feet equipped with an 80 hp diesel engine, which costed around Rs. 1 lakh. 30-35% subsidy for mechanization was given by the government through GFCCA.

CIFT's contribution in the development of fishery technology in this region was very significant. Shri S.D. Deshpande, Scientist, CIFT was a leading figure in the development of fisheries along Saurashtra coast. CIFT was regularly conducting training programmes for the local fishermen in fabrication and mending of synthetic webbing. The trawl and gillnet designs, which became popular along the coast were provided by CIFT. Long lining for tunas was initiated by the state department with the active involvement of CIFT. The various accessories used in the trawling operations were introduced and optimized for operations by CIFT. Insulated fish holds were also introduced in Veraval by CIFT.

It was in the year 1969, that the first processing plant, M/s Castle Rock, with active support and technical guidance from CIFT, started functioning at Veraval. Shri R.Venkataraman, the then Scientist In charge, CIFT Sub Station, Veraval, played a significant role in the scientific development of fish processing. The shrimp catches from the 14 operational vessels were utilized as raw material. The product was mostly block Frozen PUD shrimps. This unit was a huge success and this paved way for the burgeoning of processing plants and the fishing Industry in Veraval in the ensuing years. The export of shrimps continued till the late 70's and it was only in the early 1980's that the processing and export of fish species and cephalopods took off on a large scale.

Another landmark was posting of an Assistant Director in charge of survey and research and commissioning of three research trawlers of 14.8 m LOA, MFV Silver Pomfret, MFV Gulf Shrimp and MFV Indian Salmon at Veraval. The synthesis of outcomes of studies carried out from these vessels had helped in the development of fishery technology in Saurashtra.

Another important development was the processing and export of Whale shark (*Rhincodon typus*) from Veraval in the early eighties. The industry had flourished in a big way and this resulted in the indiscriminate killings of whale shark which finally led to a ban on the fishing of this species by the Govt. of India.

Present scenario

The marine fisheries scenario of Gujarat has changed considerably in the resulting years. There was a burgeoning in the number of fishing vessels, particularly in the number of mechanized trawlers (Table: 1). The total number of fishermen engaged in fishing have also increased in large numbers and all these have resulted in dwindling catches and expansion of the fishery to deeper waters, to depths more than 100 fathoms.

Table: 1. Change in fishing pattern

No. of fishing boats	1986	2004
Trawlers	1919	7402
Gill-netters	956	3082
Other crafts	310	1498
Non-mechanized boats	8000	12365
Total	11,185	31,000
Average catch (t) boat / year	29.5	19.6
Fish processing units	12	57
Fish catch – Gujarat (t)	3,30,000	609136
Total Export (Quantity(t))	22,220	1,08,386
(Value(crores))(1990-91)	Rs. 76.88	Rs.614.41

The composition of catches have also changed substantially. Pomfret (*Pampus argenteus*, *P. chinensis* and *Parastromateus niger*), Seer fishes (*Scomberomorus* sp.) and Jew fish (*Protonibea diacanthus*) which formed the bulk of the catches are now replaced by small breams, ribbon fishes etc. Steep rise in the prices are also evident (Table: 2).

There are 57 fish processing plants in Gujarat with a total production of 108386 t/year and contributing about 23% of the total export of marine produce from India. The unit value realization from these plants is

Table: 2. Increase in unit value of fishes

Species	1980-85	2005-06
Fin fishes		
Pomfrets	12.00-18.00	300.00
Seer fishes	4.00	75.00
<i>Protonibea diacanthus</i>	9.00	50.00
Ribbon fishes	0.75	20.00-25.00
Croakers	3.00	25.00
Shrimps		
<i>Penaeus merguensis</i>	50.00-55.00	250.00
<i>Penaeus semisulcatus</i>	40.00-50.00	250.00
<i>Metapenaeus monoceros</i>	8.00-12.00	150.00
<i>Solenocera crassicornis</i>	45.00-50.00	55.00
<i>Parapenaeopsis styliifera</i>	8.00	55.00
Lobsters	75.00	500.00
Cephalopods	0.75-1.50	45.00 - 50.00

about Rs. 56.69/kg, which is much lower than the average Indian values which stand at Rs.147.86/kg. Unless steps are taken to incorporate value addition in the traditional products, this condition cannot be improved.

Basic facilities starting from amenities at the landing centers, to the fish processing facilities and for transportation of the finished product is found to be grossly inadequate and these are some of the crucial bottleneck that hampers development in this region.

The national review committee based on the fishery statistics of 1995-1996 has recommended an optimum fleet size of 8283 (Motorized crafts) and 8440 (Mechanized crafts). But the fleet size during 2003-2004 was 18653 and 12365 in the mechanized and non-mechanized categories respectively. This clearly indicated the over-capitalization in the fisheries sector in the state. The recent survey carried out by CMFRI show the total number of trawlers as 8002 and constituting about 30% of the total fishing vessels in the state.

Future scenario

Basic infrastructure facilities should be improved at all the major fish landing centers like Veraval,

Mangrol, Okha and Jakau. Strict adherence to the Fisheries Regulation Act will help in a big way in sustaining the fishery resources. Mesh size regulations and use of bycatch reduction devices in trawls should be made mandatory. Adherence to the stipulation of 40 mm square mesh for the codend should be strictly ensured.

The entire fishing operation is confined to the near shore areas i.e., to a depth with in 100 m depth contour. And it can be seen that the resources in this zone are declining and measures to extend the fishery to deeper zones, by introducing multi-purpose, multi-day vessels have to be initiated. Horizontal expansion of the fishing vessels to include long lining for tunas, Squid jigging etc. should be encouraged, which will reduce the pressure in the currently fished grounds.

Studies show that the fishery resources are harvested at the optimum along Gujarat and there is no need for furthering the number of vessels. Reduction and the final phasing out of subsidies will prevent the burgeoning of the fishing vessels.

Revalidation of the potential resources to determine the optimum resource exploitation should be carried out immediately to re-estimate fleet size composition and number. Issue of fishing licenses from the state government should be based on this study.

Public participation is a must to ensure adoption of responsible fishing and extension services for both harvesting and post-harvesting technologies should be assured. Regular training in this regard for the benefit of fishermen and processing plant workers can be taken up by the state government on a regular basis.

The traditional practice in Gujarat of observing closed seasons during monsoon and special days such as 'agyras' (11th day of the lunar phase), should be advocated and popularized, since these can be excellent measures for controlling excessive fishing pressure. The state imposed ban on the monsoon fishing till August 15th should be strictly monitored.

Manpower needs of the fisheries sector of India

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The fisheries sector which includes fishing, aquaculture and the processing sub-sectors has made important contributions to domestic food production in the country through the years by providing animal protein, generating much needed foreign exchange and contributing to the rural economy. The fisheries sector is faced with a number of problems and to tackle them sufficient adequately trained manpower is needed in the various areas of specializations. It is well known that this sector is confronted with an over supply of fishers but the sector lacks specialized personnel of international standard. The nation has to strengthen the existing technical and management capabilities to monitor, exploit and manage fish stocks in the EEZ. The aquaculture industry requires many more hatchery experts, technicians, farm managers and professional fish farmers. The processing industry requires qualified fish processors, plant managers and post-harvest technologists.

The country has made great progress in fisheries education since independence. A number of institutions have been established to produce manpower in fisheries at various levels. Establishment of several Fisheries Colleges and Deemed Universities have resulted in the production of bachelor's level, master's level and doctoral level manpower in adequate numbers. But now the irony is that many graduates and higher degree holders have encountered difficulty in finding placement in

fisheries and a number of them have to take up non-fisheries related employment. It is imperative now for the country to re-examine the manpower needs of the sector. We have to admit our inability to provide appropriate technical manpower for the fisheries sector and it is an indication of institutional weakness of the fisheries educational institutions. Lack or inadequacy of national fisheries manpower planning and/or policies in relation to the categories of manpower and their appropriate educational level are the causes for the problems of manpower production in the country. Considerable rectifying measures are needed so that fisheries education and training systems can be improved in response to the real needs of the sector which constantly change.

It has been estimated that at the national level the jobs to be created in the fisheries sector are more than 7000 per year of which skilled manpower requirements may be around 3500 per year. Proper manpower requirements of the fisheries sector in India are yet to be made. There have been more attempts here and there, but a consolidated picture is nowhere in sight. Further, some of the estimates appear to be far from realistic; they are either thorough underestimates or overestimates; which is due to uneven growth of the sector directly linked to international factors, funds allocation, utilization pattern and management constraints.

Eventhough a number of institutions have been established at various levels by various agencies at



various places, there is no uniformity in standards and there is wide variability in the quality of manpower produced. Some institutions are in a sorry state of affairs due to various reasons. Considering the futile efforts made by the existing agencies in the past, the results are nowhere in sight. A new approach must be considered for quality assurance in manpower production. The only imperative solution seems to be the formation of "Fisheries Council of India" with full statutory powers to rectify the present situation. Any delay in this regard will further damage the long term interests of the sector.

Educational levels

- I. Post-primary or elementary level with emphasis on practical training.
- II. Post-secondary level; i.e. certificate/diploma.
- III. Bachelor's, masters or doctorate degree.

Manpower categories

- I. Professional skilled fishermen, professional skilled fish farmers, skilled labour and professional skilled fish processors.
- II. Extension workers, Technicians, Laboratory/farm/factory/fishing assistants.
- III. Administrators, managers, research scientists, teachers, supervisors, etc.

Fisheries training and education needs at different levels

- I. Strengthening training at post-primary/elementary level to provide appropriate training with hands on experience for skilled labour required in the sector (Lower level manpower).

Entry: 5/7 Standard - Pass/Fail.

Duration: 2 to 12 months certificate course.

Medium of Instruction: Local Language.

Location: Fisheries Training Centre/Krishi Vigyan Kendra, etc.

Funding: Fully funded by government with provision of stipend to each trainee.

Number: Not more than 20 per batch.

Annual manpower needs: 2000.

- II. Strengthening training/technical education at the post-secondary level to provide appropriate training for middle level manpower like professional skilled fishermen, fish farmers, fish processors and instructors. This should include a balanced instruction of theory and practicals.

Entry: 10th Standard/H.Sc. – Pass.

Duration: 2 or 3 years certificate/Diploma course.

Medium of Instruction: Local Language.

Location: Fisheries Colleges/Fisheries Polytechnics/Fishermen Training Institutes/Fisheries Schools/Junior Colleges/Vocational Institutes, etc.

Funding: Fully funded by government with provision of Freeships/Scholarships/Fellowships/Stipend etc.

Number: Not more than 20 per batch.

Annual manpower needs: 1000.

- III. Strengthening fisheries education and training programmes at University level to provide appropriate education and training for extension staff, research scientists, technical staff, administrators, teachers, managers etc. The syllabus should contain adequate courses in fisheries management, aquaculture, fish processing, fisheries economics and fisheries extension (Manpower at higher level). Specialization at post-graduate level.

Entry: 10+2/Pre-University/Intermediate/H.Sc. etc. - Pass.

Duration: Bachelor's as 4 years programme/Master's as 2 years and Ph. D. as 3 years.

Medium of Instruction: English.

Location: University Departments/Fisheries Colleges/Deemed Universities/Research Institutes etc.



Funding: Liberal Scholarships to weaker sections. Partial/Full funding from Government.

Number: 20 to 30 intake per year at UG level and 50% of that at PG level.

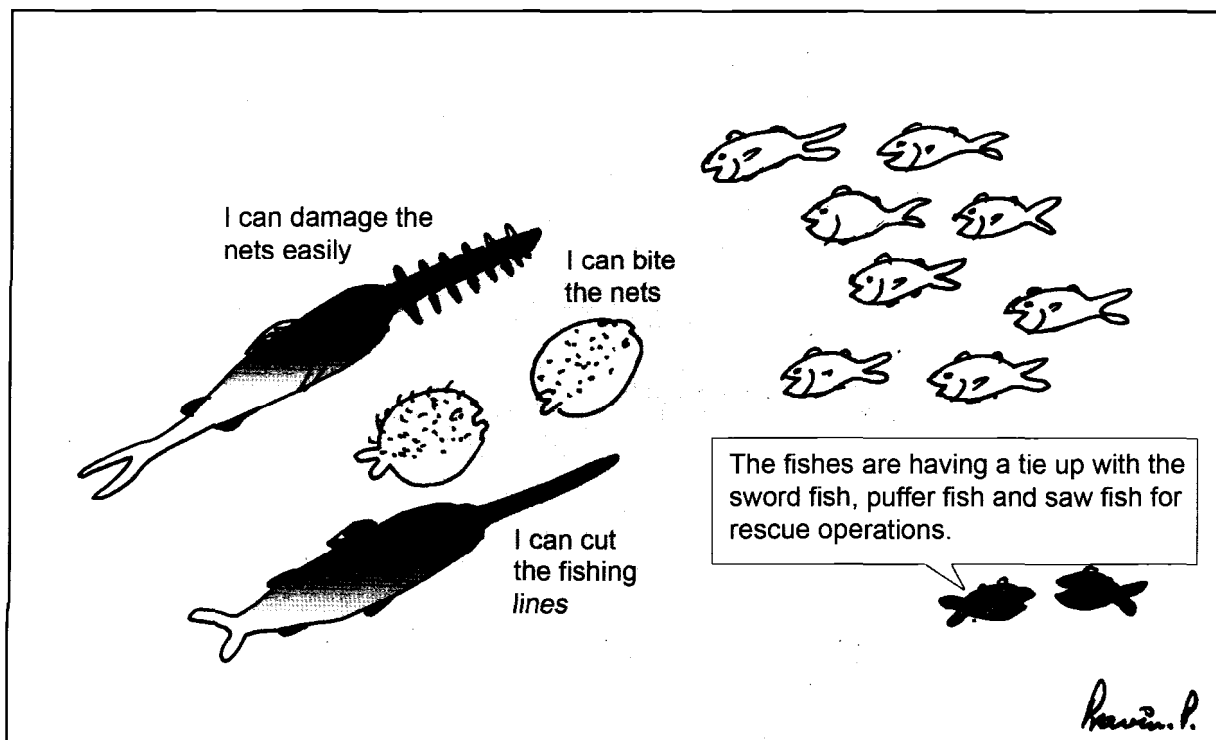
Annual manpower needs: 500.

It is necessary to highlight the fact that fisheries is a relatively new field of education in India. It has to compete with well established disciplines in agriculture, engineering, law, medicine and others. To accelerate the development of fisheries, there should be sufficient government financial support to Universities, colleges, schools, institutes, training centres, etc. To ensure high quality educational systems and financial help, scholarship programmes for highly motivated and qualified students for maintenance of the quality of fisheries education, it is required that the minimum standards of admission are maintained of students into schools, institutes, trainings centres, colleges and Universities. The major objectives of level II and III should be to produce manpower who are job providers and not

job seekers. Self-employment goal can be achieved only if the quality of education is excellent.

The estimates indicated above are modest but we have to begin somewhere. The existing track record of quality of education is much to be desired. Manpower needs are assessed taking into consideration turnover need (Retirements, death, resignations etc.) and growth needs. All depends on the sectoral growth which decided the needs at a particular time and demands periodical assessments of manpower needs. Our manpower should be equal to the best.

It is very essential that short term training programmes/workshops/seminars/symposia/refresher courses etc. are conducted for the benefit of all categories of manpower at periodic intervals for the benefit of in-service personnel/experienced staff etc. for giving new information/training etc. so that the manpower of the fisheries sector in the country at any given time is equal to the best in the world.





CIFT technology and its wide applications in many other areas of marine and agricultural sciences

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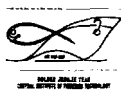
Observation of the nature with all its functional and environmental parameters and features is the primary requisite to make a related subject more scientific. The matter reported here, gives brief details of the instrumentation technology developed basically in CIFT and later improved, extended and modified from time to time, for observing the nature, including that of the underwater marine environment and the systems under operation. The technology developed since Sixty's, started with underwater observation of the trawl system, was further improved and extended to many other areas, incorporating state of the art developments, consequent to its commercialization and implementation in more than 180 Departments, through out the country. The basic technology consists of:

1. More than five dozens of sensors, some of them with new innovative designs and others with suitable alterations for compatibility to different and stringent operational requirements at remote sites.
2. Electronic signal conditioners and processors, matching to the sensors and the specific needs of the field investigations.
3. Standardization of the sensors and electronics to enable implementation of large multi disciplinary

systems and turn-key projects, with facility to select the required sensors, signal processors and other operational facilities, including automatic operation attached with memory module, computer and wireless data transmission to distant points.

The need for gathering more and more information from the open environment is increasing along with our activities for sustainable development and exploitation of the natural resources. The success of these developments are mostly due to the positive interactions with the actual users, scientists and experts. The interactions resulted in the applications of the technology in most of the applied sciences connected with nature, where nature has to be observed accounting the numerous operational parameters individually and collectively in an integrated manner. The national training courses conducted and field demonstrations and technology evaluations with detailed discussions enabled to improve the systems and sensors matching to diverse conditions, for gathering the correct information with out much modifications and deformations.

The author expresses his gratitude to the Directors of CIFT and the ICAR officials and all concerned, for giving opportunity to work on a wider area of application, rather than limiting to



fisheries technology alone. He is grateful to his colleagues in CIFT who were associated with numerous development, extension and training activities and also the scientists and engineers of the different user institutes who adopted the technology and implemented them in their projects and activities.

The need and scope of electronic instruments for gathering information from operational systems at remote sites

Systems operated in open environment are linked to the environmental features and operational constraints. Analysis of such systems need lot of data linked to its ground truth and need much data on their performance and the environmental features associated with them. It is applicable to investigations in all environmental sciences including agricultural sciences, marine sciences and other energy and environmental sciences. The operational parameters pertaining to air, water and soil are interlinked and in most cases *in situ* measurements are most desired for integrated analysis.

The advancements in sensor technology have enabled to sense the data directly from the open environment. The progress in this vital area is comparatively poor, compared to others owing to many complex problems. The developments in electronics in many areas of instrumentation can be copied down here. But this can be done only after gathering the basic primary information which is obtained from the sensors used for them. There is not much to copy from other advanced fields of electronics to this area of sensor development. The technology available are connected with factory instrumentation and the operational environment is much different and the required working facilities cannot be provided.

The technical and operational features of the sensors and systems developed and implemented

A series of sensors and measurement techniques have been developed with technical features matching to the stringent requirements of the operation in the hostile environment pertaining to

marine applications, remote locations of agricultural sites and other cases.

Sensors

There are about 60 types of sensors designed for operation and data collection from remote sites, applicable to fishing technology, fish processing, technology, marine environmental measurements, agro-climatology, water resources, water management and other related activities connected with open environment. Many of the existing sensors were suitably modified and properly matching to applications in those diverse areas. The sensors were standardized for easy adaptability.

Signal conditioners and processors

A series of signal conditioners were designed matching to these sensors, with operational features matching to the operational constraints of the remote locations. This also includes signal processing techniques requiring extremely low power, solid state memory devices, computer interface cards etc. as peripherals of the main system.

New field applications

A series of new field applications have been generated using the technology for better analysis of the environment with its operational systems. This also includes programmes for attracting students of applied sciences to conduct their dissertation works, participation of NGOs to rural scientific educational activities etc.

Novel field applications generated for better analysis and evaluation of the nature, leading to its sustainable development

The following are some of the cases of applications and installations made in different subjects. Most of these cases were executed on turn-key basis and also incorporating new designs, new sensors and new signal processing techniques matching to the specific needs of the cases. Most of them are special cases where additional information were required for implementing projects and programmes for systematic analysis and evaluation of the respective activities.



They are classified into two categories, namely ocean sciences and agricultural sciences.

Marine sciences including fisheries technology, coastal engineering, port and harbour engineering, fisheries hydrography, oceanography etc.

1. Multi-channel Wave Recording System was designed for Ocean Engineering Center of IIT, Chennai for monitoring analysis of the impact of waves on ocean structures. The system consisted of 17 nos. wave sensors and computerized data storing and analysis facility for simultaneous acquisition and analysis of the impact of waves. The system was installed on an oceanic structure and operated at Bay of Bengal.
2. Ocean Measurement System with 10 nos. sensors of water current direction, salinity, temperature, operational-depth etc. was designed for evaluation of the water dynamics and water quality around the floating oil rig of ONGC, operated in Bay of Bengal.
3. Automatic Tide Recorders designed were installed by Fishery Oceanographic Department of Kerala Agricultural University, for studies related to water mobility in Vembanad Lake, Kerala, for evaluating the real time tidal levels for locations simultaneously, around Cochin back waters, and data acquired by.
4. Tide and Wave Telemetering Systems were installed at the coasts of Trivandrum, Alleppey, Tellichery and Calicut and operated for more than 10 years continuously since 1979 and data collected by CESS, Trivandrum. Tidal and wave energy profiles were analysed for evaluating the wave energy profile, leading to the installation of the first wave energy project in Vizhinjam. Similar types were installed along Gujarat coast by Gujarat Maritime Board.
5. Portable type *in situ* marine environmental measuring instruments were designed with technical features for faster and more effective survey of the marine environment and got implemented in more than 40 Departments of maritime Universities and other research institutes, for monitoring underwater parameters directly from water depths, and useful for investigations and assessment, coastal engineering, coastal hydrography, marine geology, ocean technology, validation of remote sensed data etc. The marine environmental parameters measured by these instruments at different depth ranges up to 200 m are: water current and direction, water salinity, water temperature, suspended silt, water turbidity and underwater radiation. Operational depth and the related instruments are: Salinity-Temperature Meter (ST Meter), STD Meter, STRD Meter, Tide recorder, Ocean Current Meter, Trawl-Depth Meter, *in situ* Turbidity Meter, Remote Silt Meter etc.
6. Sixteen Channel Environmental Data Acquisition System was designed for validation of coastal resources with satellite imagery and operated by Orissa Remote Sensing Application Center, (ORSAC), Bhubaneswar.
7. Ship-Borne Data Logger was designed as a composite unit with 10 sensors for integrated measurements of the marine environment operated by Dept. of Physical Oceanography, CUSAT, Cochin.
8. CTD Recorder was designed for the specific studies and evaluation of impact of tide into the coastal land, in terms of the consequent micro-level water table variations and salinity intrusion in ground water. The system with automatic data recording facility was operated by Centre for Earth Sciences Studies, Trivandrum, concerned with EIA and Coastal Zone Management.
9. Coastal Ocean Dynamics Monitor with 10 channel data on waves and oscillatory water current was designed for deployment at ocean floor for gathering information relevant to underwater oscillatory water mobility related to 'Chakara' phenomenon and the system was operated by



- NPOL and Marine Geology Department of CUSAT, Cochin under a DST sponsored scheme.
10. Coastal Oceanographic Data Acquisition System consisting of 16 nos. sensors of underwater and meteorological parameters was designed for investigations connected with coastal erosion and coastal management studies and was installed and operated by CESS, Trivandrum.
 11. Ten nos. of Tide Salinity Conductivity Temperature Systems were designed and installed for acquiring data on those parameters continuously and with permanent installations along the ten locations in coastal areas between Alleppey and Munambam, in order to evaluate the total water mobility, quality and related water quality changes, by RC of National Institute of Oceanography, Cochin.
 12. An automatic fresh water pumping system was designed, consisting of water salinity and water temperature measurement system attached with automatic operation of a pump and was operated by CPCRI, Kasaragod for pumping water automatically when conductivity goes below certain selected value.
 13. FORV Sagar Sampada of Department of Ocean Development was installed with a continuous surface salinity and temperature system and incorporated with the main data acquisition system and computer.
 14. Thermocline Temperature Chain System was designed for acquisition of temperature data from five depths over a range of 150 m depth of the thermocline region with facility for continuous acquisition of data directly in PC along with graphical tabular presentation of the five points. The equipment is being used by Regional Centre of National Institute of Oceanography, Visakhapatnam in connection with correlation of the ground truth data with that obtained through satellite remote sensing.
 15. Environmental Data Acquisition System, consisting of 30 sensors including those for marine water quality was designed for School of Environmental Sciences, M.G. University, Kottayam, and operated for various EIA project studies.
 16. Trolley Dynamics Monitoring System was designed for continuous connectivity to computer along with digital LCD display on the important dynamic parameters, namely trolley speed, towing load the model ship, heave and tilt of the model ship etc.
 17. Portable Environmental Data Acquisition System including facilities to measure salinity, turbidity, temperature etc along with other environmental parameters was designed for NITK, Suratkal for studies on the EIA on water quality, in rivers and open water bodies and operated by them.
 18. The under water sensors and associated electronic instruments developed for monitoring the hydro-dynamic and functional parameters of the under water trawl system have enabled to observe the under water and thus evaluate its performance for achieving optimum design features.
 19. The operational parameters of under water trawl system, namely operational depth (trawl depth), under water line tension, angle of attack, tilt and fore and aft tilt of otter boards, water flow inside the net, mesh shape, warp load, bollard pull, towing speed and other related fishery oceanographic parameters viz. salinity at trawl depth, temperature at trawl depth, illumination at trawl depth etc were implemented partially in many of the fishery technological institutes such as Central Institute of Fisheries Education, Mumbai, Fisheries College, Tuticorin, Fisheries College, Mangalore, Ashok Leyland (Marine engine manufacturers), CIFT, Cochin and Faculty of Fishery Science, West Bengal University of Animal and Fishery Sciences, Kolkata. The development of sensors with under water wire telemetering facility led to the formation of multi channel systems, such as Fishing Log with seven

sensors giving data on trawl performance, associated marine environmental parameters and Universal Marine Telemeter with 15 sensor giving data continuously during experimental trawling.

20. Multi-channel freezer Temperature Recorders were designed for large cold storages with sensors up to 16 nos., for centralized monitoring of large and different locations, using long cables, with automatic operation and recorded with real time. These equipment with sensors up to 16 nos., have been installed in more than 20 processing plants in Kerala and Gujarat.

21. Behavior studies of marine animals could be done more effectively using Fish Activity Recorder, Oyster Activity Recorder, Barnacle Cirri Counter and Prawn Stimulation sensor, and some of them are being used by Zoology Department of Punjab University and Vikram University and also research students of CMFRI and CUSAT at different occasions.

Agricultural sciences including, agro climatology, seasonal plant diseases, ecology, agronomy, water resources and management, water technology, soil and water conservation engineering, influence of environment on architectural structures etc.

A. Large and individual portable systems were designed to meet the nature and requirements of different user agencies, incorporating the required sensors and the operational facilities. A few new sensors were developed and many were altered to meet the location specific needs. A few novel signal processing techniques were incorporated for gathering additional data for better interpretation.

Automatic Weather Stations of different models having 7 to 18 nos., were implemented in many Departments, as mentioned below, with different combinations and numbers of sensors and also with computer memory module connectivity, for evaluating the influence of meteorological and environmental parameters on plant diseases and plant growth. All the systems mentioned here have

automatic operation with data processing in computer. Some of the Centers where these were implemented are:

1. Agricultural Meterology Department, Tamil Nadu Agricultural University, Coimbatore (Seven units).
 2. Agricultural Research Station, Kumarakom, Kerala Agricultural University, with 16 nos. sensors.
 3. Forest Genetics and Tree Breeding Institute, Coimbatore.
 4. Agricultural Meterology Department, Hissar, Agricultural University, Hissar with 16 sensors/parameters.
 5. CWRDM, Kozhikode with an Agro-climatological Station with Seven sensors.
 6. Wonderla Holidays, Bangalore, with 10 sensors and automatic operation attached with computer interface, for evaluating the suitability of the area for the amusement activities.
 7. Water Technology Centre, TNAU, Coimbatore installed with Eight sensor system for correlating the data with water resources.
 8. Regional Centre of TNAU, Kovilpatty installed with a Eight channel system for acquiring agro-climatological data in relation to the experiments.
 9. Tata Thermal Power Station, Mumbai installed *One system for related investigations.*
 10. Envirotek Pvt. Ltd., Chennai in connection with factory environment.
 11. VSSC, Trivandrum for measuring the vertical temperature using the tall tower, with Six nos. temperature sensors mounted on it.
 12. PMCTW, Thanjavur with 12 nos. sensors, connected with energy conversion studies with solar panels.
- B. Hydro-meteorological Data Acquisition Systems were developed by incorporating other related data from nearby and related water resource, soil, plants etc. in order to make integrated



studies, along with the meteorological parameters. Such systems with different location specific designs were implemented, selecting sensors up to 28 nos. as stated below:

1. Orissa Remote Sensing Applications Centre, with 12 parameters for acquiring data on coastal area for comparing the remote sensed data with ground truth data.
2. Water Management Centre of National Institute of Technology, Srinagar with 36 nos. sensors/parameters for acquiring data from large surrounded area.
3. ERRC, Trivandrum with 12 nos. sensors and computer connectivity for environmental impact studies.

C. Aquacultural studies connected with environmental and water resources and quality data were carried out after incorporating the sensors, matching to the studies, namely: water salinity, water temperature, water resources, underwater radiation, water flow through the feeder channel etc., along with other air parameters, as mentioned below:

1. CARI, Port Blair was installed with a system having 12 parameter and operated by the Fisheries section.
2. Zoology Department, Shripushpam College, Erode was installed with a similar system.

D. Architectural Evaluation Systems:

The technology was spread over to other areas of architectural and structural engineering, where information are needed from open environment connected with the performance of architectural structures. Systems were designed and installed with sensors up to 36 nos. collecting data on the comfort parameters, physical performance including shock and vibrations etc. Some of such cases are:

1. Architectural Engineering Department, TKM Engineering. College, Kollam with 28 sensors and computer connectivity.
2. Architectural Engineering Department, PMCT,

Thanjavur.

3. Architectural Engineering Department, Tyagaraja College of Engineering, Madurai with 16 nos. sensors and computer connectivity.

E. Green House Studies could be made, incorporating the sensors inside and out side of green house, and operated. The technology was further extended for monitoring complex agricultural climatological phenomenon related to plant growth and weather parameters. The equipment installed at Water Management Centre at Kerala Agricultural University, Vellanikkara consists of 26 sensors for gathering information from four green houses located at one area and data fed to memory module with computer connectivity.

F. Bio- Gas System Monitor:

The technology was further expanded to serve bio-gas energy systems by providing the basic information on its internal and external operational parameters. The equipment designed and installed at the Kayamkulam for Department of Physics, Kerala University has 10 channel data with computer connectivity.

G. Soil moisture-plant growth related measurements:

Multi-channel type soil moisture meters were designed and implemented in many places. The equipment used by Rubber Research Institute of India, Kottayam has 30 sensors and is suitable for fast measurements of soil moisture with added advantages of undisturbed measurements and from deeper locations, continuously for years.

H. Water conservation characteristics of coconut pith were studied by Soil and Water Conservation Engineering Centre of Kerala Agricultural University at Konni, using one system attached with 54 sensors, spread over a large area, and using a single portable meter.



I. Soil moisture studies related to horticulture practices.

Equipment was designed with nine sensors for measurements of soil moisture from nine points, connected with horticulture related studies by Horticulture College, Kerala Agricultural University, Vellanikkara.

J. Solar radiation studies related to plant growth:

The Solar Radiation Measurement Systems designed for RRII, Kottayam and installed at Kottayam, Nasik and Assam has a novel type sensor with five sensors connected in a series, to acquire the average value at the shades of plants, rather than estimating the same by laborious and highly erroneous process. Further, the long term integration facility of the system attached with both incoming radiation and the average values at the shades of plants, enable to correlate the data more quantitatively related to many plant growth studies. Another similar system is at Regional Agricultural Research Centre, KAU, Pilicode.

K. Solar radiation related to energy tapping devices:

The solar energy conversion systems can be studied more systematically accounting the incident energy, as done by Physics Department, St. Thomas College, Palai.

L. Soil temperature-related studies:

Different designs of soil thermometers were made and introduced with many added facilities, viz. Multi channel measurements from several distant points up to 500 m simultaneously, continuous undisturbed, un-modified measurements, long term measurements from deeper depths and attached with memory module. This led to many novel field investigations. Some cases of applications are:

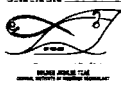
- i. Studies on turtle egg hatching in relation to temperature was carried out by Forest and Wild Life Centre of Orissa using Soil Thermometer with 27 sensors simultaneously distributed in the soil pits in sea beach and measurements

made simultaneously from distant points. Another similar system with 16 sensors was installed at Point Kalimore, Tamil Nadu by Zoology Department, Shripushpam College, Erode.

- ii. Temperature inside compost processing pit was studied by Kerala Forest Research Institute, Peechi using one equipment with 10 nos. soil temperature sensors attached to it. The equipment was subsequently modified with 100 cm long sensors with the sensing head at its tip and with facility for piercing into the measurement points and was used by the Horticulture College, KAU, Vellanikkara.

Integrated measurements for holistic studies and applications could be carried out using the equipment capable of making automatic operation at remote sites. Some cases are given below:

- i. The Environmental Data Acquisition System used by School of Environmental Studies, MG University, Kottayam was incorporated with 30 sensors for measurements from soil, water, plants and air with facility for long term continuous measurements useful for numerous EIA investigations, connected with the parameters of soil, air, water, plants etc.
- ii. Six nos. of integrated Water Level-Rain fall-Silt Recorder were designed for CRIDA, Hyderabad and installed at remote catchment sites for integrated studies and related with rain fall-water level rise-water discharge suspended silt caused by erosion. Other related instrument used simultaneously was Water Level Detectors.
- iii. Running Display of weather data were displayed at the gate of SPIC, Tuticorin gathering data simultaneously from weather related instruments. Data was exhibited for the attention of the public. Similar type installation was done at Kovilpatti Regional Centre, of TNAU. These large running displays are meant to warn the public on alarming weather data.



- iv. Efficiency of solar energy tapping system was studied using the Solar Radiation Monitor used by Physics Department, St. Thomas College, Palai and M/s. Veega Land/Wonderland Holidays, Bangalore with systems attached with 23 sensors and data acquired from distant points, for centralized monitoring.
- v. Water current measurements with novel techniques of contact-less electro-inductive pickup and signal processing for average values, made the measurements easy and more useful. Further, the improvements for automatic stabilization under water made it free from cosine angle error. Automatic versions also were introduced. These were installed and operated at many places, including: The multi channel water current system installed in Hydraulic Engineering Lab of Engineering College, Trivandrum, Marine Survey Wing of GSI, Energy Management Centre, Trivandrum, CWRDM, Calicut etc.
- vi. Flow and Discharge Monitor with its sensors employing a novel and rugged method of hydrodynamic tilting lever attached with contact-less electro-inductive pick up, made it rugged for all types of waters in large pipelines. Several such units capable of making bulk flow rate and total discharge were installed in the large pipelines of Kerala Water Authority at Calicut, Kannur, Thalassery, Karnataka Water Supply Corporation and Gujarat Electricity Board.
- vii. New design of Water Detector having facility to detect both surface and bottom made the ground water survey easier and faster. Many such instruments were used by Research Centers of CRIDA, Hyderabad, CSWCRTI, Ooty, Water Technology Centre, TNAU etc.
- viii. Automatic grain size analysis made easier and more scientific based on the principle of hydraulic equivalent sedimentation process, where the total analysis is done automatically without requiring manual and laborious sieving and consequent errors.

Equipment based on the method was installed at Ganga Development Authority, Varanasi for evaluation of the sediment characteristics of the area and School of Marine Sciences, CUSAT, Cochin for analysis of marine sedimentation processes.

Testing, calibration and certification

The instruments were tested and calibrated wherever facilities are available, in the country, as detail below:

- A. India Meteorological Department, Pune for weather related instruments.
- B. Central Water and Power Research Institute, Pune for hydraulic instruments.
- C. Indian Institute of Technology (Ocean Engineering Centre), Chennai for hydraulic and other water related instruments.
- D. Sophisticated Test and Instrumentation Centre, Cochin University of Science and Technology, Cochin.

Inter-institutional and multi-disciplinary collaboration achieved

The developments started in CIFT originally concerned with fish technological investigations, expanded to fish processing technology and subsequently to many related activities of marine sciences namely coastal engineering, ship instrumentation, fisheries hydrography, behavior studies of marine animals etc. The association of the author with scientists of ICAR institutes, enabled him to visualize the vast scope and potential in agriculture - energy based activities. The ICAR ad-hoc project sanctioned to CIFT, further helped to make detailed evaluation and expansion of the technology to many other related fields. The commercialization of the technologies through NRDC of India accelerated the expansion process, as well as improvements over the basic systems. Over the last more than 20 years after commercialization, all the aspects including the



sensors, electronics etc. were improved and expanded for more applications, as stated in the implementations made through out the country. The national training courses conducted with the support of ICAR and Department of Electronics, Government of India enabled more interactions with many experts in wide areas of activities connected with natural sciences, and also got opportunities to expose and evaluate the systems in different agro-climatic zones.

At present the technology have been implemented in more than 180 Departments, mostly through the commercialized agencies. The instruments are being used to observe the nature along with its associated systems and is applicable to such agencies who want information from nature. The different disciplines where the technology was implemented are: Agro-climatology and Agro-meteorology, Agronomy, Agricultural Engineering, Horticulture, Soil and water conservation engineering, Dam safety, Erosion and sedimentation, Energy and environment, Supplementing additional ground truth data base to GIS studies on natural resources for better analysis and forecasting, Coastal hydrographic survey, Forest ecology, Water resources engineering and water management, Environmental impact assessment applicable to marine and inshore issues, Fish technology, Fish processing technology, Behavior of marine animals to simulated environment, Fisheries oceanography/hydrography, Ship instrumentation, Ocean Technology, Coastal engineering and Coastal zone management.

The major contributions / achievements

1. Sensors developed with innovative as well as improved designs are found to be more apt and useful for conducting related field operated investigations.
2. The developments led to the acquisition of many additional information useful for better analysis of the field systems.
3. The technology consisting of more than five dozens of sensors and instruments, were demonstrated to the experts, through nine national training courses of six to 21 days duration and other national special events to establish the authenticity of the techniques.
4. The technology was commercialized through the approved procedure of ICAR and NRDC of India very successfully, as it is complete in all respects and indigenous.
5. The technology is applicable to a wide range of applied subjects coming under the mainstream activities of the country in general and ICAR in particular.
6. The effort and expenditure invested for this activity is negligibly small.
7. The success of this development is attributed to the sharing of the technological knowledge among the Departments.
8. The sensors and instruments were tested and calibrated at the available centers.
9. The academic aspect of the technology has become the curriculum of SNOM-Navy and CUSAT, Cochin.

Some early research in fisheries extension at CIFT

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Extension work has been an integral part of the Central Institute of Fisheries Technology right from its inception. The liaison of the Institute with the fishing and fish processing industries has been very strong from the very beginning of the Institute, and the result is before us for all to see. The industry connected with fisheries has shown a remarkable development all over the country and particularly in the coastal areas; and in this, CIFT has played a very important role. Fortunately, this role has been documented and this paper is focused on the same.

In one study (Balasubramaniam and Kaul, 1984 a) the adoption of nine innovations developed for mechanized fish trawlers was examined from trawler owners in Cochin area of Kerala. Awareness regarding the innovations was fairly good except for the use of recommended painting schedule, use of appropriate engine horse-power, use of electronic instruments, use of tickler chain, and use of anodes for protection from corrosion. The extent of awareness was rather closely followed by the extent of adoption. Higher adopters tended to spend more time in fishing, had costlier engines installed on the boat, and spend more on painting the boat.

One of the very important innovations developed by CIFT is the CIFT fishing boat designs. In one study, 12 such standard designs were examined for their adoption by 54 boat building yards (Nair, Kaul and Kandoran, 1987). It was found that 88% of the boats

were based on CIFT designs with or without modifications. Modifications were made to suit local conditions in some of the cases. Ninety one percent of the boat building yards have adopted CIFT designs.

Regarding traditional fishermen of Kerala, it was found that all the 80 fishermen respondents were aware of the use of cheaper wood materials for building fishing crafts, use of ice on-board the vessel, and use of synthetic net materials (Balasubramaniam and Kaul, 1985). About 69% of the fishermen were aware of the engines for craft propulsion, but none were aware about the use of chemical wood preservatives. As regards adoption, all the fishermen involved in the study were using synthetic net materials. About 49% were using engines for propulsion, and 5% were using cheaper wood materials for building fishing boats. Chemical wood preservatives and the use of ice on board the vessel, were not being used by any one.

One paper reports the results of a trial of an improved design of lobster trap by 45 lobster fishermen (Kaul and Kandoran, 1987). On an average, roughly one-fourth of the existing total number of traps were replaced by improved traps as a trial. It was found that cost of local trap, seasons of use of improved trap, and annual catch by indigenous trap, influenced the extent of trial.

The CIFT has issued a number of important recommendations meant for adoption by fish curers.

Balasubramaniam and Kaul (1982) found that in Calicut district of Kerala, all curers of small curing centres used quality fishes for curing whereas only about 18% curers of large centres used quality fishes for curing, due to the increased time lag between catching and curing at the large curing centres. Fifty percent respondents of large curing centres had used good potable water from hand pipes in their sheds and in the small curing centres none had provision for water supply in their curing sheds. In both the centres, no respondent had adopted the use of disinfectants and detergents for washing and cleaning operations to reduce the microbial contamination. Instead of processing tables, 8.9% respondents of the small curing centres had used clean cemented floor for dressing and salting. A majority of the curers has used the open ground for removing the viscera and uncleaned floor for salting the fishes. Of the large curing centres, 25% curers and 27.8% curers of the small curing centres were keeping the floor, salting tanks and accessories clean by frequent washing with water. Regarding salt to fish ratio, 60.7% of the respondents at the large centres and 75.9% of the respondents at the small centres had adopted the recommended ratio of 1:5 for the small and medium varieties of fish and 1:4 for larger fish varieties. Chemical preservatives to enhance to storage life of the cured products had not been adopted by the curers. Similarly, improved packing materials were not used for packing and all the curers were found to use cheap coconut leaf mats for packing cured products.

In one analysis it was revealed that total investment, experience in fish curing, distance of curing yard from the house, and size of the curing yard could discriminate effectively between adoption and non-adoption of four improved fish curing practices (Balasubramaniam and Kaul, 1984b). A scalogram analysis of the adoption of eight improved fish curing practices showed uni-dimensionality and this was also confirmed using chi-square values (Kaul and Balasubramaniam, 1985).

In a study on the effect of mass media on the adoption of fish curing, it was found that radio and

newspapers as mass media were very important for the adoption of improved fish curing practices (Nair, Kaul and Balasubramaniam, 1985). However, although the effect of newspaper subscription was very clear, the effect of radio ownership seemed to be masked by newspaper subscription. There was no interaction between the two factors. These results point tentatively to a difference between the contents of the messages available in these two types of mass media.

Another report on fish curing during this period showed that about 22% of the variance in adoption of fish curing was accounted for by total investment in the curing yard, alone (Kaul and Balasubramaniam, 1985). The greater the investment, higher was the adoption index. In lower investments, fish curing would be likely to be taken as a way of life rather than as an economic enterprise (Firth, 1946). Total investment was also positively related to the capacity of the curing tanks and size of the curing yard. Also, the total investment on the curing yard and not total income was related to adoption. The higher investors tended to live further away from their curing yards.

Kaul, Thiagarajan and Balasubramaniam (1987) reported that 95% of the respondent fishermen wanted to get trained. The training needs were fairly strong in all subject areas, with the highest demand being for fishery engineering.

A study of the adoption of recommended quality control practices by fish processing factories revealed that the percentage of adoption of 55 recommended practices ranged from 21.43 to 100 (Kaul, Krishna Iyer and Kandoran, 1989). The average adoption index was 84.48. The rate of rejection or reprocessing at the factory itself was positively correlated to the quantity of water used per tone of processed material.

Research workers in fisheries extension may also be interested in some other work which was completed during that period. In a study of attitude change among undergraduates it was found that attitude towards extension education did not show



significant overall change after a course on extension education and communication (Kaul and Balasubramaniam, 1987).

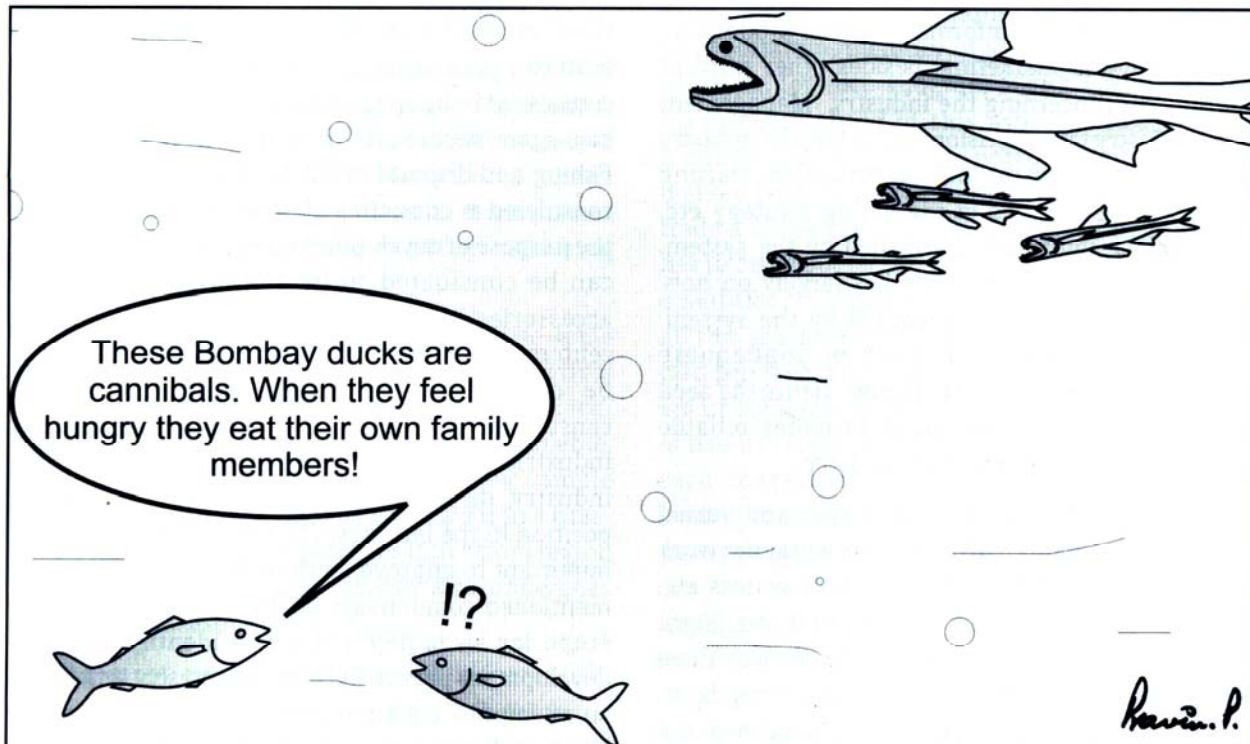
Several studies were modified and further refined the methodology of evaluation of Summer Institutes (Desai and Kaul, 1981; Desai and Kaul, 1982; Desai, Kaul and Prabhu, 1983; Krishna Iyer and Kaul, 1986). A system was developed which could act as the basis for a mathematical theory of extension education (Kaul, 1984; Kaul and Thomas, 1987). A system was developed for measuring training effort with the help of simultaneous changes in the relevant skills and attitudes (Kaul and Nair, 1989). Improvement was suggested in the methodology for sensory evaluation of fish quality (Kaul and Nair, 1984). Information-seeking behavior of various types of fishermen and fish processors revealed the relative importance of various subject-matter areas (Kaul and Thomas, 1983).

It is hoped that this overview will stimulate thinking and make future research in fisheries extension more relevant to the needs of fishermen, fish processors and exporters.

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Survey and statistics for the development of fisheries

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Every industry develops its own statistical system incorporating information on its production, distribution and marketing, besides other relevant information concerning the industry. Management of the industry takes decisions regarding the industry in respect of its expansion, diversification, starting of new units, changes in marketing strategy etc. based on the information provided by the system. The validity of such decisions lies largely on how reliable are the statistics provided by the system. Decisions based on incorrect or inadequate information usually end up in failure. Hence the need for a statistical system which provides reliable information pertaining to the industry.

Fisheries in our country is a vast and varied industry. Over 7000 km of coast-line, a vast net work of rivers, streams, reservoirs brackish waters etc. provide fishing area for the industry to thrive. Eight million fishermen, making use of more than three lakh boats of different types and sizes, bring in an annual catch of over six million tons to cater to the needs of fish-eating population of the country, besides earning foreign exchange to the tune of Rs. 7000 crores every year through the export of fishery products. These figures reveal how vast the industry is, which spans the length and breadth of the country. Obviously an industry of this magnitude deserves sound statistical base. This base will be highly necessary when contemplating development programs for the industry.

The Industry can be considered to be made up of three main sectors (viz.) marine fisheries, inland fisheries and aquaculture. Each sector can be considered to be special in its own way. Each sector can again be broadly divided into two parts viz. fishing and disposal of catch. Each of these can be considered as consisting of different components for the purpose of development programs. Thus, fishing can be considered to be comprising of fishing accessories like fishing boats, nets, fish landing centers, fisheries harbours etc. Disposal of catch can be considered as related to its marketing, consumption, providing it as raw material for other industries etc. Because of its importance to the industry, disposal of catch occupies a significant position in the industry. The first part viz. fishing is important to improve on the catch itself. The above mentioned components of the industry offer wide scope for an in-depth study to identify areas for development in each of them. The present write-up is an attempt to initiate thinking on the subject of the above lines.

Some important aspects regarding fish as food item, and fisheries as an industry need to be considered in this context. Fish is a highly perishable food item. Its freshness does not last for more than a couple of hours after it is caught. Its acceptability can be extended for 2-3 days by putting it in ice. If it has to be kept for longer periods, either it has to be frozen, or canned or sun-dried after due



processing of the material. Another note-worthy feature of fish is its location-season specific nature. Not all the varieties of fish are available throughout the country, as also same variety of fish at the same place throughout the year. For instance, availability of Bombay duck is confined to the states of Maharashtra and Gujarat, while sardine is available in Kerala and Karnataka coasts only after the South West Monsoon. Variation of cost of one variety of fish to another is also an important factor concerning the industry. Some varieties are highly expensive and cater to the needs of affluent class, while some other varieties are cheap and relished mostly by low income group. Thus seer fish and pomfrets are expensive while sardine and anchovilla are the cheaper varieties. Another important, feature of the industry is its inter-linked nature. For instance, fresh fish markets of major cities receive supplies from even far-flung areas. Thus, if the supplying centre is affected in any way, its impact can be felt at far-off places also, irrespective of the distance. Similarly freezing plants receive raw material from distant places and dry fish is supplied to distant marketing centres.

At this stage, it is pertinent to enumerate some of the areas of the industry where statistical information will benefit the industry. As such, information on certain areas is already available. Where lacking, it has to be obtained by sample surveys. Such surveys need be carried out in a time-region framework as the practices differ from region to region, and availability of fish also undergoes change from season to season.

The most important point of information concerning the industry is the total fish catch. It serves as a measuring yard for the industry as any development program should reflect in the total fish catch. In fact, India is one of top ranking nations in the world in terms of total fish catch. This figure for marine sector is available with all relevant details with the Central Marine Fisheries Research Institute, Kochi for the last over five decades. This Institute publishes fish catch statistics variety-wise and state-wise for each year. For inland sector, no such

statistics are available. Each state Fisheries Department collects and publishes statistics for the respective state. As the procedure for collection of information is not uniform, the figures published by different states cannot be compared. A sort of stream-lining of the procedure is necessary to compare and pool the information. This essentially, is the first step in this respect. Regarding catch from aquaculture, no information appears to be available. Steps are necessary to cover this gap.

Soon after landing, considerable quantities of fish are marketed at the place of landing or at the nearest retail centre. If fish are to be transported from the landing centre to other retail centres, ice has to be used to maintain the acceptability of the fish at the receiving centre. Depending on the distance of transportation, quantity of ice ranging from 0.5 kg to 3.0 kg. for each kilogram of fish has to be used. An in-depth study of this aspect is necessary to identify the major transporting centres, major market centres and the practices involved in this trade and the varieties of fish covered by this. This has to bring out facts relating to icing, as inadequate quantities of ice can result in poor quality of the fish at the marketing centre. Further, where long distance transportation is concerned (say over 1000 km or so) larger quantities of ice, up to 3 kg per kg of fish has to be used. This results in more space in each container being occupied by ice than fish, leading to excess overhead expenses. In such cases, transportation of frozen fish (instead of iced fish) can be considered. Though initial costs in freezing are higher than in icing, as the container can hold much higher quantity of fish in frozen condition, for long distance transportation frozen fish may prove more economical. Industry can be advised accordingly after working out the comparative economics.

Similar to fresh fish, considerable quantities of dried fish are also traded. In-depth study in this area is also called for to identify the major trading centres, quantities, varieties and practices involved in this trade. The sun-dried fish are concerning mostly low-cost fish and cater to the needs of low-income group.



Improvements in this area by popularizing more scientific drying methods will benefit the people at both ends of the trading line.

Fishery products are exported from our country to other countries. They earn handsome foreign exchange for our country. Details regarding the quantities of different types of products exported, countries to which exported and earnings thereof are all collected and maintained by the Marine Products Exports Development Authority (located at Kochi). A study of these figures over a period, enables us to decide whether any change in market strategy is called for. A number of fisheries harbours have been constructed along the coast-line. Fisheries harbour gives boost to fishing activity in the area, as all the infrastructure facilities necessary to carry out the fishing operations and disposal of catch will be available at the fisheries harbour. A survey of these harbours will reveal the utilization of existing facilities, additional facilities required and throws light on where further harbours will benefit the industry.

A considerable quantity of fish wastes emerge in fish processing. These include prawn shells, guts, intestines of fish etc. At present, they are not profitably utilized. Mostly the material is used only as manure for coconut trees. Technologies have been developed to prepare industrial products out of these wastes, thus making better use of them. Surveys to find out the quantities and places of availability of these, will be helpful to make use of the technologies and produce products of better utility.

In recent times, aquaculture has made rapid strides. In fact, most of the material required by fish freezing industry comes from aquaculture. However, indiscriminate aquaculture leads to severe environmental problems. Information on water-bodies suitable for aquaculture with particulars of extent of the area, location etc. together with the

necessary technical advice, will be a big boost for fisheries in general and aquaculture in particular.

Ice is an important item to maintain the acceptability of fish as a food item. At present, it is used according to the availability rather than according to the requirement. Inadequate icing of fish can result spoilage of the item and create health problems for the consumer. A survey regarding the practices adopted in icing and its availability at the required centre will help in stream-lining the supply of ice to the industry.

Fishery products are subject to quality inspection at the exporting point and also in the imported countries. Rejections of the product take place at either end on some grounds or other. A study of the grounds of rejections can help improve the quality of the product and reduce, if not altogether avoid, rejections.

Last, but not the least, is the opinion survey among the fishermen who conduct fishing operations. The survey can be as to how they make use of existing facilities and their further requirements to conduct their operations more efficiently.

A few of the areas where survey and statistics will be helpful to develop the fishing industry are enumerated here. However, the list is not exhaustive. There are other areas in the industry, where in-depth study will identify gaps to be covered. A full fledged authority (on the lines of Bureau of Commercial Fisheries of United States) to keep continuous contact with all aspects of the industry will be helpful in the development of the industry. This is particularly necessary, as there is wide scope for the development of fishing industry in our country. Such an authority will popularize research results of the Fisheries Research Institutes and will be an indispensable technical adviser for the fishery industry in all respects.

Aquaculture development in Manipur through utilization of the wetlands

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Situated at the eastern threshold of the country, the state of Manipur is the fourth biggest state among the 'Seven Sisters'. It literally means "The Land of Jewels". It is a state having only about 20% of its land area in valley with peaks rising about 3000 m above msl. Average altitude of valley areas is about 775 m. Climate of the valley is tropical to semi-temperate and the hills have a semi-temperate to temperate outfit. The state has distinct winter, summer and monsoon seasons. Normally, the maximum air temperature goes upto 36 degree Celsius and minimum at 1 degree Celsius. Rainfall is bountiful, average being 200 cm with heavy precipitation during June and July. The central plain of Manipur valley, being the flood plains of Imphal/Manipur rivers and its tributaries, has thick deposit of sand, clay and slit. Most of the valley soils are grey colored and are under hydromorphic conditions. Such conditions increases with the nearness to the lake. Permeability is low and on drying, the soil turns yellowish due to oxidation. Soils of Manipur hills are associated with reddish loam. They appear to belong to red, yellow and lateritic groups. The foothills in few areas are covered with gravel and sand but are loamy at most of the places.

Utilization of wetlands for aquaculture in Manipur

Most of the wetlands in Manipur are formed as a result of accumulation of water in the low-lying areas. They are infested with various types of aquatic vegetation and the depth is becoming lesser and lesser as a result of silt deposition. In the neglected

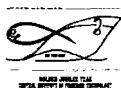
water areas several tanks and ponds are gradually choked with the weeds and aquatic vegetation, virtually converting them into swamps. The wetlands face problems with a continuous deterioration of these resources. A major cause of this problem is unsustainable utilization of the wetlands by their main users i.e. local fishermen. Of the total wetland area of 950 sq km of Manipur, the Loktak lake contributes 289 sq km. The Loktak lake has a large catchment area of 5,96,000 ha. The water spread area of the lake is 289 sq km at the maximum water level during monsoon months. On the periphery of the lake, properly planned fish seed farms and grow out farms can be established.

Development of wetland resources for aquaculture: Enhancement of the wetlands

Enhancement in the form of development of culture based fisheries, habitat improvement, fertilization, feeding and elimination of predators or competitors need to be done to improve the present level of fish production. This requires little input and often provides high returns to input of labour and capital. Enhancement need to play a role in not only generating food, income and wider benefits from under utilized degraded resources, but also conserving the aquatic diversity.

Development of cage and pen culture

Fixed cage culture may be taken up by the fisherman community of Loktak lake. The size of the cage to be provided may be either 4 m x 2 m x 2 m



Details of Swamps, Beels and lakes in Manipur

Sl. No.	Name	Area (in hectares)
1.	Awangsoi	123
2.	Biraharikom	40
3.	Dolaithabipat	100
4.	Godapat	38
5.	Haosabalthingel	500
6.	Hasoi	13
7.	Haotok	100
8.	Ikoppat	3500
9.	Keinou Awangsoi	125
10.	Kharungpat	2500
11.	Khullakpat	300
12.	Khoupum	300
13.	Kokpat	100
14.	Laijikolu	14
15.	Laikotpat	71
16.	Laphupat	50
17.	Leimakom	25
18.	Leishembipat	29
19.	Liklai Karong & Khullakpat	33
20.	Loktak	10400
21.	Loushipat	50

22.	Meichakpi Konjeigosi of Narengsoi	95
23.	Mutum Yangbipat	14
24.	Ngakrapat	66
25.	Manungkom	60
26.	Phigeipat	75
27.	Pukhrambampat	10
28.	Pumlempat	3500
29.	Sanapat	82
30.	Takmu	500
31.	Teknapat	25
32.	Thoibi & Phumthapat	20
33.	Tharopat	125
34.	Thiyampat	5
35.	Ungamlen	450
36.	Ushoipokpi	65
37.	Utrapat	41
38.	Waithu & Phumlem	2700
39.	Yeinapat	120
40.	Chaitel Nongyaikhong	360
41.	Anoubakhong	60
42.	Lamjaokhong	200
43.	Ninthibakhong	200
44.	Suptokhong	60
Total		26956

Source : Fishery Department, Manipur (1996)

or 5 m x 5 m x 2 m which can be locally fabricated or tailored with the readily available nylon net. The fishes to be cultured may be either air-breathing fishes like *Channa* spp., *Anabas testudineus*, *Clarius batrachus* and *Heteropneustes tassilis* or carps like *Cyprinus carpio* and *Ctenopharyngodon idella* which are well adapted in the lake water itself. Fingerling of the size 8 to 13 cm may be stocked at the rate of 200 to 400 numbers per cage.

Establishment of fish seed farms and grow out farms

The wet resources have large extent of catchment area around the periphery. This peripheral area can

be very well utilized for the establishment of fish seed farms and grow out ponds. A target production of 5 to 6 ton can easily be achieved by following the Hi-tech system of carp culture followed in Andhra Pradesh. The grow-out ponds are to be stocked with 5,000 to 6,000 stunted year-lings per hectare.

Culture of air-breathing fishes

By virtue of their hardy nature and air-breathing habit, air-breathing fishes are excellent species for utilization of swampy and shallow derelict waters.

Some air-breathing fishes inhabiting Loktak lake which are fit for culture includes *Anabas testudineus*,



Channa orientalis, *C. striatus*, *Clarius batrachus*, *Heteropneustes fossilis*, *Monopterus albus* and *Notopterus notopterus*. Although these form a natural capture fishery in the lake, their production is very low due to the lack of proper management programmes. Their intensive culture may, therefore, be taken up using cage culture and pen culture techniques in the peripheral areas of Loktak lake.

Development of shell fish and crustacean fisheries

Apart from fishes, some of the aquatic mollusks and crustaceans are also included among the fisheries of economic importance. In Loktak lake, edible mollusks which form the main capture fishery include *Angulayara oxytropis* (Tharoiningkohabi), *Bellamya crassa* (Labuktharoi-macha), *Cipangopaludina lecythis* (Labuktharoi-achouba), while that of crustaceans comprise *Macrobrachium hendersoni piatyrostris* and *M. lamarroides* which are locally called Khajing-macha. Since these are much liked by the consumers, their intensive culture should, therefore, be taken up along the selected peripheral areas of Loktak lake using pen culture or cage culture techniques for the mollusks and crustaceans.

The culture of these species can also be under taken either in polyculture system along with carps or alone in monoculture system.

Establishment of farms for local indigenous fishes

Some commercially important indigenous fish species like Ngaton - khabak (*Labeo angra*, *L. bat* and *L. dero*) and Pengba - Tharak (*Osteobrama belangeri*) are now on the verge of disappearance from Loktak lake. The indigenous fishes Pengba (*Osteobrama*

belangeri) and Ngaprum (*Monopterus albus*) are important in Manipur which fetch high price than carps and air-breathing fishes like Singhi and Magur. Of the two *Osteobrama belangeri* has been successfully bred by using Ovavid in Manipur. The culture techniques have to be developed on scientific lines and extend it to the private sector. Since this species is available in Loktak lake it indicates the suitability of the environment of the lake area. In order to propagate Pengba, small ponds may be constructed on the periphery of the Loktak lake for culturing this species.

Conclusion

The utilization of wetlands resources for aquaculture development in Manipur is a very delicate subject which needs utmost care. These wetlands are becoming increasingly important for conservationists and resource managers because of their ecological significance.

Some of the constraints limiting the enhanced fish production in the region are poor transfer of technology, lack of entrepreneurship and lack of good infrastructure facilities. Particularly communication is a major problem here. Suitable sites have to be selected keeping in view of the environmental and socio-economic conditions of the local people and the fisherman, because most of the wetlands are common property resources and used by the local communities for a variety of purposes, often leading to conflicts of interest among different wetland users. Considering all these, an integrated, holistic development approach taking into account all aspects of the wetland use, conservation and suitable development plan is needed.

On the parameterization of the uncertainty of environmental variability on fisheries resource management

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The complex productive marine ecosystems that have evolved over centuries are in the verge of collapse due to incessant expansion of human activities. The reproductive capacities of several stocks have eroded due to generally attributed reasons like overfishing, destructive fishing practices, pollution etc. The collapse of Pollock population of the Bering Sea and Gulf of Alaska and Peruvian anchoveta is now attributed to a decline in the zooplankton biomass, by several researchers. The disaster of Japanese sardine population and of cases elsewhere had been conventionally attributed by the fishery scientists to fishing activity as the most prominent cause. Amazing restoration of the stock had occurred with all these stocks which exhibited up and down pattern. An in-depth scrutiny of the landings reveals that marine populations throughout the world oceans exhibit this type of up and down variations. The pattern of variation follows the dome shaped population curve depicting a period of increased stock productivity and swift population growth succeeded by a stock decline. This roughly coincided with a decade period. It is also true that there are populations, which do not show this pattern also. Advances in oceanography coupled with observations of earth-orbiting satellites

pointing to regime shifts involving entire communities structures of large-scale ocean areas call for a revision in the currently practiced management measures which in general focused on biological factors. A deeper analysis of several factors especially physical factors like stratification of the ocean, oceanic circulation, upwelling, monsoon systems in the Indian ocean etc. is needed to throw light on decadal resource variability.

Stratified ocean

A brief perusal of factors affecting the productivity of the ocean reveals interesting information. The oceanic waters generally show stratified behaviour. The sunlight penetrates to a few tens of meters of depth. The photosynthesis takes place only at the surface layer of the ocean and the plants use nitrates, phosphates and other nutrients contained in it. The organic matter thus produced travels to the deeper layers of the ocean which upon ultimate decay release the nutrients, but at great depths.

As stratification of seawater remains considerably stable, the nutrients remain entrapped in the deeper waters, as the upward diffusion of nutrient molecules in a stratified water column is an

exceedingly slow process. This causes the surface layer of most of the oceanic water to remain as biological deserts. This is particularly so in the tropical waters which experience high actinic radiation so that upper layer become warm and practically non-productive. The impairment of biological productivity by the removal of nutrients from surface waters, as organic detritus getting locked in deeper sea is well documented. The changeover of the seasons especially in temperate waters and tidal mixing are the causative factors for the transport of nutrients from the subsurface nutrient pool to the photic zone. The situation gets altered in shallow waters of the sea and continental shelf areas where the organic matter gets transported only to the depths of those areas where re-mineralization and redissolution of the plant nutrients occur very close to or within the photic zone. This, in a great measure, accounts for the improved rates of primary organic production of the shallow seas.

Oceanic circulation

The oceanic circulation is driven by three external influences, viz., (i) wind stress (ii) heating and cooling, and (iii) evaporation and precipitation - all of which, in turn, are ultimately driven by radiation from the sun. Of the solar radiation [$W.m^{-2}$] received at the sea surface, 93% is absorbed by the sea. Winds drive ocean currents by releasing some of their momentum to the oceanic surface layer and the wind stress approximates to a quadratic function of wind speed. Squally winds create larger stresses than would a steady wind of the same average speed. Wind induced currents are among the strongest currents in the oceanic surface layer. Oceanic circulation ultimately results from certain balance of forces.

Fluid masses traveling large distances over the earth's surface follow curved trajectories rather than straight lines, as they do over short distances or in non-rotating reference frames. Ocean currents are expressed relative to the ocean floor which rotates with the earth. The circulation of the ocean surface currents, to a large extent is a reflection of the

circulation of the atmosphere which drives them. The apparent deflection of moving bodies from their expected straight line motion caused by the rotation of the observer's reference frame is termed Coriolis effect.

Coriolis force is proportional to the velocity of a moving object and also to Coriolis parameter. This is proportional to the sine value of the latitude. Coriolis force is directed perpendicular to the direction of the motion. In the Northern Hemisphere it is directed to the right of the motion, and in Southern Hemisphere it is directed to the left. To make the picture complete in relation to temporal and spatial considerations, it is necessary to consider geostrophic flow and Ekman transport. In the former, the pressure is balanced by the Coriolis force. The geostrophic flow near the sea surface tends to flow directly along topographic contours of level. Geostrophic flow is associated with pressure gradient while Ekman transport represents the movement of water near the sea surface in relation to direct action of the wind and is confined to a few tens of meters deep.

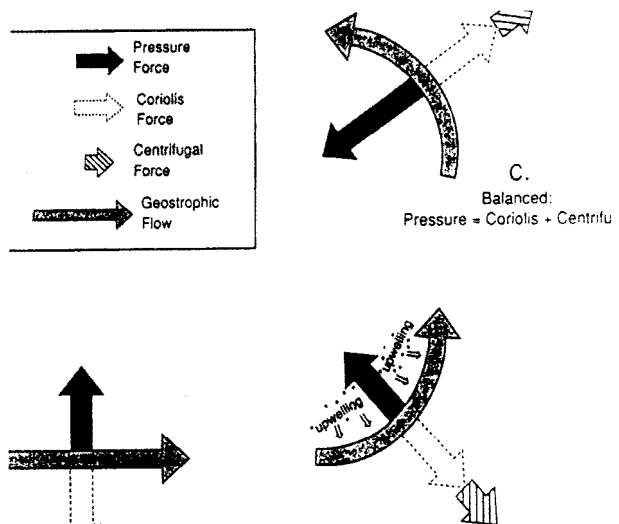


Fig. 1. Schematic representation of pressure force and Coriolis force showing the associated flow vectors in geostrophic current flow and wind-driven surface Ekman transport. Balance of forces and zones of upwelling and downwelling depending on direction of rotation are also shown.



The surface waters are driven by the wind, and each successive layer of water is dragged along by the layer above. Due to Coriolis deflection, the surface water flows to the right of the wind direction in the Northern Hemisphere, and each successive layer of water flows to the right of the layers above, in a pattern called the Ekman spiral. Divergence of surface waters cause upwelling of deeper waters, and convergence of surface waters cause downwelling.

The edge of a continent bordering an ocean basin, is usually considered to include the coast, continental shelf, continental slope, and continental rise. Upwelling occurs frequently along continental margins where winds drive surface currents out to sea and deeper waters surface to replace them. It also occurs in some places at sea where surface currents diverge; resulting in the rise of deeper waters to replace the departing surface waters.

Upwelling

Upwelling is quite pronounced in the equatorial regions where trade winds blow from the surface water from east to west in the tropics across the ocean. Areas of rich biological productivity occur under conditions of upwelling, particularly coastal upwelling and are quite marked in the equatorial regions. This occurs in the continental margins when wind drive off the surface currents to the ocean and the deeper waters take its place. The Ekman transport contributes to the upwelling and downwelling of coastal waters. The local topography of the coast and the continental shelf also influence the ocean currents favouring exchange of water from the depths to the surface. Unrelenting winds drive bulky offshore movement of ocean surface water with simultaneous reduction of fluid pressure below the surface causing fluids flowing from higher to lower pressure along surfaces of equal gravitational potential. Coastal upwelling regions include California Current region of the western United States and North-west of Mexico, the Canary Current region of North-western Africa, the Benguela Current system off South western Africa, the Peru Current system off Western South America, the southern part

of South-west coast of India, Somali Current, the northern boundary of the Gulf of Guinea off Ivory coast and Ghana and the region off South-eastern Brazil. In a generalized way, it may be stated that this occurs when a large-scale transport of surface waters occurs. Coastal upwelling areas are regions of exceptional biological activity turning them to good fishing grounds for shrimp, sardines, anchovies, mackerel and other fishes.

Besides the wind induced upwelling, shelf-break upwelling has been amply confirmed by satellite imagery, equatorial upwelling, wind stress curl, vortex driven effect, effects due to stationary thermocline and coastal run off contribute to the biological productivity. Of these, coastal run off with an estimated 38,000 km³ fresh water runoff carrying with it nutrients that range from traces to several orders of magnitude make the ocean areas off the mouth of rivers a highly productive marine habitat. The mouths of large rivers, especially in Type I estuaries flow of fresh water is sufficient to maintain a steep interface with the intruding sea water. The strongest upwelling of the Indian Ocean occurs along its western coastline when the Southwest monsoon produces strong Ekman transport away from the coasts of Somalia and Arabia.

Downwelling

Ekman transport also contributes to the downwelling of coastal waters. The oscillatory tidal currents when viewed from above flow in elliptical patterns due to Coriolis deflection. All oceans are interconnected at their southern ends. Winds not only drive the surface currents, but they may generate deeper currents as well. Ekman has considered the effects of the deflecting force of the earth's rotation and the eddy viscosity.

The South Pacific Coastal upwelling region along the coasts of Peru, Chile and Ecuador is one of the richest fishing regions in the world. The Peruvian situation may be considered in this context. Normally the winds off the Peruvian coast blow from the southeast. The Ekman transport (southern Hemisphere) is to the left, or out to the sea. The

nutrients brought up with the upwelled water to the sunlit surface zone foster increased biological activity and a healthy fishing industry. This upwelling-causative wind continues on across the ocean (trade winds) and carries the equatorial surface current. The slackening of these winds for prolonged periods, which cause slackening of the upwelling along the Peruvian coast with attendant return of the nutrient-depleted surface water south east along the Peruvian coast, spells disaster to the fishing industry. The unwholesome coastal current is called El Niño. The occurrence of El Niño, a coupled ocean-atmosphere system of the Pacific is now predictable a few months in advance with the advanced oceanographic observations warning the fishing industry of the impending disaster. Annual sardine landings in eastern ocean upwelling regions as compiled by Parrish *et al.* (1983), for a 50 year period are given in Fig. 2, demonstrating the abundance and decline of sardine landings.

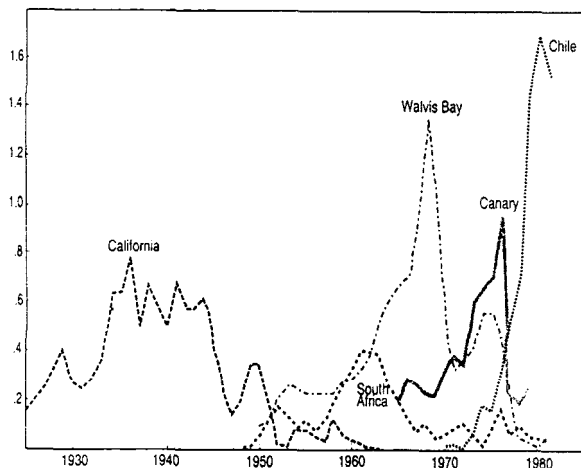


Fig. 2. Annual landings of sardines in some eastern ocean coastal upwelling regions from 1930 to 1980.

Further, the authors noted that the general shape of the graph showing the rapid abundance and decline over the years were rising higher and getting narrower. Following the rationale then prevailing, the authors attributed the sudden decline as caused by human technological interventions causing devastating fishing pressure on the population and the technological ability to shift operational base to the next region. In Fig. 3, a general ocean wide

synchrony in the landings of sardines in the coastal regions of the Pacific Ocean is displayed.

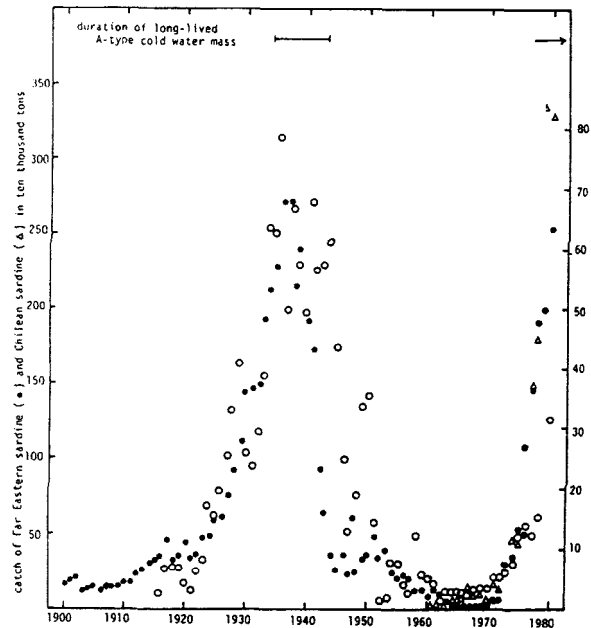


Fig. 3. Annual catch of sardines in certain coastal regions of the Pacific Ocean revealing ocean wide synchrony.

The Peruvian fishing industry

The Peruvian fishing industry is a reflection of these processes. Normally the winds are blowing from the south east. The Ekman transport (Southern Hemisphere) is to the left, or out to the sea. The nutrients brought up with the upwelled water to the sunlit surface zone foster increased biological activity and a hearty fishing industry. The same winds that cause this upwelling continue across the oceans as trade winds which the equatorial surface current with them.

The Indian oil sardine

The Indian oil sardine (*Sardinella longiceps*) had exhibited alternating pattern of availability since last century constituting the single largest fishery resource of the region during the upwelling season. Longhurst and Wooster (1990) while studying the abundance of oil sardine and upwelling on the south west coast of India, observed that the replenishment may be correlated with coastal sea level measured



in a month or more before the period of peak spawning. This ocean region is characterized by extremely low levels of dissolved oxygen within the thermocline, and these oxygen deficit waters are observed to move upward on to the continental shelf during periods of strong upwelling. The authors opined that as the sea level is inversely related to upwelling intensity, perhaps intense upwelling may cause the adult oil sardine to be excluded, because of oxygen limitation, from more favourable near coastal habitat. The result would be a lowered degree of reproductive success.

Spawning peaks in tropical upwelling systems tend to be timed as to coincide with seasonal maxima in upwelling intensity. Increased intensity of wind-induced upwelling would tend to favour population

growth of costal pelagic fishes. Tropical systems have shown such long-term upward trends as shown by Indian sardine (*Sardinella aurita*) and anchovy of the Gulf of Guinea.

The Indian ocean

Further scrutiny of the Indian ocean region is desirable. The Indian ocean is the smallest of all the oceans while the Pacific ocean is the largest. Three Mediterranean seas influence the hydrographic properties of Indian ocean water masses; The Persian Gulf, with minimal influence, the Red Sea and Australasian Mediterranean Sea. Seasonal reversal of currents dominates the circulation in the Arabian Sea and Bay of Bengal. The prevailing monsoon systems in the Indian ocean are summarized in Table 1.

Table 1. Monsoon systems in the Indian ocean (The wind cycle is indicated in the upper part and currents that develop in response to wind are indicated in the lower part)

May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Transition	Peak					Transition	Peak				winds
	South west monsoon						Northeast monsoon				
	Somali Current										North hemisphere
	South west monsoon				North equatorial current						
E. jet	current			E. jet	Equatorial undercurrent						Equator
				Equatorial countercurrent							South hemisphere
South Equatorial Current											

Arabian Sea circulation is characterized by the occurrence of strong coastal upwelling in the East Arabian Current. It owes its existence to an offshore transport direction in the Ekman layer. The circulation in the Bay of Bengal is by anticyclonic flow during most months and strong cyclonic flow during November. In January these currents are weak and variable. Southern Indian ocean does not experience monsoonal (seasonally reversing) winds.

Monsoonal climate dominates the northern Indian ocean, and its effects are felt far into the

subtropics of the southern hemisphere: North east or winter monsoon; South west or summer monsoon. When the south west monsoon is fully established during July-September, the entire region north of 5° S is dominated by the eastward flow of the south west monsoon current with velocities close to 0.2 to 0.3 m.s⁻¹, but an acceleration of 0.5–1.0 m.s⁻¹ occurs south and southeast of Sri Lanka. The south equatorial currents expand slightly toward north reaching 6° S in September. The transition before the onset of the northeast monsoon is again characterized by the equatorial jet. Concentrating

all eastward flow in a 600 km wide band along the equator it reaches its peak in November with velocities $1.0-1.3 \text{ m.s}^{-1}$ and disappears in January when the annual cycle is repeated.

Hydrological properties of the Indian Ocean due to direct monsoonal effect are restricted to the surface mixed layer and the western boundary currents. Hydrology of the water masses of the surface layer varies considerably with the seasons particularly in the Indian Ocean than in any other ocean. Striking characteristics of the hydrology of the Indian ocean are the closure of the Indian Ocean in the northern sub-tropics and the blocking effect of the equatorial current system. The entire northern Indian Ocean appears as a continuation of the western pacific warm pools as regards the distribution of sea surface temperature (SST). Surface currents in the Indian Ocean are shown in Fig. 4 and 5.

Decadal time scales

Since the advent of industrial fishing is on highly commercial scale, the sardine and the anchovy dominated the world fishery production especially in the temperate waters showing enormous decadal-scale variation in the landings. The sardine fishery of Japan unfolds peculiar features. It reached an initial peak of more than 1.5 million tonnes in 1935 and then collapsed. It remained in the dormant state for nearly three decades with a sudden rebound of population in the mid-1970s crossing a figure of 5 mt in the 1980s. Subsequently the population suffered a phase of decline. The anchovy catch grew during the intervening period of low sardine abundance attaining peaks in 1950s and 1960s. The anchovy catches then declined and the sardine population established its rebuilding. In the 1990s observations are that sardine populations are on the decline with the quick rise of anchovy.

Is it justified to consider these as replacements of one population with other? The observed changes occurred after several generation cycles of the order of decades. A focused study by Soutar and Isaacs (1974) on the analyses of anaerobic sediments of

Southern California Bight showed no rigidly consistent pattern of alternation in abundance of sardine and anchovy scales. However, when more analyses of the paleo-sedimentary fish-scales were done, a pattern of alternation was found in which one of the species tends to maintain numerical dominance over the other, for periods of approximately 30-35 years. Studies made in Gulf of California had shown similar trends. More observations are needed to establish the validity.

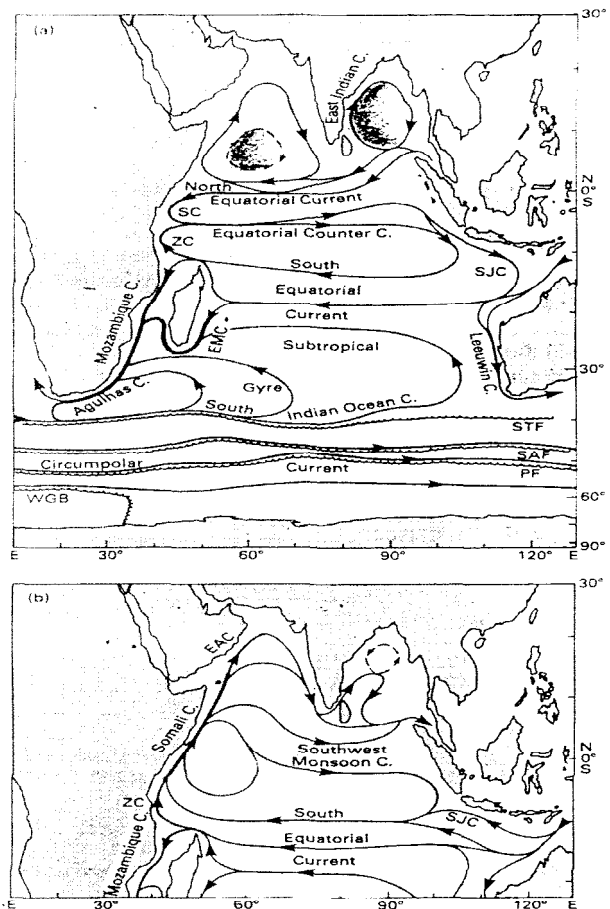
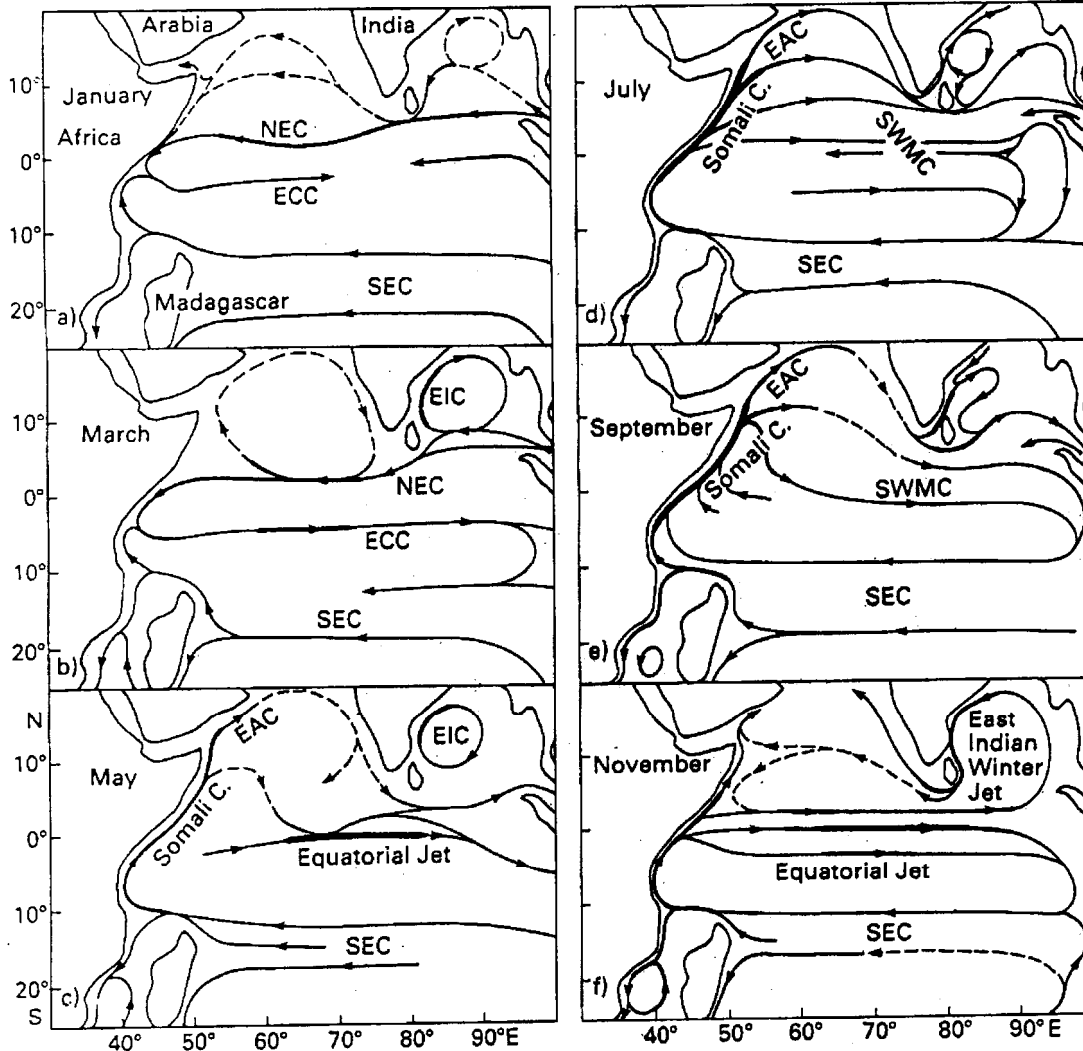


Fig. 4. Surface currents in the Indian Ocean during late North east monsoon season: March to April (upper figure) and late South west monsoon season, September-October (lower figure). Circulation south of 20°S remains the same (EAC: East Arabian; SJC: South Java; ZC: Zanzibar; EMC: East Madagascar; SC: Somali currents; STF: Subtropical Front; SAF: Sub Antarctic Front; PF: Antarctic Polar Front; WGB: Weddel Gyre Boundary)

Fig. 5. Surface currents in the northern Indian Ocean (SEC: South Equatorial Current; NEC: North Equatorial Current; ECC: Equatorial Counter Current; SWMC: South west Monsoon Current; EAC: East Arabian Current; EIC: East Indian Current)



Expert consultation to examine changes in abundance and species composition of neritic fish resources under the aegis of FAO in 1983 could not come to any consensus especially when one was confronted with the most intense environmental anomaly (El Niño 1982-1983) when Chile made the record catch of sardines and the disastrous collapse of Peruvian anchoveta during the milder 1972 El Niño. In the tropics and sub-tropics El Niño characteristics generally exhibited low ocean productivity and deprived conditions for marine organisms. Abrupt fish population dynamics in the

world ocean had been a recurrent feature.

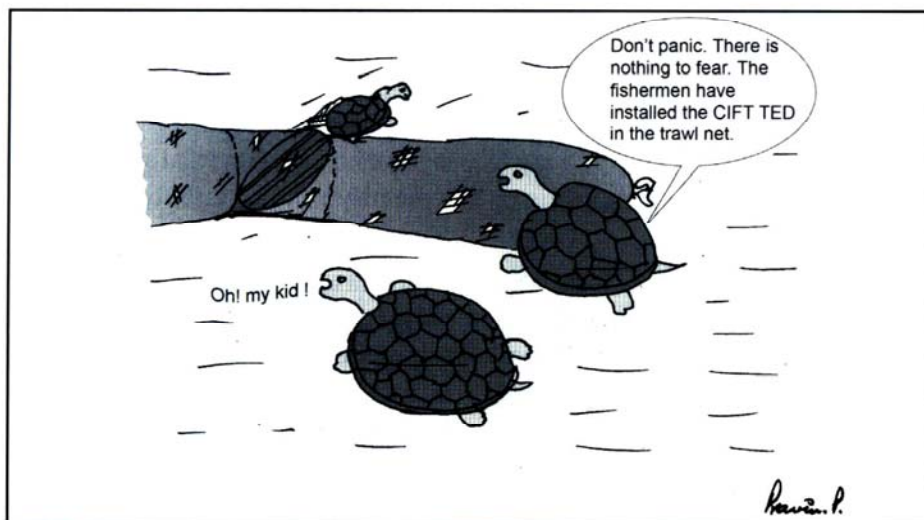
Oceanography has progressed considerably through studies of the physical principles that drive the oceans and with the help of mathematics and theoretical fluid dynamics, a stage is in sight to predict the behaviour of the ocean. Several of the conceptual models proposed to explain the variability of marine resources have not been successful which compelled marine scientists to introduce the concept of chaos as it has been noticed that biological population interaction models tend to exhibit chaotic behaviour. This attempt was also

not successful. In an attempt to extend our understanding of the short and long-term variability beyond the limits posed by the available data, several research groups have begun the task of developing numerical models of marine system. The massive computing power, which is increasingly available now can lessen the burden associated with rigorous analysis. With these methods which facilitate simulations into the future we hope to get reasonably accurate estimates of resource trends. Kawasaki and Omori (1988) hypothesized that global climatic changes were considered to be the principal causative factor for the changes in population regimes in which temperature may be a tracer of other underlying processes rather than being itself the primary cause of population variation. Pacific Ocean with very large water mass and consequently with great heat storage capacity, its effect on earths climatic system remains global. This view was supported through sustained research efforts by Bakun (1990) who opened up a new vista for effective cross disciplinary interaction between marine biologists and physical scientists. In spite of multidisciplinary analysis, an explanation for the interdecadal variability of marine fish population happening synchronously in separated world oceans is yet not fully understood and a rational all

encompassing explanation remains elusive.

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Contributions of Central Institute of Fisheries Technology in the fish inspection system in India

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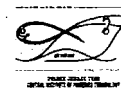
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Export of fish and fishery products from India commenced in 1953 with the export of a small consignment of frozen shrimp from Cochin. In those days, there were only three or four exporters in the field and the volume of export was too small fetching foreign exchange less than 2 crores of rupees. At present there are over 400 exporters in the country with a total value of export touching Rs.6,646.69 crores in 2004-05. Quality control and pre-shipment inspection system was instrumental for this phenomenal growth of the seafood industry.

At the early start of the industry, the exporters were free to ship their consignments without any inspection for quality. Later, in the light of certain setbacks, Govt. of India decided that any consignment exported from this country should meet certain pre-determined and specified standards of quality. This resulted in the enactment of a comprehensive legislation entitled "Export (Quality Control and Inspection) Act 1963". This act came into force with effect from 1st September 1963. The responsibility of organizing and conducting the inspection including issue of the Export Worthiness Certificate was given to the Central Institute of Fisheries Technology (CIFT), Cochin, under Section 7 of the said act. Dr. V.K. Pillai, the then Senior Research Officer of CIFT was given full powers to operate the system. It worths special mention that no additional

staff, space or facility had been given to CIFT in the beginning. Dr. Pillai, with his top-most dynamism and match-less tactics was able to run the show most effectively using the limited space available in the rented building of CIFT and deploying a few Scientists of the Quality Control Section of the Institute for inspection purposes. He and his staff worked from 7 AM to 7 PM on almost everyday for the smooth functioning of the system. This author had also the unique opportunity of working with Dr. Pillai in the inspection scheme. Dr. Pillai had a special element in his character with which he could easily understand the technical problems of the industry and at the same time not compromising on the quality aspects of marine products offered for inspection. During a short span of time, the sea food processing industry of India started showing lot of affection to Dr. Pillai and even now, the industry remembers the contributions, he had made to the seafood inspection system.

In the early periods of seafood inspection, as the industry was also in the infant stage, it was decided that a form of voluntary inspection system will be initiated from 1st September 1964. According to this system of inspection, the exporters willingly subjected their products for inspection to check whether they conform to the prescribed knowledge and confidence to the processors to get familiarized



with the inspection system.

The usual practice of any inspection agency is to inspect any consignment and to pass or fail it depending upon quality. But, CIFT was following a separate strategy. By any chance, if any consignment fails, the Scientists of the Quality Control Section will visit the factory, identify the root cause of the rejection and work with the industry and develop appropriate technology to solve the problem. Thus, the technology developed by the Institute to solve the problem of black-spot formation in frozen shrimps, canned shrimps, thaw drip-loss in frozen shrimps, dehydration in frozen shrimps, *E. coli* contamination in shrimps, *Staphylococcus aureus* in shrimps, Salmonella in fish and shrimps etc. have given considerable boost to the seafood industry to produce products as per global norms and requirements. The deodorant, antiseptic ointment and cloritest paper developed by the Institute had great welcome by the industry and are, even now, been used extensively by the Trade.

Subsequently, the export of marine products was brought under compulsory pre-shipment inspection system with effect from 15th March 1965. Initially only frozen shrimps and canned shrimps were under the purview of statutory inspection which was gradually extended to other commodities. Later, consequent upon the decision of Govt. of India, inspection of marine products was taken over by the Export Inspection Agency from 1st May 1969.

The pioneering work done by the Central Institute of Fisheries Technology in the area of seafood quality assurance stands as milestone in the history of pre-shipment system in India.

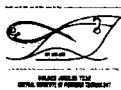
With a view to make the quality control and inspection scheme more meaningful and effective, it was felt imperative that, in addition to the end product inspection, the processing plants should be encouraged to adopt Good Manufacturing Practices (GMPs). Accordingly, government of India introduced the In-process Quality Control (IPQC) Scheme for processed sea foods with effect from 31st December,

1977. Under this scheme, processing of fishery products for export purposes was permitted only in processing units approved by a panel of experts consisting of five members. It worths special mention that in this five member team one was a Scientist from Quality Assurance Section of CIFT.

Later, as per Govt. of India notification S.O. 1153 A.dt. 09.04.1988, the IPQC System was retitled as "Quality Control and Inspection in Approved units-QCIA". Another change was the introduction of a new system - "Modified In-process Quality Control (MIPQC) Scheme". In these schemes also there was an Expert Member from CIFT who played a significant role in the approval of sea food processing factories of the export trade. Later, the MIPQC system was again renamed as IPQC to keep similarity with other export commodities, but incorporating the same Team of Members.

The sea food industry had a serious setback in 1996. Based upon certain serious defects in the sea food products exported from this country, the European Union blacklisted our country and the exports of marine products came to a standstill. On discussion with EU Authorities, they expressed unhappiness in the existing inspection system. As a compromise they demanded that the entire sea food factories have to be approved as per EU norms. For this a two tier approval system was suggested. The former, Inter Departmental Team – IDP consisting experts from CIFT, MPEDA and EIA will first visit the factories. If found satisfactory the case will be referred to a senior-level committee called Supervisory Audit Team (SAT) with two Members from CIFT. If SAT recommends the factory for approval, the case can be referred to Ministry of Commerce, for onward transmission to European Union who will finally approve the unit. This system, even now continues without much modification.

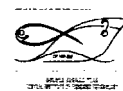
In the Golden Jubilee year of CIFT, the Institute can definitely feel proud on its pioneering contributions to the marine products inspection system and taking the industry to new horizons.



Cift Golden Jubilee 1957-2007

Our Well Wishers

1. Associated Trades & Agencies, Cochin, Kerala
2. Asvini Fisheries (P) Ltd, Bhimavaram, Andhra Pradesh
3. Baby Marine (Eastern) Exports, Mandapam, Tamil Nadu
4. Basic Technology (P) Ltd., Kolkata, West Bengal
5. Blue Water Foods & Exports, New Mangalore, Karnataka
6. Book Supply Bureau, New Delhi
7. Britto Exports, Chennai, Tamil Nadu
8. Castlerock Fisheries Ltd., Thane, Maharashtra
9. Cochin Frozen Food Exports Pvt. Ltd, Aroor, Kerala
10. Cherukattu Industries, Aroor, Kerala
11. Chirag Group of Companies, Navi Mumbai, Maharashtra
12. Coir Board, Cochin, Kerala
13. Deepmala Marine Exports, Veraval, Gujarat
14. Devi Fisheries Ltd., Visakhapatnam, Andhra Pradesh
15. Devi Seafoods Ltd., Visakhapatnam, Andhra Pradesh
16. Dionex (India) Pvt. Ltd, Mumbai, Maharashtra
17. Esmario Export Enterprises, Kollam, Kerala
18. Falcon Marine Exports Ltd, Bhubaneshwar, Orissa
19. Forstar Frozen Foods Pvt. Ltd., Navi Mumbai, Maharashtra
20. Gadre Marine Export, Ratnagiri, Maharashtra
21. Geo Seafoods, Cochin, Kerala
22. GKS Business Associates (P) Ltd., Aroor, Kerala
23. Gopal Seafoods, Veraval, Gujarat
24. Greaves Cotton Ltd., Cochin, Kerala
25. Handy Waterbase India (Pvt) Ltd.
26. Hindustan Newsprint Ltd., Kottayam, Kerala
27. Innovative Foods, Ezhupunna, Kerala
28. Jayalakshmi Sea Foods (P) Ltd., Visakhapatnam, Andhra Pradesh
29. Jinny Marine Traders, Veraval, Gujarat
30. Joeltech Systems, Cochin, Kerala
31. Kerala Livestock Development Board Ltd., Thiruvananthapuram, Kerala
32. Kings Marine Products, Kollam, Kerala
33. Labindia Instruments Pvt. Ltd. Gurgaon, Haryana



34. Lourde Exports, Cochin, Kerala
35. Marine Products Exports Development Authority, Cochin, Kerala
36. Merck Specialities (P) Ltd., Mumbai
37. Millipore (India) Pvt. Ltd., Bangalore, Karnataka
38. MSC Marine Exporters, Bhimavaram, Andhra Pradesh
39. Naik Frozen Foods Pvt. Ltd, Mumbai, Maharashtra
40. Naik Ice & Cold Storage, Ratnagiri, Maharashtra
41. Nekkanti Sea Foods Ltd., Visakhapatnam, Andhra Pradesh
42. Nila Seafoods (P) Ltd, Tuticorin, Tamil Nadu
43. Nissema Printers & Publishers, Cochin, Kerala
44. Push Engineering, Pune, Maharashtra
45. Qualigens Fine Chemicals, C/o Angel Agencies, Cochin, Kerala
46. Rabia Sea Foods, Cochin, Kerala
47. RF Exports, Eramalloor, Kerala
48. San Group of Concerns, Kollam, Kerala
49. Sasson Dock Matsyodyog Sahakari Society, Dighoda, Maharashtra
50. Scientific Suppliers, Sambalpur, Orissa
51. Shimpo Exports, Kolkata, West Bengal
52. Southern Book Star, Thiruvananthapuram, Kerala
53. South Indian Federation of Fishermen Societies, Thiruvananthapuram, Kerala
54. Surya Mitra Exim Pvt. Ltd, Bhimavaram, Andhra Pradesh
55. Suvarnarekha Exports Pvt. Ltd, Visakhapatnam, Andhra Pradesh
56. Torry Harris Seafoods (P) Ltd., Eramalloor, Kerala
57. Varian India Pvt. Ltd, Chennai, Tamil Nadu