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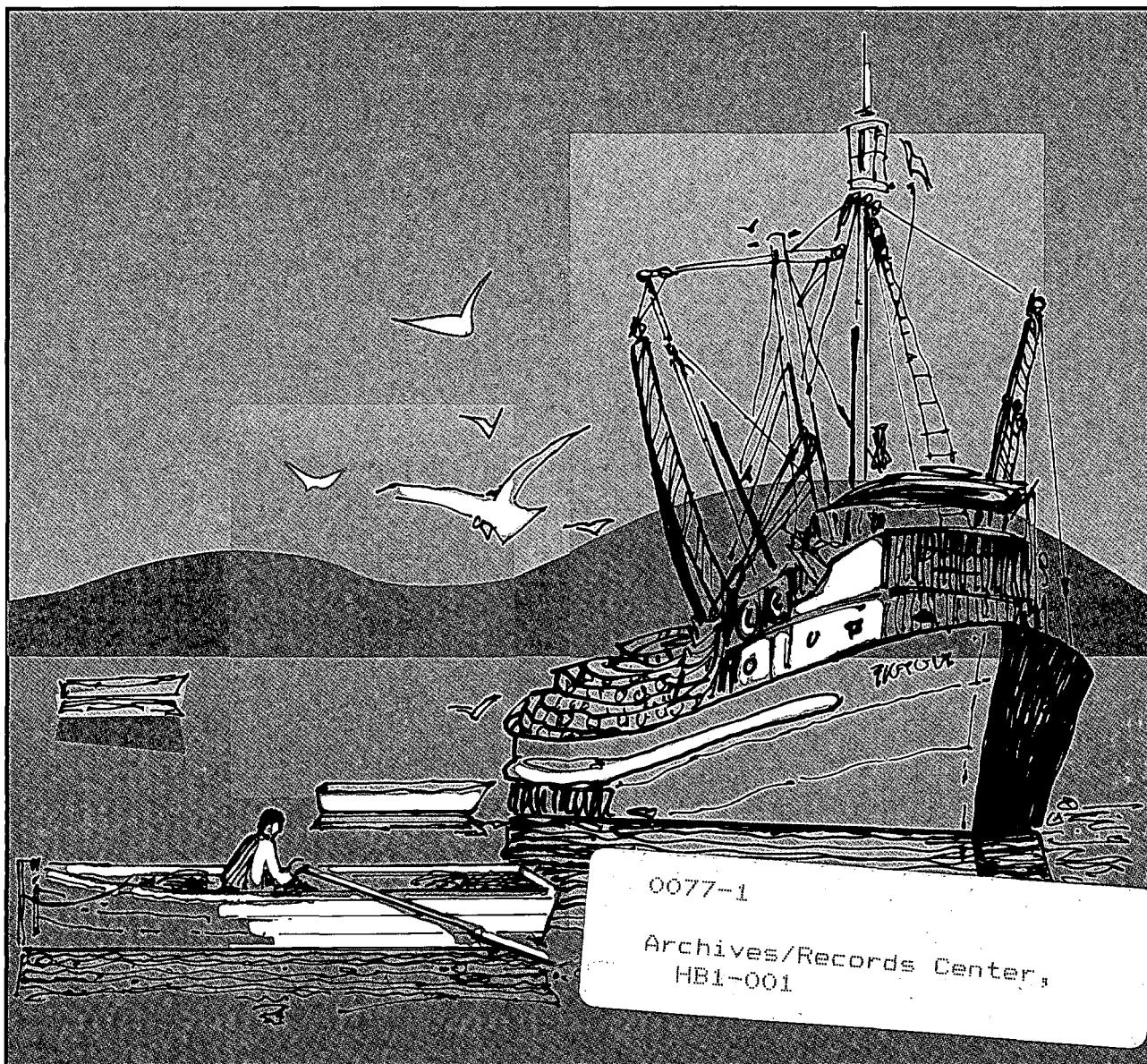
WORLD BANK TECHNICAL PAPER NUMBER 147

FISHERIES SERIES

Fisheries and Aquaculture Research Capabilities and Needs in Asia

Studies of India, Thailand, Malaysia, Indonesia, the Philippines, and the ASEAN Region

The World Bank/United Nations Development Programme/Commission of the European Communities/Food and Agriculture Organization



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FISHERIES SERIES

Fisheries and Aquaculture Research Capabilities and Needs in Asia

**Studies of India, Thailand, Malaysia, Indonesia,
the Philippines, and the ASEAN Region**

The World Bank/United Nations Development Programme/Commission
of the European Communities/Food and Agriculture Organization

The World Bank
Washington, D.C.

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ABSTRACT

This document embodies the results of two missions on fisheries and aquaculture research capabilities and needs. The first part deals with a study of India and the second with the ASEAN Region, with particular reference to Thailand, Malaysia, Indonesia and the Philippines.

The report on India deals with existing research programs, organizations and needs. It also discusses the research process in terms of the formulation of research agendas, the conduct of research as well as the application of research.

The ASEAN Regional Study starts out with an examination of the organization and conduct of fisheries and aquaculture research at the national level and then proceeds to discuss cooperation in research in terms of regional and international mechanisms. It includes a comparative analysis of national, regional and international research. Institutional issues including the inter-relationships and capabilities of government, the private sector and academia are also dealt with.

ACKNOWLEDGMENTS

The Members of the Mission are grateful to the following agencies for supporting this study:

Multilateral Agencies: (Steering Committee) The World Bank; United Nations Development Programme; Commission of the European Communities; and Food and Agriculture Organization.

Bilateral Agencies: DANIDA — Danish International Development Agency; AIDAB — Australian International Development Assistance Bureau; ICOD — International Centre for Ocean Development (Canada); NORWAY: ICEIDA — Icelandic International Development Agency; SIDA — Swedish International Development Authority; ODA — Overseas Development Administration (United Kingdom); ITALY; FRANCE; USAID — United States Agency for International Development; THE NETHERLANDS; GTZ — Deutsche Gesellschaft für Technische Zusammenarbeit (Germany).

FOREWORD

This Technical Paper is one of seven mission and working group reports prepared during the Study of International Fishery Research (SIFR) in 1989-90. The juxtaposition of potentially high socio-economic benefits from fisheries and the relatively low level of success achieved in fisheries development projects has been a matter of serious concern and challenge to the donor community as well as to national fishery administrations. In view of this, the First Fishery Development Donor Consultation held in 1986 decided to undertake a Study of International Fishery Research to determine ways in which research could bring about improvements. This comprehensive effort has now been completed, thanks especially to the effective financial support of a group of multilateral and bilateral donors and the essential intellectual contributions made by virtually hundreds of professionals from academia, fishery administrations and donors who were associated with various stages of the Study.

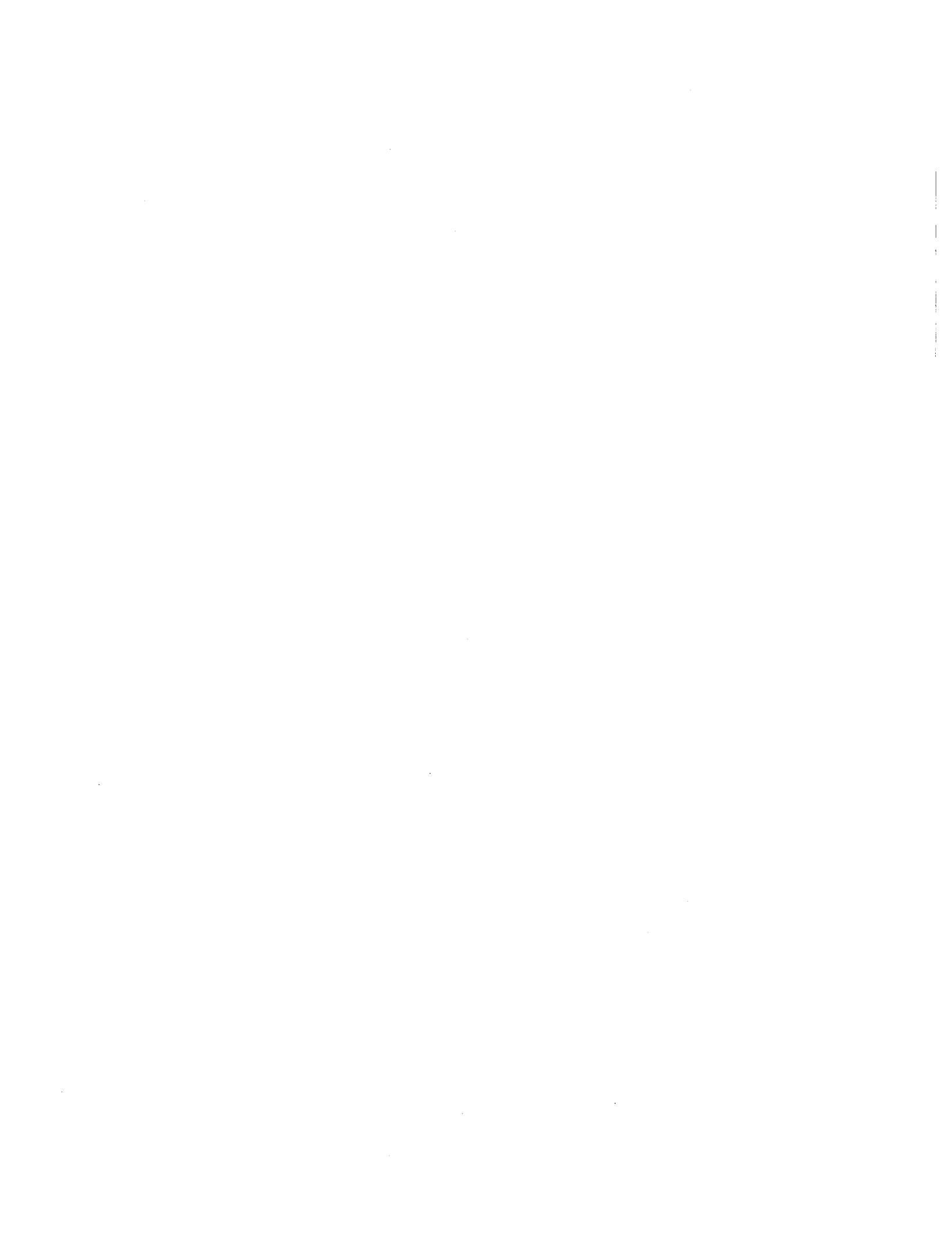
The objectives of the Study were to identify the specific constraints to fisheries management and development (including aquaculture) posed by the lack of information or the inaccessibility of existing knowledge; to determine high priority research needs; to examine the capacity of developing countries to undertake research; and to propose a strategy and an action plan for improving donor support. It was carried out through a series of missions and by four working groups which addressed specific research topics under the direction of a Study Team Leader and a Deputy. SIFR identified a number of key strategic research areas which are vital for the future development of the sector. Institutes in developing countries may not immediately be able to carry out all of this research, but the Study clearly identifies them as the ultimate beneficiaries of its thrust. In the meantime, countries with important fishery resources and the willingness to further develop their research for improved management and sustainable use of their resources should be assisted in drawing up national research agendas and building up their capacities. In this context, the findings of regional missions are a useful starting point. This volume contains the reports of missions to India and the ASEAN Region [Thailand, Malaysia, Indonesia and the Philippines] and is intended as background information to support the main study which is being published as "Study of International Fishery Research".

I wish to express my sincere thanks to the fisheries researchers, and fishery administrators in developing countries, as well as the leaders and members of the missions and Steering and Advisory committees for their vigorous effort and thoughtful contributions. It is my sincere hope that these Technical Papers will prove stimulating and provide practical guidance to donors, research institutions and fishery administrations in making progress toward sustainable resource utilization and the realization of new opportunities from fisheries and aquaculture in developing countries.



Michel J. Petit

Director, Agriculture and Rural Development Department



ACRONYMS

AAETE	Agency for Agricultural Education, Training and Extension (Indonesia)
AARD	Agency for Agricultural Research and Development (Indonesia)
AFS	Asian Fisheries Society
AIT	Asian Institute of Technology
AMAF	Asian Agriculture Ministers
BAS	Bureau of Agricultural Statistics (Philippines)
BFAR	Bureau of Fisheries and Aquatic Resources (Philippines)
BFDA	Brackish Water Fish Farmers Development Agency
BOBP	Bay of Bengal Program
CGFI	Coordinating Group on Fisheries
CGIAR	Consultative Group for International Agricultural Research
CIBA	Central Institute of Brackish Water Aquaculture
CICEF	Central Institute of Coastal Engineering for Fisheries
CICFRI	Central Inland Capture Fisheries Research Institute
CIDA	Canadian International Development Agency
CIFA	Central Institute of Freshwater Aquaculture
CIFE	Central Institute of Fisheries Education
CIFT	Central Institute of Fisheries Technology
CMFRI	Central Marine Fisheries Research Institute
COFAF	Committee on Forestry, Agriculture and Fisheries
CSIR	Council of Scientific and Industrial Research
DOD	Department of Ocean Development
DOST	Department of Science and Technology
FAO	Food and Agriculture Organisation
FFDA	Fish Farmers Development Agencies
FSI	Fish Survey of India
ICAR	Imperial Council of Agriculture Research
ICLARM	International Centre for Living Aquatic Resources Management
IDRC	International Development Research Centre
IFP	Integrated Fisheries Project
IFPRI	International Food Policy Research Institute
IIMA	Indian Institute of Management, Ahmedabad
IIOE	International India Ocean Expedition
IOC	Intergovernmental Oceanographic Commission
IPFC	Indo-Pacific Fisheries Commission
MARD	Malaysian Agricultural Research and Development Institute
MPEDA	Marine Products Export Development Authority
NACA	Network of Aquaculture Centres in Asia and the Pacific
NARRDS	National Aquatic Resources Research and Development System (Philippines)
NBFGR	National Bureau for Fish Genetic Resources
NEERI	National Environmental Engineering Research Institute
NIO	National Institute of Oceanography
NRCCWF	National Research Centre for Cold Water Fisheries
PCAMRD	Philippine Council for Aquatic and Marine Research and Development
QRT	Quinquennial Review Team
RCCF	Research Coordination Centre for Fisheries (Indonesia)
RICA	Research Institute for Coastal Aquaculture (Indonesia)
RIFF	Research Institute for Freshwater Fisheries (Indonesia)
RIMF	Research Institute for Marine Fisheries (Jakarta)

SAU	State Agricultural Universities
SCORRAD	Standing Committee on Resources Research and Development
SEAFDEC	Southeast Asian Fisheries Development Centre
SIFR	Study of International Fishery Research
SRC	State Research Council
TCDC	Technical Cooperation Among Developing Countries
TTC	Trainers Training Centre
UGC	University Grants Commission
UNCLOS	United Nations Conference on Law of the Sea
UNDP	United Nations Development Program
UPM	University Pertanian Malaysia

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**Fisheries and Aquaculture Research
Capabilities and Needs in Asia:
Study of India**

MISSION:

3-19 July 1989

MEMBERS:

Francis T. Christy, Jr. (Leader)

David James

William Royce

P.V. Dehadrai

P.R.V. Sinha

1. INTRODUCTION

A Study of International Fishery Research in developing countries is being undertaken under the auspices of the World Bank, FAO, UNDP and the Commission of European Communities, with the support of a dozen bilateral agencies. The purposes of the Study are to determine the high priority research needs, the capacities of developing countries to undertake the necessary research and the ways in which donor support can be made more effective in improving the research process.

As part of the Study, missions have been undertaken to selected countries and groups of countries for the purpose of assessing research capabilities and identifying the factors that serve to facilitate or impede the research process. India was selected as one of the countries for examination because of the importance of its fisheries and the strength of its research institutions.

The mission members included Dr. Francis T. Christy, Jr., leader; Mr. David James (FAO); Dr. William Royce (consultant); Dr. P. V. Dehadrai (Deputy Director-General, Indian Council of Agricultural Research); and Dr. V. R. P. Sinha (Director, Central Institute of Fisheries Education). The mission visited India during 3-19 July, 1989.

It should be emphasized that the purpose of the mission was not to provide a critical review specifically of India's fisheries research program but to examine the process in terms of its relevance to the needs for improved fisheries research in developing countries in general. It is not possible to avoid specific references to apparent deficiencies in the research programs in India. But such references are important because of their implications for other developing countries. In many cases, India has already taken important steps to deal with these deficiencies.

2. BACKGROUND

Fisheries production in India reportedly rose from 1.89 million tons in 1970-74 to 2.80 million tons in 1983-87. In the latter period, production from marine waters was estimated at 1.7 million tons and from inland waters 1.1 million tons. The data, however, are of questionable accuracy and it is possible that the actual production from inland waters is considerably less than the production that is reported (Chua Thia-Eng 1986). In the last five years, marine production has fallen slightly according to both FAO data and estimates from State Governments.

Export data, which are probably relatively accurate, show an increase from 36,000 tons in 1970-71 to 97,000 tons in 1987-88. Export value increased from Rs. 350 mil. to Rs. 5,300 million (US\$ 330 million). A large part of this increase is due to the rising prices of prawns, the main constituent of exports and to inflation. The average unit value of exports rose five-fold over the period. Within inland fisheries, a large part of the production comes from aquaculture in small ponds and tanks. Under a programme of Fish Farmer Development Agencies, average yields per hectare rose from 582 kg/yr in 1978-79 to 1566 kg/yr in 1987-88. The number of hectares cultivated under the programme rose to 185,000 indicating a production of 290,000 tons. The amount of production from inland aquaculture outside the programme is not known and estimates range widely, both in terms of the amount of area under production and the average yields. Total production from inland waters may be considerably lower than the reported figure of 1.1 million tons.

There appears to be considerable potential for increase both through higher yields from culture fisheries and better management of riverine and reservoir fisheries.

Almost all marine production comes from the near shore waters (less than 50 m in depth) and is taken by about 22,000 mechanized vessels and 150,000 non-mechanized country craft. This area is heavily overfished and the only opportunities for increased catches are through the management of the resources that would allow rehabilitation of the stocks.

Potential production from areas deeper than 50 meters has been estimated to be quite large and considerable investments are being made to develop these resources. However, there is little hard evidence that production will be commercially feasible. Production by deep water trawls is not likely to be successful. Production of tunas and cephalopods may offer some opportunities but has not yet been demonstrated to be economically feasible.

Brackish water fish culture is still in its infancy and contributes little to total production. It is estimated that there are about 50,000 ha. presently under culture with average yields of prawns from 100-500 kg/ha/yr. Both the area and yields can be increased considerably.

3. CURRENT RESEARCH ORGANIZATION

On the recommendation of the Royal Commission on Agriculture in 1928, the Imperial Council of Agricultural Research (ICAR) was established in 1929 as an apex body which was the turning point in the history of agriculture research in India. After 1947, with the establishment of the Ministry of Agriculture, the fishery sector was organized and subsequently fisheries research institutes were established under the Ministry. In 1966, most of the fisheries institutes were merged with ICAR system.

Till the end of the 6th Plan (1981-85), the following institutes in fisheries existed:

1. Central Marine Fisheries Research Institute, Cochin.
2. Central Inland Fisheries Research Institute, Barrackpore.
3. Central Institute of Fisheries Technology, Cochin.
4. Central Institute of Fisheries Education, Bombay.

In 1971, a national grid of integrated cooperative research was established through the All India Co-ordinated Research Project involving Central Research Institutes of ICAR, Agriculture Universities and State Governments. In fisheries, 4 projects on carp culture, air-breathing fish culture, reservoir fisheries and brackish-water farming helped in evolving and standardizing the packages of technologies for direct transfer to the field.

During the 7th Plan period, it was felt that several divisions in fisheries research institutes had grown in their coverage of different fisheries but were restricted in their activity through sharing of inadequate funds and were not able to impart the required thrust to the development of resource specific fisheries. Therefore, in 1986 the existing CMFRI and CIFRI were divided into marine research and brackish-water research institutes and freshwater aquaculture and cold water fisheries institutes with separate status for inland capture fisheries. In addition, the Bureau of Fish Genetic Resources was also established.

However, paucity of funds has compelled the newly established institutes to share the existing infrastructure, equipment, scientists and supporting staff.

During the 8th Plan period, it is envisaged to provide the necessary infrastructure to the new institutes and strengthen the old ones by completing the committed programmes spilling over from the 7th Plan period.

The current components of fisheries research in India as shown in Table 1 can be broadly grouped into the following categories of organizations: (a) ICAR System; (b) Ministry of Agriculture; (c) Ministry of Commerce; (d) Ministry of Food Processing Industries; and (e) Other Bodies such as the Council of Scientific and Industrial Research and the State Agricultural Universities.

ICAR SYSTEM

Central Marine Fisheries Research Institute, Cochin

- *Mandate*

To conduct research for assessing and monitoring the exploited marine fisheries resources leading to their rational exploitation and conservation; to assess the under exploited and unexploited marine fisheries resources of EEZ; to understand the fluctuations in the abundance of marine fisheries resources in relation

Table 1. Fisheries Research, Training And Development Bodies

<i>Indian Council of Agricultural Research</i>	<i>Ministry of Agriculture</i>	<i>Ministry of Commerce</i>	<i>Ministry of Food Processing Industries</i>	<i>Council of Scientific and Industrial Research</i>	<i>State Agricultural Universities</i>	<i>Other Bodies</i>
Central Marine Fisheries Research Institute	Central Institute of Fisheries Nautical and Engineering Training	Marine Products Export Development Authority	Fishery Survey of India	National Institute of Oceanography	Karnataka	Department of Ocean Development
Central Inland Capture Fisheries Research Institute	Central Institute of Coastal Engineering for Fisheries	Export Inspection Agency		Central Salt and Marine Chemicals Institute	Tamil Nadu Kerala	Department of Biotechnology
Central Institute of Freshwater Aquaculture	Integrated Fisheries Project			National Environmental Engineering Research Institute	Andra Pradesh Assam	University Grants Commission
Central Institute of Brackish Water Aquaculture				Central Food Technology Research Institute	Uttar Pradesh Bihar	Department of Science and Technology
Central Institute of Fisheries Technology					Orissa Maharashtra	Indian Institute of Technology
Central Institute of Fisheries Education					Madhya Pradesh	Indian Institute of Management
National Bureau of Fish Genetic Resources						National Bank for Agriculture and Rural Development
National Research Centre on Cold Water Fisheries						Voluntary Agencies
						Private Industry

to changes in the environment by conducting vessel based programmes; to develop mariculture technologies for fin fish and shell fish in open seas; to study the coastal ecology as related to artisanal fishing, endangered ecosystems and pollution and to conduct transfer of technologies and post-graduate and specialized training and extension education programmes.

- *Organization*

The main institute is in Cochin. It has regional research Centres at Bombay, Madras, Waltair, Mangalore, Kakinada, Veraval, Lakshadweep. In addition, 28 field stations collect the requisite fish landing data.

The Institute manages the FORV Sagar Sampada (OAL:71.5m), which is funded by Department of Ocean Development, in coordination with other Institutes.

The Institute had 192 scientists and 326 technicians in position in 1986-87. The budget for the Institute in 1989-90 was about US \$2.75 million.

Central Institute of Fisheries Technology, Cochin

- *Mandate*

To develop technologies for handling, processing, preservation, product development, quality control, packaging and transportation of fish and fishery products; to conduct research for improvement of indigenous craft and gear; to develop suitable designs for craft and gear for operation in the inland, inshore and off shore waters and to conduct transfer of technology, training and extension education programmes in fisheries technology.

- *Organization*

The main Institute has a spacious building at Cochin. Sub-centres are at Veraval, Bombay, Calicut, Kakinada and Burla. There are positions for 141 scientists at CIFT.

Central Inland Capture Fishery Research Institute, Barrackpore, West Bengal

- *Mandate*

To study population dynamics of exploited fishery resources of rivers, lakes, reservoirs, beels, canals, estuaries, lagoons etc. exceeding 10 ha in area of the water spread; to evolve management systems for obtaining optimum production in various categories of natural and man made water bodies and wet lands exceeding 10 ha in water spread; to investigate causes/effects and remedies of riverine, estuarine and lacustrine pollution; and to study impact of river valley projects on the fisheries of the various states concerned and to conduct training and extension education programmes.

- *Organization*

The parent institute is in Barrackpore, West Bengal with riverine, estuarine and lacustrine Division headquarters at Allahabad, Vadodara and Bangalore with several sub-stations at strategic locations such as Gauhati, Agra, Raipur, Patna etc. CICFRI had 94 scientists, 96 technicians and 287 administrative and support staff in position in 1987-88. The budget for 1989-90 was about US \$1.5 million.

Central Institute of Freshwater Aquaculture, Bhubaneswar, Orissa

- *Mandate*

To conduct research more specifically in nutrition and reproductive physiology, genetics, pathology, pond environment monitoring and aquaculture engineering with a view to develop extensive and intensive warm freshwater fish farming systems for commercially important fin fish and shell fish in water bodies having less than 10 ha water spread area; to conduct specialized training and extension programmes in warm freshwater aquaculture and to act as a nodal agency to provide scientific information and transfer of technology for freshwater aquaculture development.

- *Organization*

With a 1000 pond complex, the CIFA at Bhubaneswar has sub-centres at Calcutta and Bangalore. The Institute is also the lead centre of NACA for regional aquaculture and functions as an advanced centre for aquaculture with UNDP aid.

CIFA had 41 scientists, 42 technicians and 187 administrative and supporting staff in position in 1986-87. In 1989-90, the budget was about US \$790,000.

Central Institute of Brackishwater Aquaculture, Madras

- *Mandate*

To conduct research leading to development of economically viable systems of technology for aquaculture of fin and shell fish in brackishwater areas. To assess brackishwater aquaculture potential taking into account the requirement of maintaining ecological balance and environmental health and to act as a nodal agency for providing scientific information and transfer of technology for the development of brackishwater aquaculture in the country.

- *Organization*

The new Institute has yet to acquire its own building. The infrastructure has been transferred from CICFRI, Barrackpore and CMFRI Cochin along with redeployment of scientists and supporting staff. It is likely to be established at Madras.

CIBA had 23 scientists, 8 technicians and 60 administrative and support staff in 1986-87. The budget was about US \$760,000 for 1989-90.

Central Institute of Fisheries Education, Bombay.

- *Mandate*

To conduct post-graduate and doctoral degree programmes and certificate courses in different subjects relevant to fisheries science; to conduct research in disciplines relevant to fisheries science; to conduct short term and long term training courses for human resource development in various fishery technologies.

- *Organization*

The main institute is at Bombay with sub-stations at Barrackpore, Kakinada and Lucknow. It also has field training Centres in M.P. and Haryana. It has the status of a deemed university.

It has a survey/research/training ship M.V. Saraswati (OAL:36.57m) acquired under NORAD aid.

There were 48 scientists, 101 technicians and 177 administrative and support staff in position in 1987-88. The budget for 1989-90 was about US \$1.4 million.

National Bureau of Fish Genetic Resources, Allahabad

- *Mandate*

Collection, classification and cataloguing of information including development of a data bank of fish genetic resources of India, maintenance and preservation of fish genetic material; development and operation of a gene bank; management and conservation of endangered species; identification, maintenance and preservation of pure fish lines evolved by CIFA, CIBA and CMFRI and characterization of altered genetic stock.

- *Organization*

Yet to acquire its own building and temporarily located at Allahabad. It is planned to establish sub-centres in brackish-water, and marine zones as well.

National Research Centre on Cold Water Fisheries, Haldwani, U.P.

- *Mandate*

To carry out research on cold water fisheries leading to the development in the upland areas of the country; to evolve suitable technologies for fish culture in the cold waters of the upland areas of the country; to assess the resources of the cold water fisheries; to train manpower for the development of cold water fisheries of the country and to conduct training and extension education programmes.

- *Organization*

This is a new establishment which has acquired the land at Champahat (4000 ft height) in the Uttar Pradesh Hills of Pithoragarh district. The Institute proposes to have Centres in the North Eastern region and Peninsular hills.

The Centre has only a few scientists and technicians at present. The budget for 1989-90 was US \$170,000.

MINISTRY OF AGRICULTURE

Central Institute of Fisheries Nautical and Engineering Training, Cochin

Based in Cochin, it has centres in Madras and Visakhapatnam. A unique Institute, it prepares candidates for fishery boat operatives for final professional examinations conducted by the Mercantile Marine Department under the Directorate General of Shipping, Government of India.

Central Institute of Coastal Engineering for Fisheries, Bangalore

This nodal institute has expertise in pre-investment surveys for undertaking turn-key jobs on the construction of fishing harbours and brackishwater farms. Credit for establishing 4 major and 26 minor fishing harbours and 110 landing centres along the 7517 km coast line of India goes to CICEF and also for undertaking the establishment of 6 commercial level shrimp hatcheries in 5 different agroclimatic zones of India under UNDP grants.

Integrated Fisheries Project, Cochin (IFP)

The institute has contributed to the post harvest sector, having developed more than 80 products and has been making sustained efforts to promote domestic marketing of marine fish products as well as demonstrating new techniques for export industry. IFP has grown through a nucleus built under Indo-Norwegian collaboration since 1952.

MINISTRY OF COMMERCE

Marine Products Export Development Authority

MPEDA was established in 1972 and is based in Cochin with branch offices in all major centres of seafood production and export in India. It is responsible for promotion and regulation of marine products exports. It is now a nodal agency for joint ventures in deep sea fishing and is promoting the development of brackish water shrimp farming.

Export Inspection Agency

The Export Inspection Agency was established in 1969 to ensure quality control of products for the export market. Standards for bacteria, virus, heavy metal contamination, etc. are worked out in cooperation with MPEDA and the Indian Institute of Packaging.

MINISTRY OF FOOD PROCESSING INDUSTRIES

Fishery Survey of India: Bombay

The Institute has 6 zonal stations along the East and West coasts of India and operates 29 vessels variously equipped for surveys of the EEZ. The data largely relate to catch per unit effort and availability of fish. Current efforts are on pelagic and demersal resource assessment.

The FSI has a capital investment of about US \$20 million in survey vessels, workshops and buildings. It has 58 scientists, 18 engineers, 451 technicians and 210 administrative and support staff. The current budget is about US \$6 million per year.

OTHER BODIES

Council of Scientific & Industrial Research (CSIR)

In addition to financially supporting several ad hoc research schemes in fisheries, it also has three national level Institutes viz., National Institute of Oceanography, Goa (NIO), Central Salt and Marine Chemicals Research Institute, Bhavanagar and National Environmental Engineering Research Institute (NEERI),

Nagpur which have major fish and fishery related involvement. Establishment of NIO is the direct result of the International Indian Ocean Expedition (IIOE) conducted during 1960-65 jointly by several Asian, European, American and Russian Research vessels.

Agricultural Universities

Of 26 State Agricultural Universities (SAU) under State Government administration (with about 15 to 60 per cent of their budget coming from ICAR), several have developed Fisheries Faculties/Departments/Divisions. Some of the major Agricultural Universities with fisheries programs are:

- SAU, Karnataka (Mangalore)
- SAU, Tamil Nadu (Tuticorin)
- SAU, Kerala (Cochin)
- SAU, Andhra Pradesh (Hyderabad)
- SAU, Assam (Jorhat)
- SAU, Uttar Pradesh (Pant Nagar)
- SAU, Bihar (Pusa)
- SAU, Orissa (Bhubaneswar)
- Department of Ocean Development (DOD)

DOD which was created in 1981 directly under the Prime Minister, deals with ocean related research and development as a catalyst. It supports research by other related organizations. It creates national facilities such as research ships, one of which is operated by CMFRI in a coordinated manner. Fisheries related aspects are included in its programmes on Antarctic Expeditions, ocean surveys (EEZ) and grants in aids for marine research projects especially for island development such as those in Andaman & Nicobar and Laccadives.

Department of Biotechnology

Promoting biotechnology research in several fields, the Department has granted funds for projects on genetic improvement of carps and shrimp productivity enhancement programmes to ICAR Fishery Institutes.

University Grants Commission (UGC)

Over 500 Universities are managed by UGC in the country supporting research in biology with several fishery related projects. Many of these projects have built in collaborative components with ICAR Institutes.

Department of Science & Technology

Through several agencies, the Department supports ad hoc and regular fishery related research in Universities, Agricultural Universities and ICAR Institutes. Currently CIFT is operating a coordinated project on

transfer of fish processing technology to identified groups of women in Kerala with marketing arrangements to make them self supporting.

Indian Institutes of Technology

From among the 5 most prestigious Engineering Institutes in India, 2 of those at Kharagpur, West Bengal and Pawai at Bombay are associated with high-tech research in fishery related fields such as farm engineering and biotechnology of sea weeds.

Indian Institute of Management

The Ahmedabad IIM has developed a separate division exclusively on fishery survey/economics and has participated actively in the R & D of Indian fisheries.

Voluntary Agencies/Private Industry

A large number of voluntary agencies financially supported by the Department of Rural Development, GOI, FAO/CIDA have been active in the field of research on rural aquaculture, on area development basis in Tamil Nadu, Kerala, Andhra Pradesh, Madhya Pradesh, Uttar Pradesh, Haryana, Gujarat, Maharashtra and Rajasthan.

Similarly, Hindustan Lever, Tata, OMCAD, Vorion Chemicals, Therma, Anchor Fisheries have undertaken research components while establishing their aquaculture, feed formulation and fish processing industries.

SUMMARY

The total expenditures for both central and state fishery development schemes, including all development and administrative expenses as well as research is currently about US \$150 million per year. This is roughly a 50 per cent increase in real terms over the amounts spent in 1980.

Figures are not readily available for the expenditures for fisheries research. But the estimates given above for the ICAR institutes (excluding CIFT, NBFGR and NRCCWF) amount of over US \$7 million in the estimated budget for 1989-90. For the ICAR institutes there are authorized positions for 670 scientists, although currently only about 540 of those positions are filled. There are also about 600 technicians and over 700 administrative and support staff.

4. FISHERIES RESEARCH NEEDS

The need for fisheries research in India is examined first with regard to the objectives for the management and development of India's fisheries, second on the basis of questionnaires addressed to the participants in a seminar held by the Mission, and third with regard to evidence of problems and the current status of Indian fisheries.

RESEARCH RELATED TO MANAGEMENT AND DEVELOPMENT OBJECTIVES

In India, fisheries development has three important stated objectives, whether prosecuted in marine, brackish or fresh waters. These are:

- earning foreign exchange
- contributing to food supplies and food security
- provision of employment and increasing earnings

Although the principal objective varies between sectors, research is required to sustain and backstop the development in all sectors. It can be assumed that the objective of the research is to support the achievement of the fishery development objectives, whether through basic, targeted or applied research. With regard to each of the three major objectives, certain subject matter areas can be identified that will be useful in determining research needs.

Export Earnings

Prawn capture: little opportunity to increase catches except possibly in deeper water areas but research will be useful in examining possibilities for capturing prawns at a later stage in their growth cycle when individuals are larger and command higher prices.

Prawn culture: significant opportunities may exist but require research on a variety of aspects. Research on markets is important in view of the likelihood of falling prices.

Tunas: export demand is high and stocks are available to Indian fishermen. Changes in government regulations may be required to facilitate private investment. Although technology is generally available, research may be desirable to increase efficiency of fish catching methods in waters available to Indian fishermen. Opportunities may also exist for tuna and other large pelagic fishing by small-scale fishermen and these opportunities deserve research.

Cephalopods: similar possibilities and research needs exist for cephalopods as for tunas.

Value-added processing: export earnings can be significantly increased by exporting more highly processed products. This applies not only to prawns but also to tunas and cephalopods. Several kinds of research activities are necessary to achieve this.

Employment and Income

Inshore capture fisheries: there is a great need for a wide range of research activities on inshore capture fisheries in order to prevent continued declines in fishermen's incomes. The highest priority research need for capture fisheries, identified at the Seminar (see below), was for the conservation and management of

over-exploited species. It should be noted, however, that in a fully exploited fishery, there is a trade-off between employment and incomes. Greater employment means lower catches per person and lower incomes (if prices do not increase).

Offshore and Deep-sea fisheries: the development of tuna and cephalopod fisheries may provide some opportunities for increased employment and earnings. A major focus for research should be on techniques that are labour intensive and that can employ small-scale fishermen.

Inland capture fisheries: opportunities exist for increasing catches from natural and man-made bodies of water which will help increase employment and earnings. Research to realize such opportunities is necessary, particularly with regard to environmental aspects.

Aquaculture: further development of freshwater and brackish water aquaculture can lead to higher employment and earnings. Research to improve such culture activities is critical.

Processing: research on processing can also help meet employment and earning objectives.

Food Supply

Inland fisheries and aquaculture: opportunities for increased food supplies from inland capture and culture fisheries exist but will require additional research of various kinds.

Stock rehabilitation: increased yields of low priced fish can probably be achieved through better management of inshore stocks. Currently, juveniles and even larvae of commercial species are being taken by trawl nets, set bagnets, prawn seed collectors and other gear. There is an urgent need for research to determine the extent of the losses and ways in which they can be prevented.

Environmental improvements: in some areas, environmental degradation is damaging fish stocks and reducing potential yields. Research in this area is also highly desirable.

RESEARCH NEEDS IDENTIFIED AT SEMINAR

A seminar was held in Madras on 12-13 July as part of the Mission and in cooperation with the FAO Bay of Bengal Programme. There were 20 participants including directors of many of the fishery research institutes, heads of university fishery departments and representatives of the fishery industry. The participants were asked to list their suggestions for research needs. These lists were grouped by major subject. The participants were then asked to rank the items within each subject in order of importance. The ranking follows:

Capture Fisheries

1. Conservation and management of over-exploited species
2. Diversification of fishing methods to tap underutilized species
3. Resource assessment
4. Models for multigear/multispecies fisheries
5. Biology and population dynamics of commercial species
6. Community level participation in Management

7. Vessel development
8. Energy optimization
9. Improving gear performance
10. Improving craft performance (traditional)

Culture Fisheries

1. Seed production technologies
2. Development of culture methods for brackish water species
3. Nursery management
4. Feed formulation and technology
5. Culture methods for seasonal water bodies
6. Captive brood stock development/management
7. Grow-out systems of different intensities
8. Mass culture of live food organisms
9. Wild seed collection regulation
10. Disease prevention management

Extension

1. Transfer of technology: methods & strategies
2. Methods of providing research output to extension service
3. Education and training of fisher folk
4. Participative extension & development
5. End-user oriented extension and analysis
6. Management and enterprise strategies

Post Harvest Technology

1. Product development from conventional and non-conventional species
2. On board handling and preservation systems
3. Shrimp trawl by-catch utilization

4. Market demand analysis including new product acceptability
5. Conversion of low-value fish to high value products
6. Packaging and product presentation

Fisheries Management & Planning

1. Economics of fisheries
2. Economics of aquaculture
3. Improvement in utilization of research
4. Feedback from field to give direction to research
5. R + D Management and strategies
6. Development of fishery forecasting systems.

EVIDENCE OF PROBLEMS NEEDING RESEARCH

A third approach to the identification of fisheries research needs lies in an examination of the evidence of problems in the management and development of fisheries. Such evidence can be found in recent studies and reports on fisheries (eg. IIMA 1989, ICAR 1988, CMFRI 1986, etc.) and also emerged during the mission's interviews and the Seminar.

Capture Fisheries

- *Inshore Marine*

About 99 per cent of the total marine catch is taken in the inshore area (less than 50 m in depth). According to estimates from the State Governments, marine landings for the most recent four years (1984-5 through 1987-88) were 1.698, 1.716, 1.713, and 1.658 million tons. These estimates indicate stagnancy if not decline, in the trends of marine landings. Similarly, prawns which are among the most valuable species landed, also show stagnant or declining trends. For the years, 1984, 1985-6 and 1986-7, the exports of frozen shrimp were 55,000, 50,000 and 49,000m. tons, respectively even though the average unit value of the exports rose by 30 per cent in the three year period.

It is generally accepted that inshore stocks along most of India's coast line are significantly over fished. It is also evident that there are many areas of rising conflicts between fishermen using non-mechanized vessels and those using mechanized vessels, particularly shrimp trawlers. Furthermore, the IIMA noted that there are preliminary indications - that the trawling industry in India's east coast [for fin fish as well as prawns] is discarding about 130,000 tons of fish per year at current levels of fishing activity... (a figure that clearly needs confirmation, IIMA 1989).

The problems of over-fishing are clearly reflected in the high priority given by the seminar participants to research on the conservation and management of over-exploited species and to related topics.

Some research related to these issues has been and is being undertaken by some of the research institutes. CMFRI, for example, has studied the biology of prawn species (i.e., life cycles, growth rates, feeding habits, migratory patterns etc.).

However, such research while important appears to be undertaken in isolation of other research related to the problems of over-fishing. It does not appear to be coordinated with, for example, research on gear selectivity or on the biology of species taken incidentally by trawlers. Some research, such as improvements in high opening bottom trawls, may indeed be counter productive if it leads to additional fishing effort.

In addition, other kinds of research which would be important for dealing with the problems of over-fishing, do not appear to be undertaken at all. This would include, for example, research on the factors affecting the mobility of capital and labour into and out of fisheries; the development of bio-economic models specific to the prawn fisheries; the consequences of motorization of country craft; techniques and technologies for increasing age of prawns at first capture; etc.

Several points need to be noted. One of these is that India is not alone in the lack of attention accorded to some of these topics. Awareness of their importance is just emerging. A second point is that steps are now reportedly being taken that will facilitate multi-disciplinary, problem-oriented research. ICAR will now allocate funds on a project basis and will monitor each project. In addition, ICAR institutes are now required to include economics and policy planning in their programs.

- *Offshore Fisheries*

The offshore stocks beyond 50m in depth currently produce very small catches. The potential yield, however, is estimated to be very high. For the whole area from the coast to 200m in depth, total potential yield has been estimated at 4.5 million tons, of which 500,000 is for oceanic pelagics. For the area between 50 and 200 m, the potential has been estimated at 2.2 mil. tons.

This widely quoted estimate has attracted considerable attention and stimulated the adoption of several schemes designed to encourage commercial development; with a notable lack of success.

Several different research institutes have responsibilities for the conduct of research designed to support the development of offshore fisheries. The Fishery Survey of India (FSI) is the nodal organization for the survey and assessment of marine fisheries in the offshore, deep sea and oceanic waters. It also has the mandate to assess the suitability of different types of craft and gear for deep sea and oceanic fishing.

The Integrated Fisheries Project (IFP) has carried out extensive exploratory and experimental fishing operations along the continental shelf and slope up to 250 fathoms along the south-west and south-east coasts.

The Central Marine Fisheries Research Institute (CMFRI) has the responsibility to assess the underexploited and unexploited marine fisheries resources of the Exclusive Economic Zone.

Recently, the Marine Products Export Development Authority (MPEDA) has been appointed a nodal agency for Joint Ventures in Deep Sea Fishing. (IIMA 1989). This is not, however, a research function.

It might be noted that FSI is within the Ministry of Food Processing Industries; IFP is within the Ministry of Agriculture; CMFRI is part of ICAR; and MPEDA is in the Ministry of Commerce.

These various kinds of activities, which include surveys as well as research, are quite costly and involve a large number of vessels. The FSI has 12 vessels over 30m in length; CMFRI operates two large vessels- one of 32.6m OAL and the other 71.5 m OAL; and IFP has a fleet of five experimental fishing vessels, 17.5-28m. in length.

Not all of these vessels, of course, are fully engaged in activities designed to lead to the development of the offshore stocks. Nevertheless a considerable proportion of their time is devoted to this objective.

A major difficulty is that the commercial feasibility of harvesting the offshore stocks has not been demonstrated. At a recent seminar several of the participants emphasized the need for commercial feasibility studies. (CMFRI 1987). For example, it was stated that, with regard to the unexploited offshore stocks, no systematic study has been made to obtain the most valuable fishery resources information, which comes from actual fishing and advantageous disposal of catch and which would provide data not only on the quantity and the quality of the resources available in a particular but also on the fishing cost and the comparative economic return. Economic assessment of the fishery resources potential is very important and requires to be considered on a priority basis... (K. Chidambaram, 1987).

The CMFRI Seminar adopted several recommendations aimed at resolving deficiencies in the research and difficulties in the research process. The recommendations called for pooling of vessels and manpower and the development of a co-ordinated action plan; simulated commercial fishing that would demonstrate economic viability; development of a viable marketing system and consumer acceptance for the largely unconventional resources, incentives for scientists to participate in the cruises of research and survey vessels, such as hardship allowance or Triple Daily allowance; a multi-disciplinary approach and an organizational set-up involving different sectors; and the development of a pragmatic national policy.

• *Inland Capture Fisheries*

Currently, it is estimated that riverine fisheries produce about 25,000 tons of fish and reservoir fisheries from 40-50,000 tons. Such estimates, however, are extremely difficult to obtain and may, therefore, be of questionable accuracy.

There are reportedly 29,000 km of rivers that could be used for fishing and 1.45 million ha. of reservoirs. According to these estimates, rivers produce about one ton of fish per kilometer per year and reservoirs about 30kg/ha/year.

There are a number of serious impediments to the further development of inland capture fisheries. These include insufficient supplies of seed for stocking; pollution; the use of water bodies for irrigation and hydroelectric power, not entirely compatible with uses for fisheries; ineffective enforcement of regulations; and unsatisfactory leasing policies.

The Central Inland Capture Fishery Research Institute (CICFRI) is undertaking extensive research, mostly on population dynamics and other biological aspects and to some extent on problems of pollution.

Questions can be raised about the allocation of research effort to this sector. CICFRI has about half the manpower and budget of CMFRI whereas the estimated production from inland capture fisheries is less than one-twentieth of that from marine capture fisheries. CICFRI has about twice the manpower and budget of the Central Institute of Freshwater Aquaculture (CIFA) even though inland capture fisheries produces only a small portion of the amount produced by freshwater aquaculture.

The 1989-90 budget for CMFRI amounts to about US \$1.60 for every ton of marine catch. For CIFA it was also about US \$1.60 for every ton of fish produced by freshwater aquaculture. But for CICFRI, the amount was about US \$20 for every ton of inland fish captured.

This comparison is not entirely appropriate since research expenditure should not necessarily correlate with sector production. Indeed, some of the problems with which CICFRI deals, such as pollution of rivers and reservoirs, are of importance to other sectors as well as to fisheries and its budget should be evaluated in broader terms than those of inland fisheries production. Furthermore, research expenditures should relate to potential for increase in production (which is fairly large in inland waters) rather than current amounts.

Nevertheless, the budget appears to be disproportionate relative to those of other institutes. In addition, the kinds of problems facing inland capture fisheries are essentially of an institutional and policy nature. There is a need to adopt more effective regulation, improve leasing policies, analyze multi-sectoral use of water bodies and improve enforcement capability. Increased emphasis on social and economic research would be beneficial in dealing with these issues.

Culture Fisheries

• *Freshwater Aquaculture*

Freshwater aquaculture in ponds and tanks has been traditionally practised in India for many years. It has been a simple system making use of wild seed and naturally available feeds producing yields of 50-400 kg./ha./yr.. There are no estimates of the number of hectares under production using the traditional methods.

Semi-intensive freshwater aquaculture systems were developed and demonstrated by the All India Coordinated Research Project on Composite Fish Culture and Fish Seed Production during 1971-1980. These paved the way for taking up development projects and the initiation, in 1973-74, of the programme of Fish Farmers Development Agencies (FFDA's) at district levels in different states of India. This program has been successful in increasing yields from 582 kg/ha/yr in 1979-80 to an average of 1566 kg/ha/yr (with ranges from 400-500 kg/ha/yr in Gujarat, Maharashtra, Karnataka and Rajasthan to 2500 kg/ha/yr in Haryana and West Bengal). Presently, there are 185,000 ha. of water area under this program indicating a total production of 290,000 tons of fish/year.

The potential production from freshwater aquaculture is quite large, through both extensification and intensification. A four-fold increase in total output could be achieved by increasing the area under production to 250,000 ha. and by increasing average yields to 5 tons/ha/yr.

To increase the extent of area under production, the primary requirement is for increased extension work and technology transfer. Another critical task, applying to both extensification and intensification, is improvement of leasing policies. Such policies differ widely among the different states but in many cases, a major impediment is lack of sufficient tenure, in terms of number of years, to allow for a satisfactory return on the capital investment that is required. In addition, with short term tenure, banks are unwilling to provide credit.

A related and particularly critical difficulty is that of the social tension that results from privatization of the tanks and ponds. Fish culture rights are provided to individual farmers, generally with very low rental fees. In some cases, the ponds are privately owned. But in other cases, they are owned by the community and used for a variety of purposes in addition to fish culture.

In the process of ... privatization of the resources, a conflict gets generated between the owners of the resources (community bodies) and those who are the beneficiaries of privatization. While the community members at large are deprived of access to these resources, they stand to benefit very little by way of lease rent. Similarly, where other dominant communities in the village observe the profits of fish aquaculture, they also begin to create problems for the poorer fishermen who were given the ponds and the tanks earlier. Thus, in the process of accelerating production by privatizing community resources, new social tensions are introduced... The common villager does not understand the concepts of ownership of a pond or proprietary rights of a pond. Further, villagers have free access to ponds as it is used for other purposes also. The pond is considered as a common property with the fish farmer having temporary rights to fish. This leads to temptation for poaching when the pond has a good stock of quality fish. Roughly 45 percent of the ponds were affected by poaching. (IIMA 1989). Undoubtedly, such social tensions also impede the extensification of aquaculture into new ponds and tanks.

In addition to the problems mentioned above, freshwater aquaculture requires research on several other matters. However, since these are generally related to both freshwater and brackish water aquaculture, they are discussed below in a separate section.

- *Brackish Water Aquaculture*

Brackish water aquaculture, particularly for prawns, has been of strong interest in India for many years. This interest led to the establishment of the Central Institute of Brackishwater Aquaculture (CIBA) in 1985. A current proposal for the 8th Five Year Plan calls for a development program of US \$180 million.

At present, only about 50,000 ha of brackishwater ponds are being used for shrimp culture. For the most part, cultivation is through the traditional filtration system which produces low yields of about 3-500 kg/ha/year. In comparison, yields in Taiwan and Japan amount to more than 6000 kg/ha/yr.

The potential for development in India is large. An additional 100,000 ha. have already been identified through site surveys as being suitable for prawn farming and a total of 900,000 ha. has been estimated as potentially suitable. Adoption of semi-intensive cultivation practices could greatly increase average yields.

However, the realization of such potentials is impeded by a number of factors. These include the lack of seed and feed, problems of leasing policies, the need for improved engineering and technology, insufficient supply of trained extension workers, etc. Some elements of these, as discussed below, could benefit by improved research efforts.

Another problem, which has just recently emerged and which may have considerable impact on future development activities is that of the possibility of decreasing shrimp prices in the world market. Ecuador, Taiwan and several other countries are rapidly increasing their production from shrimp cultivation which already appears to be placing a downward pressure on prices. If this trend continues, it will affect marginal producers (and may also affect capture fisheries).

- *Freshwater and Brackishwater Aquaculture*

In addition to the above problems, research would be desirable on a number of aspects that are important for both freshwater and brackish water aquaculture.

- (i) Pond dynamics, water quality and pollution.

The tropical aquatic environment of ponds, tanks and impoundments, both freshwater and brackishwater, need in-depth studies on the mechanism of nutrient sedimentation and its release for enhancing bioproductivity and optimising the results of applied inputs. There is need for standardising the assessment techniques for water quality and pollution load characterisation for culture environment of different systems and commodities.

- (ii) Aquaculture engineering.

Development of technically and economically feasible methods of drainage, seepage, silt removal, selective harvesting, would be needed. Cost-effective design and construction guidelines for new systems are needed for more efficient management and increased productivity. Rehabilitation of acid sulphate soils for brackishwater farming needs site specific treatment and development. Site selection criteria, design and construction guidelines are needed for cage and pen culture as well as for sea farming.

- (iii) Controlled breeding and seed production.

Controlled reproduction of a number of species is yet not achieved. Raising of spawner and brood stock management would need major research support for the study of reproductive physiology. Investigations are needed on factors controlling maturation and spawning, acceleration of sexual development, etc. to maintain greater control over breeding. Ecophysiological aspects of breeding need study for the creation of conditions conducive for spawning.

(iv) Genetic research.

The research methodology for genetic improvement of stocks of cultivated finfish, shellfish and molluscs needs development. Assessment of available genetic resources would be a primary requirement for the development of stock improvement programmes. Methods for the assay of manipulatory techniques for stock improvement such as gynogenesis, polyploidy, etc. would be needed.

(v) Nutrition and feed formulation.

Research is needed to study the nutritional value of natural feeds in nursery and growout systems. Nutritional requirements will need to be assessed for various life stages of different cultivated commodities for proper feed formulation. Research is necessary for the assessment of the nutritional values of locally available ingredients for the formulation of cost-effective supplementary and balanced feeds for different life stages of cultivated species. Standard methods need to be developed for nutritional analysis.

(vi) Fish health management.

Systematic research is needed on diseases and their causative factors for different commodities. Diagnostic procedures along with preventive and immunoprophylactic measures for the control of diseases need to be developed. All these would need similar methodology and approach although their application may be commodity or site specific. Research is necessary to standardise health monitoring methodology and management techniques especially for intensive production systems.

(vii) Social and economic aspects.

Many of the major issues are social and economic in nature. The problems of conflict resulting from privatization have already been mentioned. In order to deal with these, research is required to develop programs that will facilitate improved aquaculture while protecting or enhancing the welfare of the weaker sections of the community. With regard to prawn culture, research is required on global market conditions; the net benefits to the economy of investments in culture programs; the distribution of benefits among farmers, the community and society as a whole; and the effects of prawn culture development on production of fish for low income consumers.

- *Research Effort*

Several research institutes are, to a greater or lesser degree, capable of dealing with most of the various kinds of research tasks mentioned above. These include, CIFA, CIBA, CMFRI, CIFE, the National Research Centre for Cold Water Fisheries and the National Bureau for Fish Genetic Resources.

One of the difficulties is that a high degree of coordination is required in order to avoid duplication and diffusion of effort among the many institutes involved. Some of the research at CMFRI and CIFE falls directly within the mandates of CIBA, CIFA and NBFGR. For example, for the 8th Five Year-Plan, CIFE proposes undertaking research on fish reproductive physiology, genetics and breeding and fish digestive physiology, nutrition and feed formulation.

CIFE concentrates on student research under guidance of the staff. It is stated that the areas of research will be carefully and tactically selected to provide a Sound Science and Technology back up of higher knowledge and specific problem solving to supplement the efforts of sister fisheries institutes involved in their pursuit of applicable research in technology development, without any duplication (Anon. 1989).

The distinction between basic and applied research, however, are not entirely clear and several of the topics being explored by CIFE might properly be called applied while some of those of CIBA, CIFA and NBFGR tend toward the basic side.

Although duplication of effort might be reduced by effective coordination among the institutes, there may still be a weakening of research effort by the diffusion of scarce scientific man power.

SUMMARY

There seems to be one theme that runs through all the foregoing discussion of research needs. It is that the most pressing problems facing improved management and development of Indian fisheries appear to be of an institutional, economic and social nature rather than a technical one. This includes such problems as:

- improved management of inshore coastal fisheries
- reduction of conflict between large scale and small scale fisheries
- rehabilitation of overfished stocks
- reduction or better use of trawl by-catch
- establishment of satisfactory leasing systems for culture fisheries, both in inland and brackish waters
- controls to prevent environmental degradation
- demonstrated economic viability of offshore fishing
- ineffective enforcement of regulations

Looking into the future, over the next 10-25 years, it seems clear that these kinds of problems will become increasingly severe. It can be anticipated that the trend of rising real prices for fish products will continue, as growth in demand continues to outstrip growth in supply. As the prices of fish rise more rapidly than the costs of fishing, there will be increased pressures on the stocks with the likelihood of increased overfishing and conflict. Higher prices will also stimulate greater production from aquaculture but if leasing policies remain unsatisfactory, may also contribute to social problems. Problems of meeting the needs of low-income consumers can also be expected to increase.

In dealing with these problems, research can have an important role to play, even though the problems must be resolved by those responsible for fisheries management and development. The research required for these kinds of problems requires inputs from social and economic analysts as well as from scientists in the harder disciplines. The studies must be inter-disciplinary and problem oriented, making use of a systems approach.

It is noteworthy, in this regard, that India is taking important steps along these lines. As noted above, the ICAR research institutes are now required to include economics and policy planning in their programs, and research funds will be allocated on a project basis.

The project orientation will, of necessity, incorporate targeted innovative research since many of the problems that must be dealt with will require new approaches and methodologies. For example, improved management of inshore fisheries can only be accomplished with the involvement of the fishermen and fishing communities. More effective fishermen involvement will, in turn, require innovative research on the communities and the possibilities for collective action within the context of local social and cultural rules and traditions. Innovative research of a multi-disciplinary nature will also be necessary for dealing with the problems of improved management of the coastal zone. The increased emphasis on project orientation, however, should not diminish the importance of continued basic research since this is critical for providing a foundation for scientific advancement.

5. THE RESEARCH PROCESS

Three elements of the research process were examined by the mission: (a) the formulation of research agendas; (b) the conduct of research; and (c) the application of research results.

THE FORMULATION OF RESEARCH AGENDAS

For the institutes within the ICAR framework, there is a complex system for the preparation of research agendas. This system has undergone several changes within recent years, which further complicates the task of analysis.

Most of the ideas for research are initiated by the scientific staff and the officers of the research institutes with only occasional direction coming from outside. The research proposals are reviewed by a Research Advisory Committee and, subsequently, by a Staff Research Council (SRC). The SRC is chaired by the director of the Institute. It is expected to review the progress of the ongoing projects, approve the programmes, carry out review of the completed projects, identify areas and formulate new projects (ICAR 1988).

In addition, each Institute has a Management Committee. This is also chaired by the Institute director and has representatives from ICAR headquarters, the Institute's scientists, research establishments and user departments in the region. It conducts a broad review of all of the work of the Institute, but has only recommendatory powers.

The ICAR has established eight Regional Committees. Each of these is chaired by the Director-General of ICAR and its members include directors of the Institutes within the region, as well as representatives of development councils, State Agriculture Universities, State Development Departments, etc. In addition, a number of farmers are appointed to serve on the Committees.

The functions of the Regional Committees are to review the status of agricultural research and education in the region and to analyze, discuss and make recommendations on location-specific problems. These Committees meet once a year.

At the level of ICAR, there is a Governing Body which is the chief executive and decision making body of the Council. On top of that is the supreme body of the ICAR Society which is designed to provide broad policy guidance for the ICAR.

Finally, each Institute is supposed to be examined every five years by a Quinquennial Review Team (QRT). The QRT is intended to provide a thorough review and critique of the Institute's work. It is intended as a peer review and, therefore, is made up of members from other similar research and education bodies.

The research ideas are developed into research projects, generally on a five year basis. In this process, each of the above bodies has some degree of influence. Ultimately, of course, the research agendas must conform to the funds allocated to the Institute.

There are several possible sources of difficulty in the process of developing research agendas. For one thing, the process seems unduly cumbersome. A plethora of committees and councils has been involved in setting directions and reviewing proposals. This has not only put a heavy burden on the individual researcher to prepare for the reviews but has also led to a diffusion of advice with the result that very little direction may actually have been given.

The individual scientists have, therefore, been largely relatively free to choose their own topics. When this occurs, there is a tendency to select narrowly focussed subjects which can be investigated for the primary

purpose of publication, as a means for justifying promotion, rather than for the purpose of producing improvements in fisheries management and development. Current changes in the formulation of research proposals will, it is expected, reduce some of these problems.

The inclusion of the users of research results in the process of formulating research agendas is an important element in ensuring research relevance. In the past, research users have had little influence on the direction of research and, with some exceptions, the researchers at the Institutes have been largely isolated from the industry and the fishermen. With regard to the potential development of deep sea resources, the IIMA noted that there is a need for cooperation of the Research and Survey Institutions and the Industry (IIMA, 1989).

As a general comment, the IIMA stated that it is important that the research should be directed to solve both immediate and the long range problems of fishing industry. The industry should...be made to actively participate both at the planning and execution stages of the research programmes (IIMA 1989).

With regard to small scale fisheries, which produce two-thirds of the marine catch and employ perhaps 80 per cent of the marine fishermen, there is very little evidence of research directed towards their needs thus far, although this is likely to change with the inclusion of economists and policy analysts on the staffs of the Institutes.

The inclusion of economists, policy analysts and sociologists on the various advisory committees and councils would also be helpful in the formulation of research agendas. The transfer of technology, for example, will not occur unless the technology is economically and commercially feasible. An economist's view of a research proposal can be helpful in avoiding wasteful projects or in suggesting modifications that would enhance the likelihood of success.

Similarly, research projects, particularly with regard to vessel and gear technology, may have successful outcomes for the target fishermen but could also produce secondary effects damaging to other fishermen or to the community welfare. Thus it would be desirable for a sociologist to have the opportunity to screen research proposals.

Another possible source of difficulty is that of the large number of institutes involved. With seven ministries and more than twelve institutes with an interest in fisheries research it is difficult to plan effectively and avoid overlap in the formulation of research agendas. A high degree of coordination is required, which might best be handled by the creation of a centralized ministry of fisheries.

THE CONDUCT OF RESEARCH

With regard to the conduct of research, it appears that it is generally of high quality. Scientists are generally well (though perhaps narrowly) trained and laboratories are usually well equipped. Certainly no other developing country has as large and as competent a group of fisheries scientists as India.

As shown in Table 1, there are over a dozen major institutes and centers dealing with fisheries research within the national system. Most of the Institutes also have regional centres and, in addition, fisheries research is also carried out at several State Agricultural Universities.

The Institutes together with FSI have a total of fifty vessels for research, survey work and training on fishery matters. Several of these are large, modern and well equipped.

While the quality of the equipment is good and the competency of the scientists is high, there are certain elements that may impede more effective implementation of research. One of these is the challenge that the large number of centres poses for the coordination of research, several of which have been created in recent years. As noted by the ICAR Review Committee, the proliferation of institutes has led to a considerable

duplication in the research work being carried out by the former and new Institutes. This leads to unnecessary wastage of our scarce national resources. We feel that there is an urgent need for the ICAR to take a fresh look at the mandate of each of our Institutes and take measures to suitably modify the mandate of the former Institutes in the light of the establishment of the new Institutes (ICAR 1988). Although steps along these lines have recently been taken with regard to the ICAR fisheries Institutes, the problems of coordination are not easy to overcome in view of the number of ministries and institutes involved.

Aside from the problems of overlap, it seems that much of the research being undertaken is fairly narrow in scope and mono-disciplinary in nature. In all countries throughout the world, it is traditional that persons trained as biologists or zoologists have dominated the administration of fishery research institutes as well as fishery departments. Frequently, the basic training for these administrators has been in methodologies formulated in developed countries for temperate zone fisheries. This has contributed to a narrow approach to fisheries research and fisheries management and development. India does not appear to have escaped this tradition, although it seems clear that efforts are currently being made to broaden the approach.

Broadening the approach may also benefit from greater exposure to new developments occurring outside India, particularly in areas of fish culture and processing. Industrial technologies in other countries, especially those related to food packaging, are advancing rapidly and new machinery and materials are being introduced. In order to ensure the success of the processing industry and to maximize returns from a limited resource base, India needs to take up these new technologies. It would be advantageous if there were more opportunities for the younger research workers, who are charged with assessing the technologies, to view them at first hand through overseas visits. Study of the machinery, materials and finished products would give them a better understanding of the market requirements the Indian products must meet.

APPLICATION OF RESEARCH RESULTS

The mandate of the research institutes with regard to the application of research results is not entirely clear. The stated policy appears to be that the ICAR institutes should be responsible only for research, graduate education and extension education. Direct field-level extension should be the responsibility of the development departments of the Central and State Governments, and the ICAR and the State Agricultural Universities should be involved only in the first-line extension activities and in educating and training the extension workers of the state agencies and farmers (ICAR 1988).

However, some of the institutes appear to have among their aims a more direct involvement in the transfer of technology. CIFT, for example, has the aim of extension of useful research findings to the actual users throughout the country (CMFRI 1987). CMFRI has the stated objective to conduct transfer of technology. CIFE has the objective to demonstrate on a limited scale the proven technologies developed by the ICAR fisheries Institutes.

The major responsibility for the application of research results lies with the agricultural extension services which operate out of the State Agricultural Universities. The extension workers, however, generally have extremely large areas to cover, are not often equipped with transport means, even bicycles, and are not particularly well trained especially in fisheries.

In addition to the general extension workers, other groups are being used to transfer technology. These include the Brackishwater Fish Farmers Development Agency (BFDA), the Fish Farmers Development Agency (FFDA), The Farm Science Centres (KVK), the Trainers Training Centres (TTC) and the Lab-to-Land Programmes. The last mentioned were organized in 1979-80 by ICAR for the purpose of directly transferring technologies developed at the Institutes to the users.

There are, in addition, certain non-governmental operations engaged in technology transfer. There are several NGO's working directly with fishermen, especially the small-scale fishermen using non-mecha-

nized craft. Although they are not generally engaged in research they are capable to taking research results produced by others and getting the fishermen to put them into practice.

Finally, the FAO Bay of Bengal Programme (BOBP) is operating on the east coast of India as well as within other countries in the region. This Programme, funded by Sweden and Denmark, is directly focussed on, and limited to, the small-scale fishing sector. It has undertaken a number of projects experimenting with improvements in gear and craft technology, all of which have directly involved the fisherfolk.

The work of the NGO's is generally effective in transferring technology, although there is sometimes a long learning process in working out the most acceptable technology. The chief drawback of the NGO's, however, is that they do not have sufficient manpower to work in more than a few villages, so that the total effect is limited.

The work of the BOBP is also very effective, although it is limited to the east coast of India. Its effectiveness lies largely in the involvement of the fishermen early in the stage of the research and throughout the research process. The experience has shown that success requires sustained and intensive effort by the workers over a period of many years.

With regard to the government research institutes, however, there appear to be a number of problems impeding successful transfer of research results. One of these, noted above, lies in the inadequacies of the State extension services. In addition, there appears to be very few linkages between the research institutes and the extension services except in a few cases where direct links have been set up, as in the case of CIFA working directly with FFDA on carp seed production and carp culture. The absence of direct linkages between research producers and those responsible for transferring the results into practice operates as a severe constraint to transfer.

Direct linkages between researchers and users of research also appear to be very weak. In large part, this may be due to the lack of relevance of the research to the fishing industry. As stated in the report of the 3rd QRT on CIFT (1989), the present system of project formulation, approval and monitoring by the Research Advisory Committee, Staff Research Council and Management Committee has not served the purpose as the dissatisfaction of the major users indicates.

With regard to marine fisheries, the IIMA stated that it was pointed out that at present none of the fishery surveys conducted so far have established commercial viability of any of the fisheries to facilitate investment. Although this statement may be exaggerated, it does raise the question as to whether the extremely high cost of conducting the surveys have produced commensurate results.

With regard to shrimp processing, although there has been considerable research on processing technologies, despite thirty years experience, India is still exporting frozen shrimp which form the raw material for the reprocessing factories in developed countries (IIMA 1989).

6. SUMMARY AND CONCLUSIONS

India faces considerable difficulties in the development and management of its fishery resources for a variety of reasons. The Indian subcontinent covers a vast region with long coastlines and different ecosystems, both on land and in the sea. The fishery resources are diverse, as are the fishery technologies and systems. Small-scale fishermen operate from thousands of landing places along the beaches and live within socially and culturally disparate communities.

Responsibilities and programs for fisheries management and development are split between the national government and state governments which differ in their policies and approaches. National policies have largely been export-oriented, supporting relatively large-scale fisheries for shrimp. For many of the states, the primary concern is for the welfare of the small-scale fishermen using non-mechanized craft.

These difficulties also affect programs for fisheries research. Research directions formulated at the national level cannot always be fully relevant to the problems at the regional and state levels. The size of the research establishment, which is necessary to deal with the range of issues, makes coordination of research a difficult task. The large number of fishermen living in communities scattered along the extensive coastlines, using diverse gear for a wide variety of species presents major difficulties for data collection.

In view of these complexities, it is not surprising that the Mission found some areas where the research process could be improved. The most important of these is that, with a few notable exceptions (e.g., research on inland aquaculture), there could be considerable improvements in the relationships between the fisheries research institutes and the research users. This refers both to the formulation of research agendas and the application of research results two sides of the same coin.

In addition to these difficulties specific to India there are also difficulties of a more general nature. Significant changes are taking place in the characteristics of fishery problems which are moving from an expansionist phase with opportunities for increased investment in fish harvesting to a management phase where control over investment is necessary and aquaculture is growing in importance. As this occurs, major changes and readjustments are required for research programs.

In the past, research was focussed on export commodities, the development of large scale operations and technologies for improving fish harvesting capacity. Training and education has largely been devoted to these objectives with an emphasis on such skills as the assessment of stocks and the transfer of technology from developed countries. In general, it can be said that research in developing countries has tended to imitate research in developed countries, even though the conditions and constraints to fisheries management and development are quite different.

The past approaches are not adequate to deal with the changing problems and new perceptions of the critical issues. Among the most important needs for the future is research on the social and economic aspects of fisheries and an increased emphasis on the problems of fishermen and fishing communities. Three areas can be singled out as of particular and immediate importance:

- Improved management of fisheries is critical. The condition of open access in marine and inland capture fisheries is the major reason for depletion, economic waste and conflict among user groups. Without adequate control over access, these consequences will become increasingly severe. Research is fundamental for the formulation of management practices suitable for the specific situations. This requires a sound understanding of the economic forces that are at work and of the social conditions within fishing communities and groups of fishermen.
- With regard to the further expansion of aquaculture, the critical constraint is the lack of effective and equitable leasing policies and arrangements. Social and economic research is necessary for the

formulation of measures to reduce conflict over fisheries use rights to inland water bodies and to allow for efficient investments in development.

- The rise in the real prices of fish products due to the scarcity of supplies has important implications for low-income consumers as well as for fisheries management. This calls for research on national food policies including policies with regard to exports and subsidies for export commodities. The social and economic consequences of alternative policies need to be examined.

These issues are common to many countries. Only a few of them, however, have, like India, taken steps to deal with them. The requirement for each of the ICAR fisheries research institutes to include economic and policy research is an important initiative.

Through the implementation of such an initiative, the institutes should be in a better position to work with the research users in the formulation of research agendas and to be more responsive to the needs of the fishermen and the industry. With the social scientists acting as a kind of conduit from the users to the institutes, a bottom-up approach to the setting of research agendas will be facilitated and the relevance of the research will be improved. Simultaneously, there needs to be an improvement in the conduct of innovative targeted research which is essential for advancement in fisheries management and development within the special conditions and needs of the Indian situation. Here again ICAR has taken an important initiative in the decision to allocate research funds on a project basis.

Such changes in approach are not trivial. They have significant implications for the research process and will require new directions in the administration and the conduct of research.

Finally, for research to be used effectively, it must be recognized that it is only part of a much larger set of issues within the overall objective of achieving effective fisheries management and development. These issues involve many players outside of the research sector and they require such institutional and organizational changes as the provision of satisfactory use rights for both capture and culture fisheries, decisions on the allocation of use rights, removal of bureaucratic impediments to action and the devolution of fisheries management authority to local levels. Without such changes the value of research will be greatly reduced.

**Fisheries and Aquaculture Research
Capabilities and Needs in Asia:
Studies of Thailand, Malaysia,
Indonesia, the Philippines,
and the ASEAN Region**

MISSION:

18 July - 11 August 1989

MEMBERS:

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PART A. BACKGROUND AND SITUATION ANALYSIS

1. THE ORGANIZATION AND CONDUCT OF FISHERIES RESEARCH AT A NATIONAL LEVEL IN THE ASEAN REGION

The mission referred to in this report was undertaken as part of a comprehensive Study of International Fishery Research (SIFR), in developing countries. The objectives of the SIFR are to determine:

- (i) the priority needs for fisheries and aquaculture research;
- (ii) the present capacities of developing countries to undertake the research that is needed; and
- (iii) the ways in which donors could contribute effectively in supporting desirable investigations

This mission report has been written for the information of the SIFR Study Team. It takes a critical look at ongoing national, regional and international research efforts, attempts a qualitative assessment and suggests priorities. The criticism should not be construed in a negative sense but as an identification of issues. Within the time available there was no opportunity for an in-depth analysis and so many of the positive elements in the various research programmes are not documented.

In the four ASEAN countries visited, the responsibility for the organization and conduct of research in fisheries varies from one country to another. However, in all cases, whether responsible for research or not, the fisheries departments come under the ministry of agriculture. This predominance of agriculture, and the attempted application of agricultural production models to fisheries, is considered in more detail elsewhere in the report but it is evident that it has constrained the development and particularly the management of fisheries. As a small and often neglected part of a large ministry, fisheries professionals, both in research and administration, have had difficulty in making their voices heard. In all the countries there is adequate justification for the establishment of separate fisheries ministries. The high foreign exchange earnings from exports, which now top US\$2.5 billion for the four countries, and the importance of fish in the traditional food supply, where it accounts for more than 50 percent of animal protein, would both support a more prominent role for fisheries in government. Sustaining the high export earnings as well as increasing domestic consumption, which is an objective of all Government plans, must be back-stopped by adequate research.

The overall impression, stemming from unsatisfactory management and uncontrolled development although with some encouraging exceptions, is that national research commitments and performance are not sufficient to meet the needs. The possibility for research cooperation between the countries of ASEAN, which are linked through political and economic objectives, is obvious. However, regional research efforts seem not to have taken off perhaps due to the lack of a fully effective mechanism for funding and coordination with ASEAN. There is a growing pursuit of a common objective and a desire to share resources among fishery administrators. The region's research scientists are anxious to cooperate in this.

THAILAND

The Department of Fisheries (DOF), which comes under the Ministry of Agriculture and Cooperatives, has the major responsibility for the conduct of research to back its own mandate for the management and development of fisheries. A generalized evaluation is that although the research is being conducted the results are not always being properly used to formulate management policy by the DOF. The particular

example is the degree of overfishing in the Gulf of Thailand. The administrators' complaint seemed to be the scientists do not give us the results we want. A number of interpretations can be put on this but it should be noted that the total commitment to research is about ten percent of the DOF budget. The DOF also has the responsibility for extension services and enforcement.

The structure of the DOF is diffuse with a Director General responsible for nine separate divisions. Those responsible for research include:

- the Marine Fisheries Division with HQ in Bangkok and research centers to cover the Eastern and Southern Gulf of Thailand and the Andaman Sea
- the Fishery Technological Development Division responsible for post harvest research and development
- the Inland Fisheries Division
- the Distant/Foreign Fisheries Division
- National Inland Fisheries Institute
- the Brackish Water Fisheries Division
- National Institute of Coastal Aquaculture (Songkhla)
- Phuket Marine Biological Centre

The involvement of universities in research is not large. The universities are controlled by the Bureau of University Affairs but draw their research funding from the National Research Council under the Ministry of Science, Technology and Power. Chulalongkorn University has the strongest programme in marine and brackish water research, Kasetsart University specializes in inland fisheries research and the Prince of Songkhla University in lake fisheries. Srinakharinvirot University has a Marine Science Centre, in Bangsan Choburi Province, which undertakes basic research. The Institute of Food Research and Product Development of Kasetsart University and the Agro Industries Department at Prince of Songkhla University are involved in post-harvest research.

All of the universities work closely with the DOF but some strains are apparent, mainly due to lack of DOF funding for university research. It was interesting that the universities visited commented that graduates had no difficulty in finding employment especially in the booming aquaculture sector; however, their research was being seriously constrained by lack of funds. This results in almost no long-term research, except where external funding is available such as in the ASEAN/Australian Coral Reef Project.

Formulation of Research Programmes

The DOF and the universities both seem to suffer the same deficiencies in the formulation of research programmes. Although these should reflect the priorities in the national plan there is very little coordination and, in the absence of guaranteed funding, long-term programmes are not possible.

Within the DOF, research projects are identified by staff at the section level in response to problems that are apparent. Thus, they are almost invariably short-term ad hoc responses. There are opportunities for discussion with the private sector and other ministries at annual meetings but there is no direct involvement with industry in setting priorities or conducting research.

Projects resulting from the formulation process are submitted to the Budget Bureau of the Office of the Prime Minister which clears the budget prior to submission of the whole research package to Parliament. Extra budgetary projects also have to be cleared by the Department of Technical and Economic Cooperation. Guidance is provided by a policy oriented Science and Technology Development Board.

Implementation of Research

The research community in Thailand struggles to implement their programmes with little encouragement or incentive. Salaries are relatively low and prospects limited. Although there is a good cadre of staff in all the institutes visited, there seemed to be little stimulus to implement programmes, except in aquaculture research and some notable personal initiatives. As the publications are almost exclusively in Thai, it is difficult to evaluate implementation; however, this coupled with poor access to research information and documentation must result in work already done elsewhere being repeated in Thailand. Conversely, results obtained in Thailand are not used in countries with similar problems.

Application of Results

The lack of action in applying the results of research as management action in the Gulf of Thailand fishery is documented elsewhere. The processes of management and development are unresponsive to research results or to policies that imply that fishery development is a process involving people.

National Research Priorities

The highest priority for new research programmes is aquaculture and within that to water management and feed. The main area of budget allocation is for enforcement, with no increase for capture fisheries.

In the capture fisheries priority attention is being given to artificial reefs in the hope of compensating the coastal community for government inaction in protecting artisanal fishery interests by controlling the trawl fleet.

Research priorities in the post-harvest sector are directed to fresh fish handling, surimi and analogue product development and added value to export products.

The inland fishery priority is for development rather than research although socio-economic research is in progress. Management of inland capture fisheries is restricted to enhancement to compensate for losses due to agricultural and forestry practices.

MALAYSIA

In Malaysia, fisheries is a department under the Ministry of Agriculture. The Department of Fisheries is divided into three divisions: Planning and Research; Management and Development; and Extension and Education. It is also responsible for enforcement. Implementation of marine and inland research is the responsibility of the Fisheries Research Institute, Penang, which operates seven research stations as follows:

- National Prawn Fry Production Centre (Kedah)
- Marine Fish/Prawn Breeding Centre (Terengganu)
- Fisheries Research Centre (Terengganu)
- Freshwater Fisheries Resource Centre (Melaka)

- Fisheries Research Centre (Johor)
- Fisheries Research Centre (Sarawak)
- Brackish Water Fisheries Research Centre (Kuanton)

It is proposed that the Terengganu Fisheries Research Centre will become the SEAFDEC Department of Marine Fisheries Management. The Institute in Penang has three main programmes: Resource Assessment, Aquaculture, and Aquatic Ecology. It is well equipped and well staffed with upgrading of staff being funded by ADB. Nevertheless, there was an undercurrent of dissatisfaction with administrative problems affecting the motivation of researchers and their rewards.

The only post harvest research undertaken by the institute is a project on mollusc depuration. Otherwise post-harvest activities are the responsibility of a corporate body, the Malaysian Agricultural Research and Development Institute (MARDI) with headquarters in Kuala Lumpur and an outstation in Terengganu. MARDI has active programmes on fish quality research.

Research activities involving the universities and the private sector are coordinated at the ministerial level.

Within the university system marine fisheries research is undertaken by the Faculty of Fisheries and Marine Science at Universiti Pertanian Malaysia (UPM). There are four main thrust areas:

- Development of offshore fishing gear
- Coastal oceanography of Malacca Strait and South China Sea
- Fisheries management
- Technological development of aquaculture

Post-harvest research is done by the Faculty of Food Science and Biotechnology, UPM, who are investigating surimi as raw material for fish balls, quality control and live shipment. In addition fundamental studies on catheptic enzymes and histamine formation are under way.

Formulation of Research Programmes

The formulation of research is well organized. Research scientists make an annual submission of research and development requirements through the Fisheries Department to the National Science Council. Both departmental and University proposals are screened by this Council. MARDI responds to industry needs in formulation of research proposals.

Implementation of Programmes

In the Department, Research and Planning Committees monitor progress. Within the Institute the section heads meet on a monthly basis to discuss implementation. Other bodies may be involved in implementation, for instance the site selection for artificial reefs is done in conjunction with fishermen's groups and local government. The monitoring is undertaken by the Institute.

Both the Institute and UPM are involved in externally funded regional projects such as: the ASEAN/Australia Coral Reef Studies, the ASEAN/US Coastal Management Project and Fish Disease Studies with IDRC (UPM will become the centre for IDRC's Fish Disease Network). The scientists valued involvement in these projects highly, both as a source of funds but more importantly for enrichment of their own knowledge and strengthening of personal relationships.

Secure funding and good planning have meant that a balance between short-term applied research and more long-term basic studies can be achieved in Malaysia.

Application of Results

The Institute publishes its results in the Fisheries Bulletin and the Malaysian Journal of Agriculture for the more academic reader while the fishermen have access to extension papers and receive Fishing News twice a year. The universities publish in the scientific literature and make no special attempt to apprise the Department of their results. MARDI publishes reports and extension material.

Although the Department does listen to scientific advice, recently there have been indications that such advice is not having an influence on policy. Malaysia led the region in management with the active involvement of fishery economists in licensing schemes. More recently management has been weakened and extra licences granted for inshore fisheries as well as to foreign vessels working off Kuantan, Sabah and Sarawak.

Priorities

The main priority for the Institute is upgrading staff skills and computer facilities. The highest research priority is given to offshore fishing with aquaculture second. Coastal fisheries are accorded a considerably lower priority as the objective is to encourage coastal fishermen into aquaculture or offshore fishing.

The university is establishing a major 20-year programme to study the monsoon generated ecology of the South China Sea and to evaluate the use of reservoirs for fisheries.

INDONESIA

Indonesia is anomalous in ASEAN terms as fisheries research is the responsibility of an Agency for Agricultural Research and Development (AARD). There are seven Directorates General in the Ministry of Agriculture: Food Crops, Animal Husbandry, Estate Crops, Fisheries (DGF), Agency for Agricultural Education, Training and Extension, Secretariat for Agricultural Mass Guidance and Agency for Agricultural Research and Development. AARD took over fisheries research in 1975 from the DGF which, however, retained resource management within its mandate as well as four fishery development centres. These centres cover freshwater fisheries, brackish water fisheries, mariculture and quality control. There is inevitably a blurring of the line between research and development which results in considerable duplication. The navy has the responsibility for enforcement which effectively restricts the DGF to an advisory role.

Within AARD a Research Coordinating Centre for Fisheries (RCCF) coordinates three research institutes.

The Research Institute for Marine Fisheries (RIMF) (Jakarta) conducts research on biology, stock assessment, ecology, fishing gear, vessels and socio-economics. Post-harvest technology was arbitrarily added to the mandate of RIMF in order to reduce the number of institutes. The Research Institute for Freshwater Fisheries (RIFF) (Bogor) conducts research on freshwater and open waters, lake and river basin fisheries. The Research Institute for Coastal Aquaculture (RICA) (Maras) conducts research on mariculture and brackishwater pond culture.

Within the university system there are 11 universities offering fishery courses. The universities have the responsibility for education, research and extension. Due to severely limited budgets they are generally unable to undertake any research and concentrate on the other activities.

- The five overlapping fishery development centres operated by DGF are:

- Freshwater Fisheries Development Centre
- Brackishwater Fisheries Development Centre;
- Mariculture Development Centre
- National Centre for Fishery Quality Control and Processing Development
- Fishing Technique Development Centre

Formulation of Research Programmes

A research committee on fisheries has been created. This is headed by the AARD RCCF, with membership of AARD institutes and the DGF. It is intended that this committee will meet every six months. At an operational level the research institutes have the chance to meet five times per year with staff of DGF. In addition, DGF meets annually with provincial authorities with the presence of AARD. The fishery development centres discuss their research proposals directly with DGF. There is no forum where industry can have a voice in research except through dialogue with AARD staff. The result of these meetings is a set of research proposals which are far in excess of the limited budget. Priorities are assigned using the guidelines of the national five-year development plans.

At present the emphasis is on aquaculture as a result of a requirement in the national plan to increase aquaculture production by 9.6 per cent per year (capture fisheries is planned to grow by 4.2 per cent per year). Research budgets have thus been transferred to aquaculture and capture fisheries research has been further impoverished despite the fact that it deals with one of the world's largest EEZs. The present plan calls for an increase in export earnings from fisheries but also includes a requirement to increase domestic consumption, generally by inland capture fisheries.

Implementation of Research

The research facilities are in general of a high standard; RICA and RIFF occupy new premises while plans have been made to move RIMF from the present cramped location. Development of the institutes and a manpower training programme have been funded by a World Bank loan. The principal constraint to research is the very limited budget allocations. Since the dramatic reduction in oil revenues, Indonesian Government budgets have been directly linked to the price of oil and thus drastically reduced. The marine research sector has suffered most seriously. Coupled with a shift of emphasis to aquaculture, shortage of funds has reduced the days at sea for the two RIMF research vessels from 300 in 1983 progressively to 0 in 1988. The vessels are tied up with full crews. In 1989 there is a provision for 60 sea days. Another example is the post-harvest technology section which for 1989 has a research budget equivalent to about US\$7000, after committed costs have been paid. Under these circumstances it is obviously not realistic to expect high quality research. The lack of operating budgets, together with low salaries, has a discouraging effect on the highly trained young staff that are returning from study abroad under the World Bank manpower development programme.

A further serious constraint is the lack of access to existing information which could be provided by upgraded library facilities and access to international data bases. Much of the research undertaken in Indonesia is a repeat of what has been done elsewhere but remains unknown to Indonesian research workers. There is also a problem of communication at a national level due to the distances between research stations.

Application of Results

With the present research performance the fishery managers and those responsible for development are not getting the results and the service they require. Within the DGF there seems to be a lack of appreciation of what research could deliver and too much encouragement to the private sector to develop in an unplanned way. Although there is a cohesive policy for management and development, implementation appears to be difficult. In this respect AARD proposed a policy research initiative that would clarify the policy objectives and identify the options, as well as monitor and evaluate the implementation.

In theory, the research results generated by AARD are passed to the DGF and its development centers. Their application at the field level is through the Agency for Agricultural Education, Training and Extension (AAETE). These formal links are well thought out and have good potential but at present there is difficulty in translating the results from AARD in a way that can be assimilated by DGF and AAETE.

National Research Priorities

The emphasis in new programmes being given to aquaculture research has been noted. It is clear that a fishery as complex as Indonesia's requires research into management and development policies but the DGF with a staff of only 700 is inadequate for implementation. In general the western part of the archipelago, where resources are overexploited, should have a strategy based on careful management. On the other hand, the eastern, less populated part has significant unexploited resources that could underpin a national development strategy. The deep waters are lightly exploited but survey and assessment capacity is too small to provide effective development assistance.

PHILIPPINES

Fisheries research in the Philippines, as well as management and development, is passing through an uncertain phase, in common with other political and economic aspects of life. The new Government returned the Bureau of Fisheries and Aquatic Resources (BFAR) to the Department of Agriculture but absorbed all the fisheries field agents into the agricultural extension network as Regional Agricultural Production Technicians who are now responsible at municipal level. Data gathering for resource assessment is no longer possible as statistics have been transferred to the Bureau of Agricultural Statistics (BAS) as part of the national statistical system. The data they gather is inadequate for management and BFAR has no capacity to collect their own data. The total BFAR staff has been drastically cut to about 500 and although there are political moves to create a new ministry of fisheries it seems likely that these will be diluted to strengthening fisheries within agriculture.

The organization and conduct of fisheries research in the Philippines is complex and confusing. The country's research and development system requires coordinated action and financial resources rather than new prescriptions for activities that are unlikely to be undertaken due to lack of funds. For instance the National Aquatic Resources Research and Development System (NARRDS) five-year R&D plan (1988-1992) produced by a newly emergent Philippine Council for Aquatic and Marine Research and Development (PCAMRD) makes no mention of links with BFAR. PCAMRD was created by the Department of Science and Technology (DOST) in 1987 as one of the sectoral planning councils mandated to provide research directions in fisheries and aquatic resources in the national research system.

BFAR, BAR and PCAMRD compete to establish research agendas through a variety of interlocking national and regional research and development committees which include inputs from a municipal level.

BFAR has a need for research to backstop its management role. The research function is clear in its new headquarters organization of nine divisions:

- Fishery Resources Research
- Post-harvest Research
- Aquaculture
- Fishing Technology;
- Policy Research and Economics
- Fishery Support Services
- EEZ and Allied Services
- Licences Division (International)
- Resources and Administration

The universities also have a role in research but are for the time being crippled both financially and materially. A decision to move the College of Fisheries from Manila to Iloilo with World Bank loan funding was taken some time ago but difficulties are being experienced with its re-establishment. Although the College has produced ambitious plans it will be some time before a significant contribution can be made to fisheries research.

Formulation of Research

There is a disappointing lack of clarity between the preparation of plans and the funding and facilities needed to carry them out. The mechanism of preparing five-year R&D plans is intrinsically good provided that the plans are taken into consideration against the implementation of the previous plan.

DOST through PCAMRD has the coordinating responsibility in planning. Three ministries are involved. These are:

- Department of Agriculture (DA) - through BFAR and BAR. The DA responds to the Agricultural and Fisheries Councils set up at national, regional and municipal levels
- National Economic Development Authority (NEDA) responds on research priorities through national, regional and municipal Development Councils
- DOST controls the research agenda through PCAMRD

Implementation of Research

The ability to implement the plans is clearly constrained by the lack of funds and manpower. The level of implementation is low as a direct result. For instance the most recent publications on stock assessment, produced with assistance from ICLARM, are based on over-simplified methodology imposed by low quality of the available data. Difficulties with implementation are most unfortunate as the Philippines has a pool of competent and well trained fisheries scientists.

Application of Results

The Philippines has a good tradition of extension. However, the recent transfer of BFAR field personnel to become Regional Agricultural Production Technicians, with responsibility for all agricultural crops, has clearly weakened the capacity to deliver fisheries extension information at the community level. The decentralization of management to the municipal level has also taken place without providing the understanding or the means to do it efficiently.

National Research Priorities

The highest priority is given to the conservation and management of degraded and overexploited marine and inland resources. As a component of this, there is a requirement to expand aquaculture. Another priority is to explore new (more distant) fisheries and develop new products as part of the strategy of increasing employment.

2. COOPERATION IN RESEARCH: REGIONAL AND INTERNATIONAL MECHANISMS

There are very distinct similarities between the fisheries of the ASEAN countries, both for capture fisheries, in marine and inland waters, and for aquaculture. The resources are similar and similarly heavily exploited, and there are close parallels in the way that fisheries are pursued. Socially and economically there are good reasons for cooperation but there are political impediments, some of which were exacerbated by the extension of jurisdiction.

In the face of common problems and limited resources for research, there should be a strong incentive to cooperation at a regional level. Indeed there are encouraging signs of growth. Research workers in all the countries visited were, without exception, positively disposed to regional cooperation and anxious for its extension. The reasons they gave varied but the following were important:

- Regional cooperation often mobilized donor funding for research which was not available from national sources. The relationship between donor and regional group is often simpler than the donor/recipient country interaction.
- Coordinated regional programmes can bring out what is best in the region.
- As part of a network the individuals have access to a much greater pool of information.
- Participation in regional programmes stimulate staff intellectually and also result in better personal relationships.
- Regional arrangements can often avoid entanglement in national bureaucracies.

With these acknowledged advantages it is not surprising that a number of regional organizations dealing with research have emerged. However, in the absence of coordination specialization has not occurred. No regional or international organization has taken a strong leadership position in research cooperation. It is possible that this has been unwittingly prevented by the number and complexity of the various groups. Profiles of the organisations involved in research are given below.

ASEAN

The ASEAN Coordinating Group on Fisheries (CGFi) reports to the Committee on Forestry, Agriculture and Fisheries (COFAF) of the ASEAN Agriculture Ministers (AMAF). The members are the directors of fisheries from the ASEAN countries. The CGFI has regular meetings but there is no technical secretariat to provide ongoing coordination which results in a lack of follow-up and continuity. Each ASEAN project has a coordinating country and in its relationships with donors ASEAN has created some regional frameworks, for example: the ASEAN/UNDP Small-Scale Fisheries Development Programme, the ASEAN/UNDP Monitoring Control and Surveillance Project and the ASEAN/CANADA Post-Harvest Fish Technology Programme. Other ASEAN activities come under the Committee on Science and Technology (COST). Examples are the ASEAN/Australian Coastal Resources Management Project, the ASEAN/US Coral Reef Project. There are a number of technical working groups in COFAF that have been funded by the ASEAN/Australian Economic Cooperation Programme that illustrate the long-term nature of the assistance required. For instance, the Fish Working Group set up in 1977 under this funding has been active for twelve years and has strengthened the research base and made good communication between scientists. However, this is one of four groups (Grains, Horticultural Products, Fish and Livestock) and a recent decision has been taken to reduce the work on fish and grains in favor of the others. It may be that the network that has been created cannot survive in the absence of external funding as there is no strong national initiative to regional research.

The plan to create an ASEAN Fisheries Development Centre in Indonesia has not proceeded. Whereas ASEAN COFAF would appear to be an obvious candidate for regional leadership it has not assumed the role, perhaps due to the lack of an implementing arm.

SEAFDEC

The Southeast Asian Fisheries Development Centre (SEAFDEC) was created in 1967 and has membership of Malaysia, Philippines, Singapore, Thailand and Viet Nam (until 1975). Japan has been the sole external supporter contributing 30 percent of the total budget. Indonesia has consistently refused to join SEAFDEC, which has effectively removed its chances of regional leadership. The Training Department in Thailand has a Research Division with three sections: Resource Evaluation, Fishing Gear Technology and Statistics and Socio-economics. The Marine Fisheries Research Department in Singapore is responsible for post-harvest technology and has worked mainly on fishery products, e.g. production of surimi from low-value fish. The Aquaculture Department in the Philippines has in the past been involved with brackish and marine aquaculture in ponds and cages. Recently, the staff has been substantially reduced and the programme restricted to cage culture.

The SEAFDEC Council recently agreed to establish a Marine Fisheries Resources Management Department in Kuala Terengganu, Malaysia, as the fourth department to give SEAFDEC a department in each of the Southeast Asian member countries.

Buildings and staff for the various departments are provided by the host country while the Japanese provide equipment and expatriate (Japanese) experts. While the priority of SEAFDEC is training, it also conducts research in support of the training. It seems that much of the research principally benefits the host country and does not have much regional impact at present. However, as the organization matures a regional perspective is becoming clearer. SEAFDEC now operates ASEAN projects on a case by case basis and will provide the administrative centre for the ASEAN/Canadian Post-harvest Project.

ASIAN INSTITUTE OF TECHNOLOGY (AIT)

AIT in Thailand is an international post-graduate technological institute established in 1969. Within the Division of Agricultural and Food Engineering there is a very strong aquaculture programme. While the emphasis is on teaching at masters and doctoral levels, the thesis work involves research. The research undertaken is heavily slanted to production of herbivorous fish to contribute to domestic food supplies. There is also some work on sewage fed tilapia as feed for carnivores.

NETWORK OF AQUACULTURE CENTRES IN ASIA AND THE PACIFIC (NACA)

NACA is at present an FAO/UNDP project based in Bangkok with four regional lead centres in China, India, Philippines and Thailand. It will become independent as an Intergovernmental Organization on 1 January 1990. NACA has been operational since 1980 within a wider framework than ASEAN and under the general umbrella of Technical Cooperation among Developing Countries (TCDC). Its original members were Bangladesh, China, Hong Kong, India, Indonesia, Malaysia, Nepal, Philippines, Singapore, Sri Lanka and Thailand. NACA was set up to pool national resources for aquaculture development under three main headings: research, training and information exchange. Inter-disciplinary research on farming systems is carried out with the aim of ensuring supplies of fish. Training is provided for core personnel for national development. An information system provides information for development planning, research and training. These activities will enable some rationalization and control of the massive funding that banks are targeting towards aquaculture for high value species. NACA is also interested in cheap fish for the masses as a result of enhancement of open waters and extensive mollusc culture.

With a great deal of energy being taken up by converting to an intergovernmental organization, NACA is not at present in a position to take on regional research leadership in aquaculture. It does, however, offer a different model of a wider geographical coverage in a specialized field.

FAO

FAO inputs to research in the ASEAN region are provided through the Indo-Pacific Fisheries Commission (IPFC) and more narrowly through the Committee for the Management and Development of the South China Sea. (This has Hong Kong as additional member to the ASEAN group.)

The IPFC covers a much wider region and perhaps for that reason has created a more diffuse interest amongst the members. It suffers from not having an autonomous budget that could be used to stimulate research. Standing committees and working parties are used to coordinate research. The Standing Committee on Resources Research and Development (SCORRAD) was set up 1978 to review and coordinate research and development (R & D) activities but has so far failed to do so and is under review by the IPFC. The mandate of SCORRAD has been limited to resources research with the hope that the performance will improve. Unfortunately, unless initiatives are taken to stimulate national and regional research programmes improvement is unlikely. There are working parties on inland fisheries, aquaculture and fish technology and marketing. These enable small groups to meet with FAO support and to provide information in form of reports to the Commission. The Working Party on Fish Technology and Marketing has taken the initiative to obtain funds from Australia to strengthen a network of cooperation between fish technology research workers in the region. After twelve years and seven meetings, the network is strong but it is unlikely that funding will continue. It will be interesting to see if the network can be sustained without external support. Recently a network for research on recruitment to shrimp fisheries has been established jointly by SCORRAD and IOC/WESTPAC under the OSLR programme with some Australian support. The network has not yet attracted sufficient funding for its activities.

There was a distinct impression from both research workers and administrators that FAO had failed of late to provide sufficient support for regional cooperation.

INTERNATIONAL CENTRE FOR LIVING AQUATIC RESOURCES MANAGEMENT (ICLARM)

The statement of purpose of ICLARM is broad and all embracing; it provides a framework for the activities while not necessarily covering them all at one time. The statement is quoted below:

ICLARM is organized exclusively for charitable, educational, and scientific purposes; and in furtherance of these purposes, ICLARM is to establish, maintain, and operate an international aquatic resources center designed to pursue the following objectives:

- To conduct directly and to assist others in conducting research on fish and other aquatic organisms, on all phases of fish production, management, preservation, distribution, and utilization with a view to assisting the peoples of the world in rationally developing their aquatic resources to meet their nutritive and economic needs;
- To improve the efficiency and productivity of culture and capture fisheries through coordinated research, education and training, development and extension programs;
- To upgrade the social, economic, and nutritional status of peoples in the less-developed areas of the world through improvement of small-scale rural subsistence and market fisheries;

- To work toward the development of labour-intensive systems to aid employment and of low energy systems to minimize capital and cost requirements;
- To publish and disseminate research findings and recommendations of the Center; and
- To organize or hold periodic conferences, forums, and seminars, whether international, regional, local, or otherwise, for the purposes of discussing current problems.

ICLARM headquarters are in Manila but they have opened an office in the South Pacific and plan offices in Africa (Côte d'Ivoire) and Latin America (Costa Rica). There are four main programmes:

- Resource assessment and management
- Aquaculture
- Information
- Social Sciences

ICLARM has no research facilities of its own but does have an excellent library to backstop economic and social science research. In general ICLARM cooperates with selected institutes and universities to execute its own programme under the general understanding that total resource management requires multidisciplinary research. In addition to research in participating institutes, ICLARM operates extensive networks for tropical fisheries research, training and social sciences. In selecting partners for research, ICLARM appears to have a policy of selecting the best institute prepared to participate in order to achieve research results in the shortest possible time. However, it is acknowledged that good results achieved rapidly are essential to attract funding. This fundamental policy choice for academic excellence results in a need for other mechanisms to strengthen weaker institutions. This was emphasized by a number of researchers and administrators in the region.

For many years, ICLARM has been courted by the Consultative Group for International Agricultural Research (CGIAR) as a centre of excellence for aquaculture research, where it would have a comparative advantage. Recently, it has seemed that ICLARM would become an associated centre of the CGIAR with a mandate extended from aquaculture to other areas of strategic research in fisheries.

ASIAN FISHERIES SOCIETY (AFS)

ICLARM has taken the initiative in promoting and organizing the AFS as a professional society. The AFS now has about 1000 members and is dedicated to the formation of a cadre of younger scientists. IDRC is also a supporter. The Society plays a useful role through its journal, a system of research awards, meetings, workshops and literature surveys. It provides an example of the most diffuse form of collaboration in research or integration of regional research activities.

3. RESEARCH AT NATIONAL LEVEL COMPARED WITH REGIONAL AND INTERNATIONAL PROSPECTS

NATIONAL RESEARCH

There is no question that research is required to manage and develop fisheries regardless of whether national fishery policy is principally directed towards export or to increasing domestic consumption. However, in the countries visited it is apparent that research is failing to deliver the benefits expected of it. Before giving a prescription for more research at any level, it is necessary to analyze the failure at the national level. It is simplistic to say that the failures result from gross underfunding for research as this lack of resources could also be the direct consequence of a failure to deliver results. It is clear that governments took the required steps to establish research institutes, either with external development assistance or their own resources. These institutes generally cover the marine environment, inland fisheries and aquaculture, as well as post-harvest aspects. Substantial investments have been made in manpower development and equipment but the institutes are generally being starved of operational funding for research.

There are no hard and fast rules for calculation of what proportion of government revenue should be directed to research in agriculture or fisheries but the countries of the region fail to measure up to any yardstick. In many developed countries 1 to 2 percent of GDP is considered a reasonable investment in research. Alternatively, research funding can be indexed to the gross revenue of the industry, with 0.5 to 1.5 percent of value being used for research. From export earnings alone this would imply an annual research budget in the order of \$25 million. While precise figures are unavailable total research expenditure is less than this. There was an earlier attempt to levy one percent of exports in Thailand for a fisheries fund but it failed due to industry opposition.

A variety of reasons can be postulated for lack of attention to research. These include: the international economic climate and the general inclusion of fisheries in agriculture ministries, where it has low status. It is also possible that research administrators, and those responsible for managing fisheries, do not heed scientific advice but, as in most other countries and, as noted elsewhere, base their management decisions on political expediency. Perhaps the form in which the information is delivered is not suitable and as a result the administrators are not successful in securing increased research funding within their Ministry. Unless corrective action can be taken at the national level and a firm commitment made to maintaining strong institutions, consideration of channelling further external development assistance into national research institutes could become difficult to justify.

In addition to full funding, and improvement of salaries and status of scientists, the package of measures should include careful consideration of the formulation and evaluation of research. The process of research formulation or planning is weak because it is not generally appreciated that research must be applied to solving the problems of the community, in concordance with national policy. Far too much of the research is undertaken at the instigation of research workers who, in the absence of precise national research goals, end up setting their own research goals and determining research policy. There is a gulf between them and the community they serve which could be bridged by a dialogue on establishment of goals leading to formulation and selection of research projects. A mechanism for discussion and formulation of research programmes has been introduced in some countries but it does not yet appear to function as intended.

Perhaps as a consequence of poor formulation, the evaluation of ongoing research efforts is for the most part inadequate. The institutes are to a great extent isolated and their programmes are not properly reviewed either by an internal or external body. Under these circumstances the work needed to improve fisheries is difficult to achieve and those who could benefit from research results feel that the scientists lack credibility.

The lack of delivery of appropriate research results to potential users is seen both in relation to convincing fishery managers of the need for action and in a failure to turn research results into effective extension material for the benefit of the fishing industry. A detailed study of the costs and potential returns from fisheries research should be undertaken and could be expected to show substantial benefits, even taking into account the costs of extension.

Without increased commitment to national research efforts it is difficult to envisage an increase in regional activities, although these would undoubtedly be useful if properly implemented.

REGIONAL AND INTERNATIONAL RESEARCH

In a region with a commonality of resources and problems as well as cultural similarity there are obvious advantages in cooperating in research. However, it must be remembered that larger programmes will increase, rather than reduce, the need for proper formulation and evaluation. The present attractiveness of regional programmes is based more on the ready availability of donor funding than on the technical merit. With national research efforts being starved of funds it is by no means evident that governments would be prepared to contribute to regional efforts. The lack of coordination and regional leadership has been addressed earlier.

The simplest regional arrangement is for the creation and stimulation of research networks but even at this level, funding is required. When joint programmes are considered the complexity and funding requirements increase rapidly. While regional research should be encouraged it needs to be carefully planned and coordinated. A further issue is consideration of what type of research is most suitable for national or regional implementation. There is a continuous spectrum from the applied, adaptive type of research moving towards the basic with its more defined goals. National fishery research institutes usually concentrate on adaptive research in response to ad hoc problems, whereas universities are more inclined to basic research. However, an undefined proportion of national institutes' research budgets should be reserved for long-term basic studies as research workers need to be alert to new opportunities and these are the results of basic research. Basic research at a regional level necessarily implies a long-term commitment and funding. There are excellent opportunities for moving towards the basic end of the research spectrum through regional mechanisms and a good justification can also be put forward for extending these to global or international level. Naturally the more players there are the greater is the need for coordination, planning and evaluation. However, if these can be sustained, and funding provided, a regional research programme can bring great benefit to groups of developing countries, probably at lower cost than conducting the research nationally. The elements of trust and sharing of resources still need to be improved. Scaling research up to an international level has the advantage of bridging the gap between developed and developing country researchers and could have critical impact on basic science. However, there is always the risk that the third world is used as an observation laboratory and obtains limited benefits.

A further major advantage of involving national research in regional programmes is the improvement in access to information systems. Library and documentation facilities are generally weak at national level and as a result there is a lot of duplication of research. Regional networks provide opportunities for exchange of information and access to a much wider literature.

The potential benefits of working at a regional or international level are clear, but they depend on having a national capacity to contribute intellectually and financially. They should not be seen as replacing national efforts. For this reason, the creation of new regional or international centres of excellence should be carefully evaluated as it could result either in draining away national talent or imposing too much expatriate expertise. It must, however, be acknowledged that well paid employment in an international centre is attractive to the poorly paid national scientist. National administrators need to review the rewards to scientists as a matter of urgency.

4. CONCLUSIONS ON RESEARCH ACTIVITIES

The foregoing is a generalized and critical analysis of research activities in the region. It tends to identify deficiencies in one or more systems but it should not be construed from this that the mission has an entirely negative view of research in the region. There is considerable activity and some very good work going on. Research in aquaculture is being pursued actively and success has been achieved in inland fisheries. In the post-harvest area most attention has been paid to improvement of the quality of export products. The tempo of marine research has declined in recent years during a period when extended jurisdiction has implied the need for more management related investigations.

A number of explanations for the deficiencies have been given but ultimately they can be traced to the lack of coherent national fishery research policy. The governments of the region need to enunciate in clear terms the objectives in respect of fisheries development and the management strategy to achieve these objectives. Strong institutions to provide research information to backstop the strategy would be included.

One area that seems neglected in fishery policies is the importance of fish in domestic food supplies. While a policy of increasing domestic supply does not necessarily conflict with encouraging exports, there are disturbing trends at present. The current lack of policy and absence of effective management leaves the industry free to make decisions on short-term economic grounds. This has resulted in a dramatic increase in aquaculture. The feed requirements to support aquaculture encourage biomass fishing, removing conventional species from the nations' plates and replacing them with high-priced products of aquaculture. These are beyond the means of all but the most wealthy consumers.

While the above describes ongoing research activities and identifies weaknesses and constraints, it is also important to address the needs for research. These can only be correctly determined following identification of the principal fisheries issues in the region. The following attempts to address some of these basic issues in a somewhat provocative manner. The purpose of this approach is to promote discussion by raising concerns over the direction fisheries appear to be taking and to question whether these directions are rational.

PART B. THE INSTITUTIONAL ISSUES

The examination of fisheries research needs in South East Asia was conducted under the basic premise that, since extended fisheries jurisdictions to 200 miles have now been in effect for almost a decade, coastal states have had some time to improve economic, social and nutritional benefits from the use of their fisheries. The condition of international open access to those fisheries resources beyond the territorial seas has been removed and coastal states now have sole ownership. Under these conditions, the mission was expecting to find the basic research thrusts of national governments well established and benefitting from successful implementation of earlier research findings.

5. SUMMARY OF FISHERIES

THAILAND

Thailand has minimized the impact on its fisheries sector from the extension in national fisheries jurisdictions, which closed free and open access to Thai fleets, by seeking joint-venture fishing agreements with other coastal states stretching from Oman to Australia. It has followed a path of importation of whole fish for processing and export, such as tuna canning, in order to maintain its on-shore processing capacity which now extends to surimi production for export.

Since extension of jurisdiction, Thailand has maintained its total fish production at 2 million tons, a level previously reached in 1977. No really significant changes between species groups can be discerned in comparing catch levels in 1977 and 1987, except to note the following: increased freshwater production of 35,000 tons, decreased demersal production of 25,000 tons, decreased pelagic catches of 5,000 tons, a 20,000 ton increase in crustacea and a 10,000-ton increase in cephalopods. These figures however do not reflect actual production from the Gulf of Thailand, since these figures include all fish landed by Thai vessels including catches from outside Thailand's jurisdiction. About 67 percent of trawl catches in the Gulf of Thailand are now classified as trash fish, with no measures being implemented to curtail trawl fishing effort, although limited entry was ordered in 1982. Trawl licences are now estimated to total around 8,000 and the Department of Fisheries has recently agreed to a substantial increase.

Thailand has endeavoured and succeeded in expanding its fresh water production from stocking as well as the aquaculture of a number of species, tilapia, carp, snakehead and catfish. It has been successful in brackish water aquaculture for growing prawns and sea bass, the techniques of hatching through to grow-out all being undertaken by the private sector using small farms with simple technology. The revenues obtained from this activity are large, for example 13 hectare ponds producing gross revenues of about \$400,000/yr for three crops for a capital cost of land purchase of approximately \$35,000 per hectare or a total fixed cost of approximately one year's gross revenue. There are no apparent barriers to entry, with many pond purchases occurring in swampy and marginal land immediately behind or in mangrove areas. The same strong entrepreneurial drive is occurring in brackish water aquaculture as occurred with the development of the Thai trawler fleet.

Governmental emphasis remains primarily directed at freshwater fisheries first (90 percent of Departmental budget), then brackish water aquaculture, then coastal aquaculture (which is constrained by inability to breed groupers) and finally the marine activities where the emphasis is now directed at artificial reefs.

The result of the past activities has contributed significantly to maintaining freshwater fish production, the preferred type of fish in national consumption, while opportunities appear to have been missed for the marine areas where the dependency on trawling has adversely effected small-scale fishermen and reduced previous fishing expertise in purse seining. If the Government had provided directives toward containing

the expansion of the trawl fleet, the traditional Thai purse seiner might have evolved towards adopting this fishing technique for tuna and thus contributed to the longer-term viability of the existing tuna canning industry.

MALAYSIA

No significant changes have occurred in Malaysia's catches from 1977 compared with 1987; total catches being are about 600,000 tons. Freshwater production has increased from 5,000 tons to 18,000 tons while pelagic have decreased from a high of 300,000 tons in 1981/83 to 190,000 tons in 1987, which is 15,000 tons more than in 1977. Demersal landings have remained relatively constant at around 75,000, with a variation of between 44,000 tons in 1977 and 86,000 in 1987.

No significant changes can be detected in Malaysian fisheries since extending fisheries jurisdiction, although a freeze on fishing effort was imposed for a number of years, resulting in illegal fishing and recently granting of 4,000 additional licences for the inshore zone. Although the situation can be considered as static, it must be noted that for peninsular Malaysia over 75 percent of trawl landings are also classified as trash fish.

Aquaculture in brackish water has commenced but not to the degree reached in Thailand. Freshwater production, although increases are noted, still remains insignificant given the sizeable water areas.

INDONESIA

Indonesia has realized significant gains in production from 1.6 million tons in 1977 to 2.6 million tons in 1987. Notable increases include 200,000 tons in freshwater fish, 100,000 tons in demersal fish, 600,000 tons in pelagic species and 35,000 tons in crustacea.

Since Indonesia's gain in jurisdiction from UNCLOS is extensive in terms of area, extending over an area of 18.16 km² equivalent in distance from London to Cairo (most of it an archipelago) comparison with the other countries in the region is difficult. In addition, Indonesia has had to make significant adjustments to the new jurisdiction in a relatively short period of time. These adjustments include: numerous boundary delimitation negotiations; estimates of resource potential; and rapid attempts to develop capacity to harvest resources both within the archipelagic closing lines and outside in the EEZ in order to readjust foreign access to these resources. Although the development of resource potential in Eastern Indonesia has not been as fast as expected, it must be understood that distances and capacity of local communities with relatively small populations pose challenges to be met before achieving further development.

For the purposes of this mission, therefore, the eastern part of Indonesia (east of 130° longitude) has been excluded from the overall comments made, since it represents a development area for realizing resource potential under difficult logistical conditions. The Western part, which includes the Java Sea, Malacca Strait, Natuna Island in the South China Sea, form the basis of future comments made in regard to the coastal states of the region, where conditions are similar to the Gulf of Thailand.

It has to be stated, however, that the task for fisheries development in Indonesia is beyond existing national capacity. The dimensions associated with extension of jurisdiction are given no greater emphasis than the development of aquaculture, inland fisheries and the Java Sea management issues.

PHILIPPINES

Fish production in the Philippines has increased from 1.5 million tons in 1977 to 2.2 million tons in 1987. This increase has occurred from additional quantities of freshwater fish (150,000 tons), demersal fish (50,000

tons), pelagic (100,000 tons), crustaceans (40,000 tons), mollusc (120,000 tons) and of aquatic plants (200,000 tons).

It must be noted that the extension of jurisdiction resulted in only a marginal increase in area for the Philippines, discounting disputed claims. In this connection, the gains in freshwater production (150,000 tons) are equal to those achieved in increased marine catches of demersal (50,000 tons) and pelagic species (100,000 tons), even though the total freshwater catch of 350,000 tons is equal to total demersal landings or about one third of total pelagic catches (962,000 tons). Coastal fisheries are heavily overfished nearly everywhere and the situation is aggravated by the use of poisons, dynamiting and siltation from deforestation.

The expected commercial benefits have not been sustained for the tuna fishery despite the establishment of canning plants. Sufficient quantities of tuna suitable for canning are not available as those taken by the payaos are too small. Few tuna vessels have been able to venture farther afield in search of larger tunas. It must be also noted that fish forms the highest percentage of protein intake (22.9 percent in the Philippines) compared with other countries in the region and it is of significant importance to national diet. Most of the fresh water production gains have been achieved from stocking and aquaculture, with a sizeable production of tilapia. Milk fish raised in fresh and brackish water fish pens are also an important component of aquaculture production.

6. THE GULF OF THAILAND MODEL

The Mission needed to determine the longer-term directions in which the fisheries of the region were progressing, as a means for identifying longer-term equilibrium points in order to give relative importance to research needs. This involved attempting to understand such directions, determining whether they were rational and identifying limiting factors that might be expected to constrain the direction.

In this connection the Gulf of Thailand trawl fishery presents a most unique research study in itself. It may be characterized as biomass fishing, resulting from increased landings of greater proportions of small fish, some 70 percent of which is trash fish. (The trash fish component consists of species not suitable for human consumption, small fish for which no market exists and juveniles of commercial species.) Despite obvious ecosystem overfishing, landings apparently do not decrease as a result of (a) fishing down the food chain to smaller and smaller fish; and (b) consequent changes in species composition whereby longer-lived and high-valued demersal species are replaced by short-lived species which, despite the presence of shrimp and squid, are lower-valued species. For the Gulf of Thailand, the predominant end-use of these fisheries resources (trash fish) is animal feed with some surimi production. This has been occurring since 1969, and the ensuing 20 years reveals that the total yield curve appears to become flat topped. The trawl fishery of the Gulf has therefore become the fish meal producer that has enabled the aquaculture industry to develop with relatively low feed costs. (Thai 1987 statistics show that otter board trawls (OBT) landed 44 percent of total marine production from the Gulf. OBT catches were 17.6 percent table fish, 67 percent trash, 8 percent shrimps, 6 percent squids and 0.7 percent crabs.) However the quality of the meal produced is not sufficient by itself for aquaculture due to the poor quality of the landings. For best results, Thai fishmeal requires supplementing with imported meal.

It is evident that, from the recent downturn in shrimp prices, the cost of feed for aquaculture is critical since Thai shrimp farmers remain viable when Philippine farmers, operating intensive systems which depend on imported feed, are not. Thus, whereas the primary use of the demersal resources of the Gulf for fish meal stimulated the expansion of the aquaculture industry in terms of profitability, this predominantly single use of the marine resources as a rational direction is difficult to understand. It would not seem to represent the intent of the UNCLOS provisions to promote the objective of optimum utilization of living marine resources nor does it ensure proper conservation and management for the maintenance of living resources so as not to be endangered by over-exploitation. The principle of sustainability and maintenance of biological diversity also appears to not be satisfied.

For the Java Sea, and Indonesia's part of the Malacca Strait, the situation is entirely different. A ban on trawling imposed in late 1980 has resulted in landings of demersal fish of suitable size for human consumption, and production is now back at the level prior to the trawl ban. All catches are now taken by different fishing gear, while stocks have been rebuilt to levels as high as they were before the development of intensive trawling.

For the Gulf of Thailand situation, there was, and remains to be, an alternative. The apparent lack of action, as expressed by members of the fisheries departments and scientific institutions in all of the countries visited, was given to be a lack of political will, since scientific advice has been regularly given for necessary action from the marine research institutions that exist. In examining this question of political will, as expressed by most institutes, the Mission noted that it has in fact been provided. For example, in Thailand the implicit decision to allocate the demersal resources to the trawl fleet reflects the strength of this sector in political terms. Conversely, the ban on trawling in Indonesia was a political decision which went beyond scientific advice, and was seen as an excessive measure by the scientists who had only recommended limitations on fishing effort. The results, however, show higher production of preferred consumer fish at reduced costs. The ban changed the end use of the demersal species from what has occurred in the Gulf of Thailand and the fishery has recovered from the direction toward a trash fish fishery. One explanation of this situation could be that the political importance of the artisanal small-scale fisherman was sufficient to

reserve demersal resources for their exploitation. Conversely in Thailand the small-scale sector produced only about 13 percent and was thus in a minority position.

Similarly, Malaysia demonstrated political will and went beyond the scientific advice of placing limitations on fishing effort by the introduction of the New Economic Plan. This required an improved equity situation for Malays in national economic activities and allowed the Department of Fisheries to place a moratorium on the number of fishing licences in order that ownership patterns could be altered to favor Malays.

Most recently, the Philippines Government which formerly shared jurisdiction over fisheries with the municipalities, transferred all jurisdiction of coastal resources to the municipalities in a process bearing little connection with the advice of the scientists in favor of more traditional management measures. This decision arises directly from the issue of land reform and the need to demonstrate the government's will to transfer authority to the rural areas.

It is apparent therefore that political decisions are made that concern fisheries but that these decisions often go beyond the scientific advice emanating from fisheries research institutes or technical staff. The decisions are related to allocation issues which correctly are the ultimate responsibility of the politician.

Yet the decisions taken out of political expediency have profound implications on fisheries. The Indonesian trawl ban secured demersal fish species for human consumption and export of marine shrimp which otherwise would have degenerated into trash fish production. The Malaysia New Economic Plan provided direction for limiting fishing effort and the allocation of the licences to distinct users. The Philippine decision to transfer authority for fisheries to the local level supports the opportunity for fishing community decision-making on the use of the marine resources. The implicit decision in Thailand to allocate the marine catches to trawlers, without providing a framework that permits the trawlers to restrict their activities, results in economic overfishing. These issues by themselves present worthy research programmes for the fisheries agencies if development (production, value, consumerism, incomes and social aspects) is to continue.

The types of advice offered by the scientific and technical staff of the Departments primarily relates to: excessive fishing effort and degradation of marine coastal zones; water conflicts; logging and agricultural practices; overfishing; and sedimentation and weed problems in inland waters. All these relate essentially to resource conservation needs.

In effect, therefore, the scientific advice provided to fisheries administrations is incomplete. In particular, the various costs associated with the measures recommended are not evaluated and the options not presented. For political decision-making, ministers need to know which group of fishermen are to be affected by proposed measures or restrictions, what number of fishermen are involved and the consequences on their incomes. This in turn requires estimates of compensation to be paid to those fishermen affected by the recommendations. Justification for Government expenditure requires identification of means by which these expenditures can be recovered in the future, such as higher tax receipts from increased fishermen's income, from increased licence fees or landings taxes, etc. The point to emphasize, however, is that the advice presently being offered is incomplete since it does not identify the social or economic impact of the recommendations. The fisheries administrations/scientific institutes should have been monitoring the economic performance of the different fishing gear types so as to be aware of changes in the status quo between the fishing gears that may result in political action being necessary.

The aquaculture sector has been developed with technical advice, as was the case in the formative years of the marine capture fisheries. Research and technology have been transferred to the private sector where advice on new research and directions is heeded and funded. Here the problems of allocation do not arise in land issues (where property rights are defined) but will eventually occur with competition for water, space and feeds. The mission therefore considers it to be fundamental, in attempting to understand the overall constraints to fisheries development, to enquire why the scientific and technical aspects of aquacul-

ture have been successful in prompting government action for implementation when the inland and marine capture fisheries have not. There are several observations concerning this.

7. POSSIBLE REASONS FOR THE EXISTING SITUATION IN FISHERIES

INSTITUTIONAL CHANGE ARISING FROM UNCLOS

It would not have been unreasonable to expect that, given the conditions imposed by UNCLOS for conservation and management of fisheries resources within the new limits of fisheries jurisdiction, the ratification of UNCLOS by some ministers responsible for foreign affairs, and the expectations associated with the extensions, national governments might have established a Ministry for Fisheries. At least it would not be unreasonable for Indonesia, considering the magnitude of the EEZ and the challenges it presents, and for Thailand and the Philippines, the tenth and eleventh largest fishing nations in 1987 (Indonesia being the ninth).

Similarly, an increase in staff complement and budget could have been expected in order to improve the capacity of the responsible government organization to implement the necessary changes for meeting the conditions of UNCLOS and stimulating rational and sustainable development.

This has not occurred for the countries in this region, although the creation of a Department of Fisheries is still under consideration in the Philippines. Instead the Ministries of Agriculture have maintained their mandates for fisheries, staff increases have not occurred, responsibilities for fishing agreements etc. have been delegated to foreign affairs, implementation of fisheries policies or regulations for control or enforcement have been delegated to the military, and joint-venture issues to the commerce or trade ministries.

Increased departmental size or research capacity could also have been justified to protect the export earnings from fisheries which now amount to over US\$2.5 billion per year for the four countries under discussion.

The foregoing raises issues of why the Governments have reacted to UNCLOS in this way. There are many possible explanations. The application of an agricultural model to fisheries is one. This is further discussed below and it is considered to be relevant to research needs.

THE AGRICULTURE MODEL AND ITS IMPLICATIONS FOR FISHERIES

In the organization of agricultural ministries, divisions are made between types of crops, livestock, animal health and fisheries. Fisheries is but one of these divisions, equal to livestock or rice, etc. It is but one food commodity in an array of others.

Yet the objectives for agriculture, as defined in the five year plans of most of the countries of the region are for a percentage increase in production (linked with population increases), increased foreign exchange earnings, improved incomes to producers (within the framework of stable prices to consumers) and gains in employment. For Indonesia this stimulated the objective for self-sufficiency in rice production and subsequently surplus for export and foreign exchange earnings. Thailand has accomplished this for rice (the price being established by Government) and now for fruit from orchards. Malaysia has similar accomplishments for rubber and palm oil.

For fisheries, in its competition within the Ministry of Agriculture for budget and staff, the criteria and objectives must be the same. These are increases in production and increases in foreign exchange earnings, if the fisheries are to receive a proportional share of the agricultural budget. In doing so particular importance is given to the upward shifts in the production function instead of the declining resource base. Stable catches are considered as an equilibrium although the species composition is being degraded. These effects may explain why the fishery catch statistics of a great number of countries have been inflated.

Management of fisheries, or even basic conservation, becomes opposed to the objective for production increases when maximum production is reached. In terms of overfishing, corrective action to reduce fishing effort runs counter to the objective of additional employment.

There is another aspect. The objective to improve incomes to farmers can only be achieved, under a stable pricing policy, by lowering costs of production. This is accomplished by increasing production and improving efficiency in production such as irrigation, pesticide and fertilizer application, mechanization and genetic engineering. Applying this to fisheries means more, and more efficient units of production - usually fishing vessels with greater catching capacity. This basically results in overfishing and creates the need for management. Restriction on fishermen or fishing effort have no equivalent in farm situations. Changes in inputs or technological adaptation (such as fishing gear types or shore infrastructure or subsidy or more fishing effort) are appropriately comparable with agricultural development practices.

The rapid development of the Thai trawler fleet at the beginning of the 1960s, and its adaptation in the other countries of the region, have demonstrated the relevance of the agricultural model to fisheries in the sense that mechanization increased production in the short term. This intensification leads to overfishing in, however, a shorter period than intensification of agricultural production, which also eventually leads to degradation. The point is that sooner or later both result in non-sustainability.

As noted earlier, increases have occurred in production of fish for some of the countries. As the trawl fisheries intensified into biomass trash fish production, overall fish production did not decline because of the biological changes discussed earlier. Increases occurred through aquaculture techniques, first through the freshwater medium and then into the brackish water. This satisfied the agricultural model where the predominant client group is the farmer and the fresh water aquaculture activities were another cash crop to supplement farm incomes.

The Gulf of Thailand production for fish meal also satisfies other objectives of agriculture. The necessity for fish meal as an input into chicken and duck feed stimulates their production and lowers their costs, while overall costs to fish production, particularly opportunities foregone, are hidden. It is equally rational for the feed requirements of brackish water aquaculture in order to generate the significant foreign exchange earnings. The Gulf of Thailand situation could be seen as the result of applying, explicitly or implicitly, the agricultural development model to fisheries. The fisheries are, in fact, internalized within the agricultural decision-making process, where the overall gains in agricultural production are the ultimate goals. Thus, losses in fisheries are compensated by gains in agricultural production. This process is reversible. For example, the allocation of water to rice production, thereby creating surplus rice and shortage of fish, resulted in nutritional imbalance. Corrections were then made to stock paddys with fish from hatcheries at the expense of some rice production.

If the argument for the institutional constraint inherent in agricultural objectives is not sufficient, then the question that must still remain is why there were no changes in capacity for implementing fisheries-specific objectives and why accomplishments in terms of significant sustainable economic, social and nutritional benefits in the decade following UNCLOS have not been realized? Intuitively, it does not appear entirely rational for four tons of live weight fish to be turned into feed to raise one ton of high export value shrimp, with no direct contribution to the domestic fish supply of a country. Furthermore, even if it is considered economically justified, the catch of the trash fish used for feed should not be added to the production of shrimp to show overall increased production. It would be more rational to deduct it since four tons of input equals one ton of output.

There is an additional point that needs to be stressed. During the last ten years, there has been associated with the decline in end use of fish to consumers a deterioration in conditions for fishermen. There have been, however, significant improvements for farmers from aquaculture. However, if the overall degradation of the resource base and of the economic conditions of coastal fishermen are considered, then it could be concluded that management issues for fisheries are not in practice a prime objective of agriculture. Probably this is because the client group within agricultural ministries are farmers and not fishermen.

There should therefore be concern that, under the agricultural ministries, capture fisheries have not shown signs of sustainable rational development. Provision has not been made to modify the inherent common property nature of the resources. Sufficient capacity to realize the potential and expectations arising out of UNCLOS are not evident and basic living conditions of fishermen have not improved. Further, security in incomes has not been assured; and, with the exception of Indonesia's trawl ban, consumer choice has not been improved. This quick assessment of the responsibility of agriculture for the problems of fisheries obviously requires further investigation. If this assessment is in fact correct, then it will help to explain the failure of fisheries scientific and technical advice to achieve results.

THE ADEQUACY OF THE SCIENTIFIC ADVICE

Fishery scientists have been working for several generations with their traditional concepts to apply science to fisheries. Some of this may have contributed to the present misunderstanding. One particular concern is the interpretation of the yield curve and maximum sustainable yield (MSY). In discussions with fisheries officials in the region, Thai scientists acknowledged that under increased fisheries pressure on demersals the total yield curve has, at best, flattened out after having passed the level of effort corresponding to MSY, the traditional FMSY point. Malaysian scientists noted that demersal production continues to increase and that overall MSY has therefore not been reached. Indonesia has a more difficult assessment problem since the trawl ban caused a change in fishing effort and patterns. However, total yields have now returned to former levels and stocks have been rebuilt. The Philippines is in a similar situation as the Gulf of Thailand, the scientists recognizing overfishing and acknowledging that the FMSY point has been passed.

There must be concern about comprehension of the model in many countries in so far as interpreting that the yield curve is considered to be fixed, while production increases are viewed as movement along the yield curve toward a maximum. It is not understood that yield curves change as fishing effort and fishing patterns change. The annual catch and effort statistics reflect no more than a trajectory across a family of yield curves, while individual stocks or fishing areas are progressively depleted. Because of the aggregation of species and curves there are no decreases in total production so that management action is apparently not required until the overall yield starts to decline. For example, with the heavy pressure of the Thai trawler fleet causing decline in the levels of abundance in longer-lived demersal species, the consequent increase in squid populations, followed by the introduction of high-opening trawls, must have shifted the yield curve. In effect, by using the model for aggregated yields the biological research has provided a false sense of security. In addition, using a model that considers bulk production from undifferentiated biomass does not satisfy industry and market needs. Yet, it has been used as a source of investment criteria. Although application of simple economic variables such as price might have indicated decreasing revenues, this is not by itself sufficient.

The stock assessment techniques for single species, as applied to tropical demersal multi-species fisheries have not helped in solving these problems. The present trends towards assessment by analytical methods, without an understanding of multi-species interactions, can only slightly improve knowledge. There remains a long-standing need to improve the research on interactions. Analysis of age, size and unit price by species has the advantage of leading to simple biological analysis but again is not sufficient. (This approach differs from that of freshwater fisheries where aquaculture and stocking were adopted as a means to enhance wild production.)

There have also been economic signals such as when grouper landings declined resulting in higher prices which initiated aquaculture research for breeding groupers in captivity. The sea bass culture is another example.

The consequence of considering total yield as the only measure for development is overfishing, leading to the use of demersals for fish meal mainly as feed for aquaculture with increasingly limited quantities being selected for direct human consumption. This would lead to the conclusion that maximum economic

efficiency is obtained by aquaculture production of high priced luxury sea-food items for foreign exchange earnings.

In absolute terms, the long-run implication of this is the single use of marine species as feed components for aquaculture production. The efficiency of this, however, should be considered against the input/output relationship: four tons of live weight trash fish to yield one ton of aquaculture output such as prawns. In terms of fisheries production, however, the present practice of reporting production of both aquaculture and trash fish would appear erroneous since the trash fish is converted into higher priced prawn production. It is difficult to see how both feed and aquaculture productions can be added together to indicate total production.

There is no doubt that the input/output relationship for aquaculture follows industrial efficiency criteria, such as that provided for by modern chicken production. Here capital/labour ratios are maximized in favor of capital; space is minimized and feed becomes the essential ingredient for efficiency in growth/weight. The result is increased production with lower per unit input costs. Aquaculture production follows the direction of chicken production in terms of efficiency, the price of prawns having been reduced to almost twice the price of chicken at the retail level. No doubt greater economies are required to further reduce production costs of prawns and these will most likely occur in terms of space and feed input costs, since capital cost for aquaculture sites will increase from strong demand. It must be recognized that the minimization of space for growing prawns, whereby density is increased, will result in production losses from disease and added costs from deterioration in water quality. Furthermore, feed costs will increase as demand grows against a finite limit to the levels of trash fish inputs for feed from marine capture fisheries. (Norway already has to import fish meal to sustain its salmon production.) This, in turn, should stimulate accelerated research into diminishing the fish input in aquaculture feeds by developing substitutes.

In economic terms, the rationalization of the aquaculture production process is relatively clear. What appears not to have been considered is the opportunities foregone in this production process. For example, it is difficult to conclude that the price/quantity relationship for prawn production can be greater than the summation of the price/quantity relationship for each individual marine species to arrive at total aggregate demand. There already exists consumer demand for groupers, pomfrets, breams and bass. There is also the compelling issue of fish demand by the bulk of national populations in the region as an important and culturally acceptable source of protein. On these terms, it would then appear to be difficult to explain the current trash fishery as a rational single use concept for the benefit of national populations in the use of a national renewable resource.

Aside from the social costs involved, there is also the costs of the opportunity foregone from encroachment into mangrove areas by constructing aquaculture ponds, thereby reducing important rearing areas for wild prawn production and therefore reducing yields of prawns from the marine capture fisheries. It is difficult therefore to accede to the fact that the efficiency criteria associated with prawn aquaculture production is rational, in the sense of the best use of a national resource in overall economic terms, when the opportunities foregone are not taken into consideration. It is furthermore difficult to accept that the possible yields from the marine capture fisheries have to necessarily compete with feeds for aquaculture, particularly when supply/demand relationships for food fish in this region is forecast to require an additional five million tons by the year 2000, only 10 years hence.

There would therefore appear to be a need for further examination of the issues mentioned above in connection with the evolving single use of marine fisheries for fish meal production.

The region is therefore faced with a situation where neither the users (fishermen) of the resource nor the consumers of fish have benefitted, with the exception of Indonesia. Gains have been made in foreign exchange earnings and farm income. These are the principal issues that must now be addressed. Are the narrow confines of economic gains from fisheries balanced with the social and nutritional losses particularly when the economic gains are restricted to foreign exchange earnings? What is the mechanism required

to put the above in proper perspective? If a proper perspective can be identified, then the next question to be asked is whether there is sufficient knowledge available from research to address the needs and, if not, why not? Then, of course, the gaps and needs can be directly addressed and the appropriate institutional framework established.

8. DETERMINING THE PROPER PERSPECTIVE FOR FISH

The proper perspective for fish and fisheries must be seen within a political, social, economic and nutritional framework.

After a decade of experience with extended jurisdiction over the marine resources, countries of the world should now be in a better position to formulate appropriate objectives for fisheries and to monitor their performance in meeting those objectives. The choice of objectives is, of course, the right of the individual country but research and discussion, within an international framework, would be useful in providing information on which to base the choice.

The objectives of fisheries, and the policies by which they are to be achieved, must be seen in relation to national food security as well as to the nation's economic goals. Although fish is rarely a crucial element in food security it is a culturally acceptable component of the food supply and a very important source of dietary protein, especially for the poor. One would therefore expect to see among national policy objectives consideration of ensuring sustainable food fish supplies to the domestic market. The Second World Conservation Strategy implies this as an objective, in addition to protection of rural community-based economic activities, in proposing that indigenous people get first priority to resource bases.

The problem appears to be that there is no existing mechanism by which the performance of fisheries as a sustainable renewable resource is measured. The practice of recording gains in production which is generally being applied is not sufficient. Neither is the *laissez-faire* approach of allowing the industry to determine how common property marine resources are turned into food, under open access conditions. National policy must first establish the political, social, economic and nutritional goals. The simplistic approach is to give priority to supplying fish to the domestic market with only surpluses being exported or used as feed. This is not practical, due to the variety of species and range of prices, and therefore adjustments must be made but they must be made consciously taking into account national food strategy and a requirement of consumer satisfaction.

9. THE SUFFICIENCY IN KNOWLEDGE

AQUACULTURE

Given the great gains made in aquaculture production, the research already undertaken and its transfer through to the private sector on a small-scale low-cost operating basis, the success is proven. There are obvious needs to further reduce production costs in order to be more competitive.

The research requirements are:

- (i) Genetic improvement in species to improve health, growth and feed requirements. This research is starting in a number of national institutions.
- (ii) Water quality and pond management research as a means to overcome the problems of water supply as a 'fugitive resource' by closing the system and improving understanding of the density issues. Insufficient progress has been made in water quality management due to its 'fugitive' nature and the inability of government institutions to resolve water conflicts even within the agricultural context: vis-a-vis irrigation, fertilizers, pesticides, logging, aquatic weeds and fish.
- (iii) Feed, which is the greatest part of aquaculture input costs for carnivores. Research is being undertaken through all the national institutes on vitamin content and its importance. AIT and ICLARM however view the fundamental issue in this area to be solved by concentrating research on herbivores where feed and its costs are not a constraint. It was even suggested that herbivores such as tilapia could be considered as input to fish meal for carnivores, using human wastes as a basic feed for the tilapia. Such issues as bivalve production for feed supplement are not presently under consideration, whereby the feasibility of large-scale mussel production in contaminated waters might be a partial solution. Attendant with this are the contaminants that may be compounded in the feeding process. There is not sufficient holistic attention being given to the aquaculture feed issues, where feed is the constraint to reducing costs of production, where present supplies are being derived from marine capture fisheries with finite limits in supply, and where alternative sources are urgently required.

POST-HARVEST

The above area of availability and quality of feed for aquaculture has not been well researched by those involved in post-harvest activities. It will become increasingly important and more information is urgently required. While there is an obvious need to provide more and better feed, the research required should be guided by a policy that preferably integrates direct human consumption with feed use to ensure balanced full utilization.

Increased attention is also required for research to improve fish quality which together with product development can add maximum value to limited resources. This applies to fish both for export and domestic markets. Linked to quality improvement is a requirement to guarantee consumer safety. Intensive aquaculture can lead to problems with pathogenic bacteria and viruses, while increased environmental pollution seems to be leading to more red tides and thus to toxic bivalves.

It is apparent that important work on monitoring the health and quality aspects of fish is a low priority for the region. This reflects the absence of any consumer policy for fisheries within the government structures. In many cases it is the first activity to be subject to budget cuts within the government on the premise that it is a private sector function! Under the conditions of open access to capture fisheries, the immediate term interests of the industry must be checked by governments if consumerism is to be satisfied to any degree.

The industry often views control activities and inspection as a threat and interference. One must expect a far greater social consciousness in the future by governments toward the food requirements of consumers and to this end a significant and dominant part of research needs should be given to consumer needs and protection. Given the extent of environmental degradation, consumer protection is becoming increasingly important as can be seen by the requirements imposed by importing developed countries for fish from this region.

An important objective originating from research should be a focus on consumer needs which can be expected to provide important directions for capture fisheries in terms of size requirements, oil content, flesh condition and overall quality requirements (contaminants), all of which are absent in the present strategy of fisheries departments. Other areas where more knowledge is required include full utilization of the small shoaling pelagic species and prevention of losses of dried fish.

INLAND FISHERIES

Freshwater fish in Thailand, Philippines and Western Indonesia are the preferred consumer fish. Significant losses are occurring from the conflicts in water use mentioned earlier. Little research is being undertaken to measure these losses and the general approach being followed is toward stock enhancement and aquaculture production.

Perhaps too much attention is given to transferring other research results to national needs, such as introducing (tilapia, catfish, carps) instead of directing national research towards indigenous species and their enhancement. The consequence could be a loss in efficiency and catastrophic reductions in natural species.

Approaches to seek more use of closed water systems are being followed as a means of overcoming water quality constraints.

MARINE FISHERIES

For the marine capture fisheries the main new development direction adopted by fisheries departments are towards artificial reefs for habitat rehabilitation or as barriers to trawlers. The research requirements associated with these is lacking. In general, the areas of fish behavior and reef impacts are not well understood or being actively studied. For example, there are very few cases to be found where research is concerned with fish migration and spatial requirements for the life cycles of marine species. While it must be recognized that the catch potential of the Gulf of Thailand can probably be significantly increased by a fishing closure alone, there are also needs to catch certain specific species at larger sizes. Where a fishery should be prosecuted in order to catch that size of fish cannot be determined readily because the spatial dimension is missing.

Given that some 25 years of survey have been carried out by Thailand on marine resources, it is regrettable that the knowledge accumulated over this period, together with the competencies of the marine scientific staff, have not been applied to provide a more rational development of the fisheries. Had application and demonstration occurred, confidence in the benefits of fisheries management might have been more widely accepted within the region and Thai experience and expertise through technical cooperation might have been satisfying regional needs. In the same way, Philippine expertise in small pelagic marine species and coral reef-dependent species might have evolved into specializations for application in the region. The acceptance of such expertise regionally would clearly only be expected to occur after demonstration projects had revealed significant benefits. Under the present overfishing situation with no identifiable benefits from management interventions, these skills are mostly wasted. Indonesia and Malaysia differ in that Indonesia has obtained different results from its fisheries as a result of the trawl ban, while Malaysia has demonstrated experience in zonal controls over fisheries and limitations on fishing effort.

It is the opinion of the mission that the overriding constraint to successful application of the scientific expertise within the region has been the context within which the capture fisheries have operated, namely the agricultural objectives. If talents are not to be wasted, there is an urgent need for defining a new set of objectives for fisheries that encompass consumer needs and protection; sustainable development including maintenance of biological diversity; compensation for environmental degradation in terms of enhancement to compensate losses in fish production; improvements in living conditions; tenure; income to fishermen; provision for domestic fish consumption needs including the poor, fish export requirements and fish meal inputs. The formulation of such objectives would provide an appropriate framework within which the scientific fisheries expertise of the region would be able to respond effectively. Whereas this may appear overly-simplistic, there is sufficient reason to believe that a major constraint to the further development of capture fisheries in the region exists within the agricultural framework and the somewhat single-disciplinary nature of the fisheries agencies.

10. GOVERNMENT, UNIVERSITY AND PRIVATE SECTOR CAPABILITIES AND RELATIONSHIPS

The most noticeable aspect associated with fisheries research is the almost complete monopoly that national fishery authorities have over capture fisheries. Contracting research to universities or private consultants is not evident at all and, even if it were, research by other groups would be curtailed by the insufficiency of data outside of the Government context. As a result, most university research is on benthic communities, artificial or coral reefs, mangroves, etc. This research is relevant to environmental concerns but does not address the critical issues of fisheries management.

This is not the case for aquaculture, where a number of universities have on-site facilities and full graduate research programmes underway. The only comment that can be made in regard to the aquaculture on campus is that it is somewhat surprising that traditional disciplinary approaches are still being followed, instead of establishing a faculty of aquaculture with interdisciplinary approaches.

For the capture fisheries, marine sciences dominate the university activities and these remain traditionally mono-disciplinary and unrelated to the needs of capture fisheries.

Private sector expertise was not evident, with the exception of some funding grants provided to AIT for aquaculture feed research. In all the years that the capture fisheries have operated, no funding for research has been identified from the industry.

11. REGIONAL MECHANISMS AND NEEDS

For each of the sectors involved in fisheries, marine, inland and aquaculture, there are substantial research needs. Of these, aquaculture has already the most directed national research and the results of such research have produced significant benefits for Thailand and the Philippines, to a lesser but still significant extent to Indonesia, and marginal results to date for Malaysia. Inland fisheries, with the exception of Indonesia and Malaysia, have reached a production plateau under existing technology. The primary constraint to further development appears to be the fundamental research requirements for improving knowledge on indigenous species and their habitat requirements, while the institutional issues associated with water quality and environmental alteration lack focus in Governmental policies. Introduction of a policy directed towards compensating losses to fish production from competing resource uses would to some extent, include a more correct pricing of fugitive resources as well as a better costing of other development practices. For the marine fisheries, a completely new direction is required. This should widen the traditional research carried out under the heading of marine biology to include social and economic aspects associated with the management and development of fisheries. In this connection, the suggestion forwarded by the Director-General of AARD in Indonesia for policy research has particular relevance to the needs of the region which, by implication, can be extended to South Asia. The primary focus of such policy research should be related to the consumer aspects of the marine capture fisheries as a vehicle for widening consumer choice, sustaining food supplies for the population, improving the economic value of fisheries and, to all intents and purposes, preventing trawl fisheries from degenerating into single use trash fish fisheries. Competent economists, in conjunction with fish technologists, should in a relatively short time be able to measure the opportunities foregone from existing practices in marine fisheries, provide new directions for the use of marine resources while monitoring the actual performances of fisheries within the countries in the Asia region as a whole. Associated with this activity are the improvements in economic value of the fisheries that can be provided to the users (fishermen), the allocation aspects required to improve incomes and tenure to the types of fishermen involved. To some extent, therefore, the social benefits to be derived from the fishery will be included with the economic and nutritional benefits. The formulation of appropriate policy objectives, as shown above, which are inter-disciplinary by nature, can be expected to accelerate the adoption of inter-disciplinary approaches by fisheries agencies.

There may be a rationale for policy research to be carried out at an international level as the problems of marine fisheries in relation to food and consumer needs cover an area much wider than Southeast Asia. However, it must be remembered that the policies would have to be applied at a national level, in the face of governments' current difficulties to (a) effectively control trawl fleets; (b) overcome the short-term economic interests of the processing sector, and (c) address the common property nature of marine resources. An international policy research mechanism would have to be carefully thought out to ensure that it provided information to governments as the basis for decisions rather than appearing to focus international pressure to force changes.

As mentioned earlier, the mission had reservations concerning the immediate wisdom of encouraging regional mechanisms where national commitments, at least in terms of financial contributions, were not forthcoming. The INFOFISH and NACA intergovernmental organizations are, however, two mechanisms that have, or will have, such commitments, although most of the operating revenues are, or will be, earned from other sources. There are, however, efficiencies to be gained in regional research which become particularly relevant for expensive types of research, such as genetic engineering or bio-technology for aquaculture purposes or artificial reefs. Other aspects for research, such as for feeds, because of their implications to competitive production, might appear to be necessarily national in character even though there are global implications. Similarly, research on indigenous freshwater species and habitat requirements would appear to be a national requirement in the first instance, although there are benefits to be derived regionally.

The mission believes that the Governments of the region remain as yet unconvinced that the benefits of regional cooperation in fisheries research are positive. With scarce financial resources, it is perhaps more

appropriate for them to support national research endeavors. This does not apply to donor-supported activities but it is noted that these activities have not shown long-term momentum in terms of national importance. It would therefore appear expedient to not suggest regional mechanisms for research in fisheries until national governments are prepared to give a clear indication of the importance of such a mechanism as a national commitment. There does, however, remain a meaningful role for a regional mechanism that can support national institutional building, principally because of the efficiencies that can be obtained. In this regard the collapse of the South China Sea Project or technical support to that Committee would appear to have been premature. In the absence of this regional mechanism, however, ICLARM has assumed this function with its networking of scientists.

It may be further noted that, if national capabilities in fisheries are not being used to their potential to further develop fisheries, the need for regional mechanisms would not be supported. If capture fisheries were to embark on a different course, as described above, specializations and national capabilities might be expected to be shared in the spirit of technical cooperation, as evidenced between Canada and the USA.

SEAFDEC has assumed a regional role in providing training, and also conducts some research, but, as noted, Indonesia remains unprepared to join. As ASEAN as a whole has no coordinated approach to research or training in fisheries there remains an incomplete regional arrangement for these basic activities.

For the international mechanisms, INFOFISH appears secure in its funding from commercial interests as well as receiving financial commitments from its Member Governments. It meets the criteria established by the mission. NACA, to all intents and purposes, is expected to follow the same path, although the funding from commercial interests does not presently appear quite so secure.

The other candidate for international leadership is ICLARM, which is a global research institute with representation in Africa and Latin America in addition to Asia. As noted earlier ICLARM is under consideration as an international centre for fisheries research under the CG system.

At issue, however, is the need to identify the appropriate vehicle for bringing about change to ensure that fisheries provide a full contribution to sustainable economic, social and nutritional needs of developing countries. In the opinion of the mission, a fundamental need is for the appropriate formulation of objectives for fisheries in these terms. In this connection, the proposal for policy research, as advanced by the Director-General of AARD, is fully supported since policy research can, and should, encompass in an interdisciplinary manner the formulation of objectives to satisfy sustainable economic, social and nutritional needs. This, in turn, will provide the impetus for introducing fisheries management measures. There remains, however a question over whether this can be initiated within a national context, where it might remain within the agricultural sector and perhaps not address the full breadth of the opportunities that are believed to exist. These issues are by no means restricted to this region, as mentioned repeatedly above; many other countries are similar. The problem may even have a global dimension which suggests that a policy research need exists in a wider frame than that for Southeast Asia, even though the multi-species tropical fisheries aspects are largely contained within Asia.

The discussion therefore centres around the means by which national governments can be convinced that the constraints imposed by agriculture are not serving the fisheries in terms of potential. The vehicle for convincing is seen to be policy research and, in this connection, perhaps the most direct means of effecting change is to place policy research for fisheries within an international framework.

There are, in the opinion of the mission, other issues requiring accelerated research attention.

The advances made in aquaculture production within Southeast Asia and the similarity in products globally may also provide justification for a global center to research new aquaculture species, develop appropriate disease controls, essential feed inputs, contaminants and water quality controls. There remains, however, the need for a focus on indigenous species rather than the existing transfer of techniques to other regions for tilapia, carp, etc. and this need will have to be balanced against the efficiencies from any global

aquaculture research institute. Careful consideration is required to separate areas where national capabilities should be rewarded for research activities, while efficiencies from international research can complement aquaculture production techniques.

It must also be recognized that fisheries research is equally important for upwellings. To improve the understanding of the environmentally driven shoaling pelagic species and their possible contribution to food supplies. This area of research has for too long been dominated by traditional equilibrium fisheries models and the need for innovative research is obvious.

Finally, an effective international research institute would need to emerge from strong national or regional institutions rather than to be superimposed, without a strong foundation. It has been demonstrated that the strengthening of national capacity is required.

PART C. CONCLUSIONS

The above represents the mission's identification of major research issues required for fisheries within the next decade. It should be noted that all of them are directed at food production and food security, as this is essential for sustaining economic development for fisheries by improving the basic economic value. The sustainable economic value element is the most basic element missing from existing practices in favor of uncertain foreign exchange earnings of restricted high-priced species. As portrayed by a number of countries following extended fisheries jurisdiction, the key element to sustained fisheries development is the creation of domestic demand if fisheries are not to be dependent on the repercussions of volatile international markets. The long-term sustainable performance of fisheries is therefore inextricably linked to national consumption.

The mission considers that its report justifies the need for research, that the existing research activities in national institutions require sharp refocussing to overcome the constraints imposed by overfishing, environmental degradation, emphasis on export earnings, the deteriorating social conditions affecting fishermen and the erosion of consumer choice. It considers that the successful utilization of fisheries skills in the region need harnessing to meet more appropriately formulated national objectives for fisheries. It is suggested that the major client groups benefitting from the fisheries resources should be the fishermen and the consumers. Reformulated national objectives for fisheries will require a broadening of the existing single-discipline skills of the agencies responsible for fisheries, require more inter-disciplinary inputs to implement the objectives which in turn, will require increased participation of other institutes, such as universities, as well as private sector expertise.

Whereas the mission has reservations in recommending an international policy research institute, it supports the premise that such a mechanism may be necessary for demonstrating the considerable benefits that can be obtained from capture fisheries from a redirection of objectives. In this connection, there are strong arguments for such an institute since it must be noted that existing private, regional, international and United Nations bodies do not presently address this need. ICLARM focusses on the more scientific issues, while FAO does not conduct research and is more engaged in technology transfer. While the subject matter apparently falls within the mandate of the International Food Policy Research Institute (IFPRI), this Institute has so far concentrated on food security issues. It may be assumed that the terminology contained in UNCLOS (such as the objective for optimum utilization of living marine resources and proper conservation and management) is perhaps too vague for implementation in a national context. It should also be recognized that the common property aspects of capture fisheries require government intervention as a necessary means for providing order and direction, and this requires formidable competence within a national institutional setting. There is presently no existing body to which governments can turn for advice in developing such institutional competence. And that might also be considered a need whereby a policy research institute could report on capture fisheries to the global community, so that the benefits of UNCLOS can be appreciated by all.

The study team is invited to consider this recommendation in the light of the fact that the mission's purpose was directed at identification of research needs and was unable to quantify or elaborate, to any extent, the benefits obtainable from a change in objectives for fisheries. It is recognized that any decision to take up policy research in an international framework would require proper examination of expected benefits before proceeding, and this examination by itself might be sufficient to demonstrate the opportunities available to national governments from a change in direction. The study team may therefore wish to bring this need for a fuller examination of the other options available for capture fisheries to the attention of the World Bank and donor agencies and may wish to propose that such an examination is worthy of financial support.

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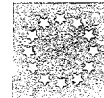
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