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# PRIORITIES

in Aquatic Resources Research  
in the Asia-Pacific Region

Edited by  
**Modadugu V. Gupta and Natalie Macawaris-Ele**

1999

**ICLARM**  
International Center for Living Aquatic  
Resources Management



## **Priorities in Aquatic Resources Research in the Asia-Pacific Region**

Proceedings of the First Meeting of the Asia-Pacific Association of  
Agricultural Research Institutions Group of Fisheries and Aquatic Research  
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Modadugu V. Gupta  
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# Contents

FOREWORD • MERYL J. WILLIAMS	iv	
INTRODUCTION	1	
AQUATIC RESOURCES DEVELOPMENT: CONSTRAINTS AND ISSUES	3	
REGIONAL PRIORITIES IN RESEARCH AND RELATED ACTIVITIES	5	
RECOMMENDATIONS OF THE MEETING	7	
EXTENDED ABSTRACTS OF COUNTRY PAPERS	9	
M.A. MAZID	Developmental Needs and Research Priorities for Fisheries in Bangladesh	10
LI YINGREN	Fisheries Development and Research Priorities in China	11
K. GOPAKUMAR	Present Status of Fisheries, Research Needs and Priorities in India	13
FUAD CHOLIK	Aquaculture and Fisheries Research in Indonesia: Priorities and Constraints	14
JANG-UK LEE	Fisheries Development and Research in the Republic of Korea	15
R.M.N. BIN RAJA OMAR	Fisheries Research and Development in Malaysia and Research Priorities for Regional Cooperation	16
I.T. BIN MD. YUSOFF		
M.B. PANTHA	Fisheries Development and Research in Nepal	17
JOHN MCKOY	Research Priorities in Aquatic Resource Management in New Zealand	18
NASIM AKHTAR	Fisheries Research and Its Developmental Needs in Pakistan	19
RAFAEL D. GUERRERO III	The Aquatic Resources Research and Development Program of the Philippines (1993-1998)	20
M.H. GUNAWARDENA	Sri Lanka Fisheries Sector—Research Policies and Priorities	21
MAITREE DUANGSAWASDI	Fisheries Development in Thailand	22
DAO MANH SON	Developmental Needs, Constraints, Research Focus and Regional Cooperation in Fisheries in Vietnam	23
STATEMENTS BY REGIONAL AND INTERNATIONAL ORGANIZATIONS	25	
MERYL J. WILLIAMS	Research Portfolio of the International Center for Living Aquatic Resources Management (ICLARM)	26
MODADUGU V. GUPTA		
P.C. CHOUDHURY	Food and Agriculture Organization of the United Nations (FAO)	28
HASSANAI KONGKEO	Network of Aquaculture Centres in Asia-Pacific (NACA)	30
MASAO SHIMOMURA	Southeast Asian Fisheries Development Center (SEAFDEC)	31
APPENDICES	33	
Agenda	33	
List of Participants	34	
List of Members and Associate Members of APAARI	37	
List of Acronyms	39	

# Foreword

The Asia Pacific Association of Agricultural Research Institutes (APAARI) and the International Center for Living Aquatic Resources Research (ICLARM) recognize that substantial benefits and efficiencies can be gained through more formal contacts between the aquatic resources research institutions in the region as well as between these institutions and those engaged in agricultural research. The Group of Fisheries and Aquatic Resources (GoFAR) has been set up to strengthen the existing linkages between them.

In the Asia Pacific region the variety and number of fisheries resources, as compared to agricultural commodities, is very large. This has, perhaps, obscured the fact that there are many common challenges to be addressed in the production and conservation of fisheries and aquaculture resources. The lack of an appropriate forum for discussing the challenges and priorities for the management and conservation of aquatic resources has resulted in a rather weak voice for the aquatic resources research sector as compared to that of agricultural research. As the Global Forum on Agricultural Research is now being formed, it is imperative that the importance of research in fisheries and aquatic resources be strongly recognized.

The first meeting of GoFAR produced substantive up-to-date information on the fisheries, aquaculture and aquatic environments of the 13 countries, one regional and two international organizations that participated. Based on this information, the participants developed a statement on the issues and constraints relating to the development and management of aquatic resources, the priorities in research and related activities, and a set of recommendations. These were communicated to the annual meeting of APAARI that followed immediately after.

ICLARM was invited to serve as the focal point for GoFAR and to collaborate with APAARI in arranging future meetings. ICLARM and its partners in GoFAR and APAARI are following up on the recommendations. Our aim is to strengthen the capacity of all research agencies in this sector and to link them with the agencies engaged in terrestrial agricultural research. This is particularly important for the countries of the Asia-Pacific region to be able to face the formidable challenge of sustaining production of fish and other living aquatic resources to meet the growing demand from larger and more affluent populations. At the same time they must protect the access of the poor to these valuable and nutritious resources while maintaining and/or restoring the quality of the supporting aquatic environments. The pre-eminence of the region in world fisheries production cannot continue without good management based on solid research, appropriately linked with and responsive to user needs and government policy.

The financial and organizational support provided by APAARI, Australian Agency for International Development (AusAID), Australian Centre for International Agricultural Research (ACIAR) and the Rural Development Administration, Republic of Korea, are gratefully acknowledged.

**Meryl J. Williams**  
Director General  
ICLARM

# Introduction

Agriculture is a vital economic activity and the main livelihood for most of the rural households in the Asia-Pacific region. Current trends suggest that the region will face severe food shortages by the year 2010 unless corrective measures are taken. Agriculture is at the heart of any effective solution to the host of problems encompassing population growth, environmental degradation, poverty and food security.

Realizing these challenges, the agricultural research institutions in the Asia-Pacific region established the Asia-Pacific Association of Agricultural Research Institutions (APAARI) in 1990 with the objective of fostering agricultural research through: information exchange; appropriate cooperative research and training programs in accordance with common needs; and strengthening the research organizational and management capability of the member institutions. At present, APAARI has 19 member institutions from Australia, Bangladesh, China, Fiji, India, Indonesia, Iran, Japan, Malaysia, Nepal, New Zealand, Pakistan, Papua New Guinea, the Philippines, Republic of Korea, Sri Lanka, Thailand, Vietnam and Western Samoa. There are also 12 regional and international organizations as Associate Members.

Since its establishment, the major emphasis of APAARI has been on crop research. However, in 1997, the forum recognized the importance of aquatic resources to the Asia-Pacific region in terms of their contribution to nutrition, employment generation and foreign exchange earnings. Despite this importance, the present state of knowledge of aquatic resources, and their species and culture systems lags behind what is known about agriculture and forestry. Management of natural resources is weakened by inadequate information and research inputs. Enhanced scientific knowledge is needed to arrest stress on these resources and increase production on a sustainable basis.

The importance of aquatic resources in world food production has only become apparent in recent years. At the global level, the Food and Agriculture Organization (FAO) and the International Food Policy Research Institute (IFPRI) recently decided to put aquatic resources into their global models of world food production. Moreover, it is also recognized that a systems approach to include agriculture, fisheries, livestock and forestry is needed in the regional efforts to alleviate poverty, ensure food security and manage natural resources. This approach would involve collaborative research partnerships among the various sectors in addressing regional concerns.

As a result, APAARI, in collaboration with the International Center for Living Aquatic Resources Management (ICLARM), organized a meeting during 11-12 October 1998 in Suwon, Republic of Korea, to bring together senior fisheries and aquatic resources research managers from the Asia-Pacific region to discuss regional priorities in research and capacity building. Participants from 13 countries (Australia, China, India, Indonesia, Republic of Korea, Malaysia, Nepal, New Zealand, Pakistan, the Philippines, Sri Lanka, Thailand and Vietnam), one regional organization (Southeast Asian Fisheries Development Center or SEAFDEC) and two international organizations (FAO and ICLARM) attended the meeting. Senior fisheries research officials from five other countries (Bangladesh, Fiji, Japan, Papua New Guinea and Western Samoa) and one regional organization (Network of Aquaculture Centres in Asia-Pacific or NACA) could not attend the meeting but have indicated interest in the meeting and discussions. Officials from Bangladesh and NACA submitted papers which are included in these proceedings.

The participants identified that although there are various networks in the region such as NACA, SEAFDEC and INGA (International Network on Genetics in Aquaculture), each focusing on a particular area of aquatic resources research, there is no common forum where researchers/planners from aquaculture, fisheries and aquatic resources management sectors can meet, exchange information and identify the regional priorities on which they could work together. They also recognized the need for close links with the agriculture sector in the common research areas, such as: integrated farming systems; watershed management; gene banking; genetic research/biotechnology; biodiversity conservation; feedstock production and management; health management; systems approach to natural resources management; and rural development and resource management policies. In view of this, the participants

recommended the formation of the Group of Fisheries and Aquatic Research (GoFAR) under APAARI. The Fifth General Assembly of APAARI held in Suwon, Republic of Korea, during 13-15 October 1998, strongly endorsed this view and GoFAR was officially formed and incorporated into APAARI in October 1998. The group discussed the current status of aquatic resources, constraints to development and research priorities of various participating countries and identified priority areas for regional collaboration in research and capacity building. Extended abstracts of papers presented at the meeting and recommendations of the group are also presented in this publication.

ICLARM and APAARI gratefully acknowledge the Australian Agency for International Development (AusAID) and the Australian Centre for International Agriculture Research (ACIAR) for their financial support and the Rural Development Administration (RDA), Suwon, Republic of Korea, for hosting the meeting. Special thanks are due to Dr. Ian Bevege of ACIAR and Dr. Seong Hee Lee of RDA and their staff for their invaluable support in organizing the meeting.

# Aquatic resources development: constraints and issues

At present, approximately 80 million tons of food fish are produced in the world annually. Based on population growth and other factors which drive demand, FAO has projected the need for an additional 40-50 million tons of food fish per year by 2010.

The participants at the first meeting of the APAARI Group of Fisheries and Aquatic Research (GoFAR) recognized that aquatic resources and fisheries, and aquaculture resources in particular, play a vital role in the economies of the Asia-Pacific region. It was pointed out that the region is responsible for about 60% of total world production from aquatic resources including 91% of aquaculture production and 56% of capture fisheries production. Aquatic production

- accounts for 30-70% of animal protein intake of people in the region,
- ranks between first to fourth in total national export earnings in most countries,
- employs between 1 and 8% of the populations directly and many more in ancillary industries including many women in the post-harvest sector,
- contributes a high quality protein to the diet of rural families, and
- is the fastest growing food production sector in the world, mainly due to rapid developments in aquaculture in the Asia-Pacific region.

The participants also welcomed the news that the Food and Agriculture Organization (FAO) and the International Food Policy Research Institute (IFPRI) had recently decided to put aquatic resources into their global models of world food production.

## Constraints and issues

In spite of the important contribution by the aquatic resources sector and the recent rapid development of aquaculture production, the world demand for fish by the year 2010 may not be met because of the constraints and issues outlined below.

### **Stock management**

- Sixty percent of major world fish stocks are overexploited or fully exploited and their catches will decline if management is not immediately improved; and
- Capture fishery resources are also threatened by landbased activities (agriculture, forestry, irrigation, power generation, industrial and urban development) which degrade aquatic habitats.

### **Aquaculture**

- Uncertain sustainability of aquaculture production due to continuous environmental degradation, disease outbreak, competition with other sectors for dwindling water resources and feeds;
- Inequity of distribution of benefits from aquaculture leading to conflicts and displacement of poorer producers, and
- The activities of the small-scale rural sector, the main fish producers, are not fully integrated into rural development policies for agriculture, livestock and water.

### **Biodiversity**

- Declining aquatic biodiversity, especially in fresh waters, limits the options for new species and strains for aquaculture and diminishes the natural productivity and resilience of aquatic ecosystems.

**Technical support services**

- Poor or non-existent aquaculture and fisheries extension services and weak linkages between research and extension in many countries;
- Lack of data for planning purposes; and
- Increasing but still inadequate research and development capacity at the national, regional and international levels.

**Profile of the sector**

- Decreasing attention to the aquatic resources sector by many bilateral and multilateral development assistance agencies;
- Lack of a fisheries and aquatic resources voice in the Global Forum on Agricultural Research, and
- Lack of priority given to the aquatic resources sector in many countries, thus endangering the food security of the millions of poor families dependent on the resources.

It was recognized that regional research collaboration would benefit all countries, organizations and networks in the region by:

- expediting the exchange of knowledge, research methods and sectoral development options among researchers working on similar problems;
- avoiding unnecessary duplication of research;
- allowing spill-over of research results outside national boundaries;
- sharing specialized research facilities and expertise (e.g., disease diagnosis),
- facilitating linkages among researchers;
- providing a mechanism whereby fisheries and aquatic resources research issues could be coordinated regionally and then raised in the Global Forum on Agricultural Research; and
- developing a mechanism for inter-sectoral activities with forestry and agricultural research

# Regional priorities in research and related activities

After a thorough discussion of national priorities in each of the participating countries in the Asia-Pacific region, the meeting identified the regional priorities in research, capacity building and linkages among national aquatic research systems (NARS) and agricultural research.

## Research

### **Marine capture fisheries**

- Coastal fisheries management with emphasis on:
  - stock assessment methods
  - impact of destructive fishing methods on non-target species
  - application of regulatory measures for management e.g., mesh size limit, closed season, exclusive devices
  - impact of environmental degradation
- Assessment of off-shore and deep-sea fishery resources
- Reduction in post-harvest losses
- Improved fishing technology, especially fishing gears and fishing vessels
- Improvement of fish processing technology with emphasis on:
  - improvement of traditional processing methods i.e., drying, curing and fermentation;
  - quality control and food safety; and
  - better utilization of low value fish through development of value added products
- Socioeconomic study of coastal fishing communities including:
  - fishing operation by low energy fishing techniques; and
  - gender issues
- Improvement of catch statistics.

### **Inland fisheries**

- Stock assessment of economically important species in river systems and lakes
- Ecosystem rehabilitation and stock management and enhancement in rivers and lakes
- Reservoir and lake fishery development and management
- Socioeconomic policies and regulatory measures
- Ecological studies related to fish kills.

### **Aquaculture**

- Genetic improvement of cultured fish species
- Aquaculture health management
- Fish nutrition and development of low-cost feed
- Identification and development of culture technology for indigenous fish species
- Improved shrimp culture systems
- Seed production technologies with special reference to brood stock management in captivity
- Integration of aquaculture with agriculture, animal husbandry and horticulture
- Environmental impact of aquaculture
- Socioeconomic and policy issues
- Transfer of technology (efficient extension services)
- Aquaculture engineering and farm management.

## Capacity building and linking NARS

### **Short-term training**

- Broodstock and hatchery management of marine species
- Fishing technology
- Health management
- Database management
- Fish processing and quality control.

### **Long-term training (M.S. and Ph. D.)**

- Fisheries management
- Oceanography
- Aquaculture genetics.

### **Institutional strengthening**

- Information exchange
- Exchange visits by researchers
- Collaborative programs in research and training (through national institutes, regional and international agencies).

## Linkages between aquatic resources and agricultural research

There is great potential for linkages between aquatic resources and agricultural research to be developed by:

- strengthening APAARI's goal of achieving food security in the region by making full use of fisheries as an important food producing sector;
- linking existing regional fisheries networks and organizations through the proposed APAARI Fisheries Group;
- drawing on the experience of crops and livestock sectors to establish aquatic resources gene banking and to study biodiversity regional needs;
- sharing of information on genetic enhancement of aquatic species and exchanging germplasm for breeding under appropriate bio-safety and quarantine protocols;
- ensuring the development of systems approach to natural resources management and the integration of aquatic resource systems with management of other rural sectors;
- studying interdependencies among aquatic resources, crops and livestock sectors with respect to water use and feeds; and
- linking fisheries research in the region to the Global Forum on Agricultural Research through APAARI.

# Recommendations of the Meeting

Participants at the Meeting recommended that:

- APAARI formally accept and encourage the formation of the Group of Fisheries and Aquatic Research (GoFAR). The integration of this group into APAARI will add value to and broaden the perspectives of the membership of APAARI and provide an established regional contact point for the aquatic research sector;
- ICLARM be the focal point for GoFAR in APAARI,
- Annual meetings be held in conjunction with the APAARI annual meetings;
- GoFAR organize and conduct workshops, conferences and projects related to its activities and priorities in the regional context;
- Closer linkages be developed between agriculture and aquatic research in the following areas:
  - integrated farming systems
  - watershed management
  - efficient water and land use
  - gene banking
  - genetic research/biotechnology
  - biodiversity conservation
  - feedstock production and management
  - health management
  - rural development and resource management policies;
- The activities of GoFAR be aimed at issues concerning commonalities among agriculture and fisheries sectors, marine capture fisheries, inland fisheries, aquaculture, research capacity building and linkages among NARS; and
- Activities in the following areas be initiated in the region in the near future:
  - Production of a comprehensive manual on integrated rice-fish farming (FAO and ICLARM indicated that they would implement this activity)
  - Gender issues in fisheries and aquaculture
  - Fodder management for grass carp production
  - Institutional strengthening in research priority setting
  - Integrated management of inland fisheries resources
  - Conservation of indigenous species
  - Mangrove-friendly aquaculture.

## **APAARI General Assembly**

The Fifth General Assembly of APAARI held in Suwon, Republic of Korea, during 13-15 October 1998 accepted the recommendations of the meeting. GoFAR was formed as a joint initiative of APAARI and ICLARM.



EXTENDED ABSTRACTS  
of country papers

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## Developmental Needs and Research Priorities for Fisheries in Bangladesh

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### Status of fisheries

Bangladesh, a country of deltaic plains dominated by three major river systems, namely the Ganges, Brahmaputra and Megna, is endowed with unique water resources comprising both inland and marine waters. Inland water resources of the country cover an area of 4 339 694 ha including open waters such as floodplains, rivers and estuaries, *beels* and *haors*, and closed water bodies such as ponds, oxbow lakes and coastal shrimp farms. Beside these, marine fisheries consisting of both offshore and artisanal fisheries have potential for increased fish production.

Fish and fisheries play an important role in the country, contributing 73% of total animal protein intake, providing full time employment to 1.4 million people and part time work for another 11 million and contributing some 10% to total export earning and 5% of national gross domestic product (GDP). An estimated 73% of rural households are involved in subsistence fishing and fish farming. The country has approximately 300 fresh- and brackishwater fish species (including freshwater prawns) and 511 marine species (including marine shrimps). Fish production during 1996-1997 was estimated at 1.37 million tons, 78.6% from inland waters and 21.4% from marine waters.

In recent years, the natural fishery stocks, including shrimp, have declined due to the deterioration of aquatic environments resulting mainly from human interventions such as: constructions of structures for flood protection and human settlement; over-exploitation; abstraction of water for irrigation; pollution; destruction of mangrove forests; and prevalence of injudicious and destructive fishing practices. The decline in fish stocks has also resulted in a reduction of biodiversity. The World Conservation Union (IUCN) has listed 61 freshwater fish species as endangered.

In aquaculture, several factors have negatively affected production, namely: (i) genetic deterioration of cultured species due to poor broodstock management and inbreeding depression; (ii) outbreaks of fish and shrimp diseases; and (iii) lack of sustainable shrimp and marine finfish seed production technologies.

### National research priorities

The National Perspective Plan formulated in 1995 set a fish production target of 1.5, 1.8 and 2.2 million tons by the years 1999-2000, 2004-2005 and 2009-2010, compared to production of 1.4 million tons during 1996-1997. To achieve these targets, the need for research and development in the following areas was identified:

- *Freshwater aquaculture*: Development of improved breeding and seed production techniques for fish and prawn; genetic improvement of culturable fish species; pearl culture in freshwater clams and mussels; fish nutrition studies; integrated farming systems; development of geographic information system (GIS); and ecoregion-specific aquaculture practices;
- *Brackishwater aquaculture*: Development of improved breeding and culture techniques for shrimp, finfish and non-traditional species such as mud crab;
- *Mariculture*: Development of breeding and culture techniques for finfish such as sea bass and grouper, seaweeds, oysters and green mussels for pearl production;
- *Inland capture fisheries*: Stock assessment, enhancement/rehabilitation studies and Hilsa fishery biology; population genetics; and management and conservation of biodiversity of aquatic genetic resources; and

\*Dr. Mazid could not attend the Meeting, but sent this presentation.

- *Marine fisheries*: Productivity and stock assessment of demersal and deep-sea pelagic fish resources; studies on the socioeconomic conditions of fishing communities; and production and quality control of fish and value-added aquatic products.

### Areas for regional cooperation

In view of the common goal of developing aquatic resources for food security, foreign exchange earnings, creation of employment opportunities and increasing farm income for resource-poor farmers, regional research cooperation in the following areas is suggested:

- Shrimp hatchery management and seed production;
- Genetic stock improvement of culturable fish species;
- Aquaculture-based farming systems research and development;

- Fish and shrimp health management;
- Development of gene banks for endangered fish species;
- Fish feed development from non-conventional sources;
- Pearl culture in freshwater and marine ecosystems;
- Stock assessment of inland and marine open water fisheries for proper resource management;
- Development of regional policy for exploitation of marine fisheries;
- Protection and enhancement of coastal and marine environments;
- Improvements in fish processing and preservation methods;
- Development of regional fisheries/aquaculture databases;
- Exchange of scientists and experts; and
- Training for scientists and technicians.

## Fisheries Development and Research Priorities in China

C H I N A

### Li Yingren

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#### Status of fisheries

The Chinese government has paid great attention to fish production since the late 1970s and established the Chinese Academy of Fishery Sciences (CAFS) as an integrated fishery research institution for basic and applied research. CAFS, with its 21 research institutes and experimental stations located along the coastline and the main rivers of China, organizes and undertakes research projects, solves bottleneck problems facing the fishery industry, carries out international cooperation, academic exchange, personnel training, and provides scientific and technical inputs to the whole fishery industry. The main areas of research at CAFS are: sustainable marine and freshwater aquaculture; enhancement of fishery resources; aquatic environment protection; aquatic product processing; fishery engineering; fishery economics; and information. Other research institutions, including universities, have also con-

tributed to fisheries and aquaculture research and development in China.

Due to the support given to research, aquaculture and fisheries production in China has been increasing. In freshwater aquaculture, CAFS has made great progress in genetic engineering and biotechnology, cross-breeding of crucian carp, extensive use of new species of carps, and developing culture techniques for other species of fish, crustaceans and turtles. Application of these research achievements in the country's developmental activities resulted in an increase in total output of freshwater aquaculture from 1 million tons in 1981 to 12.4 million tons in 1997. Successful development of technologies for culture of molluscs (bay scallop, abalone), finfish (sea breams, pufferfish, groupers, etc.) and shrimps have led the mariculture industry into rapid development. In 1997, output from mariculture was 7.9 million tons, an eighteen-fold increase

compared to 1981 output. In the capture fisheries sector, the Government's efforts in exploration/survey of resources in China's continental shelf and inland watershed systems assisted the fishing industry. One result of this endeavor is that 3 million tons of anchovy resource in the Yellow Sea and the East China Sea were successfully estimated using a quantitative model. All these scientific and technical studies were useful in decision-making, resource management and sustainable development of China's fishery resources.

CAFS has also undertaken studies on the effects of pollutants and heavy metals on fish, and coastal and inland fishery. Research undertaken on fisheries economics, fisheries information systems and fishery legislation has also contributed to the development of fishery.

### **Research priorities**

In recent years, aquaculture research has been given higher priority than capture fisheries research. Priority areas for research in the aquaculture sector are: (i) fish seed production techniques to facilitate production of high quality breeds and ensure sufficient quantity of seeds for aquaculture and restocking, (ii) fish and shrimp disease diagnosis and control involving studies on geographic and temporal distribution of viral and bacterial diseases, relations between environmental factors and disease occurrence; (iii) fish feed development including fish and shrimp nutrition physiology, development of new feeds, feed additives, development of database of raw material for feed and fish feed quality control techniques; and (iv) studies on pollution caused by industrial, agricultural and municipal pollutants and the treatment techniques for organic and inorganic pollution.

Capture fisheries research is becoming less and less important. In 1997, the production from capture fisheries declined to about 40% of the total production. At present, less than 10% of CAFS's research programs is related to marine and freshwater fisheries. CAFS is interested in the research and development of pelagic fish trawling techniques.

### **Regional cooperation in research**

The following research areas have been identified for regional cooperation

- *Shrimp disease control and prevention*. In view of the outbreak of shrimp disease in the entire country which almost destroyed the shrimp industry in 1993, cooperation is needed to develop a model for healthy shrimp farming and to control shrimp diseases.
- *Red tide prediction*. In early 1998, a serious red tide outbreak near the coastline of South China damaged the mariculture industry in the area and caused great economic loss. At present, prediction of the causes and mechanisms for emergence of red tide is still a baffling problem worldwide. Hence, CAFS is interested in cooperating with scientists from other countries to study the problem.
- *Introduction of new aquaculture species*. China is interested in introducing new species from other countries and undertaking cooperative research on these new species, and
- *Technical training*. China can provide training on freshwater aquaculture for other countries and is interested in sending its staff to other countries to study mariculture, environmental protection and research management.

# Present Status of Fisheries, Research Needs and Priorities in India

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## Status of fisheries resources

India has a vast coastline of 8 040 km with an exclusive economic zone (EEZ) of 2 million km<sup>2</sup>. In addition, the country is endowed with large inland water bodies: rivers and canals (171 334 km), reservoirs (2.1 million ha) and tanks and ponds (2.9 million ha). The country has an estimated marine fish potential of 3.9 million tons and inland fish potential of 4.5 million tons. Production in 1997-98 from both marine and inland waters was 5.4 million tons or 64% of potential resources. India ranks second in the world in aquaculture production. Carps constituted 70% of the freshwater aquaculture production and *Penaeus monodon* accounts for over 80% of farmed shrimps.

## Research strategies and priorities

India's fisheries research, under the leadership of the Indian Council of Agricultural Research (ICAR), is carried out by eight resource specific fisheries research institutes mandated to develop technologies for the exploitation of freshwater, brackishwater, coldwater, coastal and marine ecosystems, harvest and post-harvest processing techniques and an exclusive fishery university for human resources development. These institutions have contributed significantly to aquaculture, resource assessment, population dynamics, fish health monitoring, harvest and post-harvest technology and personnel development.

The immediate research strategies in freshwater fish culture include the production of transgenic species; cryopreservation of gametes and embryos, development of vaccines to prevent diseases, production of carps without inter-muscular bones, development of hatchery technologies for unconventional, but valuable fish species; gender issues, and the introduction of Hazard Analysis at Critical Control Points (HACCP) to eliminate risks associated with the consumption of contaminated fish. In brackishwater culture, the current priority area is the mitigation of social and environmental

issues in shrimp farming through the development of sustainable, environmentally friendly and economically viable aquaculture technology. There are also good possibilities for seabass and grouper farming, especially since the technology for seed production of these species has been developed by ICAR and is ready for commercial use.

In the capture fisheries, the need for large-scale sea ranching, implementation of closed seasons and mesh size regulation for marine fisheries has been identified to prevent the over-exploitation of stocks. Improved strategies for sustainable management of reservoirs and artificial lakes, increased production and assessment of impact of major river valley projects on fisheries have been identified as priorities. The introduction of the concept of Community-based Fisheries Management to fishers and fish farmers is essential for the sustainable use of resources.

Design and development of fuel-efficient and low-energy harvest technology are needed to enhance production from capture fishery. In the post-harvest sector, the country has developed excellent infrastructure for fish processing and quality control. However, there is a need to improve traditional fish processing techniques such as smoking and curing. There is vast need and scope for the production of biochemicals and biologically active chemicals from marine plants and animals.

## Areas for regional cooperation

The need for cooperation among research institutions of developing nations is recognized in order to avoid duplication of research. India is interested in collaborating in the production of biochemicals or bioactive compounds from marine organisms, such as the carrageenan, alginates and agar-agar from seaweeds. India is also interested in utilizing the expertise of the Philippines and Indonesia for economical production of seaweeds.

## Aquaculture and Fisheries Research in Indonesia: Priorities and Constraints

**Fuad Cholik**

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### Status of fisheries

Indonesia, with 17 508 islands, is endowed with vast natural resources, covering marine waters of 5.7 million km<sup>2</sup> with a coastline of 81 000 km. There has been a steady increase in fish production in recent years, from 4 million tons in 1994 to 4.6 million tons in 1997, with marine capture fisheries and aquaculture production showing an annual growth of 4.2% and 8.5%, respectively. Inland capture fisheries has almost stagnated with an annual growth of 0.2%. The marine fisheries sector, primarily artisanal coastal fishing, accounted for 70% of total fish production.

Fisheries development in Indonesia, despite the apparent increase in production, is facing various constraints. Accuracy of data on the size of marine fisheries resources and exploitation rates are topics of debate among scientists and fisheries practitioners. Availability of information on the biology of fish stocks required for management purposes is also very limited. Other constraints for development are ineffective rules, regulations and law enforcement, depletion of stocks and degradation of the environment, and limitation of technologies, human resources and capital investments.

### National research priorities

The major institutions involved in fisheries research are the Agency for Agricultural Research and Development (AARD) with its specialized institutions, the Indonesian Institute of Science (LIPI) and the universities. The Central Research Institute for Fisheries (CRIFI), under the umbrella of AARD, is responsible for research on fisheries and aquatic resources development. The Directorate General of Fisheries (DGF) with its associated institutions is responsible for packaging and dissemination of technologies. CRIFI has prepared a 10-year Strategic Research Plan for the period 1997-2006. The research falls into three categories: (i) research to support on-going development programs, (ii) research to provide short-term alternatives, and (iii) research to provide long-term

alternatives. The five major areas identified for research during the period are:

- *Utilization and management of fisheries resources and aquatic environment.* The research will cover stock assessment and bioeconomic valuation of resources; development of management strategies for conservation and sustainable exploitation of marine and inland resources; and stock enhancement and community-based resource management and dynamics of reservoir ecosystems.
- *Development of efficient and productive fishing gear and technology.* The research focuses on improvement of craft and gear; and the development of fish aggregating and by-catch extruder devices.
- *Breeding and genetic improvement of aquaculture species,* which includes characterization of various species used in aquaculture, genetic selection and hybridization.
- *Development of aquaculture technology,* including domestication and seed production technology for *Notopterus* sp., *Ophicephalus* sp. *Mystus* sp. *Neisochillus* sp., *Sclerophagus* sp., red snapper, groupers and carangids; genetic engineering of traditional culture species like common carp; and environmentally compatible technologies for brackishwater species, development of balanced feed using locally available ingredients, design and construction of submerged cages for mariculture.
- *Development of post-harvest technology,* for handling and live transport of fish and shellfish; fisheries product development and bio-technology in processing and treatment of fish industry wastes.

### Areas for regional cooperation

At present, Indonesia is involved in networking activities within and outside the country to establish collaborative research undertakings with various institutions. In particular, Indonesia has been involved in regional projects on stock assessment

of tunas in the ASEAN (Association of Southeast Asian Nations) region and continues to appreciate the importance of such cooperation in research. The following research areas are identified for collaboration:

- Studies on the management of shared stocks, straddling stocks and highly migratory species;
- Management of water bodies under stress espe-

cially the ecosystems dynamics of reservoirs used for intensive fish culture and integrated resource management:

- Diversification of cultivated species, especially to include indigenous species; and
- Sustaining shrimp culture industry involving research on management of acidifying ions produced by brackishwater pond reclamation to avoid pollution of surrounding areas.

## Fisheries Development and Research in the Republic of Korea

### Jang-Uk Lee

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#### Status of fisheries

Korean fisheries grew rapidly until the mid-1980s and have since leveled off in recent years to an average production of 3.2 million tons per annum. Since the mid-1990s, the Korean fishing industry has been facing serious difficulties not only due to overexploitation, pollution and effects of land development activities resulting in depletion of fishery resources, but also from imposition of limitations on fishing areas following the establishment of exclusive economic zones (EEZ) by countries in the region.

Longline fishery for tunas started in 1957 in the Indian Ocean and subsequently spread to the Pacific and Atlantic Oceans. This was followed by exploitation of other fishery resources, such as Pacific mackerel, anchovy, common squid, hair tail and yellow croaker. Efforts have been made to improve fishing technology and fishing gear to minimize discards, avoid catching non-target species and maximize escape of small-size fish. Artificial reefs have been in place since 1971 to enhance marine resources.

Mariculture focuses on economically important seaweeds, molluscs and fishes such as sea bream, rockfish and flounder. Culture in inland waters, which started with carps, now includes 16 species of farmed fishes. Studies on biotechnological applications and pathology of animals in aquaculture have also been undertaken.

Other studies being undertaken are on the monitoring, control and forecasting of harmful algal blooms and fishery oceanographic surveys to moni-

tor changes and fluctuations of environmental conditions affecting marine resources and ecosystems

#### National research priorities

Research is being undertaken in the following areas: (i) stock assessment of coastal and offshore fisheries resources; (ii) biological and ecological studies of commercial fish species, including migration patterns, fecundity and spawning, estimation of population parameters; (iii) acoustic surveys; (iv) short- and long-term forecasting of fishing conditions; (v) enhancement of aquaculture productivity; (vi) genetics including operation of a genebank of aquaculture species, especially indigenous species; (vii) aquatic pathology; (viii) control of algal blooms (red tide); and (ix) oceanography studies to monitor fluctuations in environmental conditions.

#### Areas for regional cooperation

As Korea shares its deep-sea fishery resources with neighboring countries such as China, Japan and Russia, a regional approach to the management of these shared, straddling stocks is needed. In addition, considering that the countries in this region have carried out research on the fisheries resources, top priority should be given to exchanging data among the countries concerned with the final objective of formulating schemes for the conservation and sustainable management of the shared resources.

## Fisheries Research and Development in Malaysia and Research Priorities for Regional Cooperation

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### Status of fisheries

In 1995, total fish production in Malaysia amounted to 1.3 million tons and accounted for 1.5% of the GDP. The sector provides direct employment to 82 200 fishers and 18 466 aquaculturists, constituting about 1.3% of the total labor force in the country.

During 1995, marine fisheries, aquaculture and the public waterbodies produced 89%, 10.7% and 0.3% (excluding ornamental fish) of total production respectively. In terms of value, the marine fisheries contributed RM 2.7 billion\* (86%), while the aquaculture sector including ornamental fish, contributed RM 439.5 million (14% of total production value).

The capture fisheries (inshore and offshore) sector in the region has been endowed with many developmental programs since the beginning of the 1960s and subsequent research with overseas aid resulted in increased fish production. However, in the late 1980s, the catch comprised of relatively smaller sized fish and different species composition with trash fish constituting about 55-65% of the catch.

Aquaculture of eel, red tilapia, catfish, mussel, oyster and cockle and prawns is being undertaken. In 1995, total aquaculture production (excluding ornamental fish) increased by 16.3% while the value of ornamental fish production increased by 12.3%. The total production from freshwater aquaculture decreased by 0.57% due to the decrease in the production of pond and ex-mining pool cultures. However, it contributed 13.9% of the total aquaculture production valued at RM 130 million.

### National research priorities

- *Marine fisheries.* At present the volume of fish landings contributed by the offshore vessels is

low at about 138 000 tons (11% of total landings). The offshore fishing industry has been looking to incorporate new technologies including the application of remote sensing in locating fishing zones to save operating costs and time by fishers at sea, and developing downstream activities for the offshore fisheries for product development and processing.

- *Aquaculture.* To achieve the target production in 2010, production of fish is expected to grow by 40 000 tons annually. The cage culture is seen to be one potential means to increase production with the sea bass (*Lates calcarifer*) and grouper (*Epinephelus* spp.) as cultured species. Research thrust in aquaculture is focused on further improvement in culture technology of these species.

### Areas for regional cooperation

Malaysia has been collaborating with regional and international organizations in fisheries development and as such, understands the importance of collaborative research undertaking. The following areas have been identified for regional collaboration.

- *Readdressing stock assessment models.* The use of ecosystem modeling developed by advanced institutions in the early 1990s should be continued to determine the status of the stocks in the South China Sea. Information on the prey-predator relationship is lacking and a close research cooperation among nations is needed to save time and funds.
- *Institution of an individual transferable quota (ITQ) system to prevent overexploitation in shared waters.* The technique has been successfully implemented in the fishing industries of Iceland and New Zealand. Feasibility studies

\*December 1999: US\$1 = RM 3.8.

on the institution of an ITQ system particularly for the South China Sea need to be carried out. Each nation should take steps to implement the ITQ system at least for some selected species that are shared in the South China Sea as well as enforce responsible fishing.

■ *Studies on biology of shared stocks.* The studies on the biology (including movement patterns of eggs, larvae and adults) of shared stocks (fish, turtles and shark) need to be continued and expedited. Data are required to ensure that fisheries management decisions are made accurately.

■ *South China Sea oceanographic studies.* A regional study on the physical and chemical oceanographic patterns of the South China Sea is needed to determine patterns of annual fish migration. This would be valuable in the management of fish resources.

■ *Mariculture of other species.* Research needs to be conducted in mariculture of abalone, giant clams, squids and other suitable organisms using artificial reefs in coastal waters to enhance and conserve the habitats as well as to increase production.

## Fisheries Development and Research in Nepal

N E P A L

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#### Status of fisheries

Nepal, being a landlocked country, is restricted to inland capture fisheries and aquaculture. There are three major river systems: Koshi, Gandaki and Karnali, in addition to other water bodies such as lakes, human-made reservoirs, ponds, permanently irrigated paddy fields and swamps, that contribute to fish production. These waters support the 185 cold- and warm-water fish species that have been identified to date. Beside the indigenous fish, seven exotic species of commercial value have been introduced (rainbow trout, carps and tilapia). Fisheries development in the country is largely an untapped resource as it presently utilizes less than 3% of the available water.

The potential of these vast aquatic resources has not been fully realized due mainly to: (i) lack of human resources to undertake research and development geared towards the sustainable and optimum use of the resources; (ii) outbreak of diseases in cultured species; (iii) inadequate management and restocking of commercially important native species in natural habitats; and (iv) lack of measures for conservation of fisheries resources.

Presently, the fisheries sector accounts for 1.5% of the agriculture sector's share in the GDP and employs nearly 1.5% of the total population

(20 million). However, considering all aspects of fisheries in Nepal, there is a need for a long-term development strategy for managing the natural fisheries resources.

Capture fisheries in rivers and lakes still makes use of traditional fishing gears and generates only marginal economic benefits, producing fish yields of only about 50 kg·ha<sup>-1</sup>. In the aquaculture sector, pond aquaculture has emerged as the most viable and popular activity. Production from pond culture increased from an average fish yield of 0.8 tons·ha<sup>-1</sup> in 1981-82 to over 2 tons·ha<sup>-1</sup> in 1997-1998. Currently, the rainbow trout, three indigenous warm-water fishes and three cold-water species are being commercially produced. Polyculture of fish has been adopted in intensive, semi-intensive and extensive fish culture systems, with the inclusion of integrated fish farming with fruit trees, vegetables, grass and other livestock

#### Research priorities

Current research in Nepal is aimed at increasing fish production which includes improvement of aquaculture technologies, year-round production of fish seed, feed formulation, assessment of riverine fish stocks, conservation of aquatic genetic resources, and establishment of a data-bank of fish resources.

### Areas for regional cooperation

The priorities identified for regional collaboration involve enhanced information exchange among research institutions in the region, capacity building programs (e.g. training and cross-country visits) on management and sustainable development of fisheries resources. Collaborative research in the following areas is suggested:

- Assessment of impacts of introduction of exotics on biodiversity;
- Development of common methodology for addressing environmental concerns in aquaculture development;

- Assessment of environmental and socio-economic impacts of mangrove destruction;
- Assessment of impact of pollutants such as drugs and chemicals;
- Studies on nutritional requirements of cultured species and subsequently, feed technology development.
- Studies on the control of diseases in aquaculture; and
- Promotion of artisanal aquaculture.

## NEW ZEALAND

# Research Priorities in Aquatic Resource Management in New Zealand

## John McKoy

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### Status of fisheries

Fisheries and aquaculture industries in New Zealand have developed rapidly during the last 30 years such that they have become major primary industries. Annual production from fisheries and aquaculture is about 600 000 tons, the capture fisheries sector being the major producer. Aquaculture production is rapidly developing but is at relatively low level. Likewise, freshwater production is also at a relatively low level.

Capture fisheries range from high value deep-water fisheries to inshore and estuarine fisheries. Annual harvests include species such as orange roughy (*Hoplostethus atlanticus*) and oreos (Family *Oreosomatidae*) fished in depths of 800-2 000 m; hoki and squids in middle depths of 200-800 m; tunas and mackerels from pelagic zones; and snappers, shellfish and flatfish from inshore areas. Aquaculture takes place in shallow inshore sheltered waters and is based around greenshell mussels, oysters, salmon and abalone.

The primary management system for fisheries resources in New Zealand is the Quota Management System (QMA) that is based on the provision of individual transferable quotas (ITQ), which in turn, refer to a specific proportion of the available total allowable catch (TAC) for any species apportioned as quota to individuals

on an annual basis, but in perpetual ownership. Responsibility for establishing levels of total allowable catches and for the administration of the allocation of quotas lies with the Ministry of Fisheries. The major policy direction within the administration of the system is to establish "sustainable fisheries in a healthy aquatic ecosystem".

### Research priorities

Research priorities in New Zealand are viewed against the fisheries management system in place and the types of fisheries and resources which are being managed within this system. Current research priorities are established in two major areas: (1) conservation of resources which is the responsibility of the Ministry of Fisheries; and (2) developmental research aimed at improving efficiency or developing new resources, which is the responsibility of the private sector. Fisheries research is focused on the following: (i) key species or resources that are commercially fished; (ii) non-commercial fisheries (traditional and recreational) based on key species; (iii) the effects of fishing on non-target species; and (iv) the effects of different fishing techniques on aquatic ecosystems.

Research strategies are based around the idea that research on key species must be conducted at a level sufficient to adequately assess and manage them. Included in this approach is the development and application of "adaptive management" techniques which incorporate experimental fisheries and decision rules. Given the high cost of research, this approach is providing a range of interesting possibilities for effective and practical management. Research priorities are also determined in part by the extent to which non-commercial fishery activities such as recreational and traditional fisheries make up a significant proportion of harvests of key resources

The specific research goals concentrate on the following: (i) fisheries resources assessment focused on developing and applying methods of risk and decision analysis to stock assessment and the evaluation of alternative harvesting strategies and management options; (ii) harvest levels to obtain accurate estimates of the size and distribution of harvests from commercial, recreational, Maori customary and traditional fishing catches as well as estimation of levels of illegal catch and fishery induced mortality on non-target species, and (iii) impacts of aquaculture and enhancement on aquatic environment involving the examination of the interaction between aquaculture and

enhancement systems on wild fisheries and the estimation of sustainable production levels of aquaculture and enhancement systems, including carrying capacity.

#### **Areas for regional cooperation**

Given New Zealand's position in the temperate southwest Pacific Ocean, it shares relatively few species with other countries in the region. The primary overlap in terms of similar systems and species is with Australia. New Zealand cooperates with regional organizations in carrying out research and assessment on pelagic species such as tunas.

The generic problems associated with the aquatic resource management in New Zealand are shared with most other countries in the region. The establishment of techniques to understand and analyze the biological systems on which fisheries resource management is based are common. Issues such as the management of diseases in both wild and aquaculture systems and modeling for management decisionmaking and risk assessment are common within the region. Expertise in these areas is very limited and there are good opportunities for sharing this expertise

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## Fisheries Research and Its Developmental Needs in Pakistan

PAKISTAN

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#### **Status of fisheries**

Central to Pakistan's economy, fisheries is a small but important sub-sector of agriculture. Fisheries and aquaculture add substantially to national income and employment and provide animal protein. Fisheries products constitute the fourth largest agricultural export commodity. Inland water resources in the mountains and plains are classified into cold-water, warm-water and cool-water zones and the marine areas include estuaries, continental shelf, coastal areas and deep seas.

In the past, there was no national fisheries research system primarily due to lack of financial and qualified human resources. In the last decade, two research centers, one at the federal level and the other at the provincial level, have been established. Research at these centers has focused on: reservoir fisheries management, breeding and genetic manipulation of major carps; limited research on trout breeding and production; and on-farm research for sustainable aquaculture. Marine fisheries research is focused on limnology, fish biology, fish harvesting methods and post-harvest activities.

### National research priorities

The aquatic research priorities in Pakistan, after human resources development, are focused on:

- Aquaculture involving sustainable pond culture of carps, genetic improvement of cultured species, performance evaluation of cultured species new to Pakistan, mariculture of shrimps and fish for food production as well as for restocking of natural habitats;
- Reservoir fisheries management and assessment of resource and carrying capacity;
- Enhancement of riverine fisheries; and
- Conservation and genetic characterization of indigenous species.

### Areas for regional cooperation

Pakistan's networking efforts with international organizations are still in a nascent stage. There is a great need for regional cooperation in the areas of.

- Institutional and manpower capacity building to conduct research on sustainable aquaculture;
- Studies on biotechnological approaches to increase fish production;
- Research on fish biodiversity and conservation of genetic resources; and
- Information exchange through access to international databases, workshops, symposia and membership in international networks.

## PHILIPPINES

# The Aquatic Resources Research and Development Program of the Philippines (1993-1998)

## Rafael D. Guerrero III

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### Status of fisheries

The Philippines is an archipelagic nation richly endowed with 220 million ha of marine waters, including 27 000 km<sup>2</sup> of coral reefs, 356 328 ha of swamplands, lakes, rivers and reservoirs and 253 854 ha of fishponds. Fisheries contribute 3.9% of the gross national product (GNP) and provides employment to about 5.5% of the national labor force. The Philippines was the thirteenth biggest fisheries producer and fourth top aquaculture producer in the world in 1996. Of the total fish production of 2.7 million tons in 1996, 35% was from aquaculture, 33% from municipal fisheries and 32% from commercial fisheries. Fisheries products account for 70% of the total animal protein intake and 30% total protein intake of people of the Philippines.

The fisheries resources of the Philippines are in varying stages of decline and depletion as indicated by a decreasing trend in production. Available information indicates that: all the major bays have been over-exploited; nearshore demersal stocks are only 30% of levels in the 1940s; current fishing effort for small pelagics is double that of

resource sustainable limits; 70% of coral reefs have been damaged; and, of the 500 000 ha mangroves in 1920, only 146 000 ha have vegetation and only 6% are in excellent condition. Fisheries resource depletion has been mainly due to: (i) overexploitation, (ii) environmental degradation due to deforestation, mining industries, agricultural and shoreline land development; (iii) low aquaculture productivity due to diseases, inadequate supply of seed and limitations in culture technologies used; (iv) underutilization of offshore and EEZ resources; and (v) inefficient utilization of fisheries products due to poor post-harvest practices.

### National research priorities

To address the major constraints for improvement of productivity and promotion of sustainable management of aquatic resources, the National Aquatic Resources Research and Development Program for 1993-1998 was formulated. The research and development priorities for aquatic resources are focused on:

- *Resource and ecological assessment for formulation of integrated management schemes and exploration of unutilized resources:* stock assessment of tuna and small pelagics; socio-economic and marketing studies; institutional and policy studies; development of management schemes for offshore and coastal, inland and freshwater fisheries resources; environmental studies including oceanographic circulation patterns, phenomena such as the red tide and marine geology;
- *Aquaculture development:* breeding and seed production, culture systems, feed development and genetic improvement of economically important species such as seaweeds, milkfish, tilapia and crabs; diagnostic kits for shrimp diseases, environmental management; institutional and policy studies; and
- *Improvement of post-harvest processing and utilization:* improvement/pilot testing of post-harvest handling and processing technologies including development of value-added products from major fish and fishery products.

#### **Areas for regional cooperation**

While there are differences in ecological and sociocultural conditions among countries in the Asia-Pacific region, there are many common areas for research and development of aquatic resources. Some of the needs that could be considered for regional cooperation are:

- Capacity building in fisheries and aquatic resources research which could be addressed through training and scholarship programs;
- Strengthening the capability of national research institutions in planning, implementation, monitoring and evaluation of research and development programs possibly through technical assistance,
- Access to knowledge and experience in fisheries and aquatic resources in the region through regional cooperative programs in education, research and extension under the aegis of the APAARI fisheries group; and
- Collaboration between aquatic and agricultural research institutions in integrated agri-aqua farming systems, pond wastewater recycling systems and use of agricultural by-products and animal wastes for production of low-cost fish feeds.

## Sri Lanka Fisheries Sector—Research Policies and Priorities

SRI LANKA

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#### **Status of fisheries**

The fisheries sector plays an important part in the country's economy contributing about 3% to the GDP and directly employing over 150 000 fishers and fish farmers and those in ancillary industries. Over the last decade per capita fish supply has been around 15 kg per annum. In recent years, the gap between domestic fish supply and demand has increased due to shortfalls in supply particularly from the north and east coasts because of prevailing war and population growth.

The contribution of coastal fisheries production to total production has dropped from 80% to 90% during the mid-1980s to 65% in 1996 due to overexploitation. Recent studies indicate that the levels of coastal fisheries production, particularly

the pelagic species caught by gill nets, have reached or are close to their potential yield. Deep sea or offshore fisheries production has been on the increase and contributed 25% of total production in 1997 as a result of the private sector's initiatives on the introduction of multi-day boats for deep sea fishing. Inland fisheries and aquaculture production are now recovering with the return of the Government's support to activities within this sector. Shrimp farming, which is the major aquaculture activity, is a major foreign exchange earner in the fisheries sector, in addition to the export of ornamental fish comprising of marine species gathered from the wild, and freshwater species collected both from natural and hatchery-reared stocks. Available information indicates that

supplies from the wild are decreasing, probably due to overexploitation and degradation of habitat. Over 50% of the fishery exports include high value commodities such as shrimp, lobster and crab and the rest are comprised of non-edible products such as ornamental fish.

The major constraints for development are overexploitation and degradation of resources, heavy post-harvest losses, conflicts in multiple use of resources and lack of demand for freshwater fish. In view of the growing importance of the fisheries sector in terms of regional development, employment generation, export trade and domestic animal protein supply, research and development activities in this sector are essential. However, there are institutional, financial and technical constraints: (i) difficulties in retaining qualified/experienced scientists and providing adequate working conditions for their professional development; (ii) inadequate allocation of funds from the Government; (iii) externally funded research programs tend to be donor-directed, not necessarily reflecting the needs of the country; and (iv) lack of technical expertise in comprehensive data collection for resource assessment and management as well as development of fishing and culture technologies.

#### **Research priorities**

In the coastal areas, research is needed for integrated approaches to conservation and management of aquatic resources to alleviate problems of overexploitation, habitat degradation and

conflicts among resource users. Oceanographic studies, resource assessment studies and development of deep-sea fishing and post-harvest processing technologies are the identified priorities in research in the capture fisheries sector. National research priorities for inland fisheries and aquaculture include: (i) development of community-based management strategies for reservoirs and seasonal tank fishery; (ii) larval rearing studies for shrimp culture; (iii) development of culture techniques for mud-crabs, sea bass, groupers and sea cucumbers; (iv) captive breeding of ornamental fish; and (v) disease control.

#### **Areas for regional collaboration**

The identified areas for regional collaborative activities are:

- Multilateral coordination of conservation and management of shared fish stocks to include harmonization of fisheries legislation and joint monitoring mechanism;
- Development of mechanisms for the exchange of knowledge in fisheries and aquaculture research among research institutes and universities within the region to develop common research programmes; and
- Development of a resource database for the Indian Ocean and its environment through sharing of satellite data/information and photos.

## **THAILAND**

### **Fisheries Development in Thailand**

#### **Maitree Duangsawadi**

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#### **Fisheries resources**

Thailand has 2 614 km of coastline and 3 750 km<sup>2</sup> of inland water area and is presently one of the world's largest exporters and importers of fish and fishery products due to its offshore fishing activities and the rapid development of the processing industry. Fishery products are also important sources of protein in the diet of Thai people as reflected in the average annual per capita consumption of approximately 30 kg.

In 1994, fisheries production was estimated at 3.14 million tons. The sector contributed 1.39% to the gross domestic production (GDP) and 12.5% to agricultural GDP. Thailand's marine fisheries production accounts for approximately 90% of the total production. By exporting fishery-based commodities, Thailand earned foreign exchange worth US\$ 4.4 billion and there is considerable potential for increasing exports, particularly from the aquaculture sector.

### **Status of fisheries**

The capture fisheries sector is made up of 30 000 vessels used for fishing offshore, including the waters of neighboring countries such as India, Bangladesh, Myanmar, Malaysia and Indonesia. The aquaculture sector involves culture of freshwater species such as Nile tilapia, gouramy, catfish, carp-like fish and snakeheads; tiger prawn and seabass culture in brackishwater; and marine culture of molluscs such as bloody cockles, green mussels and oysters. The modernized processing industry provides employment, income and foreign currency, through the export of products such as frozen shrimp and canned seafood.

The lack of systematic management and rehabilitation, coupled with the rapid development of technological base of marine capture fisheries, however, has led to rapid decline in fisheries and resources. Other factors such as pollution and illegal fishing practices have also contributed to

the decline. As such, the Government has set up management measures, e.g., limitations imposed on vessel size, type of gears, mesh size, fishing areas, installation of artificial reefs to deter near shore trawling and observance of closed fishing seasons during spawning of fishes, although implementation of these measures has been difficult. Thus, efforts need to be strengthened to improve the fishery management and insure sustainability of resources.

Harvesting from reservoirs is undertaken without any regard for size or species, depleting the stocks. Since 1978, the Government has been stocking the reservoirs and large inland water bodies with more than 30 species of fish. Various management practices are being followed for conservation and sustainable utilization of inland resources. Major problems being faced in stock assessment of reservoirs include lack of methods for studying growth and mortality of fish.

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## Developmental Needs, Constraints, Research Focus and Regional Cooperation in Fisheries in Vietnam

V I E T N A M

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### **Status of fisheries**

Vietnam has a long coastline of 3 260 km and EEZ of about 1 million km<sup>2</sup>. The fisheries sector contributes 9% of the GDP and provides about 40% of the animal protein intake. Total fisheries production, being the third largest resource-producing sector after oil production and rice farming, was estimated at 1.6 million tons in 1997, 68.7% of which is from marine capture fishery and 31.3% from aquaculture. The export value of fisheries products in 1997 was estimated at US\$776 million. About three million people are engaged in fisheries and related activities.

The estimated total standing stock of marine fish in Vietnamese waters was estimated at about 4.1 million tons with a maximum sustainable yield (MSY) of 1.6 million tons per year. Among 2 000 recorded marine fish species, about 120 species are of commercial importance. Shrimp is the most important commercial species due to its high value, followed by scads, croakers, snappers,

sardines, jack, tuna, grouper, lobster, scallop, crab, cuttlefish and squids. The aquaculture sub-sector has considerable potential to support increased production and supplies of fish and aquatic products. Approximately 1.4 million ha of total inland water area, 375 500 ha of brackishwater and 445 000 ha of marine waters have been reported to be suitable for aquaculture development, of which only a total of 600 000 ha has been exploited. The main species in brackishwater and marine aquaculture include tiger shrimp, other species of shrimp, mud crab, seabass, clams, tilapia and seaweed. Freshwater species include carps, catfish, soft-shelled turtle, frog and freshwater prawn.

The fisheries sector in recent years has achieved considerable growth and expansion, resulting in increased production and employment. However, the sector is beset with many problems such as overfishing and habitat destruction in coastal areas resulting in rapid decline in coastal fish

stocks, underdeveloped infrastructure, shortage of finances for modernization, lack of resources and management systems and lack of knowledge. In the case of aquaculture, lack of appropriate technologies for seed production of commercially important species, feed formulation and disease diagnosis and treatment have been constraints for development.

#### **National research priorities**

The most important objectives and strategies of the Government are to mobilize the full potential of fisheries and the fishing industry to effectively contribute to the improvement of the national economy and the socioeconomic conditions, including nutritional standards, of the people. To meet these thrusts, the Government has undertaken a policy to achieve five goals during 2000 to 2020, namely: (i) increase the consumption of fishery products; (ii) increase export earnings; (iii) create employment within the sector; (iv) improve the infrastructure, equipment and technological base for the fishery sector, and (v) increase the contribution to the national budget. The research priority areas that have been identified to achieve these goals are:

- Management of the environment, natural resources and ecosystems to improve the management of the environment and the country's fisheries resources and ecosystems. A key element in the Government's approach to resources management will include the establishment of closed seasons;
- Management of marine capture fishery to insure sustainable use of fishery resources. This would involve the development of a comprehensive licensing system to monitor and control fishery landings; basic research on

reproduction, growth/ mortality and migration of fishes; and expansion to offshore fisheries parallel to the efforts aimed at rehabilitating coastal resources, and

- Aquaculture development research involving studies on interaction between environment and aquaculture for the protection of the environment, development of artificial breeding technologies and sustainable use and management of land, water and fisheries resources

#### **Areas for regional and international cooperation**

In the past three decades, Vietnam has undertaken collaborative research with many organizations and countries. Recognizing the importance of collaboration in terms of cost-effectiveness, avoidance of duplication of efforts and capacity building, the country plans to further strengthen its collaboration. The priority areas for regional research cooperation are:

- Environment and resources management addressing issues on development of legal, regulatory and control framework for resources management, development of effective and cost-efficient monitoring, control and surveillance systems, and establishment of appropriate sanctuaries and marine parks,
- Marine capture fishery involving protection and restocking marine resources in coastal areas, offshore marine resources survey and assessment, establishment of effective fisheries databases and information systems, and
- Aquaculture involving artificial seed production of marine finfish, crustaceans and molluscs, development of production models for floating netcages, pens, ponds, netcages in rivers and reservoirs; and disease diagnosis and treatment of cultured finfish, shrimp, molluscs and others



STATEMENTS  
by regional and international  
organizations

## Research Portfolio of the International Center for Living Aquatic Resources Management (ICLARM)

**Meryl J. Williams and Modadugu V. Gupta**

*ICLARM, Makati City, Philippines*

The International Center for Living Aquatic Resources Management (ICLARM) undertakes research and related activities, in partnership with national, regional and international organizations, with the specific objectives of: (1) raising and sustaining the productivity of fisheries and aquaculture systems; (2) protecting the aquatic environment; (3) saving aquatic biodiversity; (4) improving policies for sustainable development of aquatic resources; and (5) strengthening the capacity of national programs to support sustainable development. ICLARM's research mandate covers all living aquatic resources, with a focus on those most critical to the poor in developing countries and is multidisciplinary in nature encompassing biophysical, socioeconomic, legal and institutional aspects of management of aquatic resources.

ICLARM uses a resource system approach for setting research priorities. It has identified eight aquatic resource systems that are similar in concept to agroecological zones used in agriculture: ponds (including rice fields); reservoirs and lakes; streams, rivers and floodplains; estuaries and lagoons; coral reefs; soft-bottom shelves, upwelling shelves; and open seas. These resource systems were prioritized for research based on: (1) the potential benefits to ICLARM's target beneficiaries; (2) the ability of these beneficiaries to utilize the resources; (3) the potential for science to contribute to the sustainable use of the resources; and (4) ICLARM's comparative advantage in research. Based on these criteria, ICLARM, in collaboration with its partners, is working in the following research areas.

### **Biodiversity and Genetic Resources Program**

Strategic research on fish biodiversity and genetic resources and the development of genetic resources research methods. A large electronic encyclopedia of fish on CD-ROM, FishBase, containing key information (nomenclature, morphology, transgenic ecology, population dynamics, physiology, pictures, maps, etc.) for over 20 000 of the estimated 25 000 species of finfish, was

developed in collaboration with FAO and other partners. A project for capacity building in fisheries and biodiversity management in the national programs of 55 African, Caribbean and Pacific (ACP) countries is under implementation. Case studies for demonstrating how to document genetic resources for their sustainable use are in progress in West Africa and South and Southeast Asia.

### **Germplasm Enhancement and Breeding Program**

Development of improved breeds of tilapias and carps and dissemination of the techniques and training of national researchers on their use. Methods developed for the genetic improvement of tropical finfish through simple selective breeding programs, with Nile tilapia as test species, are being extended for genetic enhancement of carp species in six countries of Asia. The work being undertaken combines genetics, socioeconomic evaluation of the appropriate species, farming systems and breeding goals that will yield the highest potential impact in developing countries in terms of increased protein production, efficiency, equity, sustainability and environmental issues. The techniques are being transferred to African countries.

### **Integrated Aquaculture-Agriculture Systems Program**

Improvement of small farm productivity through the introduction of aquaculture into farming systems. Work is in progress in Bangladesh, Malawi, Philippines and Vietnam. Research at these sites is linked to the development of a software package called RESTORE (Research Tool for Natural Resource Management, Monitoring and Evaluation). Research is in progress for increasing and sustaining the productivity of fish and rice in the floodplain ecosystems of South and Southeast Asia to analyze alternative resource management strategies in floodplain ecosystems. Strategic research plans for inland aquatic resource systems including reservoirs, small lakes, flood plains and waste waters, are presently being developed.

### **Coastal Aquaculture and Stock Enhancement Program**

Development of sustainable farming methods for valuable, yet low input, marine resources and the improvement of fisheries production through the release of hatchery-bred juvenile organisms. The work focuses on giant clams, black-lip pearl oysters and research on the husbandry and ecology of the sea cucumber species. Evaluation of methods for the capture and culture of high-value juvenile reef fish is being undertaken in conjunction with Australian partners. Effects of logging on inshore marine ecosystems in the Western Pacific are being studied.

### **Aquatic Environments Program**

Systems management of coral reefs, the facilitation of decisionmaking in coastal zone management and the improvement of multisectoral use of inland aquatic resource systems. The main activities are: (1) development of a global database on coral reefs and their resources, ReefBase; (2) genetic study of the heterogeneity of target coral reef species to determine the importance of pelagic transport of reef species in maintaining the biodiversity and fisheries of reefs in the South China Sea; and (3) contributions to the national training program on integrated coastal management. ICLARM in collaboration with other agencies, proposes to undertake further research in integrated coastal zone management.

### **Fisheries Resources Assessment and Management Program**

The Program is developing methods and tools for tropical fish stock assessment and management, to assess the role of marine reserves in fisheries management and biodiversity conservation, and in developing methods for acquiring data for aquatic resources management. In collaboration with FAO and other partners, stock assessment tools were developed, such as FISAT, as well as a new version of the ABee software for the estimation of length-weight coefficients. An ecosystem modeling tool called Ecopath for modeling multispecies fisheries has been developed in collaboration with the Fisheries Centre, University of British Columbia, Canada. Two new modules, EcoSim and EcoSpace, have been integrated into the Ecopath package. The effects of the implementation of marine protected areas (MPA) on coral reef fish are being monitored in two sites in

the Caribbean and on invertebrate species in the Solomon Islands. A regional project to analyze existing trawl data for determining the current status and dynamics of coastal fish stocks in eight countries of South and Southeast Asia is in operation.

### **Policy Research and Impact Assessment Program**

Strengthening of policies to ensure that the benefits of improved management of aquatic resources and increased aquatic production go to the sectors of the society which depend most on them and provide measures for assessing the impact of research to help increase and sustain aquatic output in developing countries. The Program has three major thematic areas: (1) ecological economics for sustainable use of aquatic resources; (2) impact of aquatic resources research methods and assessment; and (3) policy analysis on the contribution of fisheries to food security. The program has undertaken a number of case studies in Asia and Africa for sustainable management of aquatic resources through co-management and community-based management.

### **Information and Training Program**

The Program plays a critical role in ICLARM's work in dissemination of the results of its research, providing information services and raising public awareness of the issues that are essential for fulfilling the mandate of ICLARM.

### **Research Partnerships and Networks**

ICLARM believes that its research will be most successful when undertaken in partnership with national government and non-government institutions, regional and international organizations and with the participation of the users of the research results. This is exemplified by ICLARM's collaborative undertakings in research and other research-related activities with over 300 partners worldwide over the past 20 years. ICLARM coordinates international networks geared to address specific aspects of management and sustainable development of living aquatic resources through research and information dissemination. Two research networks (International Network on Genetics in Aquaculture [INGA] and Asian Fisheries Social Science Research Network [AFSSRN]) and an information network (Network of Tropical Aquaculture and Fisheries Professionals [NTAFP]) are being coordinated by ICLARM.

### **Role of aquatic resources research in regional fora**

In spite of the fact that fish and other aquatic products constitute the major source of animal protein for most of the poor in developing countries and that the degradation of aquatic resources is threatening food security in these developing nations, aquatic resource manage-

ment research has not received the attention it deserves. In view of this, ICLARM is trying to bring aquatic resource management issues into these regional and international fora by establishing fisheries subgroups in each of the regional fora, starting with the Asia-Pacific Association of Agricultural Research Institutions (APAARI)

F A O

## Food and Agriculture Organization of the United Nations (FAO)

### **P.C. Choudhury**

*FAO Regional Office for Asia and the Pacific, Bangkok, Thailand*

In the Asia and Pacific region, marine capture fisheries production has shown a small but steady increase reaching 35.6 million tons in 1996 from 26.2 million tons in 1984. The major issues confronting most of the countries in the region are habitat degradation, over exploitation of some coastal fishery resources, increased wastage from discards and by-catches. Many countries are trying to improve fisheries management and development through the promotion and application of the Code of Conduct for Responsible Fisheries and the associated Technical Guidelines. FAO, with financial support from Norway, is executing two important components of the Code: (i) promotion of monitoring, control and surveillance, and (ii) provision of scientific advice on fisheries management to three Southeast Asian countries (Thailand, Malaysia and Indonesia). FAO, in close collaboration with Japan, has convened two technical meetings, the first dealing with the reduction of seabird incidental catch in longline fisheries and the second on the conservation and management of sharks, both held in Tokyo in April 1997. Draft action plans developed were later discussed in Rome in July 1998. In April 1998, in La Jolla, California, a meeting of the Technical Working Group on Fishing Capacity prepared the draft action plans, which would be further discussed at the FAO Consultation scheduled for October 1998. Considering the importance of the marine fishery resources of the Bay of Bengal and the South China Sea and the direct and indirect impacts of land-based developments on the marine ecosystems of those areas, FAO

has developed regional project proposals and is seeking funding for their implementation. For the countries of the region to be able to formulate proper management options for the development of sustainable marine fisheries, accurate information on the status of the resources and the ecosystems is needed through further studies and research on the development of multi-species resource assessment models, various aspects of oceanography and socioeconomics of fisher communities. FAO's ongoing project in Sri Lanka and the activities of the Bay of Bengal Programme are addressing some of the issues related to fisheries management and socioeconomics. Researchers and technologists will have to find technical solutions for full utilization of aquatic resources. For this, research should be directed towards converting some of the low-value fish (discards and by-catches) to products for direct human consumption. More attention should also be given to quality and safety assurance related to fish and fishery products.

In inland capture fisheries, production has increased from 2.9 million tons in 1984 to 4.5 million tons in 1996. However, in the last two decades, the inland fisheries have been subjected to problems such as habitat degradation; destruction of natural breeding and nursing grounds due to human-made changes in the natural hydrology of rivers and floodplains; and conversion of floodplains/marshlands into agricultural land. Because of the negative impacts of human interventions, potential for further increase in production from inland fisheries seems to be very limited.

Considering the very important contribution of inland fisheries to rural food security, immediate remedial measures, including stock enhancement, should be implemented with a view to stopping further decline of inland fisheries. Priority research programmes on ecosystem rehabilitation and stock enhancement should, therefore, be formulated and implemented.

In 1996, aquaculture production in Asia reached 31 million tons valued at about US\$39 billion. The aquaculture sub-sector has maintained an average annual growth of about 10% during the last decade. It is important to note that about 75% of aquaculture products come from the low-income food-deficit countries (LIFDCs).

In most of the countries in the region, the potential for further growth and development of aquaculture is good and the potential can be realized by developing additional areas and by increasing production per unit area. Globally, it is estimated that, by 2010, aquaculture production could reach about 50 million tons (including aquatic plants).

The rapid development of aquaculture during the last two decades, however, has not been without problems. In many countries, it has caused environmental degradation because of the destruction of ecosystems by the clearing of mangrove forests and draining of wetlands for the construction of shrimp/fish ponds; pollution of natural waters through discharge of waste waters from aquaculture facilities; and introduction of exotics without prior ecological impact assessment. On the positive side, aquaculture has made substantial contributions to the availability of food fish and to the creation of additional employment opportunities and foreign exchange earnings in many countries in Asia. The overall consensus is that the easy growth period is over and now, as a recognized economic activity, aquaculture is facing competition with other economic activities in terms of production and marketing. For aquaculture to realize its full potential, future development must be technically, socio-economically and environmentally sustainable.

Except in China and India, the rate of growth of aquaculture is showing signs of slowing down.

The major constraints hindering aquaculture development in the region are lack of trained workers, shortage of inputs such as seed, feed and fertilizer; lack of credit facilities; weak institutional framework, policy support and extension services; poor water quality resulting from pollution and environmental degradation; inadequate infrastructure and poor post-harvest care; competition with other resource (land/water/feed) users; ineffective leasing systems and problems related to ownership and lack of appropriate technology.

About 75% of aquaculture production in Asia comes from smallscale rural aquaculture. However, it has been demonstrated beyond doubt that small-scale aquaculture is more economically viable when integrated into the other farming systems.

The strategic issue therefore is how to achieve sustainable contribution of aquaculture to food security. For the Asia-Pacific region, the overall consensus is that this strategic issue could only be addressed by resolving the issues of immediate concern: appropriateness of technologies, resource use and input supply, health management, research/ training/extension linkages, integration in the farming system, information collection and dissemination and quality and safety of aquaculture products. Every issue needs to be thoroughly studied to find appropriate solutions. In this connection, I would like to bring to your attention that the report of FAO/NACA Regional Workshop on Aquaculture Development Research Priorities and Capacities held in Bangkok, in May 1997, is now available.

On behalf of FAO, I am taking this opportunity to welcome the establishment of the Fisheries Subgroup under the umbrella of APAARI. This will facilitate collaboration and cooperation among the fisheries/aquaculture research institutions in the region. I would like to inform you that the Support Unit for International Fisheries and Aquatic Research (SIFAR) has now been established, located in the Fisheries Department of FAO, Rome. SIFAR plays the role of a facilitator in defining and promoting applied fisheries and aquatic resources research.

## Network of Aquaculture Centres in Asia-Pacific (NACA)

### Hassanai Kongkeo\*

*Network of Aquaculture Centres, Bangkok, Thailand*

The Network of Aquaculture Centres in Asia-Pacific (NACA) began as a UNDP/FAO project and became an intergovernmental organization in January 1990. The objectives of NACA are to promote sustainable development of aquaculture in the Asia-Pacific region for the purpose of: food production and food security; improving rural income and employment; diversification of agriculture farming systems through aquaculture; and increasing foreign exchange earnings. The number of member countries has gradually increased since 1990 and there are now 14 full members (Australia, Bangladesh, Cambodia, China, Hong Kong SAR, India, Korea (DPR), Malaysia, Myanmar, Nepal, Pakistan, Sri Lanka, Thailand and Vietnam). Indonesia pays an annual contribution and several other regional governments are in the process of accessing to the NACA Agreement and actively participate in the network's activities. It is also noted that many members of APAARI also belong to the NACA organization.

The major activities of the NACA include: (i) research cooperation, through a coordinated and interlinked system of aquaculture research institutions working in partnership on the development of technology, aquaculture farming systems and aquaculture management; (ii) training and education to build capacity in aquaculture research and development; and (iii) information exchange. The Organization approaches aquaculture from a holistic viewpoint, by integrating environment, social, and economic issues in its Programme of Work. The Network operates under the principle of Technical Cooperation among Developing Countries (TCDC), through which national resources are pooled and responsibilities shared for a cost-effective implementation of priority regional activities. The NACA Regional Lead Centres in India, China and Thailand, in addition to national centres, seafarming centres and associated research institutions, are working on various aspects of aquaculture research and development in NACA member countries.

NACA is presently working on its second Five Year Work programme, from 1996 to 2000, which has aquaculture sustainability as its theme. The progress in the Work Programme has recently been reviewed by the NACA Technical Advisory Committee (TAC), hosted by the Government of India at the NACA Regional Lead Centre in India and a detailed plan for the period until December 2000 prepared. Briefly, the workplan contains elements on: (i) aquatic animal health management, including development of policy guidelines on quarantine and health certification; (ii) training and information exchange in environmental assessment and management of aquaculture; (iii) support to build national capacity for aquaculture development in NACA members; (iv) information dissemination and communication; (v) establishment of regional network of aquaculture farmers; (vi) aquaculture training and education programme; (vii) development of mariculture and integrated coastal aquaculture; (viii) planning and implementation of a Conference on Aquaculture in the Third Millennium (to be held in Bangkok, in cooperation with FAO and the Government of Thailand, in February 2000); (ix) a regional research review and promotion of research cooperation; (x) aquaculture policy development, including development of guidelines for implementation of FAO's Code of Conduct for Responsible Fisheries in the region; and (xi) development of a programme for promoting aquaculture for rural development.

Two initiatives may be of particular interest to this meeting. First, NACA and FAO recently conducted a regional survey and analysis of aquaculture research priorities and capacities, which provides an overview of research needs and opportunities for research cooperation in the region. The key areas for regional research cooperation identified in the review were: (i) aquaculture nutrition and feeds; (ii) seed production and genetics; (iii) aquatic animal health management; (iv) environmental management of

\*Dr. Hassanai could not attend the Meeting, but sent this presentation.

aquaculture; (v) planning and management of aquaculture; (vi) aquaculture research for rural development; and (vii) information dissemination. Further follow up on these different issues is being planned in the next two years, with the exception of genetics, where ICLARM is already very active. Second, the NACA Governing Council in Hanoi in December 1997, approved a concept programme for aquaculture for rural development (SARDev) which specifically focuses on promoting aquaculture for rural development, specifically as a means of poverty alleviation, food production, empowerment of women and resource management in rural areas. FAO has offered collaborative assistance to formulate a detailed programme proposal. There will certainly be a need to seek cooperation with the agriculture sector in the development and implementa-

tion of this programme and specific opportunities for collaboration with APAARI institutes could perhaps be identified jointly during the formulation mission.

NACA works in close partnership with a number of international, regional and national government and non-government organizations in the development and implementation of its Work Programme and would be delighted to cooperate more closely with APAARI. NACA feels the need for cooperation among the institutions in the food production sector, which could contribute greatly to rural development in our member countries. NACA would like to offer its aquaculture expertise and experience in the integrated programme being proposed by APAARI through the establishment of the APAARI Fisheries Sub-group.

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## Southeast Asian Fisheries Development Center (SEAFDEC)

S E A F D E C

### Masao Shimomura

*Southeast Asian Fisheries Development Center, Bangkok, Thailand*

I am most honored to address you today on behalf of SEAFDEC which is active in aquatic resource management in the region. Founded in 1967 as a result of an agreement between the governments of Japan, Thailand and Singapore, SEAFDEC has grown in both size and influence in the 30 years of its existence. During this time, four departments have been established in different countries for different disciplines and coordinated by a Secretariat. The SEAFDEC membership roughly parallels that of ASEAN excluding Indonesia, Lao PDR and Cambodia, but including Japan.

At the *Training Department* in Thailand, nationals of SEAFDEC member countries are trained in responsible fishing technologies that include fishing, navigation and hydro-acoustics for fish finding. Other courses are conducted in marine engineering, hydraulic machinery and refrigeration. In the last few years, SEAFDEC has also trained personnel from Hong Kong, Sri Lanka, India, Pakistan, Maldives, Nigeria, Iran and Ghana. In addition to training, research for the development of selective fishing gear is also undertaken. The training efforts are augmented with

necessary equipment, workshop facilities and research and training vessels.

The *Aquaculture Department (AQD)* is located in the Philippines where research in genetics and breeding of aquaculture species is undertaken at its marine and freshwater stations. Regional training programs are conducted in aquaculture development, fish feedstock development, mangroves and lately in coastal fisheries management and organization of fishing communities which are also the subjects of SEAFDEC's collaborative research in member countries, notably Vietnam. At AQD, cutting edge research and development is being undertaken in controlled breeding of commercially valuable species such as sea bass, grouper, red snapper, rabbitfish, big head carp, tilapia, catfish, giant tiger shrimp, mud crab and abalone. Research also extends into mangroves and seaweed culture. AQD also provides consultancies to private commercial aquaculture units. Fundamental research and research verification are also undertaken in collaboration with member governments and international agencies.

The *Marine Fisheries Resource Development and Management Department (MFRDMD)*,

located in Malaysia, undertakes research on: (i) fishery biology; (ii) stock abundance and distribution; (iii) migration patterns; (iv) primary productivity and nutrient abundance; (v) conservation and management of turtles which includes assessment of abundance, identification of breeding grounds and tagging; (vi) compilation of catch-effort statistics for Southeast Asia; and (vii) development of selective gear to reduce capture of non-target species and juveniles. Organization of regional training programs is a regular feature of the department.

The *Marine Fisheries Research Department (MFRD)* located in Singapore, undertakes research and training in product development and packing. The research includes utilization of tuna by-products and small tuna into marketable and attractive products; quality changes in fish products including squid under short- and long-term storage; determination of triglyceride and cholesterol levels in fish and shellfish; and heavy metals in fish and fish products. Regional training and consultancy services to and for the regional fisheries processing industries are a major part of MFRD's work.

The four Departments within SEAFDEC seek ways and means in their spheres of expertise to create a climate for sustainable fisheries. SEAFDEC is dedicated to the conservation of global fish stocks, the economies of the regional countries, welfare of the region's fishers and the sustainable development of the fishing industry. SEAFDEC serves as a conceptual framework to achieve ad-

vances in regional fisheries management and the work may be considered affirmative action on behalf of the region, its fisheries, fishers and fishing communities. It can be seen from the SEAFDEC activities that it takes its role as a regional organization very seriously indeed. Other areas being emphasized in its working are the collaborative relationships with other regional and international organizations, specially with ASEAN. The ASEAN-SEAFDEC Fisheries Consultative Group (FCG) has been established and the projects undertaken include: regionalization of the Code of Conduct; studies on sharks; regional training on marine turtle conservation, ASEAN/SEAFDEC workshop on marine turtles; ASEAN/MFRD survey of traditional fish products; and a workshop on mangrove-friendly aquaculture.

The Secretariat and a division of SEAFDEC in Thailand deal with information exchange through textbooks, publications, workshops, newsletters and all other forms of communication. The need and availability of information has never been as great as it is now. SEAFDEC takes every opportunity to acquaint the fisheries world of its activities through whatever medium is appropriate. Information exchange is also effected through organization of extension training courses which are undertaken annually and are available to members and non-members. SEAFDEC compiles and publishes fisheries statistics of the region which are acknowledged as a companion volume to the FAO publication on fisheries catch statistics.

# Appendices

## Agenda

### **APAARI Fisheries Subgroup Meeting**

11-12 October 1998

Suwon, Republic of Korea

#### **11 October**

Registration

Welcome address: Dr. Seong-Hee Lee

Objectives of the meeting. Dr. M.J. Williams

Introduction of participants and briefing on organization of sessions: Dr. M.V. Gupta

#### **SESSION 1: Presentation of country research priorities**

Presentations by Bangladesh, China, India, Indonesia, Korea, Malaysia and Nepal

Chair: Dr. M. Duangsawasdi

Lunch break

Presentations by New Zealand, Pakistan, Papua New Guinea, Philippines, Sri Lanka, Thailand and Vietnam

Chair: Dr. R.D. Guerrero III

Presentations by ICLARM, NACA, SEAFDEC and FAO/RAP

Chair: Dr. K. Gopakumar

#### **12 October**

#### **SESSION 2: Regional priorities in research and capacity building**

Chair: Dr. J. McKoy

Discussion on sub-regional priorities in: (i) research, (ii) capacity building, (iii) linkages among NARS in the region; and (iv) collaboration between fisheries and agriculture on a systems perspective

Group 1: South Asia (Bangladesh, India, Sri Lanka, Pakistan and Nepal)

Group 2: East and Southeast Asia (China, Indonesia, Korea, Malaysia, Philippines, Thailand and Vietnam)

Group 3: South Pacific (Papua New Guinea and New Zealand)

Tea break

Presentation of sub-regional priorities

Group 1: South Asia

Group 2: East and Southeast Asia

Group 3: South Pacific

Identification of regional priorities in research and capacity building

Lunch

#### **SESSION 3: Recommendations**

Chair: Dr. M.J. Williams

Finalization of recommendations for: (i) establishment of mechanisms for inclusion of Fisheries Subgroup in APAARI; (ii) enhancement of importance of fisheries at national, regional and global fora; (iii) recommendations to the APAARI General Assembly

Closing remarks: Dr. R.S. Paroda

Dr. I. Bevege

Dr. M.J. Williams

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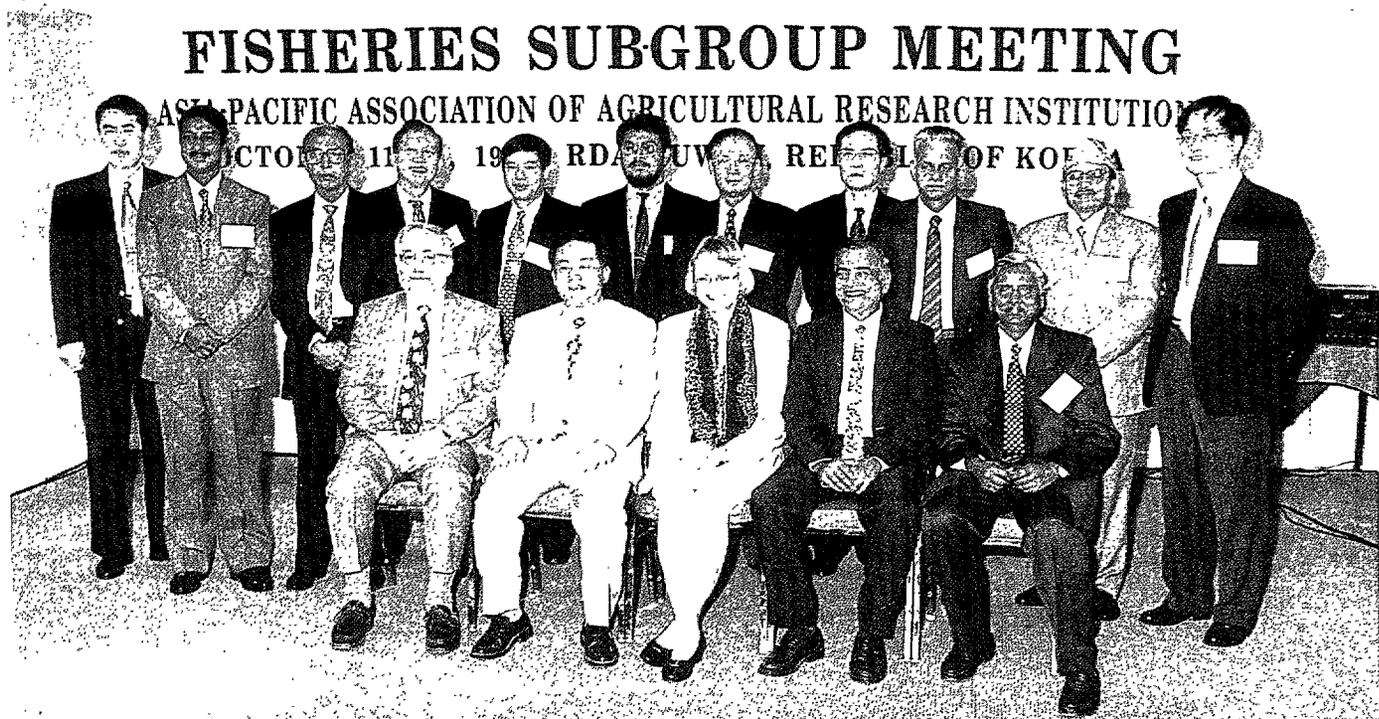
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Dr. Meryl J. Williams, ICLARM Director General, addresses the participants during the Meeting.



Participants of the APAARI Fisheries Group Meeting, 11-12 October 1998, Suwon, Republic of Korea. Seated (L-R): John McKoy (New Zealand), Seong Hee Lee (Republic of Korea), Meryl J. Williams (ICLARM), P.C. Choudhury (FAO-RAP, Thailand), Modadugu V. Gupta (ICLARM). Standing (L-R): Masao Shimomura (SEAFDEC, Thailand), Nasim Akhtar (Pakistan), M.H. Gunawardena (Sri Lanka), Rafael D. Guerero III (Philippines), Dao Manh Son (Vietnam), R.M. Noordien bin Raja Omar (Malaysia), Maltree Duangsawasdi (Thailand), Lee Jang-Uk (Republic of Korea), K. Gopakumar (India), Madhav B. Pantha (Nepal) and Li Yingren (China).

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#### **NZ Pastoral Agriculture Research Institute Ltd.**

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**International Center for Living Aquatic  
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**International Centre for Agricultural  
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**International Irrigation Management Institute**

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**International Livestock Research Institute**

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**International Maize and Wheat  
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**International Potato Center**

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## List of acronyms

AARD	Agency for Agricultural Research and Development
ACIAR	Australian Centre for International Agricultural Research
APAARI	Asia-Pacific Association of Agricultural Research Institutions
ASEAN	Association of Southeast Asian Nations
AusAID	Australian Agency for International Development
CAFS	Chinese Academy of Fishery Sciences
CRIFI	Central Research Institutes for Fisheries
DGF	Directorate General of Fisheries
EEZ	Exclusive economic zone
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross domestic product
GIS	Geographic information system
GNP	Gross national product
GoFAR	Group of Fisheries and Aquatic Research
HACCP	Hazard analysis at critical control points
ICAR	Indian Council of Agricultural Research
ICLARM	International Center for Living Aquatic Resources Management
IFPRI	International Food Policy Research Institute
INGA	International Network on Genetics in Aquaculture
ITQ	Individual transferable quota
IUCN	World Conservation Union
LIFDCs	Low-income food-deficit countries
LIPI	Indonesian Institute of Science
MSY	Maximum sustainable yield
NACA	Network of Aquaculture Centres in Asia-Pacific
NARS	National aquatic research systems
QMA	Quota management system
RDA	Rural Development Administration
SEAFDEC	Southeast Asian Fisheries Development Center
TAC	Total allowable catch