



A STRATEGY FOR
POSTHARVEST
FISHERIES
RESEARCH
IN ASIA

ARCHIV
101918

IFR

Strategy for International Fisheries Research
Stratégie sur la recherche halieutique internationale

A Strategy for Postharvest Fisheries Research in Asia

Report prepared for the Strategy for International Fisheries Research by the Natural Resources Institute with support from the Overseas Development Administration of the United Kingdom



*Natural Resources Institute
Chatham, United Kingdom*



*Overseas Development Administration
London, United Kingdom*



*Strategy for International Fisheries Research
Ottawa, Canada*



ARCHIV

639.2.001.5(5)

N 3

SIFR (Strategy for International Fisheries Research) was established in 1992 to develop mechanisms for matching the research priorities of developing countries with the interests of donors. SIFR seeks to encourage the coordination in fisheries research for the sustainable development of living aquatic resources. High priority is given to strengthening the capacity of research institutions in developing countries to conduct applied research at the local and regional level. In addition, SIFR seeks to encourage support for strategic research through the CGIAR centres involved in living aquatic resource management.

SIFR is guided by a Steering Committee composed of representatives of the World Bank, UNDP, FAO, Commission of European Communities, IDRC, and NORAD. SIFR established a secretariat in 1993 to assist in the implementation of the SIFR strategy.

SIFR SECRETARIAT: 250 Albert Street, Box 8500, Ottawa, K1G 3H9 Canada.
Tel (613) 236-6163; Fax (613) 567-4349; Electronic mail BDAVY@IDRC.CA

Published by SIFR (Strategy for International Fisheries Research)
250 Albert Street, Box 8500, Ottawa, K1G 3H9 Canada.

© SIFR (Strategy for International Fisheries Research) 1995

Natural Resources Institute, Chatham, GB

A strategy for postharvest fisheries research in Asia. Ottawa, ON, SIFR,
1995. 116 p.

/Fishery research/, /fishery industry/, /post-harvest systems/, /international cooperation/, /Asia/ - /research needs/, /organization of research/, /research programmes/, /conference reports/, /case studies/.

UDC: 639.2.001.5(5)

Contents

Preface	5
Acknowledgements	6
Abbreviations	6
Authors	6
Executive Summary	
Introduction	7
Workshop	7
A Strategy	8
The Programs	10
Chapter 1: Introduction	
Background to SIFR	13
Identification of Regional and Sub Regional Priorities - The Current Phase of the SIFR Process	16
Chapter 2: Country Statements	
Introduction	19
The Asian Postharvest Fisheries Sector	20
Previous and Current Research	28
Future and Planned Research	30
Conclusions	37
Country Summary Tables	39
Chapter 3: Strategy for Postharvest Fisheries Research in the Asian Region	
Resolution of the Main Areas of Concern	57
A Strategy	61
The Research Programs	65

Annexes

Annex 1 - Postharvest Applied Research Requirements Identified by SIFR Studies.....	98
Annex 2 - Terms of Reference for Country Papers.....	100
Annex 3 - Participants at SIFR Meeting	102
Annex 4 - Agenda for SIFR Meeting March 1994 at CIFT	109
Annex 5 - Example Format Prescribed for Research Programs	110
Annex 6 - Organisations Contacted after the Workshop in Preparation of Programs	111
Annex 7 - Background Information on Postharvest Fisheries in Asia.....	114

Preface

The Donor Co-ordination Meeting in 1986 organised by World Bank identified the need to improve the delivery of developmentally oriented fisheries research. The meeting agreed to implement a study of international fisheries research needs of developing countries and 17 donors and one private sector organisation contributed funds to a multi-disciplinary global study, the output of which was a report entitled "A Study of International Fisheries Research" published by World Bank in 1992. A Second Fisheries Donor Consultation then agreed on a program to prepare an indicative plan for international fisheries research. This included the appointment of an Executive Secretary for SIFR together with proposals to commission a series of regional workshops and other functions at which key regional participants and representatives of donor organisations could together discuss and prioritise the specific research needs for that region.

This report describes the results of a regional postharvest fisheries research workshop held in Cochin, India in March 1994. Every effort was made to identify relevant demands for research and decide appropriate priorities. Participants were asked to provide appropriate background material in a prescribed format. This presented material compiled from a wide range of sources in each country. Workshop participants circulated the initial results of the workshop to appropriate political and technical organisations within their own countries, seeking opinion and agreement to the priorities identified. This consultative approach ensured that the outcome of this workshop reflects a consensus of opinion in the Asian region on the relative priorities for postharvest fisheries research.

The report is divided into the following sections:

Chapter 1 - summarises the implications for postharvest fisheries research arising from the diagnosis and recommendations of the study of international fisheries research needs of developing countries

Chapter 2 - describes and summarises the country papers which workshop participants prepared for the workshop and presents an overview of the postharvest fisheries sector in Asia and its research needs

Chapter 3 - presents a justification for the main research priorities identified at the workshop and offers a strategy for postharvest fisheries research in the Asian region supported by six detailed research program concepts.

Acknowledgements

This study would not have been possible without the financial support from several sources. The main source of funding was provided by the Overseas Development Administration (ODA) of the United Kingdom government. Additional participation in the workshop was provided through the association of the workshop with the Food and Agriculture Organisation Indo-Pacific Fisheries Commission Working Party on Fish Technology and Marketing Meeting and the European Community STD-3 Project Meeting on "Improved Utilisation Of Low Value Fish Species" both independently funded and being held in Cochin, India. Thanks must also be given to the Director and staff of the Central Institute of Fishery Technology for being kind hosts to the meeting.

Abbreviations

ASEAN	Association of South East Asian Nations
ASFA	Aquatic Sciences and Fisheries Abstracts
CGIAR	Consultative Group on International Agricultural Research
CIFT	Central Institute of Fishery Technology
DANIDA	Danish International Development Agency
EC STD-3	European Community Science and Technology for Development - Phase 3
FAO	Food and Agriculture Organisation of the United Nations
HACCP	Hazard Analysis and Critical Control Point
ICLARM	International Center for Living Aquatic Resources Management
IDRC	International Development Research Centre
IPFC	Indo Pacific Fisheries Commission
LAB	Lactic acid bacteria
NARA	National Aquatic Resources Agency
NRI	Natural Resources Institute
ODA	Overseas Development Administration
ODA-BOBP	Overseas Development Administration-Bay of Bengal Program
SIFR	Strategy for International Fisheries Research
UNDP	United Nations Development Program

Authors

This report was compiled and written by Dr John Ryder, Mr Tim Bostock, Mr Ivor Clucas and Mr Michael Pritchard of the Natural Resources Institute in the United Kingdom. It is the output of a workshop held in Cochin, India in March 1994, organised and run by Mr Ivor Clucas with assistance from Dr John Ryder and Mr Michael Pritchard.

Executive Summary

Introduction

In November 1993 the Natural Resources Institute was asked by the Executive Secretary of the Strategy for International Fisheries Research (SIFR) to organise a workshop at which representatives from the postharvest fisheries organisations in the Asian region would identify demand-led, priority research needs for the region.

The agreed approach for the workshop was to refocus the global research areas identified in the World Bank "Study for International Fisheries Research" on the Asian region's priority needs in the field of postharvest fisheries research and to produce a strategy for postharvest fisheries research for the region.

It has been predicted that the greatest gap between supply and demand in fisheries products is likely to occur in Asia ¹ - thus **the need to place high priority on the improved use of the available resources in this region.**

Workshop

The workshop was held at the Central Institute for Fishery Technology, Cochin, India in March 1994. Invited participants were asked to prepare a country paper on the present postharvest fisheries development needs in their country, identifying the constraints to development and proposals for the research required to address these constraints. Eleven country papers were prepared.

Based on the country papers, a synthesis of the main conclusions was presented and discussed with the workshop participants. The synthesis used the portfolio of research topics identified by the World Bank study as a basis from which the topics of particular relevance to the Asian region were drawn.

Country delegates highlighted the need to address the pressing issue of fish losses (both qualitative and quantitative) and fish quality and preservation. Innovative strategic and applied research in these areas could, it was felt, play a significant role in improving the economic returns for producers at all levels and clearly benefit the consumers. The development of specialised high value products for both food and non-food uses were areas regarded as of considerable importance and of good potential for future research effort. It was also recognised that improvement of traditional products and processes could yield

¹ Robinson, M.A. 1982. *Prospects for World Fisheries to 2000*. FAO Fisheries Circular 722, revision 1. Rome.

significant dividends for producers and consumers alike. This would be a focus for applied research.

A problem facing the entire fisheries sector, both aquaculture and capture fisheries, is that of food safety. It was felt that a systems approach to understanding the multiplicity of factors affecting the safety of fish and fish products, and also the human safety issues arising from exposure to environmental hazards that arise from fisheries activities, would provide the best approach to addressing this problem. This would involve a multi-disciplinary effort involving a high component of strategic research.

The need for a multi-disciplinary approach in the appraisal, planning, management and evaluation of research activities related to postharvest development was clearly recognised. Effort in the past has tended to be polarised towards technical issues, and research priorities have been institution-led. The workshop gave rise to considerable discussion regarding the need for greater integration of other disciplines, specifically the social sciences, economics and marketing, into the research process. Only then could research be said to be addressing real constraints to development. Several of the countries had made significant advances to address this issue.

There was a strong recommendation from the meeting for the development of mechanisms to facilitate better communication and exchange of information between research workers in the region. Networks were seen as the most promising method to achieve this.

Working groups were chosen to produce preliminary programs following a format provided by the Executive Secretary of SIFR.

In the final analysis, six programs, regarded by the workshop as of equal importance to the region, were identified.

- *Losses and waste utilisation*
- *Improved traditional and value added products*
- *Biomolecules from aquatic resources*
- *Bio-preservation techniques and novel products*
- *Food safety and production systems*
- *Socioeconomic and marketing research*

A Strategy

Socioeconomics and Marketing in the Research Programs

The workshop agreed that socioeconomics was an important enough topic to be included as a separate program area. Socioeconomic and marketing research would not only attempt to solve key constraints in the fisheries sector but would also attempt to develop methodologies specifically for postharvest fisheries research which could offer an important contribution to future research programs and development assistance.

However, it was also agreed and stressed that the five technical programs identified will require thorough socioeconomic appraisal and/or marketing input(s) at all stages. Particular

areas of work will include needs assessment, production economics marketing and market research to name but a few of the skills required.

It is also proposed that a separate study be commissioned to assess the existing socioeconomics and marketing capacity within the region, specifically as it relates to postharvest fisheries, and to develop a strategy to help strengthen this capacity.

Information Exchange And Dissemination

Two inter-related problems exist within the Asian region:

Difficulties in Publication of Results

There is a great deal of research material that is not published because of the difficulties of publication. It is also often impossible for research workers to find the time to write up the results of research in the correct format for external publication. It was recommended to:

- use the IPFC meetings of the Fish Technology and Marketing Working Party
- publish in the ASEAN Food Journal
- contribute to Fish Tech News and The Fish Inspector
- give recognition to the vital role that publishing research results in the international arena plays in personal, institutional and national development
- equip institutes to a minimum computer standard to allow rapid analysis of research results and easily manipulated production of "publication ready" material

Lack of Information Exchange

The lack of access to information was the other major problem identified by the participants. The meeting recommends that:

- any measures taken to strengthen the exchange of information between fisheries researchers both regionally and world wide be supported, and insist that postharvest aspects are not neglected in such an initiative
- FAO look at the possibility of either the existing Current Contents being broadened to include postharvest research or of separate database being compiled
- FAO look at the possibility of expanding the ASFA database in the postharvest area
- a study of the costs and benefits of providing institutes with *Internet* facilities should be undertaken

Co-ordination with Existing Networks

It is proposed that existing links should be strengthened and the networks widened to include institutions and countries that have not hitherto been included. New networks need not be established.

The Programs

Losses and Waste Utilisation

This program can be divided naturally into: (i) efforts to **reduce the losses** of fish currently in the marketing chain. The expected outputs will be a better understanding of the quantity of losses both in terms of value and weight and the formulation of methods and policies to reduce these losses, and (ii) to **improve the utilisation** of fish and waste products. This will investigate and identify possible markets for products from by-catch, lower value fish, fish gluts and processing wastes and investigate and develop appropriate technologies for production of such products.

Improved Traditional and Value Added Products

The strategy should initially focus on the production of a regional and co-ordinated base of expertise in product and process improvement with the ability to develop food items for domestic and export markets that meet the requirements of the markets and are socially and economically justifiable within the producer groups. The efforts would be split into: (i) products from under-utilised or low value fish species, and (ii) products from high value species.

Biomolecules from Aquatic Resources

The strategy will include identification of new, and further development of existing aquatic-based pharmaceuticals, drugs and biomolecules, that will replace those that are currently used and to produce more environmentally friendly products and processes. Examples of existing substances include omega 3 fatty acids from fish oils, chitin and chitosan from crustacea, alginic acid from sea weeds which are already being exploited and a number of compounds which have been found recently to have probable useful properties such as protamines, lysosymes, chephalosporins and cancer inhibitors from sponges and squid.

Biopreservation Techniques and Novel Products

Biopreservation, that is the use of biological agents especially lactic acid bacteria, to preserve and protect food products, may provide a opportunity to assist traditional methods in controlling the spoilage and pathogenic microflora thus extending the shelf lives of food products and reducing the health hazard. It also has the potential to offer similar protection to fish and animal feeds, and is likely to have beneficial effects on aquaculture microflora pond dynamics. This program has a main component relating to the basic and adaptive studies on **biopreservation as it relates to food products**, but also, as a sub-program, has a component focusing on the **animal and fish feeds** aspects.

Food Safety and Production Systems

This strategy is focused on gaining information of the effect of micro-organisms, chemical pollutants and other toxic elements in aquatic production systems (pre- and postharvest) on human health and environmental degradation, and to use this information to develop effective monitoring and detection systems for aquatic products and to produce appropriate regulatory standards throughout the processing, production and marketing chain.

Socioeconomics and Marketing Research

This strategy will provide a regional base of expertise in the implementation of socioeconomic research based on a set of sound set of methodologies developed from specific case studies in the region. This will require sub-programs in **marketing systems** (which will have a focus at the sector), and **gender analysis** (which will focus on the community level). Although these sub-programs will have the specific objectives of developing expertise and methodologies, they will also produce critical information to assist in the development of technical programs.

Chapter 1: Introduction

Background to SIFR

In 1986, seventeen multi-lateral and bi-lateral donor agencies and one private sector organisation initiated a study of fisheries research needs in developing countries. The study was overseen by the World Bank, UNDP, CEC and FAO and was motivated by a shared concern amongst donors about the poor performance of fisheries research and development projects and the lack of co-ordination among donors in the provision of aid to fisheries. This extremely broadly based study covered capture fisheries, aquaculture, the aquatic environment, postharvest issues, and research disciplines ranging from ecology to policy. It was assigned 4 main tasks:

- *To determine the degree to which lack of information is an impediment to effective management and development of fisheries*
- *To assess the long term potential contribution of research to the economic and social progress of the sector in developing countries*
- *To evaluate the capabilities of the developing countries to undertake the research needed*
- *To propose ways and means to enhance, during the forthcoming decade, the effect of international aid on developing countries research capacity*

The study resulted in the publication in 1992 of "A Study of International Fisheries Research" (*World Bank Policy and Research Series No.19*) and shortly after, the establishment of a Secretariat for the, now renamed, Strategy on International Fisheries Research. The Secretariat is based at the International Development Research Center (IDRC) in Ottawa, Canada. The study recommended a strategy for fisheries research based on the diagnosis that international collaboration in fisheries research will make possible more efficient and sustainable use of living aquatic resources. Such collaboration is needed due to a rapidly increasing demand for fish as food in the face of static or decreasing supplies. The greatest gap between supply and demand is likely to occur in Asia ² — **thus the need to place high priority on the improved use of the available resources in this region.** Research, if strategically planned and managed, can provide one tool in combating this demand-supply imbalance.

Research was also differentiated into:

² *Robinson, M.A. 1982. Prospects for World Fisheries to 2000. FAO Fisheries Circular 722, revision 1. Rome*

- **strategic research** aimed at investigating basic scientific relationships to solve specific practical problems that cannot be solved by existing knowledge
- **applied research** aimed at applying existing scientific knowledge to specific problems. This included adaptive research which aims at adjusting research methodologies or results to a related problem

This approach forms a research continuum that ensures the application of research effort to existing problems.

The strategy identified four main areas of research, focused on short to medium term needs at the national level, with reference to regional and international needs.

- *Resource Conservation and Management*
- *Fish Productivity (Aquaculture and Culture Based Fisheries)*
- *Commodity Conversion and Utilisation*
- *Human Linkages, Socioeconomics and Policy*

SIFR Diagnosis of the Postharvest Fisheries Sector and Research Needs

Commodity Conversion and Utilisation concerns all aspects of the conversion of a fishery resources into food, including capture, handling, distribution, processing and marketing. The postharvest sector focuses on that part after capture.

Losses, Quality and Safety

An area of particular concern in postharvest fisheries is that of losses - how and why they occur, what they represent in terms of lost revenue to the production system and how they can be ameliorated through the application of research outputs or existing technology. Another area that needs addressing is that of fish quality and safety - which is becoming increasingly relevant as exports increase and the domestic markets become more affluent and discerning.

Utilisation

As well as making the most of the fish and fish products already in place, greater possibilities exist for using currently non- or under-utilised species - including cephalopods, molluscs and fish, especially the small pelagic species. The small pelagic species are typically used in substantial quantities for non food uses, especially fish meal, but have great potential for use as a food for direct human consumption. Well directed research could yield important dividends in terms of identifying strategies for utilisation of these various species in either traditional products (including heat processed products) or as new high value products directed for human consumption, or for high value extractives destined for food additives, pharmaceuticals and cosmetics amongst others. In all cases the research would be market led. There also exists considerable scope for harnessing private sector interests.

Multi-disciplinary Approach

Postharvest research issues are very evident in the analysis of artisanal and small-scale fisheries. These typically raise economic, social and cultural - rather than primarily technical - questions, and are quite location-specific. Relevant research is therefore closely linked with the activities under the research area *Human Linkages, Socioeconomics, And Policy*.

Because most of the research issues in the postharvest area are highly location-specific, they are suitable for combined technical and socioeconomic research at the national level. Regional co-operation in such research would also have much to commend it, especially in terms of assisting in the development of research methodologies designed to elicit information and needs from fishing communities in the small scale sector.

Information Exchange and Networks

One form of regional research collaboration among institutions in different countries that has had some success is the collaborative research network. Studies of agriculture research networks have identified several criteria for success:

- *Choosing research topics of genuine mutual interest, through a process that engages the network members*
- *Allocating by joint decision leadership roles in particular areas of specialisation to member institutions that have the necessary capacity*
- *Holding periodic meetings among the scientists conducting the research, including tours to observe and comment on their work in the field*
- *Adopting agreed-on mechanisms for ensuring scientific quality*
- *Having a network co-ordinator with research skills sufficient for participating in research programs, but not in a dominating role*
- *Having some resources available for network functions, but also resources committed by members to meet at least the bulk of their own research expenses. (There are networks that also manage donor support for members' institutional development, but they have difficulty achieving both an efficient allocation of resources and the style of open collaboration required for effective research).*

Networks should be adopted in the future to promote regional and international information exchange and collaboration on research because they can do so without some of the problems inherent in mounting new, formal regional research institutions. The involvement of existing regional institutions and regional fishery bodies in such networks should be encouraged. This approach is particularly relevant to the postharvest fisheries sector as the International Center for Living Aquatic Resources Management (ICLARM), the CGIAR centre for the fisheries sector, does not undertake research in the postharvest sector.

Specific Postharvest Fisheries Research Needs Identified by SIFR

The research needs identified by the Study can be summarised as follows:

Application of Known Science - Applied Research

- *Loss estimation and resolution*
- *Utilisation of small pelagic species*
- *Improved on board preservation and handling*
- *New product development*
- *Process development*
- *Improved handling and processing for artisanal sector*
- *Socioeconomic and marketing aspects of fish utilisation*

New Scientific Investigations - Strategic Research

- *Basic composition and deterioration processes affecting quality and safety of fish as food*
- *Application of biotechnology to fish utilisation*
- *Investigation of preservation methods and new products*

These categories are used throughout this report as they conveniently cover the principle areas of concern. It is, however, recognised that most of the categories are not mutually exclusive, thus a degree of caution is required in their interpretation. Greater detail is shown in Annex 1, extracted from the World Bank report.

Identification of Regional and Sub Regional Priorities - The Current Phase of the SIFR Process

The objective of this phase of the program is to take these priority research areas identified by SIFR and focus them at the regional level, bringing the research and donor communities together so that their interests are better matched. The regional research priorities will then be incorporated into an Indicative Plan of the Fisheries Development Donor Consultation Group (Figure 1)

The approach adopted by SIFR to identify regional research needs was via regional workshops involving key regional participants and donor representatives. The outputs of these workshops would be prioritised research needs.

A series of studies and workshops are planned for different regions of the developing world to consider the development needs of the region's fisheries and to identify demand-led research priorities at the regional and sub-regional levels.

The first of these in the postharvest fisheries area was held in Asia and is the subject of this report. There are planned workshops for South America and Africa to follow.

The Asia Workshop

In November 1993, the Natural Resources Institute was asked by the Executive Secretary of SIFR to organise a workshop at which representatives from the postharvest fisheries

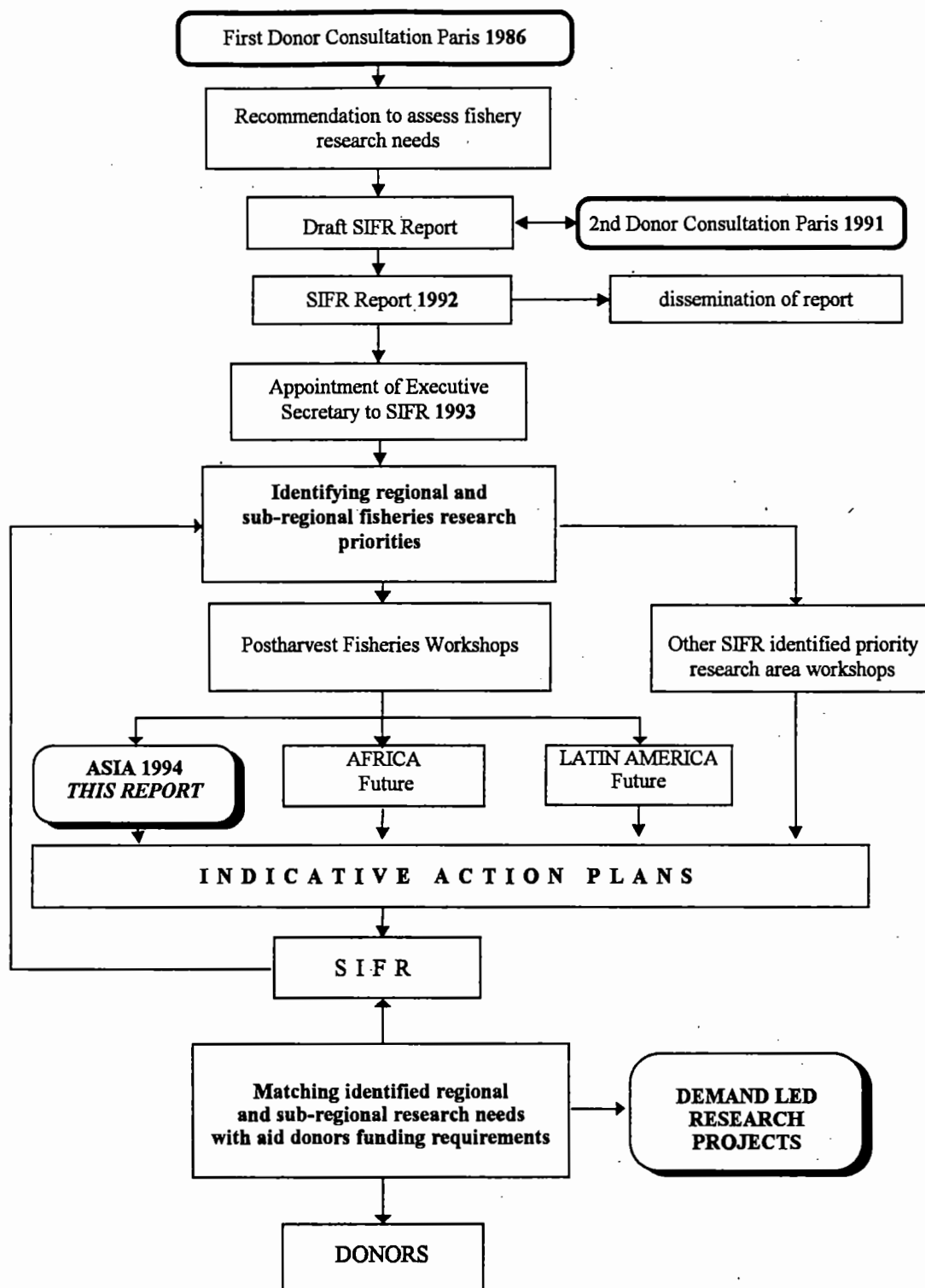


Figure 1. The SIFR Process

organisations in the Asian region would identify demand-led, priority research needs for the region.

This workshop was organised to coincide with the joint meeting of the Indo-Pacific Fisheries Commission (IPFC) Working Party on Fish Technology and Marketing, and the European Community STD-3 Project on "Improved Utilisation of Low Value Fish Species" being held in Cochin, India from March 7-9, 1994 at the Central Institute for Fishery Technology (CIPT). The SIFR Workshop followed on from March 10-12.

Senior researchers or heads of fisheries departments were contacted in 16 countries across Asia and invited to participate or nominate someone to participate in the development of a research strategy for the region.

Each participant was asked to prepare a country paper on the present postharvest fisheries development needs in the country, identifying the constraints to development and the research required to address these constraints. Annex 2 is a copy of the questionnaire used. Eleven national studies were prepared and representatives from ten Asian countries (**India, Indonesia, China, Thailand, The Philippines, The Maldives, Sri Lanka, Malaysia, Laos, and Bangladesh**) attended the workshop. Representatives from **Papua New Guinea, Norway, Denmark, United Kingdom** and **FAO** also attended. In total, there were 34 participants at the meeting representing fisheries departments, research organisations, and universities involved in fisheries research across the region. A complete list is given in Annex 3. Representatives from **Pakistan** and **Vietnam** were unable to attend, but have contributed to the formulation of the programs through correspondence with NRI both prior to and since the workshop. NRI prepared a synthesis of the country papers (which forms the bulk of the next chapter), and a review of past priority setting exercises in the postharvest area (separate background paper). These two papers were then given to participants at the workshop.

The agenda for the two and a half day workshop is given in Annex 4. Country delegates presented their background papers on the first day, and other delegates also gave informal presentations on the way in which aid agencies in UK, Denmark and Norway judge and prioritise fisheries research needs. The morning of the second day centred on discussions of the two background papers and the previous day's presentations to produce a set of priority research areas for the Asian region. Identified research and non research areas were discussed during the afternoon and the following morning by smaller groups. Preliminary programs were created for each research area following a prescribed format (Annex 5) provided by the Executive Secretary of SIFR.

Following the workshop the participants were sent revised drafts of the six programs for their comments. These drafts were circulated widely within each country to ensure that the identified regional research priorities reflected the consensus opinion in each country. Annex 6 lists the institutions who were asked for comments. These were incorporated into this strategy document.

The next chapter summarises the country papers, presents easily referenced tables and text to cover the development and research priorities for each country and generates a regional perspective to the research efforts.

Chapter 2: Country Statements

Introduction

This section of the document presents a collation and analysis of the eleven country papers submitted for discussion as part of the Workshop on postharvest fisheries research priorities³.

Representatives of the national institutions involved were requested to produce the country papers along guidelines (Annex 2). The primary intention was to elicit clear national statements and opinions on key issues related to postharvest fisheries research and development in each country. Particular emphasis was to be given to the identification of constraints to development, how these could be alleviated through strategic research and what mechanisms were in place to match the constraints with research prioritisation.

Summaries of the key issues arising out of each of the papers are now reproduced below along with one-page summary charts for each country. These attempt to highlight the past, current and future areas of research, methods of research prioritisation, methods of extension and dissemination, constraints to postharvest development and perceived development needs.

The papers all provided valuable insights into fisheries research in the Asia region, with some going much further into description of the sector as a whole. There was, however, considerable diversity in approach and presentation of data. The objective of this section of the report is, therefore, to attempt to synthesise the broadly-based country statements, collate any common themes and needs and draw pertinent conclusions.

Although some analysis is provided, it should be noted that the views expressed in this paper are those of the country paper authors themselves along with other informants they consulted, and served as the basis for further discussion and analysis during the workshop. A draft of this section was presented for discussion during the workshop to be used as a baseline to initiate discussion on prospective program areas.

³ *Papers were submitted from the following countries: Bangladesh, Peoples Republic of China, India, Indonesia, Laos, Malaysia, Maldives, Pakistan; Philippines, Sri Lanka and Thailand (for a list of the key informants used for each country see Annex 3).*

The Asian Postharvest Fisheries Sector

Development Constraints

It is apparent that the postharvest fisheries sector in this region is both diverse and dynamic, with most countries reporting export sectors which are expanding, particularly in the aquaculture sub-sectors. Marine catches and *per capita* fish consumption are not increasing at the same rates however, and in some cases are declining. For ease of reference, relevant regional statistics are appended under Annex 7.

The country papers diagnosed many problems and constraints that are facing planners and researchers and the main themes are listed in Table 1 below.

Table 1. Main constraints to postharvest development as synthesised from the eleven country reports

Human resources/expertise	<ul style="list-style-type: none"> * handling * preservation * enterprise management * research and analytical
Planning and co-ordination	<ul style="list-style-type: none"> * government co-ordination and overlap * research planning and co-ordination
Lack of information	<ul style="list-style-type: none"> * baseline data * losses data
Infrastructure	<ul style="list-style-type: none"> * market infrastructure * landing site infrastructure * transport and distribution infrastructure * ice and refrigeration and freezing facilities
Traditional processing	<ul style="list-style-type: none"> * low technology
Losses and utilisation	<ul style="list-style-type: none"> * quantitative * qualitative
Industrial facilities	<ul style="list-style-type: none"> * capacity * old machinery
Quality assurance	

Although some of these problem areas (such as human resources, planning and co-ordination) are very broadly based and not directly related to research issues in their

traditional sense, they are clearly relevant to fisheries development and could form the basis of background, strategic policy research aimed at addressing constraints to the sector in general. They were not, however, considered suitable for inclusion in future fisheries research priorities under the context of the current study.

Methods of Identifying Research Priorities

There was a considerable difference in approach to priority setting by the 11 Asian countries represented at the workshop. Whereas some, such as Philippines and Indonesia, had well-defined systems which attempt to match research with beneficiary requirements (although these were not necessarily as efficient as would be hoped), others do not present any clear strategy for prioritisation with research programs being largely based on a more traditional, institution-led approach. The following examples are taken from selected country papers:

Philippines uses a highly structured fishery research priority setting system, under the National Agricultural and Fisheries Research and Extension agenda. Priorities are set at four different levels and research is divided into technology adaptation and technology verification stages. The system has been further improved by an Australian project to develop a decision support system for research prioritisation. This system has potential for the other Asian countries.

Indonesia is also working to improve the efficiency of its fisheries research policy, by initiating a one door policy for research proposals. Indonesian policy divides research into two distinct roles, firstly support to government policies and secondly research to formulate technology packages. This can be further split into pure or strategic research and adaptive research.

Malaysia reported that the co-ordination of resources and programs could be improved, with no formal mechanisms for matching development constraints and priorities existing at the moment.

India understandably has a strong research mandate to poverty focused projects and responsibility for poverty alleviation of poor fishing communities. Work is also carried out on activities designed to stimulate exports, primarily through quality enhancement, but also through value-added product development.

Dissemination and Extension

The impact and dissemination of research, is an issue many of the country papers stress as a future priority, through themes such as the impact on beneficiary and adoption of research results by clients - either by private industry or communities or groups.

Many of the research institutions integrate a technical, scientific and food product research role with that of a developmental role. This means they are often involved in projects involving adaptive research, extension systems and technical support to development projects.

Funding

Foreign donors were reported as the major source of non-government funding for postharvest research and there was no recorded contract research for private industry, even though increased collaboration between research institutes and private industry is increasingly on government agendas.

Country Data on Institutional Capacity in Postharvest Research

Full details of the above are provided in Table 2. The following comments serve to provide further clarification and explanation of the information presented.

A major conclusion which can be drawn from the country papers is that the Asian postharvest fisheries research capacity is large and vibrant, reflecting the importance of fish as a commodity in Asia. Much diverse research is being undertaken (see country paper summaries) and it is clear that the potential [developmental] returns to the promotion of intra-regional co-operation could be large, with valuable research resources being used to their full potential.

Despite the large installed capacity in Asia, the national research capacities do differ greatly across the region. Nations such as Laos and the Maldives for example, have been unable to engage in any significant postharvest research due to their low research capacity which, in broad terms reflects the size of the country and the prioritisation of other areas of fisheries research and development. Conversely, however, countries such as India and China have extremely large research capacities. A major "inefficiency" problem recognised by many countries is the overlap of research services between different organisations exacerbated by a rigid government system.

The postharvest research capacity of the Asian countries included in the workshop have certain major characteristics. The structure of those countries with a developed research network is usually divided into a **specialist research centre**, with national responsibility for postharvest research and a number of **university departments** also engaged into research programs.

China is different in this respect, with the research framework based largely on a geographical basis. In **Indonesia, Philippines** and **Sri Lanka** there are also food/industrial research centres which will conduct research in recognition of the fact that fish is a major food commodity.

Bangladesh possesses the facilities for postharvest research, but due to a lack of funding there is next to no research being undertaken.

Laos does not yet have the structure for research, but is keen on building it up with donor assistance over the coming years.

The **Maldives** has a negligible postharvest research capacity, but wishes to build up a support capability for its important tuna fishery, particularly concentrating on quality issues.

The **Philippines, Indonesia** and **Malaysia** all reported highly developed research systems. The Philippines has an Institute of Fish Processing Technology which acts as a specialist

centre for teaching and research; Indonesia possesses the Research Institute for Marine Fisheries; and Malaysia has three institutions involved in postharvest research (Department of Fisheries, Malaysian Agricultural Research and Development Institute and the Universiti Pertanian Malaysia).

In **Pakistan** research capacity is based around the Marine Resources Centre of the Pakistani Council for Scientific and Industrial Research, which specialises in a broad basic research program as well as a program to develop technologies and products for joint venture exploitation with private industry.

Postharvest research is similarly dominated by one centre in **Sri Lanka**, The Institute of Postharvest Technology which is one of divisions that make up the National Aquatic Resources Agency (NARA). Collaborative links with academic institutions are strong however and there are many joint research projects.

India also has a similar Institute (CIFT) with national responsibility for amongst other things postharvest-research. This is a very large institution with five divisions and 102 research staff. In addition, there is a robust university based research capacity with eight State Agricultural Universities reporting active postharvest research programs. The bureaucratic administration of postharvest fisheries research is complex with five ministries having responsibility for the sector.

The **Chinese** postharvest research system is split into three categories. Firstly there are six fisheries colleges and universities, secondly there four national fisheries research institutes under the auspices of the Chinese Academy of Fisheries Science and lastly there are five provincial fisheries institutes. Reported new policies, include a new emphasis on the inland fisheries and aquaculture and the greater active collaboration of researchers with new fisheries enterprises, particularly to encourage and facilitate foreign trade.

Thailand also has a well developed postharvest research capacity but no information was reported on its structure.

Table 2 - Institutional Capacity in Postharvest Fisheries Research

Country	Postharvest research centres	Research areas and responsibilities	Facilities	Funding
Bangladesh	Fisheries Research Institute, Chandpur	Research institute charged with national responsibility for postharvest fisheries research	n/k	Government
	Institute of Food Science and Technology	Food research	n/k	Government
	Dept of Fisheries Technology, Bangladesh Agricultural university	Nutrition, bacteriology and quality assessment	n/k	Government
Peoples Republic of China	Chinese Academy of Fisheries Science (four institutes)	n/k	n/k	n/k
	Five Provincial Fisheries Institutes			
	6 fisheries Universities and Colleges			
India	Central Institute of Fisheries Technology, Cochin	National research institute with responsibility for postharvest research.	n/k	Central Government
	Integrated Fisheries Project, Cochin.	Government/donor-led program.	n/k	Central Government
	College of Fisheries University of Agricultural Sciences, Mangalore	Leading university for research into postharvest fisheries research.	n/k	Central Government
	Fisheries College, Kerala State Agricultural University.		n/k	Central government
	Tuticorin Fisheries College and Research Institute, Tamil Nadu, Veterinary and Animal Sciences University		n/k	Central government, State government, Ford Foundation, ODA-BOBP.
	Dharwad Fisheries College		n/k	Government of India, FAO, World Bank.
	Gujarat Fisheries College		n/k	State Government

Country	Postharvest research centres	Research areas and responsibilities	Facilities	Funding
Indonesia	Research Institute for Marine Fisheries	National mandate for postharvest fisheries research.	Microbiology, chemistry, processing laboratories and a pilot plant	Central Government
	Institute for Research and Development of Agro-based industry	General research into agro-commodities which includes fish. Quality control and testing.	n/k	n/k
Laos	Fisheries and Small Animals Division of the Department of Livestock and Veterinary Services.	Administrative responsibility for postharvest fisheries.	n/k	Government , ODA, UNDP, IDRC, and DANIDA.
Maldives	Postharvest section within the Ministry of Fisheries and Agriculture to be established	Product development and quality control standards.	None	n/k
Malaysia	Department of Fisheries (DOF) and Fisheries Development Board of Malaysia(LKIM)	Postharvest research into marine fish spoilage, postharvest losses, shellfish depuration, live handling and transport and extension services	n/k	Government.
	Malaysian Agricultural Research and Development Institute (MARDI)	Postharvest handling, transportation and storage, and product development.	Pilot plant facilities for canned, chilled, frozen, dried and smoked products. Basic analytical laboratories.	Government and additional grants from international donors.

Country	Postharvest research centres	Research areas and responsibilities	Facilities	Funding
Malaysia	Universiti Pertanian Malaysia.	UPM quality improvement of traditional products and mechanisation of traditional processes, and utilization of low value species.	same as above	Government and additional grants from international donors such as IFS, FAO, IDRC and ASEAN Food handling bureau.
Pakistan	Marine Resources Centre, Pakistan Council of Scientific and Industrial Research Laboratories.	National Centre for postharvest fisheries research. fish microbiology, fish chemistry, fish biochemistry.	Food bio-chemistry, micro-biology, chemistry and quality evaluation labs. Pilot plant facilities.	Government
Philippines	Bureau of Fisheries and Aquatic Resources.	Government research and advisory centre. Handling, new product development, quality control.	n/k	n/k
	Institute of Fish Processing Technology, University of Visayas.	National centre for teaching and research.	n/k	n/k
	College of Home Economics, University of the Philippines; Food Development Centre, Food and Nutrition Research Institute.	n/k	n/k	Government

Country	Postharvest research centres	Research areas and responsibilities	Facilities	Funding
Sri Lanka	National Aquatic Resources Agency.	National research agency	2 microbiology and 1 chemistry labs, and an experimental food process area	Government and foreign donors
	Ceylon Institute of Scientific and Industrial Research.	n/k	n/k	n/k
	University of Sri Jayawardenapura.	n/k	n/k	n/k
	University of Peradeniya. University of Ruhuna.			
Thailand	Fishery Technological Development Institute.	n/k	n/k	n/k

1. Based in information supplied in country reports submitted for the SIFR workshop.

2. See Abbreviations in Preface.

Previous and Current Research

Categorising the strategy areas of postharvest fisheries research is complicated by the very nature of their cross-disciplinary approach. For example, research into traditional processing is inextricably linked to artisanal development; product development cannot achieve its objectives without considering the market, economics and more often than not, the social context; and so on.

The Study for International Fisheries Research conveniently categorises the principal topics identified for global research under the title "Commodity conversion and utilisation" and these are reproduced in full at Annex 1. With some minor differences, these categories have been used to group the priority areas arising out of the Country Papers and the Workshop. These areas are, in summary:

Application of current knowledge:

- A: Postharvest losses: estimation and resolution
- B: Small pelagic fish: improved utilisation
- C: Preservation and quality on-board and on-shore
- D: Product development: domestic and export
- E: Process development: food and feed
- F: Artisanal fisheries development: handling and processing focus
- G: Socioeconomics and marketing considerations (see ⁴)

Strategic research:

- H: Spoilage and composition: spoilage reduction, food safety and functional properties
- I: Biotechnology: preservation, "special" products and food raw materials
- J: Novel preservation and products

The following additional category has been added as this merits separate consideration as well as not conveniently fitting under any of the other areas:

- K: Quality assurance, standards and control
-

⁴ As discussed in Chapter 1, the social, economic and market implications of research in these areas are considered to be **all-encompassing** by the key participants and must form an integral component to the design, prioritisation and implementation of much of the work undertaken. As such, it is assumed that these components will be fully considered in respect to each project area.

Past and current research projects for each country are presented as fully as possible in the summary charts presented as a mini section at the end of this chapter. These are now further categorised by general topic area and country in Table 3.

Table 3. Previous and current research described in the eleven country reports.

Research Category	Country mentioned
A: Postharvest losses: estimation and resolution	SRL MAL IND PHL
B: Small pelagic fish: improved utilisation	PHL SRL MAL IND PAK INS
C: Preservation and quality on-board and on-shore	PHL SRL INS MAL IND PAK THA
D: Product development: domestic and export	PHL SRL INS MAL IND PAK BGD THA
E: Process development: food and feed	PHL SRL INS MAL IND PAK BGD
F: Artisanal fisheries development: handling and processing focus	PHL SRL INS MAL IND BGD PAK THA
G: Socioeconomics and marketing considerations	IND PHL SRL
H: Spoilage and composition: spoilage reduction and functional properties	PHL SRL INS MAL IND PAK BGD THA
I: Biotechnology: preservation, "special" products and food raw materials	INS IND PAK PHL SRL
J: Novel preservation and products	INS IND
K: Quality assurance, standards and control	PHL IND PAK SRL

Key : BGD - Bangladesh; CHI - China; IND - India; INS - Indonesia; LAO - Laos; MAL - Malaysia; MDV - Maldives; PAK - Pakistan; PHL - Philippines; SRL - Sri Lanka; THA - Thailand

Future and Planned Research

A similar system is used in this section to categorise future and planned research priorities. Table 4 provides a summary of the main topics of interest to the participating countries and these are further discussed below under each main area. Additional specific country information is provided in the summary charts presented as a mini section at the end of this chapter.

Table 4. Future and planned research described in the eleven country reports.

Research Category	Principal topics proposed	Country mentioned
A: Postharvest losses: estimation and resolution	Waste processing for foods/feeds Value-enhancement through better handling By-catch Non-food use Estimation of losses	PHL SRL INS MAL BGD IND PAK
B: Small pelagic fish: improved utilisation	Canned & traditional cured products	SRL IND PHL
C: Preservation and quality on-board and on-shore	Use of ice Insulation of fishing craft	SRL IND PAK
D: Product development: domestic and export	New species Low value species (inc. by-catch) Value-added export oriented	PHL SRL INS BGD IND PAK THA MAL MDV
E: Process development: food and feed	Traditional cures (smoking, pickling, salting, drying etc.) Freshwater fish processing/preservation Shellfish depuration, handling and processing Irradiation of shrimp	PHL SRL INS BGD IND PAK CHI
F: Artisanal fisheries development: handling and processing focus	Collaborative development of: - traditional processing - improved handling	SRL CHI IND MAL MDV THA LAO

Research Category	Principal topics proposed	Country mentioned
G: Socioeconomics and marketing considerations	Economics Market systems Extension and dissemination systems Needs and impact Market sector studies & research	PHL SRL INS IND THA LAO
H: Spoilage and composition: spoilage reduction and functional properties	Pathogens and viruses Heavy metals Chemical residues Toxicology Spoilage and storage life	PHL SRL INS IND PAK
I: Biotechnology: preservation, "special" products and food raw materials	Fish oils Texture/flavour compounds Lactic fermentation products Protein - functional properties Novel products (e.g. protein & fatty acids from waste)	PHL SRL INS IND PAK
J: Novel preservation and products	Novel packaging (e.g. pouches)	INS IND PAK
K: Quality assurance, standards and control	Systems Standards	SRL MDV PAK BGD IND THA INS PHL MAL

Key : BGD - Bangladesh; CHI - China; IND - India; INS - Indonesia; LAO - Laos; MAL - Malaysia; MDV - Maldives; PAK - Pakistan; PHL - Philippines; SRL - Sri Lanka; THA - Thailand

Postharvest Loss Reduction

As would be expected, owing to its importance in the region, this topic was prioritised by most of the countries, but more in terms of a statement of principle. **Bangladesh** and **Indonesia** called for a study of losses, their size and where in the marketing chain they occur. **China** quantifies its marine losses as being only 0.3 % whereas **Malaysia** puts the figure as high as 25%. Such differences are likely to reflect the vagaries of the methodologies used to assess them. Qualitative losses such as represented by the depression in value of product due to its poor quality (or poor *perception* of quality by the market) are often not properly appreciated and can amount to an appreciable proportion of the total

commodity value; when exported shrimp is the commodity concerned, this can have a disastrous effect on the revenue realised by the country.

Bangladesh gives a useful description of the difference between quantitative and qualitative losses and stresses that the qualitative nature of losses is as equally important as their physical extent. A major issue in this research is the determination of the true economic value of losses, their importance to different groups and the economics of preventing them.

Waste management and utilisation is also an important area highlighted for future research by all of the participating countries. This centres mainly around the methodologies for utilisation of by-catch and processing wastes primarily as a means of preventing environmental pollution hazards, but also to produce new food and feed products, and ingredients.

The general focus is on the commercial sector as the levels of waste in the artisanal sector are considered minimal. Many countries see fermentation technologies as an important process for utilising wastes. Other technologies mentioned include the use of chitin and chitosan for bio-medical products and the production of fish silage and fish proteins.

Improved Utilisation of Small Pelagic Fish

As would be expected, this topic was highlighted by those countries with access to large stocks of these fish which are currently either under-exploited or suffer from excessive postharvest loss due to poor handling and traditional processing. In contrast to some other regions such as the Eastern Pacific, the use of large quantities of pelagic fish for conversion into fishmeal is uncommon and not an overriding issue.

In southern **India**, oil sardines are simply salted and dried to produce a low-value product for popular domestic consumption; similarly, skipjack tuna is caught in the northern reaches of the Arabian Sea and is again simply salted and dried. In both cases the product suffers from physical loss through infestation and value degradation through poor processing and storage. In **Sri Lanka** and **Maldives**, similar problems occur with pelagic species, especially tuna. In the latter country, tuna caught largely for freezing and subsequent export for canning, is often of poor quality (although this has improved considerably over recent times) and fails to command the best prices on the international markets.

Under-utilised pelagic resources are also found in several countries: in **India**, as well as improving processing and storage methods of traditional products, there may be considerable scope for developing the offshore tuna resource and flying fish for local markets. Moreover, it is likely that investment opportunities exist in several countries for producing value-added products utilising modern thermal processing and packaging techniques.

Preservation On-Board And On-Shore

In many countries, spoilage of fish postharvest is reported as an important constraint in terms of optimising quality and price to the producer. In many cases the problem is so serious that it has led to the development of an image problem whereby product, even that

of the highest standard (in some cases produced by ISO 9000 accredited packers), suffers a price depression compared to similar product from other countries. For example, **Pakistan** reports a considerable loss in value of shrimp sold into the international market and similar problems are known to exist for both Bangladesh and India.

Clear scope exists for improving handling on-board the fishing craft and throughout the marketing chain in all sectors of the fishing industry, from artisanal producers through to semi-industrial and industrial producers.

Product Development

Product development was one of the most popular future research priorities mentioned. It is seen as:

- a means of adding value to existing products through the development of their handling and processing techniques.
- a means of improving the utilisation of renewable resources through programs of managed exploitation of under- or unutilised species (e.g. seaweed, sea cucumbers, small pelagics)

Rather than increase levels of production of the traditional fisheries in general, the objectives here are to improve productivity and utilise scarce resources efficiently by extracting from them greatest value possible, to increase the value from resources that are easily available, and to tap into new resources where these are available. All of this should result in greater financial flows entering the fisheries sector.

The development of other *novel* products (such as biotechnology products), is discussed under "Novel preservation and processing".

The distribution of benefits from this research is, however, rarely defined in terms of beneficiaries by the participating countries. **Indonesia** emphasises new product development for domestic human consumption and therefore the increase in nutritional level of the population, whereas **Sri Lanka** stresses value added products for domestic and export markets. The **Philippines, Malaysia** and **Thailand** stress value addition in terms of increasing the returns to their domestic processing industry. The **Philippines** also sees increased collaboration between the government and private industry as being important for new product development. **India** intends to focus on the utilisation of low value species and **Bangladesh** stresses the use of shrimp trawler by-catch. The majority of countries call for the increased utilisation of waste in new products.

Process Development: Food and Feed

This is broad area which covers several fields:

- *Traditional processing*: specific technologies mentioned include drying, curing in **India**, pickling and smoking in **Sri Lanka** and a call for the mechanisation of the sector by **Malaysia**.

- *Feeds*: **Malaysia** is planning research into the development of fish protein hydrolysate for animal feeds and **India** is focusing on the use of under-utilised species for fish feeds. The lack of research in this area is understandable given the research strength of the feed industry in this field and could therefore be considered more appropriate for intervention by the private sector.
- *Freshwater fish processing and marketing*: this was highlighted by the **China** country paper which emphasised the need for an increase in facilities for research with the expansion of the freshwater sector. A similar picture emerges in other countries with strong aquaculture sectors where much of the handling and processing infrastructure is located in coastal areas often far from the freshwater production areas. Marketing studies would be essential as the dynamics of this sector are different to marine fisheries and suffer particular constraints. **Laos** supported this requirement, as it is starting a large program to develop its freshwater fisheries sector but it does not have a great deal of baseline information on how the sector operates.
- *Shellfish*: depuration, live handling and processing are priorities for **China** and **Malaysia**. **China** also sees the upgrading of traditional sun drying processing techniques as important as well as the development of new products and increased utilisation of mussels from mariculture.
- *Packaging development*: this theme is seen as having three related objectives: first to increase the value of products through increasing the marketing potential; second as an integral part of storing new products; thirdly in order to decrease problems of perishability and therefore maintain quality. This category tends to focus on export products with little mention of upgrading traditional or domestic products. **India** and **Sri Lanka** stress the role of flexible packaging with **India** seeing it as an alternative to metal cans (retort pouches are, however, regarded as a more fundamental area of research and are categorised under the Novel Preservation and products section). **Sri Lanka** sees packaging as a means of extending shelf life and as a part of product promotion. It is generally implemented integrally with product development activities.

Artisanal Fisheries Development

This is an area which drew little attention from the participating countries although it was mentioned by **Sri Lanka** in the context of carrying out research into specific technical developments such as the promotion of ice, better fish handling and fish drying and storage. Research in this area would, for example, focus on the needs of particular groups and the means of how best to address these using simple, well tried technologies.

Socioeconomics and Marketing Considerations

Socioeconomic considerations received a low priority in the majority of the country papers. This was disappointing yet not altogether surprising taking into account the technical background of the majority of the authors. Unfortunately, it is perhaps undeniable that socioeconomic research, an area of fundamental importance to the development of small-scale fisheries, is yet to be fully integrated into the planning of any research which purports to support this sector. There is a need for strategic research to be targeted at tackling some

of the constraints to the realisation of the needs of small-scale producers. Many countries continue to prioritise activities aimed at the development of their industrial sector perhaps owing to the perceived lack of technical challenge offered by the artisanal sector as well as the well known difficulties in achieving sustainable results. Greater inroads could be achieved here through a greater integration of the social sciences in the planning and management of strategic research focused on artisanal development.

India acknowledged the need for research due its mandate to be involved with employment generation projects for scheduled castes and tribes. **Indonesia** saw socioeconomic research as being necessary to relieve the constraints of small scale fisheries integrating with agro-business and agro-industry. In a related topic **India** stresses the need to look at the dissemination of existing technologies which points to a need to pay attention to beneficiaries and target groups. Although the **Philippines** recognises the importance of "bottom-up" approaches in planning projects and has been actively developing its methodologies over the last few years, it also acknowledged the difficulties involved in institutionalising the process and making it work for the beneficiary.

Market and marketing research is an area which also receives less attention than would be hoped. There is much scope for targeting research which is based on market demands. Indeed, although the better defined areas such as export shrimps receive much attention, areas involving local markets and traditional consumption patterns are largely ignored. Research in the latter could prove very fruitful in terms of developing artisanal fisheries and maintaining traditional food flows in countries where food security is becoming an issue.

Research into markets and marketing is mentioned by **India** with respect to marine products under development and already developed, and by **Indonesia** in relation to potential new products. Market studies are mentioned by **Sri Lanka** with respect to village level marketing and by **Laos** as part of the need to understand the wider postharvest fisheries sector.

Spoilage and Composition

A large number of projects involve storage trials as part of the research, and these are likely to continue to play an important role in food safety and the determination of quality parameters, particularly with respect to storage and the use of ice.

Nutritional and biochemical studies are mainly related to laboratory studies of the nutritional and biochemical structure of products and basic research into their biological breakdown or spoilage. Particular areas of research include the basic bacteriology and biochemistry of fish and shrimp which is an area that the **Pakistan** program sees as a priority. This category does not receive a higher profile as it appears from the country statements to be already covered adequately in the individual research programs. This kind of basic research is unlikely to be seen as a new priority area of research, although nutritional studies are seen as an exception to this in the **Philippines'** country paper.

There is a growing awareness of the problem of contaminated fishery products either by heavy metals or pesticide residues or by toxigenic and pathogenic bacteria and viruses. **Malaysia** plans research on the detoxification of *red tide* infected species, whilst **Pakistan**

plans research on the extent of pesticide and heavy metal residues. Although many of the studies are restricted to studying the extent and the sources of contamination many also look at remedial measures such as detoxification. The economics of such processes should be carefully studied. Many of these studies have resulted from work on quality assurance systems and investigations.

Biotechnology

As well as packaging being an important preservative technique, the use of artificial additives and biotechnology is also mentioned. The research into preservation is closely linked with the following section on nutritional, microbiological and biochemical studies. Particular areas of future enquiry are irradiation in **Thailand** and **Pakistan**, and the use of anti-biotics in **India**.

Novel Preservation and Products

This was an area of particular interest to the country delegates and primarily encompassed the identification of potentially high-value, novel compounds or so-called "bio-molecules" and the utilisation of novel packaging systems for preservation purposes. Examples of such products and processes provided in the country papers included functional proteins and enzymes for use in the food industry, and retortable pouch systems.

Quality Assurance

There is widespread recognition that the maintenance of quality is nearly as important as increasing the value and range of products. This category involves the development of systems, processes and standards and includes quality as measured by price and quality as measured by public health standards. The majority of the work involves the application of existing knowledge and to a lesser extent the basic research, into areas such as microbiology, bacteriology to support these systems and standards. This research is seen as focusing mainly on the export sector but with some countries seeing the need for it for domestic markets, e.g. **Bangladesh**, **Sri Lanka** and **India**. There is a call for some research to support public health objectives with research into the emergence of new food borne pathogens in **Pakistan** and histamine surveys in **Sri Lanka** being examples. **Sri Lanka** also plans to undertake development of Hazard Analysis Critical Control Point systems which confronts the crucial problem of turning laboratory research into practical systems.

Networking and Information Exchange

Thailand and the **Maldives** are enthusiastic to increase the flow of information within the region and from outside industrialised countries. This is particularly important for the **Maldives** which as a small island nation does not possess the research capacity to tackle a broad range of postharvest issues. This issue was raised frequently as a priority throughout the workshop.

Conclusions

The current and future research priorities of the various nations share common objectives which are centred around one main theme: that **fish catches are stable or declining and therefore losses must be reduced and the utilisation of landings must be increased, primarily in order to increase the consumption of fish protein by the populations of the countries concerned.** The development of export sectors and the increased collaboration with private enterprise is another important theme.

Many of the research priorities outlined above are technically-led from the respective institution concerned. Increasingly, however, the trend within the donor community is towards demand-led programs which truly reflect the needs of the specific sector concerned, be it the artisanal or industrial sector. There is still a large emphasis on new product development and processing even though some papers recognise the need for the increased dissemination of what has already been achieved in the past. If projects and programs are to be increasingly demand-led, there needs to be a change in approach with greater emphasis on methodologies for identifying needs of target groups and planning research activities around these.

Several difficult questions arise from this: should the target producer be the *artisanal* or the *commercial* sector?; should the target consumer be the *domestic*, low-value market or the more lucrative *export* market? If the research is for commercial producers, higher technology solutions requiring sophisticated technical research may be acceptable, whereas research for artisanal producers will often require simpler technology but more sophisticated socioeconomic and participatory methods of research. Similarly research for export products may be able to bear the increased costs which result from improvement through research whereas products for poorer markets may not.

Whichever is the target group identified, there is then the need to find appropriate research strategies which involve the full participation of these groups from planning and appraisal stage to full implementation.

In the country papers studied there is considerable focus on new products for export. However, if these are to be successful they must be economically attractive to private producers. The same applies for artisanal producers, in that if there are genuine economic returns they are more likely to be committed and the research will have sustainable outputs.

Conflict in policy between governments and private producers is also not uncommon: environmental pollution, for example, may be an important issue to the former but not the latter. Hence, whereas the former may place high priority on utilising more waste and low value species, processing enterprises will largely be motivated by the market demand for any potential product and may be put off by the research cost involved in developing new product lines. Stakeholder analysis stresses that research must analyse the motivation and commitment of the target groups it is undertaking research for⁵.

⁵ Stakeholder analysis also usually includes an analysis of all the groups involved and their interactions and not just the target group.

A key element in the process of achieving effective dissemination of applied research, is an understanding of the target market. Some of the country papers mention increased market research as a general objective, whereas in reality this should be integrated into all applied research projects. Market research is often seen in a narrow perspective of testing consumer reactions to new products, but it also has usefulness in its broader conception as the study of marketing systems and can play a useful role in targeting research and development effort. An understanding of the marketing system is useful in assessing the likely benefits of the research output to the commodity system. This has been formulated into commodity systems analysis.⁶

The objective of this chapter was to identify common regional and sub-regional themes in postharvest fisheries research in Asia. The country papers revealed a broad interest in loss reduction and recognised the need to improve quality to meet pressing international standards. A further concern was that some countries wished to focus their research on the development of their inland/freshwater fisheries which postharvest fisheries research has previously ignored. This lack of attention will be increasingly incongruous with the development of inland aquaculture in the region and the opportunities this holds for a systems approach to co-ordinating postharvest and pre-harvest research. This is made possible by management precision offered by fish farming production methods which allow an increasing degree of manipulation of the product in accordance with postharvest requirements.

In conclusion, it should be re-stressed that postharvest research in the countries studied is very diverse, with most major research topics being studied. The "vertical" coverage however is uneven and in some cases dubious, thus potential returns to inter-regional co-operation and networking would be large. Indeed, a major outcome of the Workshop and papers was the expressed need for better dissemination and information systems to facilitate learning and better research planning. It seems that there are no missing elements in the research being undertaken but that there is a need to re-orientate the approach. There needs to be a greater concentration on impacts rather than merely on outputs, in order to ensure that the large amounts of resources already being invested produce the desired effects, i.e. increasing the wealth generated by fisheries for the benefit of the populations of the countries concerned. It appears that significant efforts are being made in this direction and these should be encouraged.

⁶ *Commodity systems analysis is in contrast to the orthodox approach of research identification which is often species, product or discipline led and based. It starts with an analysis of where the key constraints are located in any system and how this restricts efforts to increase returns to the beneficiaries and the research effort is then focused on these factors. These constraints may be technical or they may be institutional, but no a priori assumption is taken. This approach builds on the systemic approaches developed in farming systems and household systems research and uses them at the higher "commodity" level. It is not only researchers who need to take on board these approaches but donors also need to take a systems approach; according to the country papers many donor programs do not include any post-harvest element whatsoever.*

Country Summary Tables

Bangladesh

China

India

Indonesia

Laos

Malaysia

Maldives

Pakistan

Philippines

Sri Lanka

Thailand

Country Summary - BANGLADESH**Research activities**

Past/current	Group	Future	Group
Shark liver oil	D	Quantification of loss	A
Poultry feed	E	Use of by-catch	A/D/E
Adhesives	D	Quality control for export	K
Storage of Hilsa on ice	H		
Sundrying	E/F		
Composition of Hilsa	H		

KEY: A: Postharvest losses: estimation and resolution; B: Small pelagic fish: improved utilisation; C: Preservation and quality on-board and on-shore; D: Product development: domestic and export; E: Process development: food and feed; F: Artisanal fisheries development: handling and processing focus; G: Socioeconomics and marketing considerations; H: Spoilage and composition: spoilage reduction, food safety and functional properties; I: Biotechnology: preservation, "special" products and food raw materials; J: Novel preservation and products; K: Quality assurance, standards and control

Prioritisation

No specific system discussed.

Extension and dissemination

Restricted to QC and inspection at export producer level.

Constraints to development

Losses due to lack of ice, remote location of communities, insect infestation; shrimp by-catch. Landing centres poorly equipped. Marketing infrastructure poor

Development needs

Training, extension and awareness at remote community level; improved fish landing sites; improved availability and use of ice; reduced losses; fish inspection and QC to optimise export value (currently depressed due to "image" problem).

Country Summary - CHINA

Research activities

Past/current	Group	Future	Group
NO SPECIFIC ACTIVITIES MENTIONED		Fresh water fish processing Shellfish quality & sanitation	E F

KEY: A: Postharvest losses: estimation and resolution; B: Small pelagic fish: improved utilisation; C: Preservation and quality on-board and on-shore; D: Product development: domestic and export; E: Process development: food and feed; F: Artisanal fisheries development: handling and processing focus; G: Socioeconomics and marketing considerations; H: Spoilage and composition: spoilage reduction, food safety and functional properties; I: Biotechnology: preservation, "special" products and food raw materials; J: Novel preservation and products; K: Quality assurance, standards and control

Prioritisation

No specific systems mentioned. Decisions made centrally, but lack of focus on fresh water fisheries development and research.

Extension and dissemination

No specific systems mentioned.

Constraints to development

Main constraints mentioned are lack of research into and research facilities for freshwater fish processing systems; lack of research into sanitary shellfish production systems. Lack of administrative and management expertise; lack of access to information on sector

Development needs

Focus on inland fisheries development, quality and processing of freshwater fish; addressing the problems of pollution in shellfish mariculture; and value-added products.

Country Summary - INDIA

Research activities

Past/current (often several topics under each group)	Group	Future (often several topics under each group)	Group
<i>CIFT</i>		<i>CIFT</i>	
Storage characteristics fish	H	Loss prevention cured products	A
Canning	E	Modern packaging systems	J
Wastes/products	E	Products from under-utilised resources	B/D
Feeds	E	Spoilage	H
Traditional cures	E/F	Market research	G
Quality control exports	C/F	Quality Assurance	K
Microbes in marine products	H		
Packaging	J	<i>Other institutions</i>	
New products from under-utilised species	D	Krill development	D/E
Process development (several)	E	Farmed fish promotion	G
Temperature and biochem. effect	H	Feeds development	E
Nutrition and toxicology	H/I	Fatty acids	I
Flavour compounds	I	Contaminants	H
Market research (export fish)	G	Product development int/exp	D
Market research, landing sites	G	Storage life	H
Market research, product testing	G		
Handling and transport	C		
Product development IMPs	J		
Flexible pouch	J		
Waste utilisation	A/D		
Aquaculture feeds	E		
Fish biochemicals	I		
On-board preservation	C		
<i>Other institutions</i>			
2 of type	B		
2	C		
11	D		
5	E		
1	G		
8	H		
1	J		
2	A/E		
1	C/F		
1	G/F		

KEY: A: Postharvest losses: estimation and resolution; B: Small pelagic fish: improved utilisation; C: Preservation and quality on-board and on-shore; D: Product development: domestic and export; E: Process development: food and feed; F: Artisanal fisheries development: handling and processing focus; G: Socioeconomics and marketing considerations; H: Spoilage and composition: spoilage reduction, food safety and

functional properties; I: Biotechnology: preservation, "special" products and food raw materials; J: Novel preservation and products; K: Quality assurance, standards and control

Prioritisation

Not indicated.

Extension and dissemination

Extension Guides; training programs; exhibitions; "open-house"; folders/pamphlets; radio TV; local journals.

Constraints to development

Lack of umbrella organisation to co-ordinate policy; delays in project implementation (overseas funded); imports of materials difficult; duplication of activities.

Development needs

Infrastructure at landing sites; improved traditional curing; cool chain development (ice); better market facilities; improved utilisation of fish including tuna.

Country Summary - INDONESIA

Research activities

Past/current	Group	Future	Group
Fish drying	E/F	Loss assessment	A
Seaweed processing	E	Product development	D
Improved on-board handling	C	Process development	E
Mollusc handling	E	Socioeconomic issues	G
Squalene extraction	D	Spoilage	H
Sea cucumber processing	E/F	Novel products	I/J
Retort pouch	J	Functional proteins	I/J
Waste utilisation	E	Quality Assurance	K
Shark utilisation	D/E		
Small pelagics utilisation	B		
Fish smoking	E/F		
Fermentation	H/I		
Live fish	C		
Fish sausage	D		
Snack foods	D		
Feeds and oil	E		

KEY: A: Postharvest losses: estimation and resolution; B: Small pelagic fish: improved utilisation; C: Preservation and quality on-board and on-shore; D: Product development: domestic and export; E: Process development: food and feed; F: Artisanal fisheries development: handling and processing focus; G: Socioeconomics and marketing considerations; H: Spoilage and composition: spoilage reduction, food safety and functional properties; I: Biotechnology: preservation, "special" products and food raw materials; J: Novel preservation and products; K: Quality assurance, standards and control

Prioritisation

Should be improved in relevance toward national development strategies.

Extension and dissemination

"Research Extension Linkage" established as an "on farm" approach.

Constraints to development

Inter-institutional co-ordination.

Development Needs

Wide ranging but include poverty alleviation, increased income and better welfare in communities through increased production and diversification; boost to exports.

Country Summary - LAOS**Research activities**

Past/current	Group	Future	Group
None discussed		Postharvest fish handling and processing Marketing Fishing communities	F G G

KEY: *A: Postharvest losses: estimation and resolution; B: Small pelagic fish: improved utilisation; C: Preservation and quality on-board and on-shore; D: Product development: domestic and export; E: Process development: food and feed; F: Artisanal fisheries development: handling and processing focus; G: Socioeconomics and marketing considerations; H: Spoilage and composition: spoilage reduction, food safety and functional properties; I: Biotechnology: preservation, "special" products and food raw materials; J: Novel preservation and products; K: Quality assurance, standards and control*

Prioritisation

Recognition that status of postharvest fisheries needs to be enhanced to provide better understanding of key issues which need to be addressed through research.

Extension and dissemination

None discussed although need for effective fisheries extension service recognised.

Constraints to development

Fish transport, preservation, processing and marketing systems are almost non-existent; quality of products is poor and is constraint to marketing; lack of qualified manpower.

Development needs

Improved transport; improved fish processing and preservation techniques at artisanal level.

Country Summary - MALAYSIA

Research activities

Past/current	Group	Future	Group
Spoilage	H	Estimation of losses	A
Losses	A	Value addition	D
Depuration of shellfish	E	Improved processing	F
Handling and transport	C	Quality Assurance	K
Value-added product development (export focus)	D		
Traditional fish quality	C/F		
Improved traditional processing	E		
Use of low-value fish	B/D		

KEY: *A: Postharvest losses: estimation and resolution; B: Small pelagic fish: improved utilisation; C: Preservation and quality on-board and on-shore; D: Product development: domestic and export; E: Process development: food and feed; F: Artisanal fisheries development: handling and processing focus; G: Socioeconomics and marketing considerations; H: Spoilage and composition: spoilage reduction, food safety and functional properties; I: Biotechnology: preservation, "special" products and food raw materials; J: Novel preservation and products; K: Quality assurance, standards and control*

Prioritisation

No formal mechanism; determined by current/future market requirements. Top priority given to developing artisanal sector. Contract research with private sector.

Extension and dissemination

Extension services run through DOF, LKIM and MARDI. Regular visits to fishermen. UPM demand-led training to processing sector. Publications in local journals; professional groups and seminar systems established.

Constraints to development

Co-ordination in postharvest fisheries. Four agencies involved but none responsible for programming, co-ordination or follow-up.

Development Needs

Loss reduction (currently 25% est.); Use of ice ; Capital and investment; Value-addition to current export products

Country Summary - MALDIVES

Research activities

Past/current	Group	Future	Group
(NO FORMAL PROGRAM IN OPERATION)		Quality assurance and health standards	K
		Improved handling of tuna	F
		Export oriented product development	D

KEY: *A: Postharvest losses: estimation and resolution; B: Small pelagic fish: improved utilisation; C: Preservation and quality on-board and on-shore; D: Product development: domestic and export; E: Process development: food and feed; F: Artisanal fisheries development: handling and processing focus; G: Socioeconomics and marketing considerations; H: Spoilage and composition: spoilage reduction, food safety and functional properties; I: Biotechnology: preservation, "special" products and food raw materials; J: Novel preservation and products; K: Quality assurance, standards and control*

Prioritisation

None discussed.

Extension and dissemination

None discussed

Constraints to development

Fish - especially tuna - quality problematic leading to value depression in overseas markets including USA, Japan and Thailand; lack of quality awareness by fishermen and collectors; lack of chilling facilities in local craft and inter-island transport.

Development needs

Improvements in handling [of tuna] by small scale fishermen and collectors to improve quality

Country Summary - PAKISTAN

Research activities

Past/current	Group	Future	Group
Protein denaturation, shrimp storage	H	Microbiology, virology - spoilage and quality	H
Lactic preservation	I	Processing effect on storage	E/H
Microbiology & biochemistry of preservation	H	Texture and flavour	I
Fish oils	I	Packaging techniques	J
Stabilised marine proteins	I	Fish oils [omega-3]	I
Utilisation of small pelagics	B	Shrimp quality assessment	K
FPC plant	B	Lactic acid bacteria genetics	I
Product development	B/D	Pesticide & chemical residues	K
Canned sardines Squid	B/E	Irradiation of shrimp	E
Quality Assurance for shrimp	K	By-catch and product development	A/D
Preservation and quality	C/F	Preservation and quality	C

KEY: *A: Postharvest losses: estimation and resolution; B: Small pelagic fish: improved utilisation; C: Preservation and quality on-board and on-shore; D: Product development: domestic and export; E: Process development: food and feed; F: Artisanal fisheries development: handling and processing focus; G: Socioeconomics and marketing considerations; H: Spoilage and composition: spoilage reduction, food safety and functional properties; I: Biotechnology: preservation, "special" products and food raw materials; J: Novel preservation and products; K: Quality assurance, standards and control*

Prioritisation

Projects aimed at loss reduction, improved efficiency, quality and preservation methods are prioritised.

Extension and dissemination

No specific methods mentioned

Constraints to development

Losses are likely to be high due to lack or insufficient of ice and suitable infrastructure on landing; posthandling conditions are unhygienic; export products such as shrimps are quality down-graded in value by 20-30%

Development needs

50% of marine catch is used for meal: there is a perceived need to utilise a greater proportion of fish for direct human consumption. Loss reduction and improvements in quality.

Country Summary - PHILIPPINES

Research activities

Past/current	Group	Future	Group
Microbiology/chemistry <i>burong bangos</i>	H	Product and process development:	
Use of TPP on fish products	I	- canning pelagic fish	B/E
Carp processing	E	- value-added products	D
Under-utilised fish	B	- seaweed processing	E
Fish oils	I	- aquaculture feeds	E
Protein hydrolysates in canned fish	H/I	Water management and waste:	A/E
Cephalopod value-added	D	- fish waste characterisation	
Tuna products	D	- treatment	
Feeds from hydrolysates	E	- utilisation	
Milkfish nucleotides	H/I	Marketing and distribution:	G
Chitin	I	- distribution/marketing systems analysis	
Value-added shrimp products	D	- price elasticity study	
Seaweed product development	D	Detoxification of fish products	H/I
Small-scale fish handling	C/F	- red tide	
Pelagic fish quality	C	- chemical contamination	
Cuttlefish quality	H	Quality	K
Octopus storage quality	H		
Small pelagic utilisation	B		
Carp product development	E		
Export handling problems	C		
Quality standards	K		
Losses	A		
Socio economics	G		

KEY: A: Postharvest losses: estimation and resolution; B: Small pelagic fish: improved utilisation; C: Preservation and quality on-board and on-shore; D: Product development: domestic and export; E: Process development: food and feed; F: Artisanal fisheries development: handling and processing focus; G: Socioeconomics and marketing considerations; H: Spoilage and composition: spoilage reduction, food safety and functional properties; I: Biotechnology: preservation, "special" products and food raw materials; J: Novel preservation and products; K: Quality assurance, standards and control

Prioritisation

Recent diagnostic planning scheme set up using participative consultation with fishermen and private sector through the National Agricultural and Fisheries Research and Extension

Agenda (NAFREDA). Emphasis on adaptive research comprising technology adaptation and technology verification. National priorities then ranked. This process encountered difficulties and methodology has been subject to improvements.

Extension and dissemination

Seminars and extension services. Little work published externally.

Constraints to development

Transfer of technologies has been weak due to downgrading of extension services and lack of active participation of private sector.

Development needs

Quality assurance at producer level. Poverty alleviation and employment generation, increase export earnings, reduce imports and improve food security.

Country Summary - SRI LANKA

Research activities

Past/current	Group	Future	Group
<i>NARA:</i>		<i>NARA:</i>	
Bivalve quality	H	Low value fish & value-added products	B/D
Seaweed processing	E	HACCP pond reared shrimp	K
Shrimp waste	A/E	Quality aspects exports	K
Quality of pond reared shrimp	H	Oils for food and feed	D/I
Fish sauce	D	Histamine survey	H
Heavy metals	H	Handling & use of ice	F
Ice melting & traditional boxes	C/F	Drying and storage	E/F
Fish quality	H	Waste processing	A/E
Traditional fish products	D/F	Village marketing	G
Under-utilised fish	B	Value enhancement	A/C
Socio economics	G	Value-added and new products	D
<i>Other institutions:</i>		Packaging development	D/E
Dry fish waste	A/E	Lactic fermentations	I
Fish smoking	E		
Spoilage and quality	H		

KEY: *A: Postharvest losses: estimation and resolution; B: Small pelagic fish: improved utilisation; C: Preservation and quality on-board and on-shore; D: Product development: domestic and export; E: Process development: food and feed; F: Artisanal fisheries development: handling and processing focus; G: Socioeconomics and marketing considerations; H: Spoilage and composition: spoilage reduction, food safety and functional properties; I: Biotechnology: preservation, "special" products and food raw materials; J: Novel preservation and products; K: Quality assurance, standards and control*

Prioritisation

Set by MFAR. Rationale not discussed.

Extension and dissemination

Collaboration and participation in some areas with local beneficiary groups.

Constraints to development

Low efficiency of existing preservation methods

Development needs

Reduction of losses; improved traditional processing; use of packaging; fish handling and use of ice; fish meal production.

Country Summary - THAILAND

Past/current	Group	Future	Group
On board Preservation	C	Value Addition	D
Returns to Domestic Industry	D	Pre processing	F
Traditional packing	F	Market Surveys	G
Insect Infestation	H	Export standards	K

KEY: *A: Postharvest losses: estimation and resolution; B: Small pelagic fish: improved utilisation; C: Preservation and quality on-board and on-shore; D: Product development: domestic and export; E: Process development: food and feed; F: Artisanal fisheries development: handling and processing focus; G: Socioeconomics and marketing considerations; H: Spoilage and composition: spoilage reduction, food safety and functional properties; I: Biotechnology: preservation, "special" products and food raw materials; J: Novel preservation and products; K: Quality assurance, standards and control*

Prioritisation

National Economic and Social Development Plans put fish processing industry as high priority. Promotion of fresh water and coastal aquaculture

Extension and Dissemination

No specific mentions

Constraints to Development

Lack of raw material supply. Poor quality raw material

Development Needs

Improved product quality and safety. Reduction of losses in traditional products. Market diversification of export products.

Chapter 3: Strategy for Postharvest Fisheries Research in the Asian Region

Resolution of the Main Areas of Concern

The country papers discussed and analysed in the preceding section provided the basis for discussion during the workshop, the objective being to resolve out from the several areas under discussion those areas of prime concern to the delegates.

The discussion focused around three main areas:

- The postharvest research areas described
- Improvements in information technology and regional institutional links
- Aid delivery mechanisms which ensure beneficiary needs are fully congruous with technical research objectives

Eleven research areas covering the majority of delegates' expressed needs as derived from the country papers were prepared for discussion. These were:

Losses

Justification: To assess the importance of losses at various points in the marketing chain and their economic importance to different groups and to develop strategies to reduce them.

Strategy: Methodology, estimation and prevention

Waste and by-catch utilisation

Justification: To increase the returns to non or under utilised resources.

Strategy: Work on market research for key traditional technologies and the subsequent potential improvement of the product.

Possible resources: shrimp waste (heads and shells); fish offal and skin; shark by products; shrimp by-catch; fish waste liquids

Potential products: chitin, chitosan, fish silage, fish fertiliser, single cell protein

Product development

Justification: To add value by means of developing products from new and existing species

Strategy: Identify markets.

Possible resources: Seaweed, sea cucumbers, snails, giant clams.

Potential products: Biscuits, snacks, soups, crackers, jelly.

Processing development - Shellfish

Justification: To provide technologies and market analysis for shellfish products.

Strategy: Studies on shellfish depuration and processing techniques and possible uses.

Processing and marketing of fresh water fish

Justification: To ensure that the postharvest knowledge exists to complement freshwater development policies

Strategy: Marketing systems studies and collation of existing processing knowledge for freshwater species.

Species: Carps, tilapias, indigenous varieties.

Traditional fish processing and artisanal development

Justification: To increase the economic returns to small scale processing by increasing utilisation of low value species, product development and enterprise development.

Strategy: Work on market research for key traditional technologies and the subsequent potential improvement of the product. Would include full appraisal of social, economic and technical needs of beneficiary groups.

Possible resources: Low value species

Likely technologies: Drying; use of ice; smoking; pickling; fermentation

Socioeconomics and marketing considerations

Justification: Fundamental social, economic and marketing research to ensure that postharvest fisheries research is strategic in nature in that it ultimately addresses immediate needs and constraints of the sector; to consider mechanisms for effective delivery of research outputs to potential beneficiaries.

Possible strategy: Marketing studies; research policy; macro-policy; socioeconomic and gender needs assessment; enterprise management and development

Biotechnology - bioactive compounds

- Justification:* To extract very high value by-products ("bio-molecules") and increase the returns to non- or under-utilised resources.
- Strategy:* To identify such products and markets, and also to develop processes to produce them.
- Potential products:* Enzymes, hormones, n-3 lipids, cancer inhibitors, Maldivian sponges, single cell proteins or protein concentrates

Biotechnology - novel preservation and "special" products

- Justification:* Novel preservation option with potential to assist traditional methods with improved safety and shelf life
- Strategy:* To research the use of enzymes and bacteria and other bio-preservative techniques.
- Research areas:* Anti-biotics, additives, enzymes and lactic acid bacteria

Quality assurance

- Justification:* It is seen as a priority by the majority of countries.
- Strategy:* Development of quality control methods, standards and systems aimed at improving quality and value primarily of export produce

Information and dissemination

- Justification:* To establish centres with the necessary information in key postharvest areas to enable its easy access and dissemination throughout the region.
- Strategy:* Key centres for quality assurance systems, artisanal processing, bio-preservation.

These themes were discussed during a plenary session of the workshop which required delegates to justify specific research areas which they would like included in the final document. The requirement expressed by SIFR was for a maximum of six programs which reflected the priority concerns of the Asian region in terms of postharvest research needs. This would provide the basis for the strategy.

The method to achieve these programs focused around the importance of the problem to the region, and where commonalities were shared between the research areas they were combined. An outcome of these discussions was that there were no sub-regional research needs, i.e. there were no research needs that were specific to say South Asia, or South East Asia.

The losses and waste and by-catch utilisation areas were combined into one program as the issues were seen as contiguous, and also vital to the region. Similarly, the product development and traditional fish processing and artisanal development areas were

amalgamated as both of the areas focused on improving or developing products and processes, but recognising the potential differences in end-user, i.e. the area of new product development was seen as being relevant to the commercial sector whereas traditional processing was targeted at the artisanal sector.

The biotechnology areas were seen as important enough to leave as two separate programs, focusing on the end product, i.e. **Novel preservation and products** and biologically active compounds, "**biomolecules**".

The **Processing and marketing of fresh water fish** theme was dropped because it did not offer specific research opportunities that were not covered by the remaining research areas, as was **Processing** (shellfish) as there appeared to be few important researchable constraints prioritised by the majority of the delegates.

Quality assurance *per se* was not included as a research topic as it was generally felt that this did not constitute research. Many of the delegates had indicated strong support for research related to HACCP methodologies, but the consensus was that this was an area already well developed and better disseminated through non-research technical assistance programs. However, the issue of **food safety** with regard to the spread of pathogenic micro-organisms and chemical contamination was regarded as an area well worthy of support and one which would have direct relevance and input to the establishment of improved quality systems.

The research area on **Socioeconomics and marketing considerations** was the only area remaining in its original form and was unanimously supported. Although the majority of the country delegates were from technical backgrounds, this did not inhibit active participation in the discussion group on this topic. The basis for a separate socioeconomics programs and also the importance of encompassing socioeconomics and marketing in all stages of the project cycle is the subject of further discussion below.

In a similar vein, the dearth of **information links** and difficulties encountered in **dissemination** mentioned by all of the country delegates is clearly another critical and all-encompassing issue, but was not seen as a research program. This will be the subject of a separate discussion below.

In summary, therefore, a final list of six priority research programs of equal merit were agreed for donor consideration, as follows:

- **Losses and waste utilisation**
- **Improved traditional and value added products**
- **Biomolecules from aquatic resources**
- **Bio-preservation techniques and novel products**
- **Food safety and production systems**
- **Socioeconomic and marketing research**

Once agreed to by the delegates, these were then discussed by specialist groups, the membership of which comprised the delegates with a special interest in a particular theme, to prepare draft programs.

Following the workshop, the country delegates were asked to discuss the draft programs with the fisheries research and development community in their countries and to report back to the organisers on the discussions and the possible involvement of other organisations in the future programs. This resulted in interest from a number of organisations not involved in the initial work (Annex 6).

A Strategy

This section outlines a strategy to address the postharvest fisheries research priorities for the Asian region. First it discusses the importance of **socioeconomics and marketing** in the project cycle, and also its need as a separate research activity, feeding outputs back into the more technical research programs on a continuing basis and concluding with recommendations. Secondly, it discusses the role of **information** in the research process and similarly makes recommendations.

Finally, the six research programs are presented (in a manner suggested by SIFR Executive) including justifications, strategy, duration and participating institutions. Each program is accompanied by a Logical Framework, as used by many donor agencies in planning and monitoring aid projects.

It will be appreciated that these are outline proposals that will require further refinement by donor organisations should they wish to pursue particular research activities.

Socioeconomics and Marketing in the Research Programs

The need to improve the use of socioeconomics and marketing in postharvest fisheries research was recognised even though the majority of representatives were from technical backgrounds. Indeed, the workshop agreed that socioeconomics was an important enough topic to be included as a separate program area, but that this did not mean that it should not be ignored in the other programs. On the contrary, it was also agreed and stressed that the five programs identified will require thorough socioeconomic appraisal and/or marketing input(s) at all stages. Particular areas of work will include needs assessment, production economics marketing and market research to name but a few of the skills required.

A separate program on **socioeconomics and marketing research** was justified because it was felt that this addressed needs not served directly by the other technically oriented programs. Socioeconomic and marketing research would not only attempt to solve key constraints in the fisheries sector but would also attempt to develop methodologies specifically for postharvest fisheries research which could offer an important contribution to future research programs and development assistance. The socioeconomic and marketing

research program will also require a multi-disciplinary approach and will provide a valuable opportunity for collaboration between technical research and social science research. This collaboration will strengthen the social science ability and capacity of the Asian Institutes involved.

The development of methodologies specifically for postharvest fisheries will benefit researchers who do not appreciate the importance and/or possess the background in socioeconomics and marketing research. If these researchers are presented with usable methodologies and examples which have been developed specifically for their area of expertise, they will be more likely to appreciate their usefulness and consequently integrate them into their future research.

It was felt that the ability of Asian fisheries research institutes to undertake socioeconomic and marketing research varied across the region.

To this end it is proposed that a separate study be commissioned to assess the existing socioeconomics and marketing capacity within the region, specifically as it relates to postharvest fisheries, and to develop a strategy to help strengthen this capacity. The Asian Fisheries Social Science Research Network based at the International Center for Living Aquatic Resource Management in the Philippines would be in a position to undertake and benefit from such a study.

Information Exchange and Dissemination

There was much discussion at the workshop about the problems of information exchange and availability. There were two inter-related problems apparent from the discussion on this topic.

- Difficulties in publishing research results
- Access to research results and information both within the region and world-wide

Publication of Results

On the first topic, the meeting felt that there was probably a great deal of research material that is not published because of the difficulties of publication. It is also often impossible for research workers to find the time to write up the results of research in the correct format for external publication. This stems from two factors: one, the pressures put on researchers to produce research results without the parallel recognition of the vital role of publishing the research results in the international arena, and; two, to have work published in a peer review journal to the exacting standards required by many journals can take many months of preparation because of the limited hardware capabilities of many institutions. These factors combined can mean that any work that is published is out of date before it is made known to the outside world or it is published as an internal report which is not readily accessible to outside parties.

It was recommended that:

- the IPFC meetings of the "Fish Technology and Marketing" working party were specifically targeted to allow preliminary and final research results to be aired publicly in a less formal way and that funds were continued to support this initiative
- "The ASEAN Food Journal" should be targeted as an appropriate journal for publication of research results for the whole Asian region, and not just the ASEAN countries
- the "Fish Tech News" and "The Fish Inspector" were recognised as important publications for keeping up to date with what was going on both within the region and more widely and that effort and funds should be refocused on producing these publications on a regular basis
- recognition was given to the vital role that publishing research results in the international arena plays in personal, institutional and national development
- funds should be made available to equip institutes to a minimum computer standard to allow rapid analysis of research results and easily manipulated production of "publication ready" material

Information Exchange

The lack of access to information was the other major problem identified by the participants. Postharvest aspects of fisheries development and research were often a poor relation to other areas of aquatic resources, such as biology, management and aquaculture when it comes to information exchange.

The "Current Contents" database produced by FAO presently covers Marine Science and Aquaculture and the Aquatic Sciences and Fisheries Abstracts (ASFA) has a very limited coverage of postharvest activities.

The use of *Internet* systems for exchange of information was also discussed but with the lack of access to Email in most of the institutions represented, it presently has limited use, but does have considerable potential. The meeting felt that the state of telecommunications links to some parts of the region may be the limiting factor.

The meeting recommends that:

- any measures taken to strengthen the exchange of information between fisheries researchers both regionally and world wide be supported, and insist that postharvest aspects are not neglected in such an initiative
- FAO look at the possibility of either the existing current contents being broadened to include postharvest research or of separate database being compiled
- FAO look at the possibility of expanding the ASFA database in the postharvest area
- a study of the costs and benefits of providing institutes with *Internet* facilities should be undertaken

Co-ordination With Existing Networks

In formulation and discussion of these programs, the authors were aware that there are existing networks of fish technology research workers in the region and that the formation of further groupings for execution of the programs suggested here would not be necessary or indeed advisable given the limitation of funds. The IPFC working party and the formation of the group to undertake work under the EC STD-3 project on "Improved utilisation of low value species" would seem to lay the foundations for a wider and more comprehensive group of research workers from Asian countries. It is not proposed, therefore, that new networks would be established but that, where possible, existing links should be strengthened and the networks widened to include institutions and countries that have not hitherto been included. This workshop provided an opportunity for the participation of a number of countries that had previously not been involved to any great extent in IPFC work. Contacts established during the workshop will, it is hoped, lead to better information exchange and collaboration between research workers in the region. The inclusion of non IPFC working party members in the following programs as leaders and members of networks working on mutually beneficially programs will help to establish this wider network of workers.

The next separated section details the six research programs

The Research Programs

Losses and Waste Utilisation

Improved Traditional and Value Added Products

Biomolecules from Aquatic Resources

Bio-preservation Techniques and Novel Products

Food Safety and Production Systems

Socioeconomic and Marketing Research

Losses and Waste Utilisation

Justification

The Problem

Fish resources in the Asian region are in short supply and there is increasing pressure on limited stocks. In addition high protein foods are limited for poorer members of the community. It is essential therefore that maximum use is made of fish that is caught and any wastage reduced.

Fish and fish products suffer physical losses and reduction in value between capture and consumption. This represents not only a loss of valuable fish protein but an economic loss to the fish seller, resulting in increased prices to the consumer.

In the fishing industries of the region there are unquantified waste products from processing operations which represent a loss of animal protein, such as, filleting waste, crustacean heads and cannery offal. In addition quantities of shrimp by-catch and fish during times of glut (particularly of small pelagics) are discarded representing a loss of animal protein for possible use as human food both in traditional fish products and minced fish products. The utilisation of these two sources would reduce fishing pressure, environmental pollution and improved utilisation of other wise low value sources as well as making maximum use of resources.

General Outputs

The outputs from this program would be increased income generation for fishermen and the processing industry. There will be an increase of per capita consumption of fish and/or increased availability of ingredients for animal feeds.

- More food available for consumption
- Reduction of fish prices to the consumer
- Reduction of pressure on fish stocks
- Reduction of pollution by reduction of wastes entering the environment
- Increasing incomes to fishing industry

The Beneficiaries

The ultimate beneficiaries of such a program will be those involved in the fishing industry (fishermen, processors and distributors) who will expect to gain from increased flow of fish products through the marketing chain and the end users who will benefit by there being more fish available thus reducing pressure on prices and increasing the nutritional status of the population. In addition the reduction of wastes will to some extent reduce pressure on limited fish stocks and so have positive effects on the environment.

Strategy

This program can be divided naturally into efforts to **reduce the losses of fish** currently in the marketing chain; and to **improve the utilisation** of fish and waste products.

Reduction of Postharvest Losses

Objectives

This part of the program will aim to reduce postharvest losses with a view to increasing benefits to producers and consumers. For fisherfolk, this will be done either by increasing the incomes that fisherfolk receive from their activities or by directly increasing the consumption of what they produce. For consumers, benefits will be delivered by decreasing losses that occur at all stages in the marketing chain and thereby decreasing prices of these products.

Outputs

The expected outputs will be a better understanding of the quantity of losses both in terms of value and weight and the formulation of methods and policies to reduce these losses. The methods will be disseminated to the fishing industries of the region through the publication of guidelines.

The outputs will be achieved by a series of inputs as indicated below:

1. Investigations of postharvest losses throughout the distribution and marketing chain.
2. The second phase of the program will depend on the outcome of the first but will entail the formulation of methods and policies for reducing and controlling the most important losses and therefore maintaining or increasing the value of the fish landed.
3. From these activities technical and marketing guidelines will be produced on primary handling systems, processing methodologies and marketing systems to ensure good manufacturing and marketing practices and thus assist in the formulation of and implementation of quality assurance systems and improve the economic returns from utilisation.

Duration

The Program will require 4 years of funding if the expected impacts are to be realised.

Location of Lead Centres

University of the Philippines in the Visayas, The Philippines
Central Institute of Fisheries Technology, India
Fisheries Research Institute, Mymensingh, Bangladesh
Universiti Pertanian, Malaysia

Location of Other Centre(s):

Institute of Postharvest Technology, NARA, Sri Lanka

Research Institute for Marine Fisheries, Indonesia

University of Diponegoro, Indonesia

Institute for Research and Development of Agro-based Industry, Indonesia

Ministry of Fisheries, The Maldives

Fishery Technology Development Institute, Thailand

Prince of Songkla University, Thailand

Kasetsart University, Thailand

Mahidol University, Thailand

Food and Drug Administration, Thailand

University of Sri Jayawardenapura, Sri Lanka

University of Peradeniya, Sri Lanka

Research Institute of Marine Products, Vietnam

Links with Other Institutions

Natural Resources Institute, UK

Utilisation of By-Catch, Gluts and Processing Wastes

Objectives

This part of the program will investigate and identify possible markets for products from by-catch, fish glut wastage and processing wastes and investigate and develop appropriate technologies for production of such products.

The examples of such products can be divided into human food products such as traditional foods (e.g. dried fish, fish balls, fish crackers), minced fish products for incorporation into fish analogues and novel food products and non food products such as fish silage, pharmaceutical products and biomolecules. As well as reducing the wastage of fish, this program will have positive impacts by reducing the waste products of the fishing industry entering the environment and thus reducing pollution.

Outputs

The program will entail a series of studies to assess the extent and nature of potential raw materials and the potential uses and markets for such products. Research will follow into appropriate technologies for the conversion of the raw materials into products with potential and guidelines will be produced for use in the countries of the region. Marketing strategies will form a key element of this advice. The environmental aspects of the disposal of liquid wastes from processing will be studied and recommendations and policies created for their appropriate use.

Duration

This will require at least 4 years of funding

Location of Lead Centre(s):

Fisheries Research Institute, Mymensingh, Bangladesh
Marine Biotechnology Centre, Vietnam

Location of Other Centre(s):

Applied Biology and Marine Resources Centre, Pakistan Council for Scientific and Industrial Research, Pakistan
Research Institute for Marine Fisheries, Indonesia
University of Diponegoro, Indonesia
Institute for Research and Development of Agro-based Industry, Indonesia
University of the Philippines in the Visayas, The Philippines
Fishery Technology Development Institute, Thailand
Prince of Songkla University, Thailand
Kasetsart University, Thailand
Mahidol University, Thailand
Central Institute of Fisheries Technology, India

Interactions with Other Programs

EEC STD 3 program; Norwegian Institute of Fisheries and Aquaculture

Logical Framework

Narrative Summary (NS)	Measurable Indicators (OVI)	Means of Verification (MOV)	Important Assumptions
Goal: 1 Productivity and value of fishery resources in Asia increased through postharvest interventions	1 Increased foreign exchange from aquatic products.		(Goal to Supergoal)
Purpose: 1 Physical and value losses reduced and fish waste and bycatch utilised for human consumption.	1.1 Reduction by 50% of losses found in original surveys.	1.1 Survey results 1.2 Feed back from extension workers and staff trained.	(Purpose to Goal) 1.1 Enabling environment to allow adoption of developed technologies
Outputs: 1 Technical guidelines and training packages on good manufacturing practices in primary production systems produced. 2 Technical guidelines and training packages on good manufacturing practices for Asian processed products produced.	1.1 At least one technical guideline from each participating country produced in local languages 1.2 Training packages produced. 2.1 At least one technical guideline from each participating country produced in local languages	1.1 Project publications. 1.2 Project training packages. 2.1 Project publications.	(Output to Purpose) 1.1 Training and extension services use guidelines produced effectively. 1.2 Effective extension services exist in target countries. 2.1 Training and extension services use guidelines produced effectively.

	2.2 Training packages produced.	2.2 Project training packages.	2.2 Effective extension services exist in target countries
3 Guidelines and training packages on the utilisation of waste and waste fish, which can be used by the fisheries extension and training services in the Asian region.	3.1 Guidelines and training packages produced.	3.1 Project publications.	3.1 As above
4 Extension workers and staff in the regional bodies trained in the use of the training packages.	4.1 Trainers familiar with the information and guidelines produced.	4.1 Project records and course evaluations.	4.1 As above

Indicative Activities

- 1.1 Study of distribution systems in selected Asian countries and with typical primary systems in place so as to qualify and quantify critical postharvest losses.
- 1.2 Formulation of appropriate methodologies for reduction of the most critical losses identified.
- 2.1 Study of typical fish processing methods in Asian region to identify critical losses of value and fish.
- 2.2 Formulation of appropriate methodologies to reduce the losses identified.
- 3.1 Study and gather information on the extent and problems associated with fish wastage in the region.
- 3.2 Investigate the possible markets and products from the presently wasted fish.
- 3.3 Formulate products and methods that can be used to utilise waste fish and which have been identified as having potential market outlets
- 3.4 Develop strategies for environmentally sound handling of liquid and solid wastes from processing activities
- 4.1 Training of trainers at regional centres in the use of guidelines and packages.

Improved Traditional And Value Added Products

Justification

The Problem

In Asia in recent years there has been significant progress in the development of the seafood industry. In spite of this, the product base is still typically limited to a few traditional fish species in each country or region. Tropical fishery resources are characterised by a considerable diversity in aquatic species with the result that there are many non-traditional, and typically low value, species currently under-utilised or not utilised at all.

At the same time, as a result of improving national economies, there is a changing consumer preference in domestic markets for a more diverse product base with a corresponding higher quality. Export markets are also opening up to developing country products with the demand for high quality fish products.

Both factors lead to an increased need for the appropriate development of products and processes to satisfy the increased demand.

These problems can be addressed by the use of new, under-utilised and existing species from either the capture or culture fisheries for either traditional or non-traditional products and destined for the domestic and export markets. This large resource and product base requires a co-ordinated development and research platform on which these further improvements in quality, diversity and value will be based.

General Outputs and Beneficiaries

The outputs of this research will be improved quantity, quality and diversity of fish products for rural and urban populations, improved income generation opportunities for fisherfolk and fish producers alike, and an improved economic return to the country for its available resources through increased receipts. Regional and national researchers will benefit from the interaction within the research community on a regular basis from this co-ordinated approach. Linkages with the efforts to improve communication and dissemination in the Asian region will be fundamental.

Strategy

The strategy should initially focus on the production of a regional and co-ordinated base of expertise in product and process improvement with the ability to develop food items for domestic and export markets that meet the requirements of the markets and are socially and economically justifiable within the producer groups. Information technology and the use of networks will facilitate the strategy.

The research will require both strategic (e.g. functional properties of proteins and other components) and adaptive (e.g. adaptation of relevant strategic research into transferable technology) efforts. It was felt that dividing the research effort into two categories based on the resource being utilised would be a useful strategy - **low value** and **high value** species

- as the range of products from these two categories are naturally divided by the level of sophistication of the likely processes. This is an over-simplification, but was felt to be the best approach.

There are research activities, however, that will be cross-cutting across both sub-programs. It is important that both programs should integrate market needs evaluation and appraisals of the needs and capabilities of potential client groups. Work should focus on removing constraints to development of the sector and may relate to consumer preferences and perceptions, as well as the more technical aspects that may be specific to the many different fish and shellfish species in the Asian region. The research in this program will be market led, and linkages with the socioeconomic program will provide the most appropriate techniques for such an approach. Socioeconomic research will also be critical in the definition of appropriate institutional structures for the production and marketing of any new products, and for ensuring that any investment is socially and economically justified.

Products From Under-Utilised Or Low Value Fish Species

This research effort will aim to improve the use of the fishery resources available that are in plentiful supply but currently under-utilised in terms of economic return or are used for non-human consumption options. This is not to say that non-food options should be ignored, indeed, two other programs of activities (*Biomolecules from Aquatic Fish Resources* and *Losses and Waste Utilisation*) have substantial involvement in this area, however, this program will focus on human food options.

Typical fish resources to be studied will include non traditional small pelagics, coastal demersal species, freshwater species, some shellfish and molluscs and aquatic plants. The actual species will vary among the regions countries.

The product focus will be on dried, salted, smoked, canned or fermented products for the domestic markets mostly, but also export markets within Asia and outside Asia. The processes to produce these products will be investigated including process improvement and the use of alternative technologies such as retort pouch technology. Packaging options will be an integral component of many research activities.

Products From High Value Species

This research effort will aim to improve the quality and diversity of products made from high value species. These will generally be focused on the export markets and the increasingly affluent domestic markets. Research activity will assist smaller producers produce the appropriate products for these markets where the resources of the high value species are within access.

Typical raw material resources to be utilised will include some tunas, larger demersal species and shrimp, though with the diversity of markets world wide, there are many other species that could be suitable for niche markets.

The production of items such as breaded and/or battered, smoked, heat processed products, IQF frozen fillets, ready meals, convenience products for both the domestic and export

markets will be investigated. Packaging options will be an important component of most research activities in this category. Process development and improvement will be a vital approach used to produce the desired products.

Duration

This program is a long term commitment for most countries as the product base will be continually increasing in terms of diversity, quality and quantity, and as such it is recommended that funding should be considered for up to 10 years

Possible Lead Centres:

Applied Biology and Marine Resources Centre, Pakistan Council for Scientific and Industrial Research, Pakistan

University of the Philippines in the Visayas, The Philippines

Central Institute of Fisheries Technology, India

Universiti Pertanian, Malaysia

Research Institute of Marine Products, Vietnam

Other Centres of network:

Institute of Postharvest Technology, NARA, Sri Lanka

Ministry of Fisheries, The Maldives

East China Sea Fisheries Research Institute, Shanghai, China

Shanghai Fish Processing Technique Development Centre, China

Fisheries University, Shanghai, China

University of Sri Jayawardenapura, Sri Lanka

Research Institute for Marine Fisheries. Indonesia

Faculty of Fisheries and Food Technology Department of Bogor Agricultural University, Indonesia

Marine Biotechnology Centre, Vietnam

Fishery Technology Development Institute, Thailand

Prince of Songkla University, Thailand

Kasetsart University, Thailand

Mahidol University, Thailand

Interactions with Other Programs:

Socioeconomics program

Postharvest losses program.

Biopreservation program

CEC DGXII STD3 project

Logical Framework

Narrative Summary (NS)	Measurable Indicators (OVI)	Means of Verification (MOV)	Important Assumptions
<p>Goal</p> <p>1 Productivity and value of Asian fishery resources increased through postharvest interventions</p>	<p>1.1 Value of aquatic resource production increases in real terms.</p>	<p>1.1 Export and trade statistics, domestic and multi lateral fisheries statistics</p>	<p>(Goal to Supergoal)</p> <p>1.1 Demand continues to rise.</p>
<p>Purpose:</p> <p>1 Value of Asian aquatic products increased</p>	<p>1.1 Value of Asian aquatic products increase by national targets in selected species</p>	<p>1.1 Export statistics; National statistics; Company reports</p>	<p>(Purpose to Goal)</p> <p>1.1 Enabling environment to allow adoption of developed technologies</p>
<p>Outputs:</p> <p>1 A regional network of expertise in appropriate product and process development created</p> <p>2 Quantity, diversity and quality of aquatic products increased</p> <p>3 Market led strategies for aquatic products developed and improved</p>	<p>1.1 Networks set up within first year of program activities</p> <p>2.1 Product ranges in market place increased</p> <p>3.1 Market strategies used in all process and product development</p>	<p>1.1 Reports, network newsletters, frequent meetings</p> <p>2.1 Market analysis, market reports; consumer surveys</p> <p>3.1 Product sales; company reports; project reports</p>	<p>(Output to Purpose)</p> <p>1.1 Participants and national policies remain supportive</p> <p>2.1 Markets exist</p> <p>3.1 Companies receptive to approach</p>

Indicative Activities

- 1.1 Survey of strengths and weaknesses of current institutions involved in this area
- 1.2 Strengthening of institutions where identified as weak
- 1.3 Set up electronic communications facilities and establish network
- 2.1 Consumer preference studies undertaken
- 2.2 Identification of under-utilised fish resources available for upgrading to human consumption options
- 2.3 Scientific studies on the intrinsic physical and biochemical properties of selected fish species as they relate to improved storage and processing characteristics
- 2.4 Scientific studies of the current processes used in marketable fish products and improvements that can be made
- 2.5 Use of novel packaging methods to improve quality, shelf life and consumer acceptance of developed products
- 3.1 Studies of selected market systems
- 3.2 Development of marketing strategies based on information gathered from market studies
- 3.3 Implementation of marketing strategies in product and process development

Biomolecules from Aquatic Resources

Justification

The Problem

There is a large and growing world-wide interest in and market for compounds used in a wide variety of manufacturing processes and that have been identified as being naturally occurring. These can take the form of pharmaceuticals, drugs, health products and food additives. The aquatic environment has been shown to hold biological resources that produce potentially valuable materials which have yet to be exploited. The high potential value of these products means that there can be pressure from potential sellers of these products to exploit the natural environment from which they are extracted with deleterious effects on the environment and biological diversity. It is with these points in mind that a program controlled and run by the region is proposed so that maximum benefits and minimum risks to the region can be realised.

Expected Outputs

It will be the aim in much of the investigatory work to identify aquatic-based pharmaceuticals, drugs and biomolecules that will replace those that are currently used and to produce more environmentally friendly products and processes. In recent years many of these substances have been extracted in the first instance from aquatic resources. These include omega 3 fatty acids from fish oils, chitin and chitosan from crustacea, alginic acid from sea weeds which are already being exploited and a number of compounds which have been found recently to have probable useful properties such as protamines, lysosymes, chephalosporins and cancer inhibitors from sponges and squid.

Beneficiaries

The identification of such compounds will ultimately lead to greater wealth creation in the Asian region and possible supplementary income for small scale fishing communities. Local coastal communities will benefit from ecologically sound exploitation.

Strategy

The strategy will include identification of bioactive molecules, but also refine the knowledge and processes of already known high value biomolecules from the aquatic resource (e.g. squalane, diacyl glycerols, omega 3 fatty acids, etc.). In the first instance the research will be concentrated on the screening of aquatic organisms to identify those that contain biologically active molecules. This will lead to the extraction, isolation and purification of such compounds and further screening for functional properties. The screening processes for different types of property are specialised and it would probably be necessary to divide the types of properties being screened for between different institutions with particular areas of expertise. In all cases, the research will go hand in hand with ecological studies to ensure environmentally appropriate development.

If a compound is found to have beneficial properties, with potential markets, research will concentrate on identifying a sustainable means of producing the compound commercially. This applies also to the already known biomolecules. Since the protection of the environment and biodiversity must be uppermost in any program of this kind there are two courses that might be taken once such compounds are identified. The first course of action might be to look at the possible sustainable production of the aquatic organism from which the compound has been extracted. This would involve studying the effects of harvesting on natural stocks and if found to be potentially harmful the possibility of sustained production by culture will be investigated. If found to be feasible this may bring employment to small scale fishing communities especially women in harvesting and primary processing. The secondary and downstream production activities are unlikely to have direct impact at a small scale level.

If the possibility of sustainable harvest from natural stocks is found to be impossible a means of synthesising the compound from non-aquatic resources will be investigated in collaboration with the end users such as the pharmaceutical industry, food additive industry etc. This may involve biotechnology and the techniques of genetic engineering to produce transgenic organisms for fermentation to produce the desired compounds.

The potential benefits from such a program are extremely high in terms of wealth creation but so are the risks. At least ten years would be required to have any chance of meaningful success.

Centred in Asia the research will concentrate on resources that are found only in Asia or which Asian countries would have a comparative advantage. Because, however, of the world-wide interest in this topic the lead research centre would liaise with research laboratories in many parts of the world doing similar work particularly in Europe, North America and Japan. The World Bank Discussion Paper 210 "Marine Biotechnology and Developing Countries" gives a detailed discussion of some aspects of proposed program and indicates the breadth of interest that exists for development of regional expertise.

Location of Lead Centre(s):

College of Fisheries, Mangalore, India
Research Institute of Marine Products, Vietnam

Location of Other Centre(s):

Institute of Biotechnology, The Philippines
Bureau of Fisheries and Aquatic Resources, The Philippines
College of Fisheries, University of Philippines in Visayas, The Philippines
Prince of Songkla University, Thailand
Ministry of Fisheries, The Maldives
East China Sea Fisheries Research Institute, Shanghai, China
Shanghai Fish Processing Technique Development Centre, China
Fisheries University, Shanghai, China

Institute of Postharvest Technology, NARA, Sri Lanka
Marine Biology Division, NARA, Sri Lanka
University of Ruhuna, Sri Lanka
Research Institute for Marine Fisheries, Indonesia
Research Institute for Agro-biotechnology, Indonesia
Food Technology Dept of Bogor Agricultural University, Indonesia
Universiti Pertanian, Malaysia
Marine Biotechnology Centre, Vietnam
Fishery Technology Development Institute, Thailand
Prince of Songkla University, Thailand
Kasetsart University, Thailand
Mahidol University, Thailand
Food and Drug Administration, Thailand

Logical Framework

Narrative Summary (NS)	Measurable Indicators (OVI)	Means of Verification (MOV)	Important Assumptions
<p>Goal:</p> <p>1 Productivity and value of fishery resources in Asia increased through Postharvest interventions.</p>	<p>1.1 Increased foreign exchange from aquatic products.</p>	<p>1.1 Export and trade statistics.</p>	<p>(Goal to Supergoal)</p>
<p>Purpose:</p> <p>1 To identify and isolate commercially valuable bioactive molecules that can be produced in Asia on a sustainable basis.</p>	<p>1.1 Interested companies willing to invest in production facilities for new molecules.</p>	<p>1.1 Project correspondence.</p>	<p>(Purpose to Goal)</p> <p>1.1 Sustained interest by public in "natural" products</p>

Outputs:		(Output to Purpose)	
1 Sources of commercially viable biologically active molecules identified.	1.1 Pharmaceutical and similar companies interested in discussing likely uses of compounds.	1.1 Correspondence on project files.	1.1 Active molecules are valuable enough to interest commercial concerns
2 Biologically active molecules isolated.	2.1 A number of molecules have been identified and shown to have useful functions.	2.1 Project reports.	2.1 As above
3 Methods of commercial production investigated and designed.	3.1 Pilot scale plant designed and operational.	3.1 Project reports.	3.1 As above

Indicative Activities:

- 1.1 Identification of likely site for aquatic resource exploitation.
- 1.2 Screening of likely sources of bioactive molecules.
- 1.3 Analysis of bioactivity.
- 1.4 Identification of active ingredient(s).
- 2.1 Molecular structure(s) and/or formulation of active ingredients investigated.
- 2.2 Isolation procedures for molecules investigated.
- 2.3 Plant for isolation produced and tested.
- 3.1 Scaling up of pilot scale plant in collaboration with possible commercial end users investigated

Biopreservation Techniques and Novel Products

Justification

The Problem

Fish are intrinsically very susceptible to deterioration through microbial spoilage, and also are a source of human pathogenic bacteria. These factors can be controlled through the use of appropriate handling and processing procedures such as drying, pickling, smoking, salting and fermentation, and through control of temperature by use of ice and/or frozen storage. However, where the practice of these methods of preservation is inadequate, for a variety of reasons, the high ambient temperatures in tropical climates lead to accelerated spoilage and increased safety problems.

Biopreservation, that is the use of biological agents especially lactic acid bacteria, to preserve and protect food products, may provide a opportunity to assist these traditional methods in controlling the spoilage and pathogenic microflora thus extending the shelf lives of food products and reducing the health hazard. It also has the potential to offer similar protection to fish and animal feeds, and is likely to have beneficial effects on aquaculture microflora pond dynamics.

It is recognised that biopreservation is a potential tool to be used alongside rather than instead of more traditional methods.

Strategy

This program has a main component relating to the basic and adaptive studies on **biopreservation as it relates to food products**, but also, as a sub-program, has a component focusing on the **animal and fish feeds** aspects. This latter component will depend on the main component for much of the basic understanding of biopreservation methods.

Biopreservation in Human Food Options

The initial strategy should be focused on providing a regional base of expertise in biopreservation with the ability to develop food and non food items for domestic and export markets that meet the requirements of the markets and are socially and economically justifiable within the producer groups. Information technology and the use of networks will facilitate the strategy.

Strategic efforts will focus study on traditional fish products to characterise their preservative principles and apply any new information gained to these and other products. It will also lead to the possible replacement of food additives in fish products with naturally produced preservatives.

A second focus will be on the identification of new lactic acid bacteria (LAB) strains with enhanced and product-specific abilities for preservation. This would lead to the

maintenance of a collection of these organisms for future use by food processors and research workers.

Duration 5 years

Possible Lead Centres

College of Fisheries, University of the Philippines in the Visayas, Philippines
Applied Biology and Marine Resources Centre, Pakistan Council for Scientific and Industrial Research, Pakistan
Food Technology Dept of Bogor Agricultural University, Indonesia

Other Centres in Network

Central Institute of Fisheries Technology, ICAR, India
College of Fisheries, Mangalore, India
Fishery Technology Development Institute, Thailand
Prince of Songkla University, Thailand
Kasetsart University, Thailand
Mahidol University, Thailand
Universiti Pertanian, Malaysia
Institute of Postharvest Technology, NARA, Sri Lanka
University of Sri Jayawardenapura, Sri Lanka
Research Institute for Marine Fisheries, Indonesia
University of Gadjah Mada, Indonesia
Research Institute for Coastal Aquaculture, Indonesia
Marine Biotechnology Centre, Vietnam
Research Institute of Marine Products, Vietnam

Interaction with Other Programs

Biomolecules, Postharvest losses and waste utilisation and follow up to CEC DGXII STD3 Project.

Links with Other Institutions

Natural Resources Institute, UK; Technical University, Denmark; Norwegian Institute of Fisheries and Aquaculture

Biopreservation in Animal and Fish Feeds

The strategy for this work would be two pronged:

To produce pro-biotic* animal and fish feeds, with particular emphasis on utilisation of low value or waste fish.

To study the role of LAB introduced into ponds via fish feeds on the dynamics of pond microflora and the possible positive effects on the environment and on the safety of aquaculture products.

Duration: 5 years

* This property allows competitive exclusion of spoilage or other detrimental micro-organisms, the positive alteration of microbial metabolism and possible stimulation of immune responses in the hosts - all positive factors for animal and fish feeds

Lead Institute: Possibly in the Philippines

Collaborating Institutions:

Mangalore College of Fisheries, India
Fishery Technology Development Institute, Thailand
Prince of Songkla University, Thailand
Kasetsart University, Thailand
Mahidol University, Thailand
Universiti Pertanian, Malaysia
National Aquatic Resources Agency, Sri Lanka
Research Institute for Marine Fisheries, Indonesia
Norwegian Institute of Fisheries and Aquaculture

Logical Framework

Narrative Summary (NS)	Measurable Indicators (OVI)	Means of Verification (MOV)	Important Assumptions
Goal			
1 Productivity and value of Asian fishery resources increased through postharvest interventions	1 Increased foreign exchange from aquatic products.	1.1 Export and trade statistics.	

<p>Purpose</p> <p>1 Safety and quality of fish products improved through use of biopreservation techniques</p>	<p>1.1 Health hazards from processed fish products reduced</p> <p>1.2 Value of processed fish products increased</p>	<p>1.1 Government health statistics; Government trade statistics</p>	<p>1 Enabling environment for use of biotechnological advances</p>
<p>Outputs</p> <p>1 A regional network of expertise in biopreservation techniques developed</p> <p>2 Biopreservatives identified and isolated for use in appropriate fishery products</p> <p>3 Probiotic feeds produced</p> <p>4 Effects of lactic acid bacteria on pond dynamics determined and recommendations given</p>	<p>1.1 Network established within one year of project initiation</p> <p>2.1 Biopreservatives produced and used in fishery products</p> <p>3.1 Probiotic feeds produced and used</p> <p>4.1 Recommendations implemented</p>	<p>1.1 Reports, network newsletters, frequent meetings</p> <p>2.1 Company reports</p> <p>3.1 Company reports</p> <p>4.1 Scientific publications; company reports</p>	<p>1.1 Participants and national policies remain supportive</p> <p>2.1 Enabling environment for use of biotechnological advances</p> <p>3.1 Same</p> <p>4.1 Same</p>

Indicative Activities:

- 1.1 Survey of strengths and weaknesses of current institutions involved in this area
- 1.2 Strengthening of institutions where identified as weak
- 1.3 Set up electronic communications facilities and establish network
- 2.1 Characterisation of principles of preservation in traditional products
- 2.2 Identification of strains of lactic acid bacteria with enhanced and product specific preservation effects
- 2.3 Determination of suitability of isolated new strains as food additives both technically and socioeconomically
- 2.4 Establishment of collection of lactic acid bacteria
- 2.5 Investigation of means of application of lactic acid bacteria or components from LAB to food products
- 3.1 Investigation of means of application of lactic acid bacteria or components from LAB to feed products
- 3.2 Experiments to follow pond dynamics of microflora and postharvest effects of microbial flora on products

Food Safety and Production Systems

Justification

The problem

With the increasing intensification of tropical fisheries there is a growing threat to human health and the environment from fish produced from both aquaculture and capture systems. In aquaculture human health problems arise from the use of fish feeds containing chemical residues and antibiotics, the proliferation and/or survival of pathogenic bacteria, viruses and parasites in aquaculture systems and the production of biotoxins. These cause stress within the ecosystem of the aquaculture ponds and in natural environments where water from ponds containing high levels of organic material and agrochemicals are discharged. The development of antibiotic resistant human pathogens is a major cause for concern as these organisms may enter the food chain with serious consequences. These problems are also likely to occur in capture systems due to pollution of the aquatic environment from industrial and domestic sources of pollution.

The current knowledge of the health and environmental impact of fisheries production systems is poor, particularly in tropical regions. Public health concerns regarding these issues are reflected in the negative economic impacts on producers of aquatic products in developing Asia. Problems of food poisoning from eating fish products are thought to exist in many countries, leading to ill health, reduction in days worked and having a negative impact on not only the fishery industry itself but also the country's economy. Large quantities of fisheries products are refused entry into important European, Japanese and North American markets on the basis of microbiological and chemical standards which may not always be appropriately applied in view of a lack of knowledge of how the production environment is affecting the quality of the products.

General Outputs

This project would aim to provide scientific data to establish accurate, measurable and appropriate criteria for assessing the safety of aquatic products. The information would be useful during the implementation of quality assurance and the establishment of Hazard Analysis and Critical Control Point (HACCP) systems by producers and for inspection bodies in exporting and importing countries. The implementation of HACCP and quality systems in producer countries is becoming increasingly more important and good reliable scientific data on which to base the systems is essential.

The generation, from the information and data gathered, of frameworks for in-country legislation to control the production and distribution of aquatic products would be another outcome of this program.

Beneficiaries

The consumer of aquatic products, in the producing and importing countries, will benefit from improvements in food safety. There will also be greater protection and awareness of the local environment where fisheries operations are carried out. The producers and postharvest product enterprises in developing countries and the regulatory and inspection agencies of exporting and importing countries would be expected to benefit from the program.

Strategy

Objective

To gain information of the effect of micro-organisms, chemical pollutants and other toxic elements in aquatic production systems (pre- and postharvest) on human health and environmental degradation. To use this information to develop effective monitoring and detection systems for aquatic products and to produce appropriate regulatory standards throughout the processing, production and marketing chain.

Specific Outputs

An understanding of the source, survival and spread of micro-organisms, pollutants and toxic compounds in a few key production systems. This will include an understanding of the dynamic interactions between human pathogenic micro-organisms and the fisheries production environment. The study will also study the survival, growth and spread of these organisms throughout the food chain to the consumer. Cost effective detection systems will be developed for use in applying quality assurance systems, enabling the improvement of production and processing systems. Scientifically valid quality standards for key fisheries products will be developed. Contaminant elimination and treatment systems will be developed. Socioeconomic analysis of production and processing practices will be undertaken to determine the likely success of any remedial measures developed by the program by gaining an understanding of the incentives and choices available to producers and processors.

The program will also produce guidelines and models for regulatory development. This will be specifically important for the utilisation of water resources by aquatic producers. This will include the siting of aquaculture and mariculture operations and the question of zoning in relation to water use conflicts with other users. As water resources come increasingly under pressure from multiple uses regulation will become increasingly important to limit the impacts of each user contaminating the activities of their neighbours. Furthermore the legislative framework for the protection of the consumer from the consequences of contamination is often weak in Asian countries and the burden of this often falls on the poorest groups of consumers. Attention would therefore be given to effective government legislation in this area using a mix of coercion and incentives and socioeconomic investigation would play a key role in determining this.

Dissemination of information generated by the program will be through the establishment of a quality assurance network for Asian producers. One centre will act as the co-ordinating

centre providing information on all aspects of quality assurance to the Asian fishery industry. Part of the system will include registers for outbreaks of diseases transmitted by aquatic products and incidents of environmental contamination.

Duration of the program: five years

Location of the Lead Centre(s):

Central Institute of Fisheries Technology, India

Applied Biology and Marine Resources Centre, Pakistan Council for Scientific and Industrial Research, Pakistan

University of Philippines in Visayas, The Philippines

Research Institute for Marine Fisheries, Indonesia

Fish Inspection and Quality Control Laboratories, Bangladesh

Location of Other Centre(s) of the Network:

College of Fisheries, Mangalore, India

University of Peradeniya, Sri Lanka

Department of Fisheries, Maldives

Institute of Postharvest Technology, NARA, Sri Lanka

University of Gadjah Mada, Indonesia

University of Diponegoro, Indonesia

Sea Products Export Quality Control Branch, Vietnam

Research Institute of marine Products, Vietnam

Fishery Technology Development Institute, Thailand

Prince of Songkla University, Thailand

Mahidol University, Thailand

Links with Other Institutions:

Natural Resources Institute, UK; FF Denmark; Institute of Aquaculture, Stirling UK;

University of Maryland, USA.

Logical Framework

Narrative Summary (NS)	Measurable Indicators (OVI)	Means of Verification (MOV)	Important Assumptions
<p>Goal:</p> <p>1 Productivity and value of Asian fisheries resources increased through postharvest interventions</p>	<p>1.1 Value of aquatic resource production increases in real terms.</p>	<p>1.1 Export and trade statistics, domestic and multi lateral fisheries statistics .</p>	<p>(Goal to Supergoal)</p>
<p>Purpose:</p> <p>1 Safety of aquatic products improved</p>	<p>1.1 Rejection of exported products reduced</p> <p>1.2 Food poisoning incidents or food related illness reduced</p>	<p>1.1 Company statistics, export statistics, inspection agencies and health statistics</p> <p>1.2 Government statistics and surveys. Health statistics</p>	<p>(Purpose to Goal)</p> <p>1.1 Safety issues continue to be important in food production</p> <p>1.2 As above</p>
<p>Outputs:</p> <p>1 Accurate, measurable and appropriate criteria for assessing the safety of aquatic products established</p>	<p>1.1 Assurance systems use criteria</p>	<p>1.1 Project reports; scientific publications, assurance systems</p>	<p>(Output to Purpose)</p> <p>1.1 Assurance systems and inspection agencies use new criteria</p>

Indicative Activities

- 1.1 Surveys of incidence of pathogenic micro-organisms in all stages of aquatic products production and marketing
- 1.2 Identification of the key factors affecting the contamination of aquatic production systems by pathogens, their survival and growth
- 1.3 Surveys to identify the sources and severity of pollution hazards affecting aquatic production and marketing systems
- 1.4 Identification of the key factors affecting the contamination of aquatic processing, distribution and marketing systems by pathogens, their survival and growth
- 1.5 Modelling of collected data to produce predictive methodologies
- 1.6 Surveys to identify the sources and severity of biotoxin hazards affecting aquatic production and marketing systems
- 1.7 Socioeconomic implications of providing interventions based on new criteria
- 1.8 Methods established to ensure public health is protected based on knowledge gained

Socioeconomics and Marketing Research

Justification

The problem

Many postharvest fisheries projects have failed to deliver sustainable economic and social benefits to their target groups, due to a lack of understanding of socioeconomic issues. Many postharvest projects have been accused of being technology-led and failing to have a client-focus. A major problem in this has been the failure of fisheries technologists and socioeconomists (economists, social anthropologists, marketing experts etc.) to collaborate in the research programs. Although the level of socioeconomic inputs will be critical to all of the research programs in this document, this specific program will have the objective of developing methodologies through collaborative work.

General outputs

To build up the knowledge of critical socioeconomic issues in postharvest fisheries development, in order to enable the design and implementation of more socially and economically appropriate research programs. A major part of this will be the development of methodologies and the creation of linkages between socioeconomists and fisheries technologists to work in multi-disciplinary teams.

The beneficiaries

- Researchers involved in programs and projects for fisheries community and sector development.
- Fisherfolk will accrue benefits from better targeted projects.
- Key operators in the fisheries sector such as processors, traders and exporters.
- Fisheries policy makers due to a better ability to target government effort and support at key constraints in the fisheries sector.

Strategy

To provide a regional base of expertise in the implementation of socioeconomic research based on a set of sound set of methodologies developed from specific case studies in the region. In order to achieve this, the following contrasting sub-programs are proposed which will both require significant collaboration with fisheries technical experts:

- **marketing systems** (which will have a focus at the sector)
- **gender analysis** (which will focus on the community level)

Although these sub-programs will have the specific objectives of developing expertise and methodologies, they will also produce critical information to assist in the development of programs to improve the productivity of the fishery sector as well as the more efficient delivery of benefits to the beneficiaries of development programs.

Marketing Systems Analysis

Specific Objectives

Many research projects are formulated without proper needs assessment, being undertaken on the basis of what the perceived need is according to the professional experience of technical experts. Marketing systems analysis should form a major component of any needs assessment, with the objective of understanding the operation and economics of the marketing chain from production to consumption, and the key constraints within that system. This commodity systems approach focuses on the systematic isolation of the research need, as a critical precursor of the definition of the research topic, rather than the use of subjective *a priori* assumptions.

Expected outputs

The study of commodity systems in three commodity sub-sectors is proposed

- small scale freshwater production and processing sector in Indo-China
- artisanal processed marine products sector in South Asia - this would include dried, salted and smoked fish and fish pickles.

These two studies would lead to an effective isolation of where the key researchable constraints lay in each marketing chain and would require social scientists to work closely with technical specialists working at all levels in the marketing chain in order to understand the key constraints.

- Asian export industry to determine the key constraints in this volatile but economically important sector.

Beneficiaries. Small scale and producers in each commodity sector and policy makers.

Duration

1-2 years

Location of Participants

Research Institute for Marine Fisheries, Indonesia
Centre of Agro-Socioeconomic Research, Indonesia
Research Institute for Freshwater Fisheries, Indonesia
Research Institute for Coastal Aquaculture, Indonesia
Central Institute of Fisheries Technology, India
College of Fisheries, Tuticorin, India
Inland Aquatic Resources Division, NARA, Sri Lanka
University of Ruhuna, Sri Lanka
Kesetsart University, Thailand

Indo-china: Laos, Cambodia and Vietnam.
Institute of Fishery Economy and Planning, Vietnam

Links with Other Institutions

ODA-Bay of Bengal Program, Madras. Khon Kaen University Thailand, East-West Center, Hawaii, Asian Institute of Technology, Bangkok, Natural Resources Institute

Gender and Postharvest Fisheries***Specific objectives***

The design of postharvest fisheries research projects and programs often ignores the central role of women in postharvest handling, processing and trading. Gender analysis is a particularly important variable in understanding artisanal systems, especially considering the gender dynamics of men as producers and women as processors and traders. Without a thorough understanding of local gender relations and their impact on the operation of the marketing chain, the ability to introduce sustainable change to that system will be limited. For the first time this study will specifically relate the issue of gender to postharvest fisheries development.

Expected outputs

Methodologies for studying gender roles, particularly focusing on participatory methods will be developed. An analysis of the major issues in gender roles for postharvest fisheries development will be presented for a selection of countries, with guidelines on gender sensitive interventions.

Beneficiaries

Female artisanal processors and traders.

Policy makers.

Dissemination

Workshop and publications.

Duration

2 years

Locations**Lead Centre(s)**

Central Institute of Fisheries Technology, India
College of Fisheries, Tuticorin, India

Other Centre(s) of the Network

Centre of Agro-Socioeconomic Research, Indonesia
Research Institute for Freshwater Fisheries, Indonesia
Research Institute for Coastal Aquaculture, Indonesia
Central Institute of Fisheries Technology, India
College of Fisheries, Tuticorin, India
Inland Aquatic Resources Division, NARA, Sri Lanka
University of Ruhuna, Sri Lanka
Kasetsart University, Thailand
Indo-china: Laos, Cambodia and Vietnam

Links with Other Institutions

Bay of Bengal Program, University of Gothenburg, Sweden

Logical Framework

Narrative Summary (NS)	Measurable Indicators (OVI)	Means of Verification (MOV)	Important Assumptions
Goal: 1 Productivity and value of Asian fisheries resources increased through postharvest interventions	1.1 Value of aquatic resource production increases in real terms.	1.1 Export and trade statistics, domestic and multi lateral fisheries statistics.	(Goal to Supergoal) 1.1 Demand continues to rise.

<p>Purpose:</p> <p>1 Impact of postharvest fisheries research activities improved.</p>	<p>1.1 Incomes and uptake of technology of fishing communities and enterprises involved in postharvest activities increased in real terms.</p>	<p>1.1 Government statistics and surveys.</p>	<p>(Purpose to Goal)</p> <p>1.1 Policy makers, researchers adopt outputs of research</p>
<p>Outputs:</p> <p>1 Identification of key constraints in Asian fisheries commodity systems.</p> <p>2 Identification of key gender constraints in postharvest fisheries development policies and programs.</p> <p>3 Design of socioeconomic and marketing research methodologies.</p>	<p>1.1 Existing programs and policies revised or new ones initiated.</p> <p>2.1 Existing programs and policies revised or new ones initiated.</p> <p>3.1 Uptake of methodologies developed by research institutes and programs.</p>	<p>1.1 Donor and government programs and policy monitoring.</p> <p>2.1 Donor and government programs and policy monitoring.</p> <p>3.1 Project reports.</p>	<p>(Output to Purpose)</p> <p>2.1 Practical assistance is possible.</p> <p>2.1 Practical assistance is possible.</p> <p>3.1 Further socioeconomic and marketing research for postharvest fisheries is undertaken.</p>

Indicative Activities

- 1.1 Commodity systems analysis of three Asian systems.
- 1.2 Design of programs and policies to remove key constraints in each system.
- 2.1 Study of the effect of postharvest fisheries policies on the status and development of women in three Asian countries.
- 3.1 Scaling up of pilot scale plant in collaboration with possible commercial end users investigated.

Annexes

Annex 1 - Postharvest Applied Research Requirements Identified by SIFR Studies

Application of known science

- *Estimation of postharvest losses, in both physical and economic terms, and improved utilisation through selection and improvement of technology, including transport, infrastructure, on-board handling, chilling systems, and cost-effective use of insulation (includes investigation of collection methods and utilisation opportunities for by-catches).*
- *Utilisation of small pelagic species.*
- *Improvement of on-board preservation and handling methods to increase fish quality by reducing spoilage caused by oxidation, bacterial growth, and autolytic deterioration and by controlling biogenic amines.*
- *Development of new products to satisfy the demands of both domestic low-income consumers and higher-value export markets.*
- *Investigation of processing methods for both food products and higher-quality fish meal products for animal feed (for example, for fish feed).*
- *Investigation of improved handling and processing methods for the small-scale fishery sector.*
 - (a) *Requirements for landing sites*
 - (b) *Saving fuel in smoking and drying*
 - (c) *Control of insect infestation in cured products*
 - (d) *Fermentation as a preservation technique*
- *Economic aspects of fish utilisation and marketing, including market and trade analyses, economic optimisation of processes, and the socioeconomic aspects of development projects in fish utilisation.*

New scientific investigations

Because commodity conversion and utilisation is not considered a priority research area for a CGIAR institute, it is important that consideration be given to ensuring that the necessary research is carried out at the strategic research level in order to provide the basis for applied research. The projects outlined below have strong elements of strategic research.

- *Basic composition and deterioration processes affecting the quality and safety of fish as food.*

(a) Analysis and prevention of spoilage through study of oxidation, muscle biochemistry, bacterial growth, and so on.

(b) Investigation of the functional properties of proteins (gel-forming or emulsifying) and lipids from tropical species.

- *Application of biotechnology to fish utilisation.*

(a) Use of enzymes and bacteria as agents in preserving and processing fish.

(b) Identification, extraction, and purification of pharmacologically active or otherwise high-value products from aquatic animals and plants (including enzymes, hormones, lipids).

(c) Use of compounds or raw material from the aquatic environment in the food industry.

- *Investigation of preservation methods and new products.*

(a) Low-cost sterilizable flexible packs as an alternative to metal cans.

(b) Reformulated products as ingredients (meat extenders) in fish or other food products, or converted through surimi-style processes, as novel fish products.

Reference: IBRD Policy and Research Series No 19 (1992)

Annex 2 - Terms of Reference for Country Papers

Information to be included in Country Statements for SIFR Postharvest Fisheries Workshops

1. What postharvest fisheries needs are there in the country? What are the development priorities and how are they formulated?
2. What are the constraints to the development process and which of these constraints could be alleviated by research?
3. What mechanisms are there for matching the development constraints and priorities so that research is properly directed?
4. What kind of assistance is most required for the achievement of development aims?
5. Outline of the structure of Postharvest Fisheries Research activities in the country as a whole.
 - (a) Institutions involved and their affiliations to other bodies such as government ministries, Universities, umbrella research organisations, private sector etc. This should include a breakdown of the structure of each organisation, their responsibilities and staffing levels.
 - (b) What are the research priorities for the various institutions and how do they fit in with the development needs?
 - (c) How do the organisations decide on their research priorities - who has a say in the final outcome? Who are on the committee or panel that sets the research agenda?
 - (d) How are the research programs financed - from foreign aid, government funds, private companies?
6. For each institution indicate the human, financial and major infrastructural resources available for the conduct of postharvest fisheries research, including the levels of expertise of professional staff, major items of equipment and any other major financial resources available from government or aid donors.
7. List the research programs undertaken or being undertaken by each of the relevant institutions as follows:
 - Over the last 5 years.
 - Currently in the program.
 - Planned for the next 5 years.

(Who is funding these programs, which staff are involved, what are the aims and objectives?)

8. How are the research results evaluated and how are they disseminated to the users of the technology or information generated? Is there a development and extension mechanism for this purpose? Is there a mechanism for the feed back on the effectiveness of research results and on the needs for research from the end users? How do the research results support the development process?

Annex 3 - Participants at SIFR Meeting

Invitees paid for by ODA and Authors of Background Papers

K Gopakumar
Director
Central Institute of Fisheries Technology
Matsyapuri PO
Cochin-682 029
India

TEL: OFF: 91 484 666845, 666846
RES: 315456
TLX: 0885 6440
FAX: 91 484 668212

Md. Helaluddin
Deputy Director
Fish Inspection and Quality Control
15 Dharmashova Cross Rd
Khulna
Bangladesh

TEL: 041-20648

Vinodini Jayaweera
Acting Director/IPHT
Institute of Postharvest Technology (IPHT)
National Aquatic Resources Agency
(NARA)
Crow Island, Colombo-15
Sri Lanka

TEL: 522005
FAX: 522932/522699

Yu Swee Yean
Associate Professor
Faculty of Food Science & Biotechnology
Universiti Pertanian Malaysia
43400 UPM
Serdang, Selangor
Malaysia

TEL: 03-9486101 EXT. 3405
FAX: 6-03-9485970

Leonor M Santos
Professor
Institute of Fish Processing Technology
College of Fisheries
University of The Philippines in The Visayas
5023 Miagao, Iloilo
Philippines

TEL: (6333) 81534/81535
FAX: (6333) 81534

Suparno
Director
Research Station For Marine Fisheries-Slipi
Petamburan Vi, Jalan Karel, S. Tubun
Jakarta 10260
Indonesia

TEL: 5709157, 5709158
FAX: 62-21-5709158

Maizan Hassan Maniku
Director, Fisheries R & D
Marine Research Section
Ministry of Fisheries and Agriculture
Male, Republic of Maldives

TEL: (960) 322328
FAX: (960) 322509

Phouang Parisak Pravongviengkham
Deputy-Director General
Department of Livestock and Veterinary
Services
Ministry of Agriculture and Forestry
Vientiane
Lao P.D.R.

TEL: 5660, 2319
FAX: 856 21 215015

Qiao Qing-Lin
Senior Technologist
East China Sea Fisheries Research Institute
300 Jungong Road
Shanghai
China-200 090

TEL: 5434690
FAX: 0086-21-5432926

Pongpen Rattagool
Director
Fishery Technological Development
Institute (FTDI)
Dept of Fisheries, Bangkok 10120
Thailand

TEL: (662) 212-2874, 2216702, 2124552
FAX: (662) 212-9446

Unable to attend but contributed to formulation of programs

Dr R B Qadri
Chief Scientific Officer
Applied Biology and Marine Resources Centre
Pakistan Council of Scientific and Industrial Research
Laboratories Complex
Off University Road
Karachi 75280
Pakistan

Nguyen Van Ngoan
Deputy Director
Research Institute of Marine Products
170 Le-Lai Street
Haiphong
Vietnam

Other Participants

DENMARK

Hans Henrik Huss.
Professor
Technological Lab
Ministry of Fisheries
Building 22, Technical University
DK-2800 Lyngby

TEL: + 45 42 88 33 22
FAX: + 45 42 88 47 74
E. MAIL: FISH@FFL.MIN.DK

INDIA

K K Balachandran
Principal Scientist
Central Institute of Fisheries Technology
Matsyapuri PO
Cochin-682 029

TEL: 666845 666846
TLX: 0885 6440
FAX: 91 484 668212

K Devadasan
Principal Scientist
Central Institute of Fisheries Technology
Cochin-29

TEL: 666845
FAX: 0091-484-668212

T S G Iyer
Principal Scientist and Head of Division
(FP)
Central Institute of Fisheries Technology
Cochin-682 029

TEL: 666845, 668576-80
FAX: 0484-668212

M K Kandoran
Principal Scientist & Head of Division (Eis)
Central Institute of Fisheries Technology
Matsyapuri PO
Cochin-682 029

TEL: 666845, 666846
TLX: 0885 6440
FAX: 91 484 668212

I Karunasagar
Head, Department of Fishery Microbiology
College of Fisheries
Mangalore-575002,
TEL: 0824 27834
FAX: 0824 440395

Duncan King
Post-Harvest Adviser
Overseas Development Administration
Bay of Bengal Program
Post Bag No 1054
92 St Mary's Road, Abhiramapuram
Madras-600 018
TEL: 4936294, 4936096, 4936188
FAX: 044-4936102

Subhash Chandra Pathak
Deputy General Manager (Fish)
National Bank For Agri & Rural
Development
Post Box 6552, Worli, Dr A.B. Road
Bombay-400 018
TEL: OFF: 4929676
RES: 6145765
FAX: 4931621
TELEX 1173770 NAB IN

P V Prabhu
Joint Director
Central Institute of Fisheries Technology
Matsyapuri PO
Cochin-682 029
TEL: 666845, 666846
TLX: 0885 6440
FAX: 91 484 668212

A V Vasanth Shenoy
Scientist (Sg)
Central Institute of Fisheries Technology
Matsyapuri PO
Cochin-682 029
TEL: 666845, 666846
TLX: 0885 6440
FAX: 91 484 668212

ITALY

David James
Principal Fisheries Research Adviser
Fisheries Department
FAO 00100 Rome
TEL: (396) 52256490
FAX: (396) 52255188
E. MAIL: DAVID.JAMES@FAO.ORG.

MALAYSIA

Cheow Chong Seng
Lecturer
Faculty of Food Science & Biotechnology
Universiti Pertanian Malaysia
43400 UPM Serdang
Selangor

TEL: 03-9486101

NORWAY

Asbjorn Gildberg
Nifa, PO Box 2511
9002 Tromso

TEL: 47776 29000

FAX: 47776 29100

Terje Strom
Professor
The Norwegian College of Fishery Science
Dramsveien 201 B, N.9037 Tromso

TEL: 47-776-44000 (44507)

FAX: 47-776-71832

PAPUA NEW GUINEA

P J Cecily
CFTC Expert
Women in Fisheries Program
Department of Fisheries & Marine
Resources
PO Box 165, Konedobu

TEL: (0) (675) 214522 (H) (675) 231976

FAX: (675) 214369

Rai Alu
First Assistant Secretary
General Services Division
Department of Fisheries & Marine
Resources
PO Box 165
Konedobu

TEL: 675-214690 (DIRECT)

675-214522 EXT 34

FAX: 675-214369

Welete Wararu
Artisanal Fisheries Economist
(Women in Fisheries)
Resources Development Branch
PO Box 165, Konedobu
NCD

TEL: 675-214522

FAX: 675-214369

Rai Alu
First Assistant Secretary
General Services Division
Department of Fisheries & Marine
Resources
PO Box 165
Konedobu

TEL: 675-214690 (DIRECT)
675-214522 EXT 34
FAX: 675-214369

SRI LANKA

T S G Fonseka
Research Officer
Institute of Postharvest Technology
National Aquatic Resources Agency
Crow Island
Colombo-15

TEL: 522005
FAX: 522932/522881

THAILAND

Pairat Sophanodora
Faculty of Agro Industry
Prince of Songkla University
Hat-Yai 90110

TEL: 074-211030 EXT. 2350, 2351
074-212889
FAX: 074-212889

UNITED KINGDOM

Ivor Clucas
Senior Fish Technologist
Natural Resources Institute
Central Avenue, Chatham Maritime
Chatham, Kent ME4 4TB

TEL: 44 634 883515
FAX: 44 634 883388
E. MAIL: NRI@UKC.AC.UK ATTN:
IVOR CLUCAS

John Esser
Programme Manager
(Environmental Studies)
School of Food, Fisheries and
Environmental Studies
University of Humberside
61 Bargate
Grimsby DN34 5AA

TEL: (0482) 440550
FAX: (0472) 751404

Andrew Graffham
Food Microbiologist
Natural Resources Institute
Chatham Maritime, Chatham

TEL: 634 880088
TLX: 263907/8 LDN G
FAX: 634 880066/77

Mike Pritchard
Senior Research Officer
Natural Resources Institute
Chatham Maritime
Chatham, Kent ME4 4TB

TEL: 0634-883072
FAX: 0634-880066

John Ryder
Postharvest Fisheries Programme Manager
Natural Resources Institute
Central Avenue
Chatham, Kent ME4 4TB

TEL: +44 634 883611 (DIRECT)
+44 634 880088 (OPERATOR)
FAX: +44 634 880066/77
E. MAIL: NRI@UKC.AC.UK ATTN:
JOHN RYDER

David Twiddy
Microbiologist
Natural Resources Institute
Chatham Maritime
Chatham, Kent ME4 4TB

TEL: 0634-883477
FAX: 0634-880066
E. MAIL: NRI@UKC.AC.UK ATTN:
DAVID TWIDDY

Annex 4 - Agenda for SIFR Meeting March 1994 At CIFT

Day 1 - March 10

1. Welcome
2. Introduction
 - *Background to SIFR*
 - *Aims and Objectives of Meeting*
3. Presentation of development and research priorities by delegates
4. Presentation of the donor perspective

Day 2 - March 11

1. Assessment of research priorities
 - *Problems identified from Country Statements and Research Priorities listed as common Themes*
 - *Open discussion to synthesise research priorities identified in presentations, identification of common needs and demands*
2. Formation of working groups, based upon identified research priorities, to produce research programs
3. Production of research programs - session 1

Day 3 - March 12

1. Production of research programs - session 2
- 2 Round up session

Close

Annex 5 - Example Format Prescribed for Research Programs

Research Program Frameworks

The proposed postharvest research programs should be described as follows:

- **justification** of the research program, by defining the problems to be solved, the expected outputs and the ultimate beneficiaries
- the **strategy** adopted for the research program, defined under the objectives to be attained, duration, and location of lead research institutions, possible links with other research institutions, and interactions with other research programs.

The various activities of the research programs are not described. They should be further defined during the preparatory phase of each research program.

Annex 6 - Organisations Contacted after the Workshop in Preparation of Programs

Bangladesh

1. Fish Inspection and Quality Control, Department of Fisheries
2. Fisheries Research Institute, Mymensingh

China

1. East China Sea Fisheries Research Institute, Shanghai
2. Bureau of Aquatic Products, Ministry of Agriculture
3. Shanghai Fish Processing Technique Development Centre
4. Shanghai Fisheries University

India

1. Central Institute of Fisheries Technology, ICAR
2. College of Fisheries, University of Ag Sciences, Mangalore
3. Marine Products Export Development Authority
4. Export Inspection Council, Ministry of Commerce
5. College of Fisheries, Tuticorin
6. Orissa State Fisheries Department
7. Andhra Pradesh State Fisheries Department
8. Kerala State Fisheries Department
9. West Bengal State Fisheries Department
10. Maharashtra State Fisheries Department

Indonesia

1. Research Station for Marine Fisheries, Agency for Agricultural Research and Development, Jakarta
2. Research Institute for Freshwater Fisheries
3. Research Institute for Coastal Aquaculture
4. Faculty of Fisheries, Bogor Agricultural University
5. Food Technology Department, Bogor Agricultural University
6. Faculty of Fisheries and Animal Husbandry, University of Gajah Mada
7. Faculty of Fisheries and Animal Husbandry, University of Diponegoro
8. Centre for Agro-Socioeconomic Research
9. Research Institute for Agro-biotechnology
10. Institute for Research and Development of Agro-based Industry

Laos

1. Department of Livestock and Veterinary Services, Min of Agriculture

Malaysia

1. University of Agriculture, Selangor
2. Fisheries Development Board
3. Department of Fisheries, Min of Agriculture

The Maldives

1. Marine Fisheries Research Section, Min of Fisheries and Agriculture

Pakistan

1. Applied Biology and Marine Resources Centre of Research Laboratories of Pakistan Council of Scientific and Industrial Research, Karachi
2. Institute of Marine Biology, University of Karachi
3. Marine Fisheries Department, Govt of Pakistan
4. National Institute of Oceanography

The Philippines

1. Institute of Fish Processing Technology, College of Fisheries, Univ of Philippines in the Visayas, Iloilo
2. College of Arts and Sciences, Univ of Philippines in the Visayas
3. Bureau of Fisheries and Aquatic Resources
4. The Philippine Council for Marine and Aquatic Resources Research and Development
5. Institute of Biotechnology

Sri Lanka

1. Institute of Postharvest Technology (NARA), Colombo
2. Marine Biological Research Division (NARA)
3. Inland Aquatic Resources and Aquaculture Division (NARA)
4. Peradeniya University
5. Jayawardenapura University
6. Ruhuna University

Thailand

1. Fishery Technology Development Institute, Department of Fisheries, Bangkok
2. Prince of Songkla University, Hat Yai
3. Kasetsart University
4. Mahidol University
5. Food and Drug Administration

Vietnam

1. Research Institute for Marine Products
2. Department of Science and Technology, Ministry of Fishery
3. Marine Biotechnology Centre
4. Seaproducts Export Quality Control Branch

Annex 7 - Background Information on Postharvest Fisheries in Asia

Introduction

The production of fish in Asia represents an important industry for many countries of the region. Not only is fish an important component of the diet of the people but its production also provides employment for many and in recent years there has been a rapid growth in the production of fish for export thus producing valuable foreign exchange earning for the countries involved.

The following information extracted from FAO sources illustrates the importance that fisheries play in the economy of the various countries involved in this initiative. This strengthens the case for donor support to postharvest fisheries research in the region which aims to make most appropriate use of fish resources for the countries and the people who rely on the industry for their livelihood.

Fish Exports

There has over the last ten years been a rapid growth in some Asian countries in production of fisheries products for export to the developed world, particularly Japan, USA and Europe. Thailand for instance has diversified into canned Tuna and frozen shrimp and records a 37 fold increase in export earnings from fish products between 1982 and 1991. The stringent requirements of the importing countries for consistent and high quality products and the need to diversify into value added products before export emphasises the need for attention to postharvest problems if maximum benefits are to be realised from fish harvests.

Fish Products

The information also shows the relative importance of the various types of fishery products for the region. The proportions of the types of product vary considerably between countries.

Fish in the Diet

Information is also given on the per capita consumption of fish in Asian countries taken from FAO Food balance sheets. This information indicates that fish is relatively important in the diet of many Asian countries in comparison with the world average consumption of 13.4kg/head/year.

Fishery Products in Selected Asian Countries

The following table illustrates the relative importance of the various types of fishery products as defined by FAO. It can be seen that the different countries in the region have very different proportions of the various commodities defined by FAO but that fresh and cured products (Groups A & B) for human consumption are very important in comparison with others

Fishery Products by Seven FAO Groupings for Asian Countries - 1991 (Tonnes)

	Fish - Fresh, Frozen, Chilled	Fish - Dried, Salted, Smoked	Crust & Moll - Fresh, Frozen, Dried, Salted etc.	Fish Prods & Preps - whether or not in Airtight Containers	Crust & Moll Prod & Preps - whether or not in Airtight Containers	Oils & Fats - of Aquatic Animal Origin	Fish meals etc
	A	B	C	D	E	F	G
Bangladesh	5,702	19,611	17,985				1,250
China	1,326,085	200,958	115,043	79,810	21,000	10,000	100,000
India	337,106	181,370	134,547	5,506		8,064	63,475
Indonesia	320,000	474,515	107,479	41,100	2,970	1,520	12,235
Malaysia	2,191	7,832	3,744	13,402	3,818		50,679
Maldives	10,085	6,942		7,188		34	3,110
Pakistan	9,178	13,077	17,167		14		35,918
Philippines	11,766	259,718	5,359	71,949	102,721		
Sri Lanka		15,920	1,131				
Thailand	233,854	82,900	261,820	318,100	94,500		285,000
TOTAL	2,255,967	1,262,843	664,275	537,055	225,023	19,618	551,667

From FAO Yearbook - Fishery Statistics, Commodities, Vol 73 (1991)

Human Food Balance Sheet for Fish in Selected Asian Countries

Country	Total Catch (tonnes)	Non Food (tonnes)	Imports (tonnes)	Exports (tonnes)	Human Food (tonnes)	Population (x 1000)	Kg Fish per capita
Pakistan	456,903	167,960	36	76,887	212,092	114,648	1.8
India	3,519,506	314,538	0	146,842	3,058,126	830,025	3.7
Laos	20,000	0			20,000	4,071	4.9
Bangladesh	840,457	0	13	28,479	811,991	111,042	7.3
China	11,224,678	333,533	46,986	603,665	10,334,466	1,116,345	9.3
Vietnam	864,000	720		55,845	807,435	65,303	12.4
Sri Lanka	189,406	0	63,152	4,046	248,512	17,000	14.6
Indonesia	2,939,318	19,334	7,158	264,506	2,662,636	180,863	14.7
Thailand	2,671,821	1,041,980	425,111	943,000	1,111,952	53,993	20.6
Malaysia	607,410	207,053	280,215	202,438	478,134	17,440	27.4
Maldives	73,659	2,333	0	43,764	27,562	207	33.1
Philippines	2,105,991	0	147,661	139,386	2,114,266	61,034	34.6
TOTALS	25,513,149	2,087,451	970,332	2,508,858	21,887,172	2,571,971	8.5

From FAO Yearbook - Fishery Statistics, Commodities Vol 73 (1991)

Fish Exports from Selected Asian Countries

The table below illustrates the important role that fishery products play in earning Foreign exchange for many Asian Countries. It can be seen that there have over the last few years been phenomenal increases in earnings in some countries, for instance a 37 fold increase in Thailand, a nearly six fold increase in The Maldives and at least four fold increases in The Philippines, Indonesia and China.

Export Value of Fishery Products from Asian Countries (1000 US\$)

Country	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Sri Lanka	21,302	18,232	24,013	17,686	22,716	20,433	26,382	23,412	22,544	21,477
Maldives	6,150	6,579	10,397	15,453	15,777	17,693	30,158	33,873	37,843	36,969
Pakistan	79,287	69,280	79,491	79,808	97,032	120,885	125,177	93,417	113,490	110,365
Bangladesh	50,208	70,260	81,219	88,653	118,154	146,853	159,956	162,404	161,372	178,932
Malaysia	118,276	104,248	105,552	106,657	132,547	191,259	191,242	210,140	229,514	264,938
Philippines	120,141	133,687	116,782	151,748	200,099	267,895	407,504	409,504	395,960	467,729
India	356,066	353,692	333,466	298,803	362,266	377,560	420,275	379,625	467,208	570,317
Thailand	28,206	42,821	85,815	138,312	283,658	267,149	537,918	726,846	794,426	1,049,962
Indonesia	231,326	234,953	228,013	236,620	340,619	441,079	664,483	767,422	983,571	1,192,082
China	267,000	267,000	290,519	267,916	494,794	721,185	969,058	1,039,516	1,301,690	1,181,989
TOTAL	1,279,944	1,302,735	1,357,251	1,403,641	2,069,648	2,573,978	3,534,141	3,848,148	4,509,608	5,076,751

From FAO Yearbook - Fishery Statistics, Commodities, Vol 73 (1991)



277723