Fisheries Policy Research in Developing Countries: Issues, Priorities and Needs

Edited by

Mahfuzuddin Ahmed • Christopher Delgado
Sten Sverdrup-Jensen • Rowena Andrea V. Santos

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International Center for Living Aquatic Resources Management

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

IFM
Institute for Fisheries Management and Coastal Community Development

Danida

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Contents

Message

This conference proceedings is the result of cooperation between three institutions that the Danish International Development Assistance (DANIDA) has been cooperating with for a long time, with very good results. It augurs well for the outcome of the International Consultation on Fisheries Policy Research in Developing Countries held on 3-5 June 1997 at the North Sea Centre, Hirtshals, Denmark.

First, a few words about DANIDA. The total budget for 1997 is about US$1.6 billion, roughly equally divided between bilateral and multilateral assistance. The bilateral assistance is concentrated on 20 program countries and is distributed roughly as 50% to Africa, 40% to Asia and about 10% to Latin America. The main objective of Danish aid is poverty alleviation. It is the intent of DANIDA to promote development that is sustainable in economic, institutional as well as environmental terms. Special concerns in aid activities include the promotion of democracy and good governance, the situation of women and the protection of the environment.

The issues of this consultation are most relevant for the above objectives. Fishers are among the poorest people in the developing countries, and fisheries are important to food security. Sound fisheries policies are important from an environmental point of view and are a prerequisite for good governance in this area. The importance of good governance is being increasingly realized, as illustrated by the theme of the 1997 World Development Report: the role of the State.

Fisheries and other utilization of marine resources have, till very recently, been regarded as *laissez-faire* businesses with no room for public intervention and regulation. Gradually, international agreements on division of marine resources among nations, quotas and catch methods have been introduced, and national control is being more or less wholeheartedly practiced. There have been, and still are, obvious conflicts between those who fish and those who study the industry. Biologists point to the complex linkages in the food chain, underline the alarming decrease in catches and highlight the risk of totally destroying whole species of marine resources. Many fishers have denied that these signs represent real problems and have preferred to regard them as a natural deviation in the biological cycles of marine resources.

Two new and interesting developments are that the points of view of practitioners and theorists are coming closer and that fisheries development is becoming a public interest area. Consequently, it is becoming very much a political issue. This consultation can, therefore, become a platform for a healthy, feasible and responsible development of fisheries and a sustainable utilization of marine resources.

Increased yields from this source of our food supply are important. The sources for producing both more and better calories for a growing world population are limited. One that can contribute more is marine products. Marine products can only be tapped productively if due consideration is given to the complex characteristics of the marine environment. I trust that this consultation can send such a twin message of a qualified hope for food prospects. The acceptance of caution and limits is now dawning on the fishing industry. The warning signals were of an acute nature, and they are being heard.

I am not so sure that such a joint understanding has been arrived at among actors in the other major food production industry, agriculture. There are, of course, many examples of harmony among practitioners and researchers on land use in agriculture in both developing and developed countries. While in many cases overexploitation of natural resources is due to economic deprivation, in some cases it stems from shortsighted greed and old *laissez-faire* habits dating from a time when new land was in abundance and technology did not really matter.

The consultation has signaled to agricultural producers that without harmony between farming practice and its natural base we might be able to increase yields for a short while, but the reaction will be harsh and sudden when nature inevitably strikes back. Sustainability is a complex concept and requires a multidimensional approach. I would like to point to one aspect of sustainable systems, namely socioeconomic viability, specifically the poverty aspect of fisheries development. An important role will have to be played by poorer people in the utilization of marine resources for the overall activity to remain politically viable.

These thrusts were highlighted by the consultation, whose subject matter and composition of participants acknowledge the need to address fishery policies through a multidisciplinary approach. It is a healthy example for researchers in many other fields that professional gatherings such as this consultation bring together scientists from several disciplines to arrive at applicable results and influence real life.

Klaus Winkel
Head
Department of Evaluation, Research
and Documentation
Ministry of Foreign Affairs
DANIDA

Foreword

Providing the knowledge base for improved policy choices leading to economic growth, poverty alleviation and environmental sustainability are important and interrelated goals of the Consultative Group for International Agricultural Research (CGIAR). Within the CGIAR, policy research has only recently expanded into fisheries policy issues. Major changes in outlook towards fisheries policies in developing countries have been prompted by significant income growth and urbanization, which in turn have led to structural shifts in dietary patterns towards increased fish consumption, particularly in East Asia. Rapid growth has also occurred in developed country markets for high-valued fishery items, which have become one of the largest natural resource-based exports of developing countries as a whole.

This report stems from a consultation held in June 1997 in Hirtshals, Denmark, on prioritizing needs for fisheries policy research in developing countries, organized by the International Food Policy Research Institute (IFPRI) and the International Center for Living Aquatic Resources Management (ICLARM), in collaboration with the Institute for Fisheries Management and Coastal Community Development (IFM) of the North Sea Centre. The financial assistance of the Danish International Development Assistance (DANIDA) is gratefully acknowledged, as is the cooperation of the Department of Fisheries of the Food and Agriculture Organization of the United Nations and of the Royal Veterinary and Agricultural University, Copenhagen. The consultation brought together selected key researchers and policymakers from developing and developed countries, and representatives of development assistance agencies concerned with fisheries. The proceedings provide both an overview of key policy-relevant research questions in developing country fisheries, and a basis for further collaboration by IFPRI and ICLARM.

Meryl J. Williams
Director General
ICLARM

Per Pinstrup-Andersen
Director General
IFPRI

Preface

Over the past two to three decades, fisheries issues have emerged from being an obscure sectoral concern or primarily a welfare consideration for a few coastal people to an important growth sector having a significant role in economic development and food security in many developing countries. While this is well known to many public and private actors in the seafood exporting countries of the developing world, it is still largely ignored by policymakers in those countries and by development partners in the more developed countries. This may explain in part why research on fisheries policies in developing countries is still a relatively new field. So far it has been largely limited to scientific discussion among fisheries biologists in the North. Only recently has the importance of the actual and potential contribution of the world's oceans and bodies of freshwater become part of the debate about food security and environmental sustainability in developing countries, at least at the level of a North-South dialogue.

This volume is an outcome of the International Consultation on Fisheries Policy Research in Developing Countries: Issues, Priorities and Needs held on 2-5 June 1997 in the North Sea Centre, Hirtshals, Denmark. The consultation was jointly organized by the International Center for Living Aquatic Resources Management (ICLARM), Makati City, Philippines, and the International Food Policy Research Institute (IFPRI), Washington, D.C., USA, in association with the Institute for Fisheries Management and Coastal Community Development (IFM), North Sea Centre, Denmark. This initiative started from the recognition that it was high time for the two international research centers of the Consultative Group on International Agricultural Research (CGIAR) with primary global mandates in fisheries research (ICLARM) and food policy (IFPRI) to work together to evolve an agenda for their own joint activities in this area, as well as to become more cognizant of the interdisciplinary work of others. The IFM, as a center of expertise in the North that had worked extensively in the South on these issues, was judged to be a very valuable collaborator in this endeavor. The Research Department of Human Nutrition, Royal Veterinary and Agricultural University (RVAU), Denmark, and the Department of Fisheries of the Food and Agriculture Organization (FAO) of the United Nations lent valuable moral support to the endeavor and collaborated in the elaboration of the agenda for the conference, as well as its implementation.

Within the area of interface between fisheries, food security, and environmental sustainability, the consultation addressed the fundamentals of achieving economic growth, reducing poverty and protecting natural resources and the environment. Sessions were primarily organized with a view to soliciting inputs from developing country researchers, policymakers and policy analysts, research partners, resource persons from developed and developing countries, donor representatives and international agencies, with a view to identifying priority areas for policy research to promote these objectives fully.

The consultation was generously supported by the Danish International Development Assistance (DANIDA), with additional support for participant travel provided by the Overseas Fishery Cooperation Foundation of Japan. A total of 40 participants attended, including a rich mixture of developing country researchers, policymakers and policy analysts, resource persons from developed and developing countries, and representatives from donor, and international agencies (Appendix 1).

The program (Appendix 2) was divided into three sessions. Keynote papers and four syntheses and review papers were presented. Meryl J. Williams, Director-General of ICLARM, and Per Pinstrup-Andersen, Director-General of IFPRI, gave keynote addresses that summarized the hopes of their institutions for the output of the conference. They emphasized both the need to integrate aquatic resources and their production into the world food debates more generally and the need to be relevant to policy

for decisionmakers in the South whose policy choices would directly impact the poor and their food security.

Session 1 was designed to set the stage for discussion of policy issues related to major changes in the demand and supply of fish and a consequent reversal of trade flows from North to South. Session 2 was designed to set the stage for the discussion of the impact of fisheries policies on food security and the environment. Discussion groups were organized in Session 3 in order to prioritize areas for fisheries policy research targeted to developing countries. Regional and global fisheries policy issues, recommended topics for fisheries policy research in developing countries, and implementation strategies were also discussed. Serge Garcia of FAO did yeoman service in recording, sorting and synthesizing points made by the individual discussion groups. A summary with the conclusions arising from the consultation that are relevant for ICLARM-IFPRI joint research priorities were presented in a joint policy brief (Ahmed et al., this vol.).

The editors would like to thank DANIDA and the Overseas Fishery Cooperation Foundation of Japan for their support. In addition, special thanks are due to Klaus Winkel for his interest in this activity, and to Ebbe Schioler, Head of Research Section within Mr. Winkel's department, for his encouragement in this endeavor. Peter Gardiner, Deputy-Director General of ICLARM, chaired the organizing committee in a collegial way that added materially to positive results and to the enduring harmony among the editorial team. On the logistical side, the editors would like to recognize the significant efforts of Laurie Goldberg and Lisa Grover of IFPRI in successfully getting participants from all points of the globe to Hirtshals, and to Kirsten Klitkou and Ninna Broen of IFM in providing gracious and effective logistical support. Finally, the editors, other than Sten Sverdrup-Jensen, trust that he will not be embarrassed by their noting that the hospitality of IFM was outstanding and that all participants enjoyed their first hand experience of the rugged and fascinating fishing communities of Northern Denmark.

The Editors

I. INTRODUCTION

The Growing Need for Fisheries Policy Research in Developing Countries*

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AHMED, M., C. DELGADO and S. SVERDRUP-JENSEN. 1999. The growing need for fisheries policy research in developing countries, p. 1-4. *In* M. Ahmed, C. Delgado, S. Sverdrup-Jensen and R.A.V. Santos (eds.) Fisheries policy research in developing countries: issues, priorities and needs. ICLARM Conf. Proc. 60, 112 p.

Abstract

The creation of EEZ and UNCLOS, and availability of technology, have enabled developing countries to exert a greater claim over world fisheries expanding their fishing capacity and fish production. Globalization and expansion of markets have brought new attention to fisheries. These developments warrant research to focus on policies for integrating fisheries issues into intersectoral policies and assess the role of fisheries in food and nutritional security in the developing countries.

Background

World fisheries have undergone rapid changes during the last few decades. New technologies, creation of Exclusive Economic Zones (EEZs), the 1982 UN Convention on the Law of the Sea (UNCLOS) and other developments have brought about drastic changes in the management of fisheries and resulted in enhanced access and significant expansion of effort and production (Ahmed, this vol.). Fisheries production grew to a record level of 112 million t in 1995 from only 20 million t in the early 1950s. On the other hand, a large portion of the production increases in the last one and a half decades came from aquaculture and culture-based fisheries and increased use of land-based inputs. The average annual growth rate of production from aquaculture during 1985-1994 has been about 10%. For a number of Asian countries such as China, India and Bangladesh, cultured fish and aquatic products represent between 25% and 50% of total national fisheries production (FAO 1997).

Moreover, with the creation of EEZ and following UNCLOS, developing countries accounted for a growing proportion of both fishing capacity and fish production. The share of the developing countries in the total world catch has increased to more than 60% in recent years from as low as 20% in the 1950s. The extension of claims by developing countries to fishing grounds under EEZ and UNCLOS were in large part supported through lending by international development agencies (McGinn 1998).

*ICLARM Contribution No. 1516

Against the backdrop of rapid growth and expansion of global fisheries production and trade, the structural characteristics of developing countries with respect to property rights, resource access and barriers to market entry have resulted in many instances of environmental degradation and produced significant inequality in the distribution of benefits between countries and between various groups within countries. Although UNCLOS undoubtedly provided benefits to developing countries and embodied needed progress towards more participatory use of world fishery resources that were controlled predominantly by northern distant-water fishing nations, it did not address the management aspects of fisheries in any significant way. Rather, most coastal states continued to encourage growth and development through expansion of effort that resulted in overfishing (McGinn 1998).

Full exploitation of many fisheries and overexploitation in some cases is widely recognized by fisheries biologists. The problem is manifested in the increasingly severe conflicts among various users and stakeholders. The negative impacts on ecosystems and habitat degradation have become a potential threat to fisheries in many parts of the world with implications for the future growth and sustainability of fisheries production. Scientists have warned about the changes that are taking place in the structure of marine food webs as a result of fishing practices that show little regard for stock and ecosystem health (Pauly et al. 1998).

Globalization and expansion of markets have also brought new perspectives to the fisheries sector. Major changes have been propelled by income growth and changes in preferences and health concerns about meat in developed countries leading to increased consumption of high valued fisheries items such as shellfish and filet fish. Developing countries too, especially in east Asia, are rapidly increasing consumption of fishery items, though the concentration is on the relatively lower value fish products. The last 20 years have also witnessed a major realignment of fisheries production in favor of the South (developing world). Growing South-North and South-South trade in fisheries commodities has linked distant production centers with diverse markets and has affected supply and led to more diversified use of fish. Global sourcing of fish purchases by large commercial companies based in the developed countries has significant implications for the price and supply of fish as well as employment and resource sustainability in coastal communities (Charles 1998). For instance, there is little doubt that higher quality species are presently more expensive than they would be in the absence of the globalization other wise. Likewise, supply of quality food fish available for purchase by the poor has decreased as a consequence of globalization of markets and free trade (Kent 1997; McGinn 1998).

On the other hand, there is widespread agreement that poor countries need to be very concerned about how to obtain the projected 50% increase in cereal imports necessary to feed their burgeoning populations by 2020 (Rosegrant et al. 1995). Fisheries represent one of the few agricultural or natural resources based exports of developing countries that can be classified as a significant success story in the 1980s and early 1990s. Developed countries accounted for 85% of the value of world fish imports in 1994, mostly at the high end of the value spectrum. In the ten years preceding 1993, the net value of fisheries exports from developing countries increased from less than a third of net developing country exports of sugar, beverage crops and tropical specialty products combined, to a level exceeding that total (Delgado and Courbois, this vol.).

New Realities and Policy Perspectives

All this suggests that fisheries issues are no longer a purely sectoral concern or solely a consideration of the welfare of coastal people. Fisheries are affected by factors within the fisheries sector, such as overfishing and other opportunistic behavior by fishers, and outside the sector, such as pollution, destruction of habitats and other environmental stress in spawning and feeding areas, as well as market and consumer behavior.

Fish is now more of a commodity for trade and export than a source of income for poor people's subsistence. Evidence suggests that the rising export trade in fish is shifting physical food resources

away from the poor, and people highly dependent on fish in their diets are exposed to insecurity with regard to fish food supplies. Kent (1997) reported that a significant drop in the share of fish in the total animal protein intake, including a decline in the amount of total intake, has been noted in recent years in some of the low income food deficit countries such as Bangladesh. Many traditional fish eating people find it difficult to compete for fish with the other users. Similarly, lucrative markets for high value species have encouraged many distant water fishing operations to move away from traditional lower value fish fishing grounds, resulting in reduced landings of lower value fish in developing countries, especially in West Africa (Ahmed 1997; FAO 1997; Kent 1997).

In view of these changes, the high stakes involved, the potential for ecological disaster, and the strong link to poverty and food security, it is striking that few comprehensive studies have addressed the overall effects of changes in the fisheries sector on food security in developing countries. Some studies generalize from a few cases. Some studies compare the present with a past that is no longer obtainable, rather than a true counterfactual. Others neglect the positive spin-off effects of fisheries development in terms of employment in other sectors, or fail to consider adequately the true meaning for the poor of a growing foreign exchange constraint with its depressing effect on employment. It is clear that policymakers in developing countries need to pay close attention to these issues and not just in the Ministries of Fisheries. As the world moves into the 21st century, the role of fisheries is being redefined and policies for its development and management will require much greater attention than in the past.

Food policy research for poverty alleviation, ecological sustainability, and food security over the next 20 years cannot neglect fisheries policy research as it has over the past twenty. There is an emerging consensus on the need to focus on five primary areas that impact on the poorer communities of developing countries. First, there is a need to assess the impact of increased international demand for what was low value fish on the physical intake of food by poor people in developing countries, while adequately controlling for the other factors that have also affected these outcomes. Second, the issue of inappropriate capital subsidies in developing countries and their impact on technology, environmental sustainability, and income distribution is vital. Third, impacts on employment and incomes need to be assessed using methodologies capable of handling the complexity of the trade-offs involved. Fourth, there is the need to better appreciate the impact of improved aquaculture technologies on the productivity of poor and marginal farmers within the context of ongoing changes in overall farming systems. Fifth, the impact of land and water allocation policies on productivity, food security and sustainability across farm, fishery, and related sectors needs to be reviewed more comprehensively. There is an urgent need to integrate fish into the models of global food supply and demand.

Recognizing these, an international consultation on fisheries policy research was held to assess the reaction of developing country policy analysts and policymakers to the major changes affecting fisheries in their countries, and their interest in policy research on specific items. The principal themes of the consultation concerned the impact of fisheries policy research on: (i) higher sector growth; (ii) alleviation of poverty; (iii) improvements in food security; and (iv) protection of the environment in developing countries. The guiding principles were: (a) to identify priority areas where policy research can determine options for fisheries policies; and (b) to assess the need for capacity building for fisheries policy analysis in developing countries.

The consultation resulted in a set of recommendations that included a list of policy research needs, an agenda for international and national research initiatives, and guidelines for improving the capacity of developing country institutions in fisheries policy research, including enlargement of the scope for collaborative research (Ahmed et al. 1997). Other outcomes included enhanced awareness among the funding agencies involved of the research needs and capacities of the developing country institutions, improved cooperation and interchange between developed and developing country institutions, including

international and regional agencies and research bodies, and recommendations on possible future regional or sub-regional research activities.

References

Ahmed, M. 1997. Fish for the poor under a rising global demand and changing fishery regime. Naga, ICLARM Q. 20(2):73-76.

Ahmed, M., C. Delgado and S. Sverdrup-Jensen. 1997. A brief for fisheries policy research in developing countries. ICLARM, Manila, Philippines. 16 p.

Charles, A. 1998.. Fisheries in transition, p. 15-37. Ocean Yearbook 13. The University of Chicago.

FAO (Food and Agriculture Organization of the United Nations). 1997. State of the world fisheries 1996. FAO, Rome, Italy.

Kent, G. 1997. Fisheries, food security, and the poor. Food Policy 22(5): 393-404.

McGinn, A.P. 1998. Rocking the boat: conserving fisheries and protecting jobs. Worldwatch Paper 142. Worldwatch Institute, Washington, D.C. 92 p.

Pauly, D., V. Christensen, J. Dalsgaard, R. Froese and F. Torres, Jr. 1998. Fishing down marine food webs. Science 279: 860-863.

Rosegrant, M., M. Sombilla and N. Perez. 1995. Global food projections to 2020: implications for investment. Food, Agric. Environ. Discuss. Pap. 5 International Food Policy Research Institute, Washington, D.C.

II. POLICY RESEARCH ISSUES IN DEVELOPING COUNTRIES

Factoring Fish into Food Security: Policy Issues[1]

Meryl J. Williams
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WILLIAMS, M.J. 1999. Factoring fish into food security: policy issues, p. 5-12. *In* M. Ahmed, C. Delgado, S. Sverdrup-Jensen and R.A.V. Santos (eds.) Fisheries policy research in developing countries: issues, priorities and needs. ICLARM Conf. Proc. 60, 112 p.

Abstract

As the aquatic resources sector, notably fisheries and aquaculture, interacts more with other sectors and is increasingly affected by policies developed in these other sectors, actors in the former will have to take a more active role in the development of policies which affect them. Much of the policy that affects fisheries and aquaculture is from outside the sector. Policy research can help inform the policy development processes for within sector and external policies. To be effective, it should be conducted with a good knowledge of the policymaking processes, an understanding of the sectoral and intersectoral linkages and be integrated with research in other sectors. In developing countries, attention must also be given to developing national capacities in policy research.

Introduction

Food security is an issue for any developing country that requires an adequate and sustainable supply of fish and other aquatic products that are accessible to the consumer and are of such quality and quantity as to provide adequate nutrition. Fish[2] contributes to food security directly through providing people with high quality food including animal protein and some important micronutrients, and indirectly through providing incomes and livelihoods to the producers. Despite their importance in many parts of the world, fish and other aquatic products are rarely included in projections of world food supply and demand.

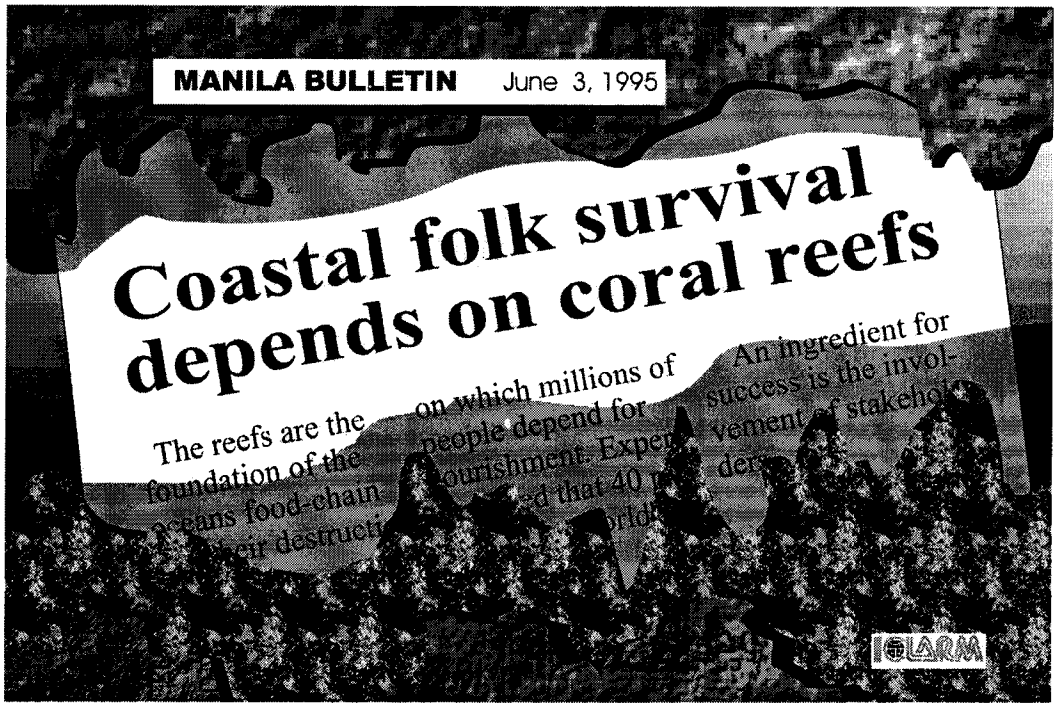
In developing countries, fish are particularly important to many poor people–often those at risk of food insecurity. Nearly half of the world's foodfish are caught by small-scale fishers. Since a crisis in the state of fisheries resources is perceived, the future contribution of fish to food security is in question and now is an appropriate time to examine the policy issues. In particular, the focus of this Consultation is to examine the priorities for fisheries policy research.

This paper will address the major trends in the world's fisheries, policy issues that face the sector, and discuss how policy research can help.

[1] ICLARM Contribution No. 1511

[2] The term 'fish' is used throughout to include finfish, molluscs, crustaceans and other aquatic products, whether used for food or for other purposes such as jewelry, industrial uses, animal feeds and fertilizers.

Figure 1. Samples of recent newspaper headlines on the status of fisheries and aquaculture.




THE SUNDAY CHRONICLE August 18, 1996
Oceans now over-exploited
Experts say world may run out of sea food due to overfishing, pollution.
WASHINGTON - A live swordfish is worth a thousar
dead s fish lying in the
In 1989, an estimated 100
million sharks were kill
worldwide; today, the
population are the lov
they have been in 45
The Business Daily June 5, 1995
Strong World Demand for Fish Spawns Fish Farming, Sea Ranching
ISLARM

Major Trends in the Fisheries Sector

Recent newspaper headlines illustrate well the public attention and concern being expressed about overexploited fish stocks, rising demand for fish and declining environmental quality (Fig. 1). There is increasing concern not only in developed countries like Canada (with its problem of collapsed cod stocks) but also in developing countries. A glance at recent press clippings in the Philippines would show many referring to red tides, fish kills, coral reef degradation, fish poaching, illegal fishing, aquatic biodiversity losses, water pollution, threatened livelihoods and conflicts over international access rights.

About 80% of fish and other aquatic products are harvested from natural stocks and the remainder are cultured. Most natural fish stocks are fully exploited and several are overexploited. To improve and restore the productivity of natural stocks, improved fisheries management is an imperative. There is also a widely held view that aquaculture is the best solution to restoring and increasing fish production, especially as demand for fish grows with growing, more affluent and more health conscious populations.

The consequences for the poor will be severe. Fish was once referred to as the poor person's protein. Increasing competition for supplies will threaten access by the poor. Diminished natural stocks also threaten the food, income and livelihood of small-scale producers, their families and the local consumers. As competition for access to supplies increases, lower income groups are unlikely to have a strong voice in resource management and policymaking. Likewise in the case of aquaculture, the poor are less likely to have access to the means of production.

Globally, per capita fish consumption has risen more rapidly than has the consumption of animal and plant products since 1961. In developing countries, fish and terrestrial animal consumption has nearly doubled (Fig. 2a) and, in developed countries, it has risen by half (Fig. 2b).

Policy Issues

In the complex settings in which fisheries operate today, a range of issues influence the fisheries and aquaculture sector. Williams (1996) described the main influences as being:

- those affecting the many options for utilization of the resources;
- the challenges of resource management;
- the challenges of sustainability of the environment and production under intensification of fishing effort and aquaculture;
- the need to integrate fisheries and aquaculture activities with those of other sectors; and
- the combined trends of national sovereignty and internationalization of resource management regimes.

Each of these influences is described below.

1) Utilization. Taking into account the large range of possible options for use of aquatic life, the best economic, social or cultural use of the resources should be sought. Increasingly, this will not be as animal feed or human food but in ornamental and recreational uses, for conservation and for specialized high value products. Improved postharvest handling will deliver the most immediate gains in supply and value. Bycatch, now estimated at about 27 million t annually, should also be better used than it is today with much of it being discarded (Alverson et al. 1994).
2) Resource management. Natural fisheries resources are classed as "commons". Coordination and restraint are required to prevent individuals continuing to exploit them beyond sustainable limits. Many fisheries resources management arrangements have failed in their tasks of coordination and restraint, leading to increasing scarcity and conflict. A central cause is the lack of any

Figure 2a. Daily per capita calorie consumption for developing countries, 1961-1992.

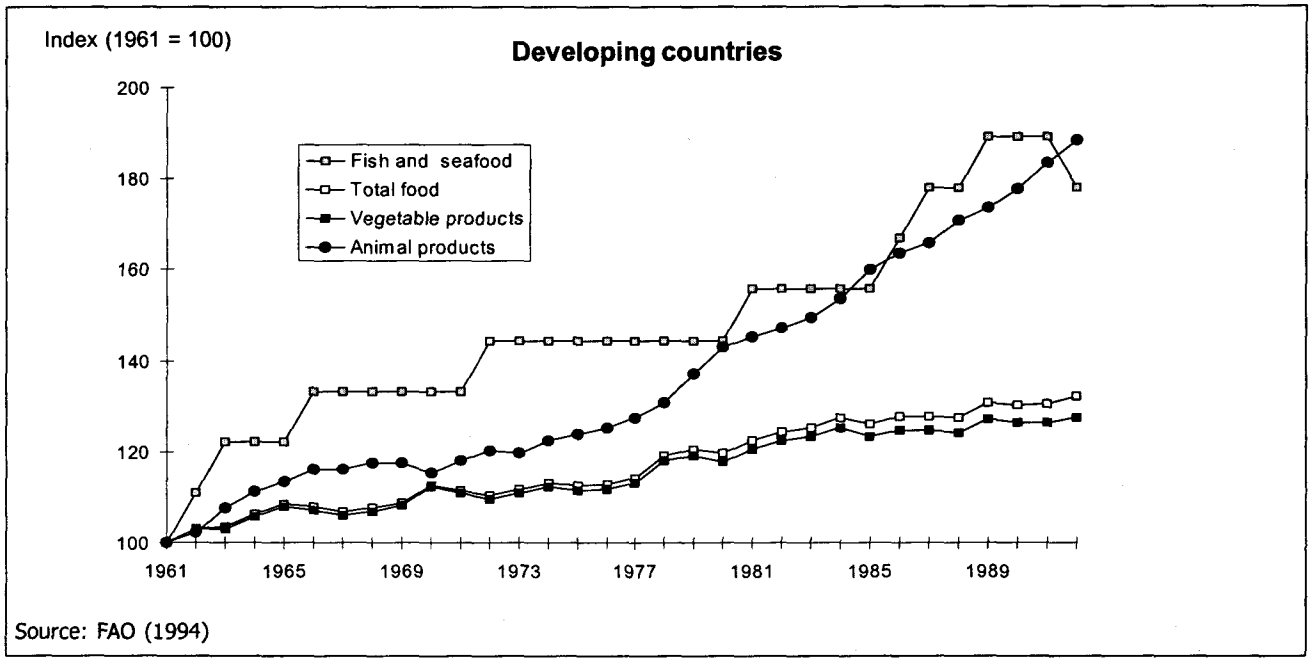
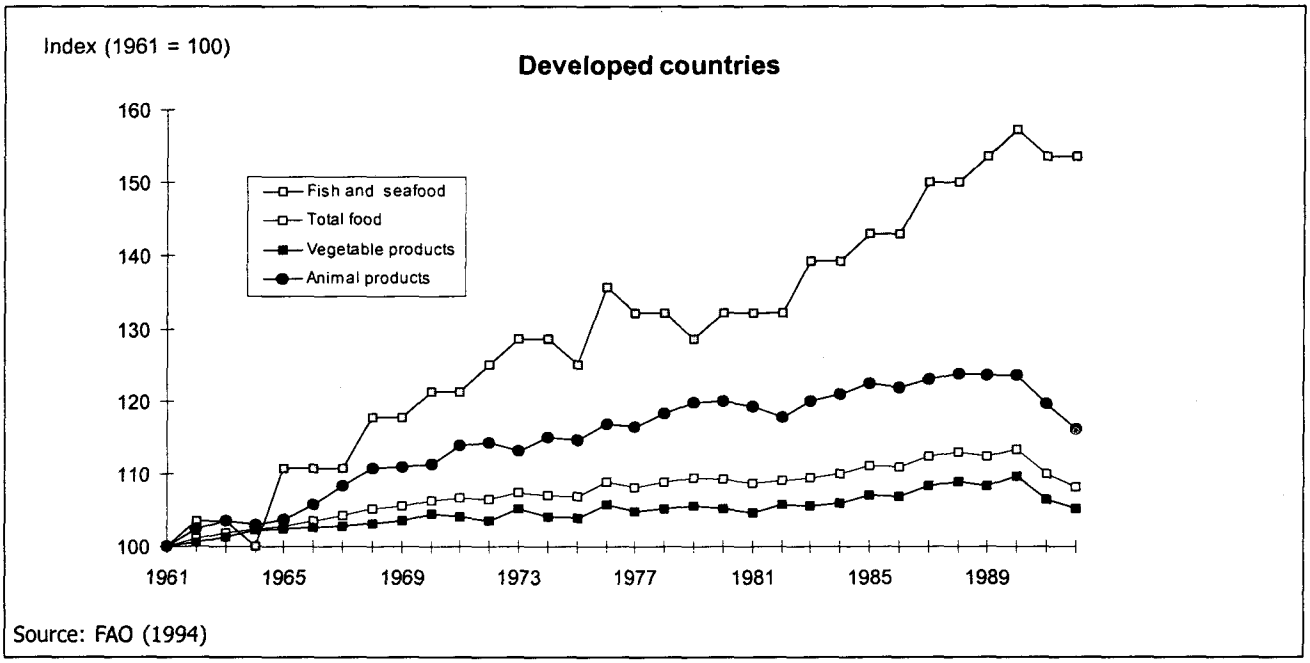


Figure 2b. Daily per capita calorie consumption for developed countries, 1961-1992.



restraint on access. However, even when access is restricted, most fisheries still have an excess of fishers who can claim legitimate access. There is a need to find partial or complete alternative livelihoods for many of those now depending on these diminishing resources. Equity in access is also critical. In the developing world, small-scale fishers frequently lose out to large-scale operators because of their greater political say and more obvious contributions to markets, exports and national economies. In many

fisheries systems, resource conflicts may be diminished, management better implemented and resources better managed when user groups are more involved in the management of resources together with, or as well as, state-level authorities. Aquaculture also faces some common property resource issues through access to suitable space and the sharing of water.

3) Intensification. In capture fisheries, intensification only produces greater yields up to a limit, after which the resource base begins to degrade. Production in some fisheries could be improved by relieving the intensity of use to allow recovery of the resources. Intensification holds considerable promise for increasing aquaculture production but again, only up to a limit and only if great care is taken to ensure it is environmentally sustainable. A large research investment and a cautious approach to intensification is needed.
4) Integration. Greater recognition needs to be accorded to the integral nature of fisheries and aquaculture resources and their interlinked aquatic and terrestrial ecosystems, of fishers and farmers in economic, social and cultural systems, and of the effects of climate and climate change. Many of the problems (e.g., siltation, pollution, coastal construction, interactions with alternative sources of employment) and their solutions lie outside the sector.
5) Nationalization and Internationalization. More than for most other food commodities, tension between national and international interests arises over issues such as trade, market competition for fish, access to fisheries resources, and management of shared stocks. In addition to the Convention on the Law of the Sea, the International Convention on Biological Diversity strengthens national rights over living aquatic resources and increases national responsibilities. Countries will have to strengthen their resource management capabilities to discharge these rights and responsibilities. The global trend towards free trade in products creates some tension with the national sovereignty granted under other international laws.

These five influences provide some background on the wide range of policy domains relevant to living aquatic resources. As Table 1 shows, policy influences are often from other sectors. Actors in fisheries and aquaculture often have little input into the policies which affect the sector. Therefore, fisheries are subject not only to policy made inside the sector and directed at it, but also by that made well outside the sector. Despite these interactions, the fisheries sector has tended to be insular in dealing with its own issues and its input is little sought by the other sectors.

The changes occurring in the fisheries and aquaculture sector show a tendency to greater interaction between the sector and others. A passive separation of the aquatic resources sector from other sectors is no longer an option. The aquatic resources sector will have to seek active engagement with policymaking in other sectors or suffer the consequences of inappropriate policies impacting them.

How can Policy Research Help?

A policy is defined as a course of action. Policies are made either in a proactive mode to create new options and pathways, or in response to changed conditions or public pressure. Policy research can provide insights into the issues and prevailing factors affecting them and suggest new options and implementation strategies and their likely consequences.

To be useful to decisionmakers, however, fisheries policy researchers working internationally should heed the following requirements:

- be aware of the policy development and decision processes and institutions, including those in other sectors;
- communicate with the relevant decisionmakers so as to make the results of the research available;

Table 1. Typical sectoral policies that influence fisheries and aquaculture and the relative inputs from each of the main sectors to the policies.

Policies that influence fisheries and aquaculture	Inputs from fisheries sector	Inputs from NRM sectors	Inputs from other national sectors	International inputs
RESOURCES AND ENVIRONMENT				
Fisheries	XXX	XX		
NRM	XXX	XXX	X	X
Environment	XX	XXX	X	X
Aquaculture	XXX	XXX	XXX	
Land use	X	XX	XXX	
Water use		XXX	XXX	
Quarantine, biosafety	X	X	XXX	XXX
Agriculture and food		XX	XXX	X
ECONOMIC				
Market	x		XXX	XXX
Infrastructure	x		XXX	
Credit	x		XXX	
Microeconomic			XXX	
Macroeconomic			XXX	XXX
Trade, exports	X	X	XXX	XXX
SOCIAL				
Social justice, equity		X	XXX	
Gender			XXX	
Ethnicity			XXX	
Population			XXX	
Civil society			XXX	
LEGAL				
International conventions	XXX	XXX	XXX	XXX
INSTITUTIONAL				
Fisheries management and research structure	X		XXX	

Note: The x and X symbols indicate the relative importance of the sectors in determining policies that influence fisheries or aquaculture, from x = little to XXX = a great deal.
NRM - natural resource management

- study and understand the interactions with other relevant sectors;
- help build national and local capacity for policy research;
- build institutional links, including those with other sectors;
- integrate policy research with biophysical, social and economic research of relevance to the policies in question; and
- focus research on areas where maximum impact is likely to be achieved.

For research that will assist policies relating to food security in developing countries, the following are some key topics which policy research could address:

- household impacts of key policy actions, e.g., trade liberalization, land and water use policies, resource access rights;
- the contributions which different technological developments in fisheries and aquaculture can have on food security, e.g., the impacts on food security of mass production of low value fish and of small-scale technologies;
- demand elasticities among different food groups, including fish; and
- national approaches to international trade, e.g., can the full costs and benefits, including environmental costs, be calculated?

Conclusion

Fisheries and aquaculture development has often occurred in isolation from other sectors and so has the development of policies that affect fisheries and aquaculture. We are now in a transition from a phase of fish production based largely on capture fisheries to a new phase where other uses of the aquatic environment are competing with fisheries and fish production from culture industries is becoming more prominent. In addition, international trade has a more prominent influence on the use of the harvest. As a result those concerned with the future of the fisheries and aquaculture sectors will have to engage themselves more explicitly with those in other sectors.

This imperative for engagement applies particularly to aquatic resources policy researchers. Therefore, I am delighted that this workshop is being co-hosted by two aquatic resources research centers (ICLARM and IFM) and IFPRI which engages in broader food policy research issues. We are also delighted to have here such a range of research talent from around the world, including Asia, Africa and Latin America, and from other international organizations such as FAO.

References

Alverson, D.L., M.H. Freeberg, S.A. Murawski and J.G. Pope. 1994. A global assessment of fisheries bycatch and discards. FAO Fish. Tech. Pap. 339, 233 p.

FAO (Food and Agriculture Organization of the United Nations). 1994. The state of food and agriculture. FAO Agric. Ser.

Williams, M.J. 1996. The transition in the contribution of living aquatic resources to food security. International Food Policy Research Institute: Food Agric. Environ. Discuss. Pap. 13, 41 p. (An edited version of this paper also appeared in the special 10th Anniversary publication of the Asian Fisheries Society.)

Achieving Food Security for All: Key Policy Issues for Developing Countries

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Abstract

More than 800 million people are food insecure, around 185 million children are malnourished and many millions of people suffer from micronutrient deficiencies. There are several key challenges that must be faced to achieve food security for all people: widespread poverty and limited economic growth; low levels of human resource development; rapid population growth and urbanization; insufficient growth in food supply; threats to natural resources; low levels of agricultural input use; poorly functioning markets; lack of infrastructure; inappropriate production and trade policies; and inadequate domestic resource mobilization and international assistance. Sustained action is required in six priority areas: strengthening the capacity of developing-country governments and nongovernmental organizations; investing more in poor people; accelerating productivity in food production; assuring sound management of natural resources; developing competitive markets; and expanding and realigning international development assistance.

Introduction

More than 800 million people are food insecure, i.e., they lack access to sufficient food to lead healthy and productive lives; around 185 million preschool children are seriously underweight for their age; micronutrient deficiencies are widespread among about 2 billion people affected by iron deficiency, over 1.5 billion people at risk of iodine deficiency, and 40 million children suffering from Vitamin A deficiency (FAO 1996).

Research by the International Food Policy Research Institute (IFPRI) and others suggests that there are several key challenges that must be overcome to achieve food security for all.

Poverty and Limited Economic Growth

The extent to which food needs are converted into food access depends on the purchasing power

of the poor. Poor people usually do not have adequate means to grow and/or purchase the food they need to lead healthy and productive lives. About 1.3 billion people in the developing world live on incomes of a dollar or less a day per person (World Bank 1996). Unless concerted action is taken now, poverty will remain entrenched in South Asia and Latin America, and increase considerably in subSaharan Africa. Poverty is strongly correlated with low levels of economic growth in the society of which the poor are a part.

Low Levels of Human Resource Development

Poor people have low productivity and lack secure access to productive resources and remunerative employment. Investments in education, health care, clean water and sanitation, which are essential for human resource development, are far below required levels, particularly in rural areas. One-third of primary school enrollees drop out by Grade 4. About 800 million people lack access to health services, 1.3 billion people consume unsafe water, and almost 2 billion people do not have access to adequate sanitation systems (UNDP 1996).

Rapid Population Growth and Urbanization

During the next 25 years, about 80 million people are likely to be added to the world's population every year (UN 1996). About 98% of the population increase is expected to be in developing countries. Most of the population increase is expected to be in the cities. The developing world's urban population could more than double to 3.6 billion by 2020, by which time urban dwellers could outnumber rural dwellers. With business as usual, developing countries will increase their demand for cereals by 80% between 1990 and 2020, and for livestock products by 160% (Rosegrant et al. 1995).

Insufficient Growth in Food Supply

Increased food production will have to come from more efficient use of land and water as any significant expansion of cultivated land is not feasible in most of the world and development of new water sources is becoming more difficult and expensive. Growth in food production has begun to lag. Crop yields are growing at significantly reduced rates and the catch and production of fish are increasing very little. Existing technology and knowledge will not permit production of all of the food needed to feed humanity in the 21st century. It is becoming increasingly difficult to maintain the yield gains already achieved, let alone to increase yields, in the high-potential or more-favored areas. In the less-favored areas, which are home to many of the world's food insecure people, yields are low and variable. Marine fisheries are overexploited and expansion in aquaculture production is unlikely to be sufficient to meet the increasing demand for fish.

Threats to Natural Resources and Low Levels of Agricultural Input Use

Degradation of natural resources undermines production capacity. Two billion hectares have been degraded in the past 50 years (Oldeman 1992). About 180 million hectares of tropical forests have been converted to other uses during the 1980s (Sharma 1992). Marine fisheries are collapsing in some parts of the world (Williams 1996). Seasonal and regional water shortages afflict most developing countries (Rosegrant 1997). Depletion of soil nutrients is a critical constraint to food production in subSaharan Africa. Past practices of pesticide use should not be sustained for health and environmental reasons. While the world has the capacity to produce enough food to meet future demands, continuing with current practices is certain to further degrade the natural resource base. Farmers

and fishers must have access and incentives to use appropriate technologies to practice environmentally sustainable agriculture.

Poorly Functioning Markets, Lack of Infrastructure and Inappropriate Production and Trade Policies

As a result of inefficient markets and poor infrastructure, food marketing costs are too high, impeding access to food by the poor. Lowering these costs through investment in improved transportation infrastructure and marketing facilities may be as important in lowering food prices to consumers as increasing agricultural productivity. Such investments are also needed to reduce losses, particularly in perishable foods like fish and fish products. Replacing existing agricultural subsidies with free market access to Europe, the United States and Japan, and integrating developing countries into the global economy through international trade will enhance their long-term economic prospects and improve food security. Similarly, eliminating capital subsidies for marine fisheries will be beneficial for both marine fisheries resources and low-income households involved in fishing.

Domestic Resource Mobilization and International Assistance

Domestic savings and, consequently, investments are far too low in many low-income developing countries. Private flows have risen substantially in recent years, especially to medium-income countries, but many of the poorer countries have been bypassed. International development assistance, particularly to agriculture, is at very low levels.

Required Action

Food security for the 21st century calls for sustained action on three fronts: (i) producing enough food to meet increasing and changing food needs due to population growth, rising incomes, and changing lifestyles, including urbanization; (ii) meeting food needs from more efficient use of land already under cultivation and marine fisheries, with better management of the natural resource base to assure sustainability; and (iii) enabling every person to acquire the means to grow and/or purchase sufficient food at all times to lead healthy and productive lives. The extent of hunger in the next century will depend on action taken or not taken now.

Sustained action is needed in six priority areas. These are: (i) strengthening the capacity of developing-country governments and nongovernmental organizations; (ii) investing more in poor people; (iii) accelerating productivity in food production; (iv) assuring sound management of natural resources; (v) developing competitive markets; and (vi) expanding and realigning international development assistance (IFPRI 1995).

The first priority area of action calls for selectively strengthening the capacity of developing-country governments to perform appropriate functions such as establishing and enforcing property rights, promoting private-sector competition in agricultural markets, and maintaining appropriate macroeconomic environments. Predictability, transparency, and continuity in policymaking and enforcement must be assured. Governments must be assisted to get out of areas that are best handled by the private sector or civil society. In many countries, nongovernmental organizations (NGOs) have come to play a much more important role in areas traditionally covered by government, such as poverty relief, health care, nutrition, and management of natural resources. To achieve food security for all, the efforts of NGOs and other elements of civil society must be fully recognized and supported, and a more effective distribution of labor between government and civil society, including NGOs, must be achieved.

The second priority area of action calls for investing more in poor people. If food security for all is to be achieved, governments, local communities and NGOs must assure access to primary education, primary health care, and clean water and sanitation for all people. They must work together to improve access by the poor to productive

resources and remunerative employment. Since a large share of the world's poor depend on agriculture for their incomes, expanded agricultural incomes are particularly important.

The third area of action calls for accelerating productivity in food production. Agricultural research systems must be mobilized to develop improved agricultural technologies, and extension systems must be strengthened to disseminate the improved technologies and techniques. Developing countries must increase their national agricultural research expenditures in the near term to 1% of the value of agricultural output with a longer term target of 2%. IFPRI research shows very strong links between agricultural productivity increases and broad-based economic growth in the rest of the economy. Agriculture is an engine of growth in low-income countries. Failure to invest in agriculture results not only in a stagnant agricultural sector but also a stagnant economy.

The fourth priority area of action is assuring sound management of natural resources. Governments, NGOs and local communities must work together to establish and enforce systems of rights to use and manage natural resources, to regulate access to marine fisheries, to improve the way water is allocated and used, to reverse land degradation where it has occurred, to reduce the use of chemical pesticides, and to implement integrated soil fertility programs in areas with low soil fertility. Investments in less-favored geographical areas, that is, areas with agricultural potential, irregular rainfall patterns, fragile soils, and many poor people, must be expanded. Most poor and food insecure people in developing countries reside in rural areas, and most rural poor reside in less favored areas. Yet, most investment, including agricultural research investment, is still focused on the more favored areas. If we are serious about reducing poverty and protecting the environment, the balance between less favored and more favored areas must be redressed.

The fifth priority area of action is reducing food marketing costs. The cost of bringing food from the producer to the consumer is very high in many low-income developing countries, particularly those in Africa. Governments should phase out inefficient state-run firms in agricultural markets, invest in or facilitate private-sector investment in developing and maintaining infrastructure, especially in rural areas, and provide technical assistance to help strengthen small-scale competitive rural enterprises.

The sixth priority area of action is expanding and reorienting international development assistance. Many years ago, industrialized countries agreed to allocate at least 0.7% of their GNP to foreign assistance. Most countries do not maintain this target. Denmark is a notable exception in this regard, contributing more than 1% of its GNP. Besides increasing international development assistance to reach at least the 0.7% target, we must realign it to low-income developing countries, primarily in subSaharan Africa and South Asia where the potential for further deterioration of food security and degradation of natural resources are great and where the inflow of international capital is very limited. Developing countries in turn must seek measures to diversify sources of external funding and to stem capital flight.

Governance and Policy

Good governance and appropriate policies are essential to achieve food security for all. Governments must provide an overall policy and institutional framework that is conducive to appropriate action by civil society and the private sector, including farmers, consumers and market agents. In low-income countries, most economic policies and many institutional changes will affect food security whether they are primarily intended to do so or not. Therefore, an exhaustive list of policies and institutions affecting food security in developing countries is beyond the scope of this paper. Only the most critical ones are mentioned below. Policies and institutional changes are needed to:

- Promote food security for the rural and urban poor in the short and long run, and ensure that gains in food security are converted into improved nutrition, particularly for women and children;
- Promote sustainable intensification of

agricultural production (including aquaculture) among smallholders while pursuing sustainable, efficient, and effective use of natural resources, including land, water and forests;

- Strengthen the effectiveness and efficiency of agricultural research and technology to support sustainable intensification and assure food security;
- Promote poverty-focused reforms of agricultural input and output markets, diversification in food and agricultural systems, and expanded investment in rural infrastructure; and
- Facilitate appropriate national macroeconomic policy environments and global and regional trade arrangements conducive to the achievement of food security for all.

Each of these five topics is briefly discussed below.

Policies to Assure Food Security for the Rural and Urban Poor

Improved policies and institutional changes aimed at making credit available to the rural and urban poor, including those employed in the catch, production, processing and marketing of fish and fish products, are urgently needed. These policies and institutional changes should build on the experience from successes and failures of recent credit programs in the developing countries, including microcredit schemes. Large-scale, highly subsidized credit schemes administered by the public sector have generally not been effective in reaching the rural and urban poor, and their impact on food security has been disappointing relative to the amount of money spent. What is needed are institutional arrangements that make credit available to the rural and urban poor without interest rate subsidies. Also, technical assistance and infrastructure support are needed to facilitate small-scale enterprises in rural areas. Labor intensive public works programs may be an effective means to develop such rural and urban infrastructure. Policies are also needed to assure social safety nets for the poor to avoid both temporary and long-term food insecurity and hunger. Such safety nets must be designed to the particular circumstances, but may involve transfers of either income or food. Small-scale credit programs and public works programs may be effective components in such social safety nets.

Sustainable Intensification of Smallholder Agriculture

Between 70% and 80% of the world's poor people are found in rural areas, and most of them depend directly or indirectly on agriculture. Until recently, policies to promote intensification of agricultural production among smallholders largely ignored issues related to sustainability and the management of natural resources. Changes in policies and institutions are urgently needed to help farmers combine production intensification with sustainable use of natural resources. In particular, improved policies and institutions are needed to assure sustainable agricultural development in less-favored areas of the developing countries. Such policies and institutions should focus on the particular problems experienced by these farmers, including periodic drought, insufficient infrastructure, and poor health and education. In particular, there is a need for additional investment in agricultural research aimed at the development of knowledge and technology appropriate for smallholder farmers in those regions. Improved policies and institutions are also urgently needed to improve the efficiency of water use, including the allocation of water within agricultural uses and between agricultural and other uses.

Strengthening Effectiveness and Efficiency of Agricultural Research

While the sustainable intensification of agricultural production calls for a number of changes in policies and institutions, effective and efficient agricultural research and technology are clearly at the core of the solutions to most of the problems facing smallholder farmers in developing countries. Developing

countries need to reexamine current policies and institutions in order to further promote agricultural research relevant for smallholder farmers. Partnerships between national agricultural research institutions in developing countries and the international agricultural research system (the Consultative Group on International Agricultural Research) as well as agricultural research institutions in the industrialized nations and the private sector must be encouraged. In particular, there is a need for stronger partnerships to fully utilize the opportunities embodied in genetic engineering and other modern scientific methods for solving the problems experienced by poor people in the developing countries.

Reforming Agricultural Input and Output Markets

Efforts to reduce rural poverty have been and continue to be severely hampered by inefficient agricultural input and output markets and lack of appropriate rural infrastructure. Smallholder farmers, particularly in subSaharan Africa, are faced with excessively high prices for fertilizers and other inputs, and low prices for their products. Efforts to move from inefficient public-sector marketing arrangements to privatized competitive arrangements have failed in many developing-countries and have been less than fully successful in others. There is an urgent need for developing country governments to find their proper role within a privatized agricultural market structure. Policies are also needed to assist farmers to adjust to a new set of relative prices as developing countries begin to open their domestic markets to international trade.

Facilitating an Appropriate Macroeconomic Policy Environment

Experience in a large number of developing countries demonstrates the importance of appropriate macroeconomic policy environments and trade arrangements in improving food security in developing countries. Past IFPRI research has shown a strong interdependence between appropriate macroeconomic and trade policy environments on the one hand and domestic agricultural market reforms and infrastructure investment on the other. Recent structural adjustment efforts in a number of developing countries have been successful in improving macroeconomic policies to the benefit of economic growth and poverty alleviation. Further efforts are needed to adjust macroeconomic policies in developing countries to the changing international environment and to participate in international efforts for further trade liberalization for the benefit of low-income developing countries and poor people within. International agreements are urgently needed to regulate marine fisheries. Continued practice of free access along with capital-intensive, large-scale methods of fish capture will further degrade marine fisheries and reduce future supplies of fish.

Conclusions

This paper has attempted to provide a concise and broad framework within which discussions can take place about the role of fisheries policy. Fish and fish products must continue to play an important role in efforts to assure food security for all. The world's oceans are a necessary and major part of any forward looking strategy to improve livelihoods and increase food supply in developing countries. Fish is a critical component of the food supply for the world's poor, providing one billion people sustenance for their daily lives and 150 million people employment. Disturbing trends in the overexploitation of natural fisheries and insufficient policy attention to fisheries by those most concerned with alleviating hunger in developing countries suggest that it is vital to remedy both the action gap and the knowledge gap on fishery policy issues. The action gap concerns the failure to develop enforceable agreements to stop the severe degradation of natural fisheries in open seas that are of special importance to developing countries. The knowledge gap concerns uncertainties over the risks and tradeoffs for food production, incomes, and equity faced by policymakers in developing countries who wish to develop fish resources to better feed their expanding populations.

If the world is to achieve food security for all by year 2020, we must make food security an overriding goal in developing countries and place the highest priority on the action necessary to achieve this goal. This will involve concerted action on all related fronts, including poverty alleviation, expanded food production at reduced unit costs, and appropriate policies to protect natural resources while expanding food production.

References

FAO (Food and Agriculture Organization of the United Nations). 1996. Food, agriculture, and food security: Developments since the World Food Conference and prospects. World Food Summit Technical Background Document 1. FAO, Rome.

IFPRI (International Food Policy Research Institute). 1995. A 2020 vision for food, agriculture, and the environment: The vision, challenge, and recommended action. IFPRI, Washington, D.C.

Oldeman, L.R. 1992. Global extent of soil degradation. *In* Biannual report 1991-1992, p. 19-36. International Soil Reference and Information Centre, Wageningen, The Netherlands.

Rosegrant, M.W. 1997. Water resources in the twenty-first century: challenges and implications for action. Food, Agric. Environ. Discuss. Pap. 20. IFPRI, Washington, D.C.

Rosegrant, M.W., M. Agcaoili-Sombilla and N.D. Perez. 1995. Global food projections to 2020: implications for investment. Food, Agric. Environ. Discuss. Pap. 5. IFPRI, Washington, D.C.

Sharma, N., Editor. 1992. Managing the world's forests. World Bank, Washington, D.C.

UN (United Nations). 1996. World population prospects: The 1996 revision. UN, New York.

UNDP (United Nations Development Programme). 1996. Human development report 1996. Oxford University Press, New York.

Williams, M.J. 1996. The transition in the contribution of living aquatic resources to food security. Food, Agric. Environ. Discuss. Pap. 13. International Food Policy Research Institute, Washington, D.C.

World Bank. 1996. Poverty reduction and the World Bank. World Bank, Washington, D.C.

III. POLICY RESEARCH ISSUES RELATED TO DEMAND AND SUPPLY

Changing Fish Trade and Demand Patterns in Developing Countries and Their Significance for Policy Research

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Abstract

Trends in trade and demand patterns for major fisheries products are evaluated for the past two decades, using aggregate annual data. Major changes have been propelled by income growth, changes in preferences and health concerns about meat in developed countries, leading to increased consumption of high value fisheries items such as shellfish and fish filet. Developing countries, especially in east Asia, are rapidly increasing consumption of lower value fishery items, and fish culture is becoming an increasingly important source of food and exports. Developed countries accounted for 85% of net world fish imports in 1994, mostly at the high end of the value spectrum. In the 10 years preceding 1993, the net value of fisheries exports from developing countries increased from less than a third of net developing country exports of sugar, beverage crops and tropical specialty products combined, to a level exceeding that total. While the real price of fish has remained relatively stable since 1970, the real price of beef has declined by 300%, suggesting that a rally in meat prices would further accentuate the shift to fish. Current evidence suggests the possibility of a 15% strengthening of the price of fish relative to beef by 2020.

Introduction

Consumption of fish and fishery products increases rapidly with income. Thirty percent of world fish production is traded, and an increasingly large share of fish exports to developed countries will be produced in developing countries in the future (FAO 1997a). Policy research in developing countries, therefore, needs to address the factors that influence demand for fish and competing products in both the developed and developing countries, and how these are likely to influence fish prices and trade flows.

The objective of this paper is to marshal and analyze salient evidence on aggregate fisheries trade and consumption trends, almost all of it produced by the Fisheries Department of FAO, and to put this in the context of other work on present and future demand for both meat and fish.[1] Conclusions will be drawn, where possible, and priorities for further research highlighted. Other papers dealing with supply issues, household food security considerations and interactions with the environment have been prepared for this Conference. No effort will be made to deal with those important topics here.

Trade Patterns

Aggregate trade patterns must be placed in the context of broader production changes occurring in the world. Global production of fish and shellfish rose nearly 15% from 1990 to 1995. Of the 112.3 million t of fish and shellfish produced worldwide in 1995, roughly 19% came from culture, as opposed to capture, compared to 13% in 1990. Growth in marine capture fisheries is mainly limited to lower value, highly variable, stocks of pelagic fish. The higher valued production of demersal species has been fairly stable since 1970[2]. About 28% of global production in 1995-largely shoaling pelagics such as anchoveta-was used for reduction into fishmeal. The dynamic factor in world fisheries is China, where fisheries production as a whole grew at 14% per annum between 1990 and 1994, with the most growth coming from aquaculture production of herbivorous carps. This increase is the main factor behind the increase in the share of developing countries, from 26% of total world fish production in 1988 to 35% in 1994. In the latter year, China and India alone accounted for roughly 60% of world aquaculture production. With annual growth rates of the order of 11% in recent years, aquaculture is one of the fastest growing sectors in world food production (FAO 1997a).

In value terms, world fish trade has accounted for a fairly stable 50% of the estimated value of fish production since 1980. However, in quantity terms, it has increased steadily from 32% in 1980 to 38% in 1990 (Alexandratos 1995). Since 1990, this trend has continued, with trade in low value products such as fishmeal accounting for most of the increased trade. In 1995, 85% of fish imports by value were by developed countries, with Japan alone accounting for 30% of imports (FAO 1997a).

There has been an important shift in the direction of trade. In the mid to late 1980s, the USA was the second largest fish exporter in the world. By the early 1990s, the USA had become a net importer of fresh demersal fish. Japan greatly increased its reliance on imports after the mid-1980s. Europe continued as a major player in world trade in fisheries, with increasing net imports over time. As a whole, the developed countries are net importers of fish and of fresh demersal fish and this trend is expected to continue (Table 1).

The "real import unit values" for fresh demersal fish shown in Table 1 are obtained by dividing the total deflated value (constant 1980 US$) of gross imports by the total quantity of gross imports.[3] The increase in the import unit value for the U.S. appears to result from an upgrading in the types of fresh demersal fish imported, reflected in higher prices for those items. The opposite effect is observed in Japan after the mid-1980s, with substitution of cheaper demersal fish.

Table 2 shows net imports of fresh pelagic fish by developing countries. Africa is a net importer, although less so now than in the mid-1980s when factory ships of the former socialist economies would unload huge quantities of cheap frozen

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[1] The analysis of aggregate fisheries trends draws heavily on the seminal *The State of Fisheries and World Agriculture: 1996* (FAO 1997a) and the underlying FAO technical papers prepared for the Kyoto Conference on Sustainable Contribution of Fisheries to Food Security, December 1995.

[2] For nonfisheries oriented readers, *pelagic* fish refers to surface feeding marine fish. Tuna and Bonitos are in fact pelagic fish, but are relatively high valued species that also tend to be highly migratory. Most pelagics are low-valued species found close to continental shelves (shoaling). They are important as food to artisinal fishers in developing countries, and as feedstock to capital-intensive industrial fisheries seeking material for fishmeal. *Demersal* fish are mid-water marine fish; they tend to be the higher-valued species common in Western fisheries (such as flatfish).

[3] This in fact creates a "price" of imports that is a weighted average import price, in constant dollars, where the weights are the relative contribution of each transaction to the total.

Table 1. Net imports and import unit value of fresh demersal fish in developed countries, 1973-1993.

Year	Net imports (t)			Real import unit value (1980 US$/t)		
	US	Japan	All developed	US	Japan	All developed
1973/75	41 267	N/A	84 642	1 584	N/A	1 505
1976/78	42 463	1 538	67 283	873	4 329	1 593
1979/81	-43 416	2 663	-21 680	1 023	4 788	1 565
1982/84	-403 287	2 557	-433 337	1 03	14 704	1 264
1985/87	-1 173 911	5 449	-1 235 505	1 089	4 776	1 448
1988/90	-815 224	29 837	-816 837	1 367	2 897	1 786
1991/93	26 781	48 539	19 800	1 723	2 123	1 978

Source: Computed from data in FAO 1997b.
Note: Net imports are imports minus exports in the same calendar year. Real import unit values are the aggregate value of imports for the country and year concerned divided by the aggregate quantities, deflated by the World Bank's G-5 Manufacturing Unit Value Index base 1980. Annual values are first calculated then averaged over three years.

Table 2. Net imports and import unit value of fresh pelagic fish in developing countries, 1973-1993.

Year	Net imports (t)			Real import unit value (1980 US$/t)		
	Africa	Asia	All	Africa	Asia	All
1973/75	-5 174	-268 874	-277 144	520	546	568
1976/78	11 502	-46 012	-35 492	641	416	460
1979/81	22 732	-84 606	-56 556	981	342	476
1982/84	138 464	-34 257	104 933	615	478	550
1985/87	180 703	-40 118	83 795	475	436	457
1988/90	118 546	-152 781	-59 450	478	355	407
1991/93	79 221	-250 260	-197 505	521	499	509

Source: Computed from data in FAO 1998.
Note: See Table 1.

pelagic fish in West Africa.[4] Developing Asia is once again becoming a major net exporter of pelagic fish. Both net exports of pelagic fish and the real import unit value are very dependent on five pelagic species that are highly variable in their appearance, and whose production runs tend to alternate between boom and bust.

High value fisheries exports with a broad market in the developed countries include fresh demersal fish and crustaceans. Most developing

[4] In West Africa in the mid-1980s, long-distance fleets of ships, particularly from the former Soviet Union and North Korea, delivered cubic meter blocks of frozen pelagics during the high pelagic landing season, from June to September. Although much of this may have gone for human consumption, the rapid rise of the poultry industry in West Africa at that time may have been a factor also. At other times of the year, the ships would concentrate on more valuable species for sale outside Africa.

Table 3. Net exports and export unit value for fresh demersal fish and crustaceans in developing countries, 1973-1993.

Year	Net imports (t)			Real import unit value (1980 US$/t)		
	Africa	Asia	All	Africa	Asia	All
1973/75	8 164	-18 575	-25 987	3 298	N/A	3 251
1976/78	2 736	18 000	13 620	948	1 943	1 517
1979/81	1 784	5 884	29 790	4 786	2 411	1 945
1982/84	2 669	46 715	86 502	3 965	2 001	1 543
1985/87	5 463	95 492	106 899	3 937	1 760	1 919
1988/90	6 589	35 142	63 718	3 519	2 419	2 184
1991/93	8 347	30 142	53 652	3 567	2 246	2 224

Source: Computed from data in FAO 1998.

Note: Net exports are exports minus imports in the same calendar year. Real export unit values are the aggregate value of exports for the country and year concerned divided by the aggregate quantities, deflated by the World Bank's G-5 Manufacturing Unit Value Index base 1980. Annual values are first calculated then averaged over three years.

countries are net exporters of these items. Developing Asia is the big player. Growth of shrimp exports from countries such as Thailand and India has been phenomenal in the past decade. Interestingly, the white-tailed shrimp is the only fisheries product for which there is a developed international future market (FAO 1997a).

Export Earnings and Prices

Fisheries have become the major foreign exchange success story of the developing countries over the last decade. Net foreign exchange earnings from fisheries exports from developing countries have increased from US$5.1 billion in 1985 to US$16 billion in 1994. After allowing for inflation, this is a 95% increase in real terms over ten years, coming at a time when receipts from traditional exports of tropical agricultural products were declining due to sharp price decreases for those items in terms of purchasing power. Developed countries have also rapidly expanded their fisheries trade with each other. Global net foreign exchange receipts increased 70% in real terms between 1985 and 1994, ending at US$47 billion in the latter year (FAO 1997a).

Table 4 shows the rise of real foreign exchange receipts of developing countries from fisheries from 1983 to 1993, compared to events in other agricultural and livestock export markets. While other traditional exports stagnate or decline in real terms, fisheries receipts are growing rapidly. Although fisheries exports originated from a small number of countries by 1993, they surpassed those of sugar, traditional beverage crops (coffee, tea, cocoa), and tropical agricultural exports combined, for developing countries as a whole.

Over the long run, prices for developing country fisheries exports have stagnated, even if in the last half dozen years there has been some improvement. While the increase in nominal shrimp prices since 1970 may seem tremendous, the price in 1996 was only 2% above the 1970 price expressed in 1996 dollars (Table 5)! Seen the same way, fishmeal prices in 1996 were only 55% of their real 1970 levels.

In recent years, the market prices of higher valued demersal fish (such as flatfish) have tended to increase because of declining supply. Factors affecting the price of substitutes for fisheries products may be more significant for developing countries in the long-term. The price of beef in 1996 was only 29% of the 1970 price when the latter is converted to 1996 dollars. Using the figures from Table 5, the ratio of the wholesale prices of shrimp to beef was 2.1:1 in 1970, 3.8:1 in 1980, and 7.1:1 in 1996.

Table 4. Real value of exports of fishery products from developing countries in perspective, 1983-1993 (in billions of constant 1988 US$).

	1983	1988	1993
Fishery products	9.3	15.0	17.4
Sugar, beverages and tropical products	31.0	24.1	17.1
Oilseeds and products	12.7	13.3	14.2
Cereals and products	8.2	4.8	5.9
Meat and livestock	6.3	5.3	5.0
Milk and products	0.3	0.4	0.6

Sources: Computed from data in FAO Commodity Review and Outlook (various) and World Bank Commodity Markets and the Developing Countries (various).
Note: Value of gross exports from developing countries including re-exports, deflated by G-5 Manufacturing Unit Value index, base 1988.

Table 5. Shrimp and fishmeal export prices in context, 1970-1996 (current US$/t).

	Shrimp[a]	Fishmeal[b]	Soymeal[c]	Beef[d]	MUV[e]
PAST					
1970	2 780	309	103	1 304	25.1
1980	10 230	504	262	2 760	72.0
1985	10 490	280	157	2 154	68.6
RECENT					
1990	10 790	413	200	2 563	100.0
1991	11 542	478	197	2 663	102.2
1992	10 950	482	204	2 455	106.6
1993	11 390	365	208	2 618	106.3
1994	13 080	377	192	2 331	110.2
1995	13 540	496	197	1 907	119.4
1996	13 119	585	257	1 781	116.4
PROJECTED					
2000	14 036	n.a.	250	2 590	127.6
2010	15 859	n.a.	306	3 220	161.0

Sources: All price data and projections are in current US$ and from various issues of World Bank Commodity Markets and the Developing Countries.
Notes: [a] U.S. frozen, Gulf brown, shell-on, headless, 26/30 count per lb., c.i.f. New York.
[b] Any origin 64-65%, c.i.f. Hamburg.
[c] Any origin, 44-46% extraction, c.i.f. Rotterdam.
[d] Australia/New Zealand, frozen boneless cow forequarters, 85% lean, c.i.f. U.S. East Coast ports.
[e] G-5 Manufacturing Unit Value index, base 1990 (to measure inflation).

The ratio of fishmeal to soymeal wholesale prices was 3:1 in 1970, 1.9:1 in 1980, and 1.5:1 in 1996.

Shrimp is one of the more expensive fishery items by weight at 2 to 4 times the value by weight of demersal fish, and 2 to 3 times the value of tuna (Table 6). Yet shrimp prices do not appear to have moved in a radically different manner than demersal fish prices over the long haul. Therefore, the lowering of beef price relative to shrimp also applies to white fish filets, beef's closest competitor on the fisheries side.

Fish Consumption Trends - Past and Present

Average human consumption of fish as food was estimated by FAO (1997b) to be 13.4 kg/capita in 1994. The global average for fishmeal utilization in the same year was 5.6 kg/capita. Fish as food has recently been estimated to account for 19% of animal protein supply to humans and 4% of total protein supply (Alexandratos 1995). Globally, fish consumption per capita has grown only modestly

Table 6. Average landing prices of various seafood groups, 1984-1994 (current US$/t).

Year	Fish for reduction	Cods, hakes, haddocks	Flounders, halibuts, soles	Tilapias and other cichlids	Tunas, bonitos, billfish	Salmons, trouts, smelts	Shrimps, prawns, lobsters	Lobsters, spiny-rock
1989	90	700	1 198	1 250	1 700	3 500	4 000	11 270
1990	95	900	1 217	1 300	1 830	3 430	3 650	11 400
1991	90	1 250	1 095	1 300	1 560	3 190	3 280	11 700
1992	93	1 350	1 163	1 350	1 650	3 470	3 750	12 100
1993	74	990	1 103	1 250	1 525	2 780	3 900	11 500
1994	85	1 060	969	1 255	1 500	2 750	4 000	11 800

Source: Annual average values from FAO Yearbook, Fisheries Statistics (1994).

over the past quarter century, from about 10.5 kg in 1970 (Westlund 1995) to 13.4 kg in 1994 (FAO 1997a).

While the developed countries consumed nearly 27 kg/capita of fish in 1991, developing countries as a whole consumed under 9 kg/capita (Phelan and Henriksen 1995). The latter figures may be compared to 36.6 kg of milk and 17.7 kg of meat. Excluding China and Oceania, growth rates of per capita fish consumption as food in developing countries since 1970 have been low. Rates of the order of 0.5 to 1% per annum (Westlund 1995) may be compared to aggregate growth rates for beef consumption per capita in developing countries of 0.6% per annum from 1967 to 1982 and 1.1% per annum from 1982 to 1993 (Rosegrant et al. 1997). It is, however, noteworthy that growth rates for poultry per capita consumed as food in developing countries were over 5% per annum in the earlier period and 3% per annum in the latter period (Rosegrant et al. 1997).

The big growth in fish consumption in the developing world in recent years has been in China, starting from a very low base. In 1970, Chinese per capita consumption of fish was estimated at 3.6 kg; meat was 10.3 kg. By 1990, fish was 9.8 kg and meat was 27 kg, exhibiting very similar growth rates. In southern coastal areas such as Guangdong, per capita fish consumption was estimated at 35 kg/capita (Westlund 1995).

Fishery items consumed as food cover a large variety of species; pelagic and demersal fish combined account for about half on average in most areas. Table 7 shows trends for per capita consumption of these items in important areas.

Much of the growth in fish consumption in China has come from freshwater aquaculture production. The increase in per capita marine fish consumption has come mostly from pelagics. The same can be seen to be true for the rest of Asia and Africa, but not for the USA and Japan. Japanese consumption trends also reflect the beginnings of diversification out of a very highly seafood intensive diet (71.5 kg/capita in 1994) into meat (FAO 1997a). In the USA and Western Europe, higher priced calories from higher quality fish is the likely route of the future, reflected in declining consumption of pelagics in the USA (mostly canned fish) and rapidly rising consumption of demersals.

Projections of Fish Consumption

Policy research tends to be effective when it reduces the risks of uncertainty faced by investors and governments, both of whom need to take a long-term perspective on the world in which they interact. Therefore, projections of future fish consumption in different parts of the world, and of future fish prices relative to other items, are potentially of great interest for policy researchers and analysts.

Projections of fish consumption into the future tend to be scarce due to data limitations and methodological complexity. Because of data problems and the chosen focus on cereals, the detailed IFPRI

Table 7. Per capita annual consumption of demersal and pelagic fish in selected countries, 1973-1993 (kg).

	China		Africa developing		Asia developing except China		USA		Japan	
Year	Pelagic	Demersal	Pelagic	Demersal	Pelagic	Demersal	Pelagic	Demersal	Pelagic	Demersal
1973/75	0.19	0.85	1.81	1.20	2.22	1.45	3.80	4.12	19.39	29.11
1976/78	0.30	0.68	2.44	1.47	2.36	1.57	3.44	4.38	18.50	22.68
1979/81	0.28	0.81	2.81	1.63	2.40	1.46	3.48	4.28	19.55	17.64
1982/84	0.31	0.75	2.60	1.58	2.66	1.43	3.16	5.00	21.18	16.89
1985/87	0.39	0.71	2.43	1.05	2.55	1.50	3.65	6.13	20.57	18.19
1988/90	0.38	0.72	2.45	1.37	2.64	1.43	3.43	8.68	18.83	17.55
1991/93	0.59	1.16	2.40	1.22	2.79	1.46	3.18	9.15	18.00	13.58

Source: Computed from FAO 1997b.

global food projections to 2020 arising out of the IMPACT model do not include fish (Rosegrant et al. 1995). The IMPACT model updated in 1997 does include five sub-categories of livestock products, along with many other agricultural categories, and this work arguably employs the most theoretically satisfactory approach to projections in the current global modeling literature, based on heavy data input. The model includes substantial regional disaggregation, allows for endogenous formation of major prices and generally reconciles supply and demand constraints.

FAO has done the only large-scale modeling of long-term future fish demand on a global scale known to the authors. Although reported in different places, it is based on work with FAO's Food Demand Model and appears to be most extensively documented. This work makes major simplifications in order to deal both with data limitations and the need for fast results. The cost is that it assumes constant relative prices for fish products into the indefinite future, which has not been the case in the past and which FAO experts have clearly argued is not likely to be in the future (Alexandratos 1995; Westlund 1995; FAO 1997a).[5] The absence of real price variation does not allow for substitution effects between fish and meat (and fishmeal and soymeal) nor does it allow for induced investment in fisheries from increased relative profitability. On the other hand, it is all we have and it addresses a critical set of issues.

The FAO projections predict an aggregate food utilization of fish of 110-120 million t in 2010, compared to 75-80 million t in 1994-1995. Per capita consumption is expected to grow from 13 kg to 16 kg. Regionally, significant per capita growth will occur mainly in China and the high-income countries of East Asia. China's per capita consumption is projected to go from 9.8 kg in 1990 to 20 kg in 2010 (15% of total world consumption), an enormous increase when population growth is considered. The increase in the high income countries of East Asia is projected to be an additional 14 kg over the 1990 total of 23 kg. Other growth is in North America (+5 kg in quantity, plus higher priced items) and Australasia (+3 kg). Elsewhere, per capita consumption is projected to be relatively stagnant (Westlund 1995). Generally, the projections confirm the view that increasing aquaculture production will be associated with higher fish consumption in East Asia and that quality upgrades will be important for growth in North American markets.

[5] Other areas where the degree of detail in the existing quantitative fish projections is not clear include urban/rural differences in consumption patterns, detailed regional disaggregation of income elasticities, and formal incorporation of supply constraints, although all of these are addressed in detail outside the projections *per se*.

Further Evidence on Demand Projections

Although we do not have better global projections for fish consumption, we do have three kinds of evidence that can be used to improve our view of the future of fisheries demand. These are: (i) detailed and methodologically sophisticated fish consumption projections for China by Huang et al. (1997); (ii) detailed estimates of future annual growth in consumption for beef and poultry at the global level, using the IMPACT model, by Rosegrant et al. (1997); and (iii) a growing literature of systems demand studies for individual countries that include disaggregated information on fish. The first set gives information on the fastest growing segment of the world market for fish. The second set shows what is happening to competing commodities. The third set can be used to elucidate income and substitution effects.

With regard to fish in China, Huang et al. (1997) distinguish rural from urban and a high income growth scenario from a low income growth scenario. Fish prices are not endogenous, but price substitution and income effects are allowed for. Under low income growth, per capita fish consumption in rural areas is projected to grow from 4 kg in 1991 to 8 kg in 2010 and to 10 kg in 2020. In urban areas, under low income growth, per capita fish consumption will increase from 12 kg in 1991 to 22 kg in 2010 to 30 kg in 2020. Under high income growth, fish consumption in rural areas goes from 4 kg in 1991 to 12 kg in 2010 and to 19 kg in 2020. In urban areas, it is projected to go from the current 12 kg to 35 kg in 2010 (like Scandinavia currently) to 61 kg in 2020 (like Japan currently). Thus income growth and urbanization are critical to fish demand in China. Huang et al. (1997) do back of the envelope calculations to show that urbanization alone will add 10% to China's fish consumption by 2020.

With regard to the second set of evidence, using the IMPACT model, Rosegrant et al. (1997) project, for developing countries as a whole over the 1993-2020 period, an annual growth in total food demand for beef of 2.78% and for poultry of 3.14%. The comparable figures for developed countries are 0.28% per annum for beef and 0.94% per annum for poultry. Combined with the fact that population growth will occur primarily in the developing countries, it is clear where the significant growth in demand for animal protein will occur. Furthermore, projected total demand growth is higher in Southeast Asia (3.60% per annum over the period for all meats) and in subSaharan Africa (3.38% per annum for all meats).

Turning to the third type of evidence, properly executed demand studies that include the significant complements and substitutes for fish as well as fish itself, give us considerable perspective on the effects of income and different prices on fish demand. A series of relatively recent studies of this type was surveyed, and four "polar" country studies are reported (Appendix Tables 1 and 2). These were chosen by separation of the studies between developed and developing countries, and choosing "high" and "low response" countries for each group. The elasticities in the appendix are converted for presentation into more user-friendly bar charts in Figs. 1 and 2.

Fig. 1 shows the importance of income response assumptions to projections of demand. Among developed countries, total expenditure on fish in the USA is seen to be highly sensitive to income. With income growth, USA consumers substitute higher priced calories for lower priced ones, rather than increase their caloric intake. It is likely that choice seafood items are being substituted for meat. Grain intake does not grow with income. Norway, on the other hand, represents the case of a developed country where fish is a staple. With income growth, consumers are substituting beef for fish, although total expenditure on fish continues to rise.

Among poorer countries, China has high income response for fish, although it is doubtful that fish is being substituted for beef. Instead, consumers are increasing their overall animal protein intake as income rises, and fish is the commodity most affected at this time, perhaps due to increased availability. Egypt, on the other hand, already has significant exposure to fish because of the close proximity of virtually the entire population to fish-

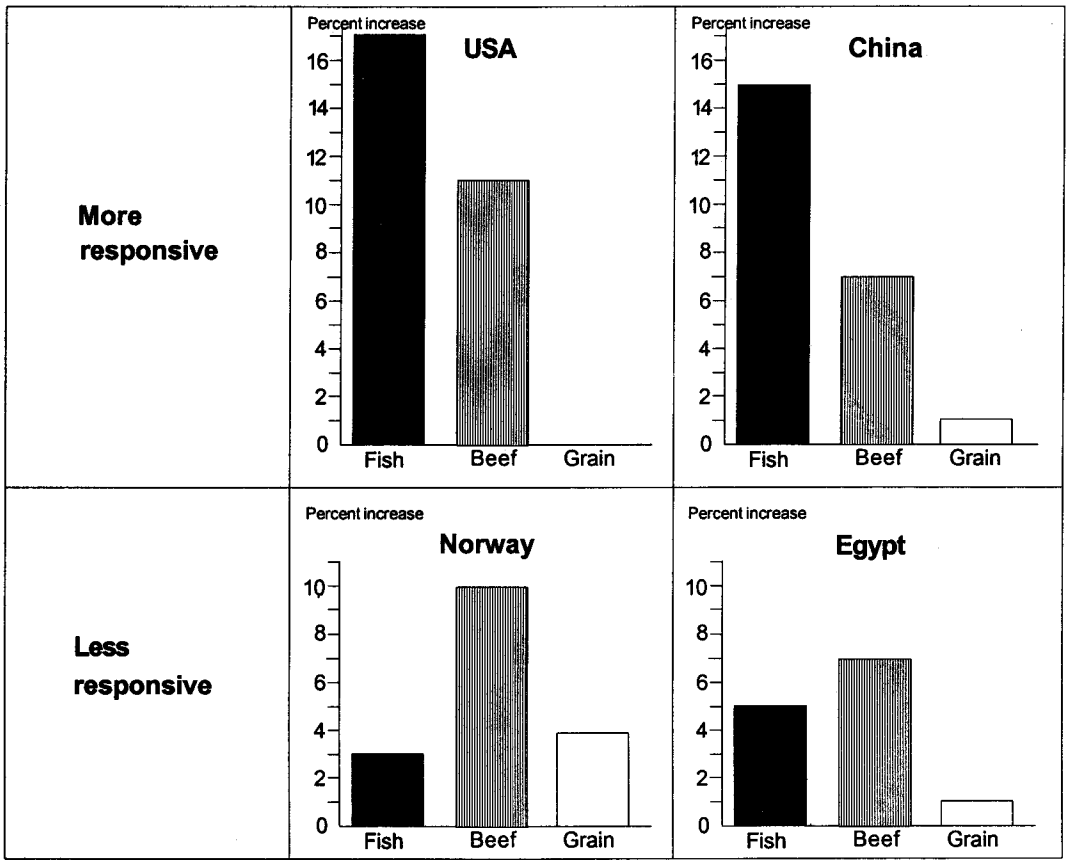
bearing bodies of water. Incremental demand for animal protein appears to be relatively low, as income increases are associated more with attempts to diversify the diet. Clearly very different mechanisms are at work in the four cases, which illustrates some of the difficulties of global modeling even with regional disaggregation.

The detailed country demand studies do allow a view of price substitution relationships among commodities and the likely reaction of consumers to changes in relative prices. These are partial equilibrium relationships and are only indicative of the overall impact of price changes.[6]

Fig. 2 shows the impact on demand for fish of a 10% change in the price of each of three commodities. Fish consumption falls when its own price rises in all four countries.

Fish price increases affect demand most in China. A rising fish price is bad news for fish producers in China (besides consumers), since a 10% price increase for fish is forecast to provoke a 13% cutback in expenditures on fish. The effect of higher fish prices in China is lower fish producer revenues. More revenue is lost through decreased sales than is gained through higher prices. In Norway, higher fish prices also have a significant effect on the amount of fish consumed and it seems unlikely that producers would gain much revenue from higher fish prices. In the USA, higher fish prices increase the revenues of fish sellers (a 10% rise in prices is associated with only a 4% fall in sales). In Egypt, higher fish prices hardly affect fish consumption, suggesting that producers and sellers can potentially capture most of the increased revenue from higher prices.

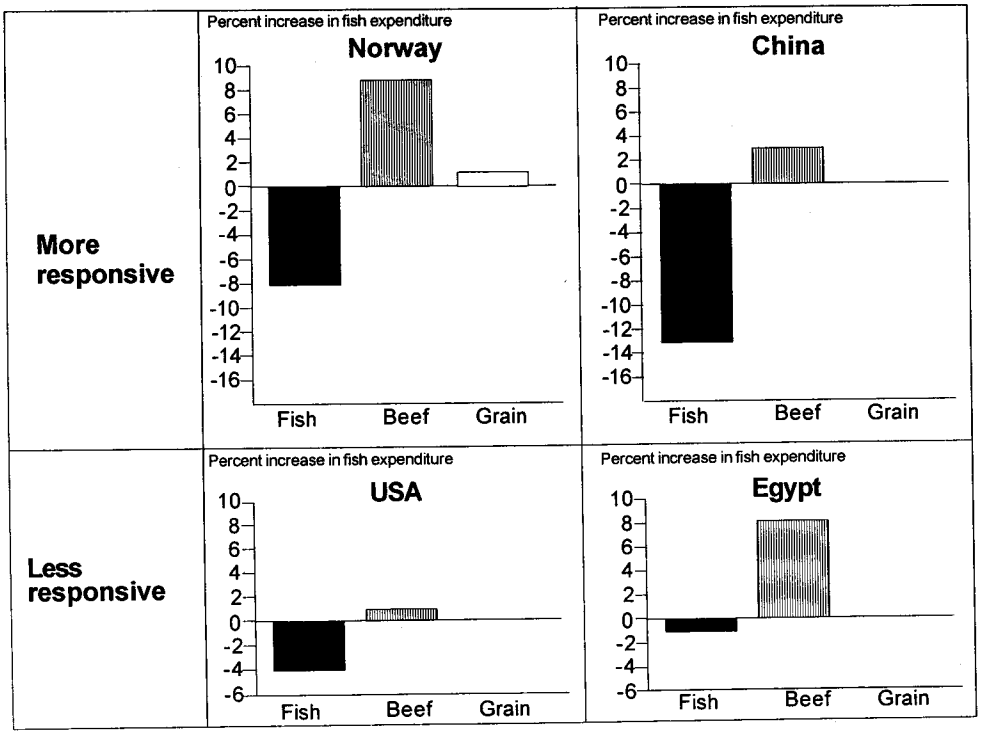
Figure 1. Effects of a 10% increase in income on consumption of fish, beef and grain.



Source: See Appendix Table 1.

[6] However, they are based on compensated elasticities that are adjusted to allow for the fact that price changes also affect consumption through changes in overall purchasing power, and this "income effect" of prices is compensated for.

Figure 2. Effects of a 10% price increase on consumption of fish.



Source: See Appendix Table 2.

Beef sellers should not be indifferent to these results. In countries where fish consumption is an important part of the diet, such as Norway and Egypt, beef prices have significant effects on fish consumption; higher beef prices increase fish demand on almost a 1% for 1% basis. Since cross price effects such as these tend to work in both directions, higher fish prices are also likely to affect beef consumption significantly. In Norway, consumers appear to be ready to shift from fish to beef, and back, rather responsively. In relatively poor China, the effect of higher fish prices may be to cut-back consumption of fish, with relatively minor substitution into beef. Possibly some of this decreased demand for fish shifts to other proteins. In the USA, where fish is hardly a staple food, fish consumption patterns tend to be rather unresponsive to prices of either fish or beef. In all four countries, fish consumption is not much affected by grain prices.

If we accept the view in Rosegrant et al. (1997) that world beef prices are likely to decline about 5% in real terms by 2020 and the emerging consensus that real fish prices are likely to rise by an order of magnitude of 10%, we would look for a long run change in relative fish/beef prices of 15%. This is a rather conservative estimate, given the three-fold decline in the price of beef relative to fisheries products since 1970 (Table 5). Coupled with the cross-price elasticity estimates between fish demand and beef price in Fig. 2, other things equal, this implies major adjustments in world markets for both fish and beef. In China, for example, estimated to account for roughly 15% of world fish consumption in 2010 under constant prices (Westlund 1995), such a relative price increase for fish would imply that fish demand would be 13% to 16% lower than it would have been if relative world prices had stayed at 1990s levels.[7] In Egypt beef demand would be at least 10% higher.

[7] These partial equilibrium estimates should not be over-worked, but they are indicative of orders of magnitude: 10% fish price change times 1.3 price elasticity of fish demand plus 1-2% (0.3 X 5%) further decrease in demand for fish because of lower beef prices.

Conclusions

This paper has attempted to raise empirical and analytical issues from recent literature pertaining to fish exports and consumption in developing countries, recognizing the increasing interrelatedness of events affecting fisheries around the world. It has highlighted major changes in the world over the past 15 years that imply that those interested in poverty alleviation and growth in the developing world cannot ignore the potential impact of fisheries on real incomes of producers and consumers.

Fisheries are increasingly becoming one of the means that the developing world can use to pay for their increasing cereal imports from the developed countries over the next 20 years. The developed countries are clearly going to become even more significant net importers of fish than they are presently (85% of world net imports of fish in 1994). Markets for high value products and for inputs to produce these items (such as fishmeal) will continue to expand rapidly. Fisheries have already surpassed the traditional export crops as a foreign exchange earner for developing countries (US$19.7 billion in 1993 in current dollars). Prospects for aquaculture based high value exports appear good, at least from a market-outlet perspective. It seems likely that policy attention to fisheries issues will increase, as was the case previously for cash crops in developing countries, once policymakers recognize that fisheries issues are no longer an obscure sectoral concern or solely a welfare consideration for coastal people.

As this policy attention increases, the glaring knowledge gaps will become more obvious. The most obvious one in the context of this paper is that we really have little idea of the forces driving relative fish prices, at least in a quantitative sense, that would permit consistent long-term predictions. Data availability is improving and this area needs to become better integrated within mainstream food modeling.

Second, sectoral marketing policies as well as trade liberalization will do much to permit the expansion of high value fisheries production in the developing countries. However, fisheries products, like milk, meat, and other perishables, tend to be associated with high transactions costs in trade, since processing is an important part of value added and consistency and trust are so important in quality control along the market chain. The high importance of transactions costs in the growth of fisheries exports for developing countries suggests an important role for governments in fisheries, not as a substitute for producers or traders, but as builders of infrastructure, enforcers of rules and facilitators of information flows.

Third, many of the high value opportunities in fisheries are capital and information intensive, which will mean that artisanal fisherfolk will have trouble participating in the fisheries boom without participatory institutions of collective action to allow them an equal footing. Governments faced with a need to involve such populations need to explore urgently how they can facilitate the growth of such institutions without stifling them. Many issues appear, at least on the surface, to be similar to the construction of smallholder dairy systems in tropical climates. There may be symbiosis to explore here.

Finally, this paper has intentionally ignored supply side issues such as technology development and environmental questions to avoid duplication. Yet there is an urgent need for more policy research on the full costs and returns to technology development in fisheries, especially for aquaculture adapted to the needs of rural and coastal people in developing countries. This may end up being one of the most important policy areas to explore.

References

Alderman, H. and J. von Braun. 1984. The effects of the Egyptian food ration and subsidy system on income distribution and consumption. Research Report 45. International Food Policy Research Institute, Washington, D.C.

Alexandratos, N., Editor. 1995. World agriculture towards 2010: FAO Study. Food and Agricultural Organization of the United Nations, Rome, and John Wiley, Chichester, U.K.

Brandow, G. 1961. Interrelations among demands for farm products and implications for control of market supply. Interregional Publication for the State Agricultural Experiment Stations Bulletin 680. The Pennsylvania State University, University Park, PA.

Edgerton, D., B. Assarsson, A. Hummalmose, I. Lautila, K. Rickertsen and P. Vale. 1996. The econometrics of demand systems: with applications to food demand in the Nordic countries. Kluwer Academic Press, Boston.

FAO (Food and Agriculture Organization of the United Nations). 1994. Annual. FAO Yearbook: Fishery Statistics. Rome.

FAO Annual. Commodity Review and Outlook. FAO, Rome.

FAO (Food and Agriculture Organization of the United Nations). 1997a. The State of World Fisheries and Aquaculture 1996. FAO, Rome.

FAO (Food and Agriculture Organization of the United Nations). 1997b. FAOStat database. Available: <http://faostat.fao.org/default.htm>. Accessed May 1997.

FAO (Food and Agriculture Organization of the United Nations). 1998. FAOStat database. Available: <http://faostat.fao.org/default.htm>. Accessed March 1998.

Gao, X. and T. Spreen. 1994. A microeconometric analysis of the U.S. meat demand. Can. J. Agric. Econ. 42: 397-412.

Huang, J. and H. Bouis. 1996. Structural changes in the demand for food in Asia. Food, Agric. Environ. Discuss. Pap. 11. International Food Policy Research Institute, Washington, D.C.

Huang, J., S. Rozelle and M. Rosegrant. 1997. China's food economy to the twenty-first century: supply, demand, and trade. Food, Agric. Environ. Discuss. Pap. 19. International Food Policy Research Institute, Washington, D.C.

Rosegrant, M., M. Sombilla and N. Perez. 1995. Global food projections to 2020: implications for investment. Food, Agric. Environ. Discuss. Pap. 5. International Food Policy Research Institute, Washington, D.C.

Rosegrant, M., M. Sombilla, R. Gerpacio and C. Ringler. 1997. Global food markets and US exports in the twenty-first century. Paper presented at the Illinois World Food and Sustainable Agriculture Program Conference "Meeting the Demand for Food in the 21st Century: Challenges and Opportunities for Illinois Agriculture", Urbana-Champaign, Illinois, 28 May 1997.

Phelan, J. and J. Henriksen. 1995. Global issues in the supply of livestock food products to urban populations. *In* Supply of Livestock Products to Rapidly Expanding Urban Populations. Food and Agriculture Organization of the United Nations, Rome.

Westlund, L. 1995. Apparent historical consumption and future demand for fish and fishery products—exploratory calculations. Paper prepared for the International Conference on Sustainable Contribution of Fisheries to Food Security, Kyoto, Japan, 4-9 December 1995. Rome. FAO/KC/FI/95/TECH/8

World Bank. Bi-annually to 1991. Commodity trade and price trends. Washington, D.C.

World Bank. Quarterly since 1993. Commodity markets and the developing countries. Washington, D.C.

Appendix Table 1. Income effects on fish, beef, and grain expenditures.[a]

Effect on	Developed		Developing	
	More responsive USA[b]	Less responsive Norway[c]	More responsive China[d]	Less responsive Egypt[e]
	(%)		(%)	
Fish expenditure	1.7	0.3	1.5	0.5
Beef expenditure	1.1	1.0	0.7	0.7
Grain expenditure	0.0	0.4	0.1	0.1

Sources and notes:

[a] Total expenditure elasticities, rounded to one decimal place.

[b] The fish and beef elasticities are from Gao and Spreen (1994). The beef elasticity is the average of steak, roast and ground beef expenditure elasticities. The 'cereals and baking products' estimate is from Brandow (1961).

[c] Fish, meat, and 'bread and cereals' elasticities are from Edgerton et al. (1996).

[d] Fish, 'beef and mutton,' and grain expenditure elasticities are from Huang and Bouis (1996). The values are averages of urban and rural estimates.

[e] Fresh fish, fresh meat, and balady flour expenditure elasticities are from Alderman and von Braun (1984). The values are averages of urban and rural estimates.

Appendix Table 2. Price effects on fish consumption.[a]

Effect on	Developed		Developing	
	More responsive Norway[b]	Less responsive USA[b]	More responsive China[d]	Less responsive Egypt[e]
	(%)		(%)	
One percent increase in the price of fish	-0.8	-0.4	-1.3	-0.1
One percent increase in the price of beef	0.9	0.1	0.3	0.8
One percent increase in the price of grain	0.1	0.0	0.0	0.0

Sources and notes:

[a] Compensated price elasticities from expenditure systems estimators, rounded to the first decimal place.

[b] Own price elasticity and cross price elasticities of fish demand with respect to meat and 'bread and cereals' prices from Edgerton et al. (1996).

[c] Own price elasticity and the average of the cross price elasticities of fish demand with respect to retail steak, roast, and ground beef prices from Gao and Spreen (1994). The cross price elasticity of fish demand with respect to cereals is from Brandow (1961).

[d] Compensated own price and 'beef and mutton' and grain cross price elasticities of fish demand are calculated from data reported in Huang and Bouis (1996). The values are averages of urban and rural estimates.

[e] Own price elasticity, and cross price elasticities of demand for fresh fish with respect to prices of fresh meat and balady flour are from Alderman and von Braun (1984). The values are averages of urban and rural estimates.

COMMENTS

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Thanks to the organizers for the opportunity to participate in this undertaking. While my research has been mainly related to agricultural policies, I have recently begun research on urban water issues and will begin work on the intersectoral trade-offs for water among urban, agricultural and other uses, including fisheries.

The Delgado and Courbois paper reviewed the changing patterns of trade, world prices, and consumption of fishery products, and available projections of demand and supply. The paper brought out the fact that only FAO has made any demand and supply projections for fisheries, partly reflecting the limited interest in the sector. Most interesting were the observations that world trade in fishery products has been quite dynamic and that wide differences in income and price elasticities exist between and within developed and developing countries. The latter suggest the importance of more empirical and analytical studies about the nature of demand and trade in fishery products, and analysis of their determinants. I also believe that such demand and trade studies have much broader policy implications, requiring more demand and trade policy research than mentioned in the paper — encompassing price, market, trade, technology, environment, water and even health policies. Let me discuss some of these and then make brief comments about estimation and data issues.

Let me start by discussing some examples of such policy issues:

Price, Market and Trade Policies

Demand and trade flows are critically determined by price, market and trade policies, and these in turn also affect supply-related variables and issues. There has been very little empirical analysis across countries of price and trade policies (through estimates of nominal and effective rates of protection) affecting the different kinds of fish and their effects on demand, trade and resource allocation around the world.

There is probably even less understanding of the potential impact of trade liberalization on resource allocation, environment, and equity concerns in the fishery sector. The fishery sector will also be (in fact has already been) greatly affected by developed country efforts to use concern about environmental and food safety standards to preserve and erect trade barriers, as evidenced by the tuna-dolphin case between USA and Mexico. This is not to say that environmental and food safety concerns should not be addressed both nationally and internationally, but that more appropriate policy and institutional instruments rather than trade barriers would be more efficient and equitable tools. Since fishery products are a major export of developing countries, more open trade policies are of critical importance to developing countries.

Technology Policies

Technology policy depends not only on the cost of technology generation but the potential benefits or impact of technological change on efficiency and equity. For the estimation of the latter, demand and trade analyses are important.

For example, the distribution of benefits from new technology between producers and consumers would have a bearing on who should pay for technology development, the role of public sector in fishery research and research prioritization. For that analysis, estimates of demand elasticities are needed, particularly since price elasticities differ widely across different types of fishery products, different consumers, and whether the fishery product is tradeable or not. Since a significant proportion of fishery catch from inland water resources is consumed directly, estimates of subsistence ratio of fish catch is also important in analyzing the equity impact of technological change in inland fisheries.

Water and Environment Policies

Since water, especially good quality water, has become an increasingly scarce resource, estimations of the marginal value of water for alternative uses, including fisheries, are necessary to determine: (i) the optimal allocation of water across uses; (ii) distribution of benefits from water use; and (iii) the value of environmental and water quality protection. Those estimates would be based on parameters of the demand function for fishery products.

Health Policies

Red Tide has become quite common in the Philippines and how much public health expenditure should be allocated for that problem would depend on the cost of Red Tide to consumers' welfare and the level of income of those consumers.

Estimation, Analytical and Data Issues

Not having had much research experience in consumption/demand/trade of fishery products, I only have a few points to make. Because of the apparent wide differences in the nature of demand for fishery product by type of fish and type of consumers, the strong substitutability between fish and meat products, and the limited availability of good quality data on fish consumption, empirical estimation of demand functions for the fishery sector is much more difficult than grains and even meat products in a number of ways:

1) The demand model must be more fully specified in terms of including a greater number of substitutable products in the functions and using a complete demand system approach;
2) The demand model must be more disaggregated: by type of fish and type of consumers;
3) The demand model should distinguish between quantity and value terms. Most demand estimation uses aggregate and secondary data. I think there is a strong case for building up a microlevel database to make more meaningful characterization of consumption and demand patterns and consumers, and estimation of demand function for fishery products. Because surveys are very expensive, international collaboration which allows intercountry comparisons is important in raising the cost effectiveness.

Policy Issues Deriving from the Scope, Determinants of Growth, and Changing Structure of Supply of Fish and Fishery Products in Developing Countries[1]

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Abstract

The supply of fish and fisheries products has shown a steady increase since the 1950s and is undergoing major changes as a result of increased and diversified market demand and trade, availability of new technology and changes in institutional arrangements. The net effects on developing countries of continued growth in production and the changing structure of the supply of aquatic products are unknown, resulting in uncertainty and imposing significant costs on the poorer segments of the population that are dependent on fisheries for food and income. This paper analyzes the major determinants of the supply of fishery products in the developing countries and discusses the relevant policy issues derived from the current context.

An increase in the supply from capture fisheries in the long run will depend upon investment in resource and habitat rehabilitation, development of fisheries on underexploited resources, implementation of agreed catch limits, and reduction of discards and wastage. In aquaculture, supply will be determined by price, cost and availability of inputs, technology, infrastructure, support services, and environmental limits. Technological development such as breeding and genetic improvements, infrastructure and other support have the potential to greatly enhance aquaculture production in the medium term. However, the supply and management of land, water resources and feed inputs will be the most critical factors for sustainable long term growth. Government policies with regard to the supply of fish need to focus on ensuring a long term basis for production, maintaining and conserving the natural resource base for fish production, and making poor fishers and farmers the major beneficiaries of the growth as an important means of strengthening their food security. In order to be compatible with these objectives, policy alternatives should look at ways of increasing the supply of aquaculture products as substitutes to capture fisheries production.

[1] ICLARM Contribution No. 1380

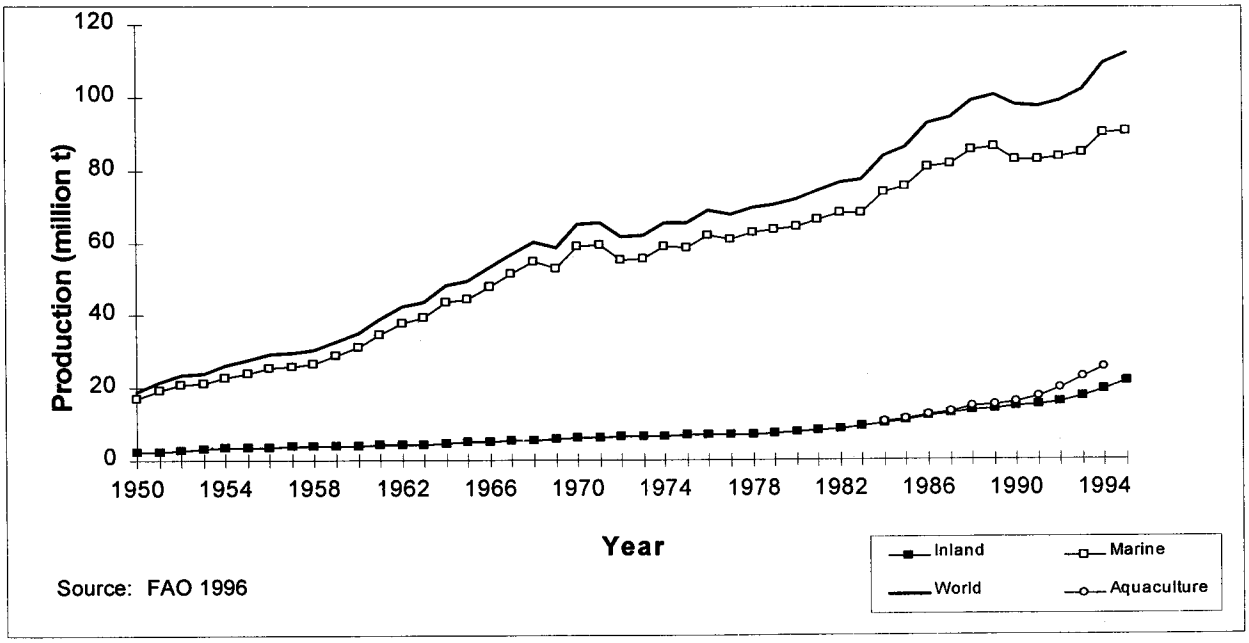
Introduction

The world supply of fish rose steadily to 112.3 million t in 1995 from only 20 million t in the early 1950s (Fig. 1). This unprecedented growth in production reflects a sharp increase in the catch from natural stocks plus a rapid growth in aquaculture production, particularly in Asian countries (China being the single largest), over the last 10 years. The structure of supply has also changed and is expected to undergo a further transition as a result of increased and diversified market demand and trade, availability of new technology and changes in the institutional arrangements and legal instruments governing local, national and international fisheries. Every desirable species is being caught with the increased use of efficient and specialized techniques of harvesting the oceans and inland waters. The 1982 UN Convention on the Law of the Sea (UNCLOS) and subsequent regional and international arrangements have provided new ownership and/or access to most fishing states, encouraging them to rapidly expand their fishing capacity and resort to modern fishing techniques, or enter into licensing agreements with foreign fishing vessels to obtain a higher catch and revenues.

In aquaculture, the mass application of low-cost fish breeding technology for a number of popular species, along with advanced farming knowledge and more intensive farming techniques, have produced more fish and supplied more valuable products. Thus, larger areas are being tapped and more resources exploited. This is likely to have profound effects on the resources and the people who depend on them (Williams 1996).

The net effects of continued growth in production and the changing structure of supply of aquatic products for the developing countries are not known, particularly for the poorer segments of the population who traditionally derived a substantial amount of their food security through participation in small-scale production, consumption and sale of these products. Williams (1996) predicted two possible effects in the context of the current transition in the aquatic resource systems of the globe. On the one hand, it could threaten progress toward sustainable food security in many parts of the world, while on the other, it could stimulate

Figure 1. Trends in world fish production in inland, marine and aquaculture fisheries, 1950-1994.



Note:
1. The production for aquaculture includes aquatic plants.
2. The following organisms included in the FSTAT 1996 were excluded from the production data presented in the figure: corals, pearls, mother-of-pearl, sponges, bluewhales, finwhales, spermwhales, pilotwhales, crocodiles, alligators, eared seals and haired seals.

improved use of living aquatic resources if appropriate policies and actions are undertaken today.

This paper discusses the resource base, the changing structure of the supply of fish, and the status and impact of policy measures on the fisheries of developing countries. This is followed by an analysis of the possible determinants of future growth and policy issues derived from them.

Resource Base - The Changing Structure of Supply

The aquatic system, which covers more than 70% of the earth's surface, serves as the primary resource base for thousands of economically important animal and plant species. There are several types of resource systems in marine and inland environments that are currently utilized by capture fisheries and aquaculture. ICLARM (1992) grouped them into the following categories: (i) ponds; (ii) reservoirs and lakes; (iii) rivers, floodplains and swamps; (iv) estuaries and lagoons; (v) coral reefs; (vi) soft-bottom shelves; (vii) upwelling shelves; and (viii) open oceans. Each of these resource systems has differing ecological and environmental characteristics. They support distinct fishery activities and are operated under different socioeconomic and management regimes, including transnational and international involvement (Table 1).

The steady growth in total production of fish has been accompanied by several significant changes in the structure of supply over the last few decades. The contribution of aquaculture has become significant. Its share of total production increased from less than 10% in the early 1980s to 19% in 1995. For a number of species, an increasing proportion of supply now comes from aquaculture. For example, 31% of salmon and 20% of shrimp come from farmed sources.

Since 1985 developing countries have been producing an increasing share of the world supply of fish from both capture fisheries and aquaculture, and earning significant foreign exchange from their exports. Foreign exchange earnings of $16 billion in 1994 show an increase of more than 300% over the last decade. The low income food deficit countries (LIFDCs)[2] alone accounted for 35% of total production (Fig. 2). The annual growth rate of fisheries production (6.9%) in these countries was also much higher than the overall growth of world fisheries (2.5%) during the period 1988 to 1994. For both China and the Philippines a growth rate of fish supply of 14% during this period was the highest among the LIFDCs. Of the total world production of 112.3 million t in 1995, 90.70 million (81%) was from resource systems that are located in the marine environment and the remaining 21.60 million t (19%) was from those in the inland environment (FAO 1997).

Aquaculture

Rapid Growth in LIFDCs

Aquaculture has become the world's fastest growing food production system. Between 1990 and 1995 the average global production grew by more than 11% annually. The rate of growth of aquaculture production for the developing countries was higher. The LIFDCs experienced a 17% growth in production between 1990 and 1994. Their share of world production of finfish, shellfish and aquatic plants was 75% in 1994. In addition, aquaculture made a significantly large contribution to the national fishery production in LIFDCs (Fig. 3). Despite rapid growth, the geographical spread of aquaculture was slow and there was very little increase in the number of species under culture. Production was dominated by long established producers and traditional species (FAO 1997). Though Africa produces less than 1% of total aquaculture production, there was a threefold increase over the last decade. In Latin America the production of selected high value commercial species increased very rapidly, while rural aquaculture showed little growth (FAO 1996).

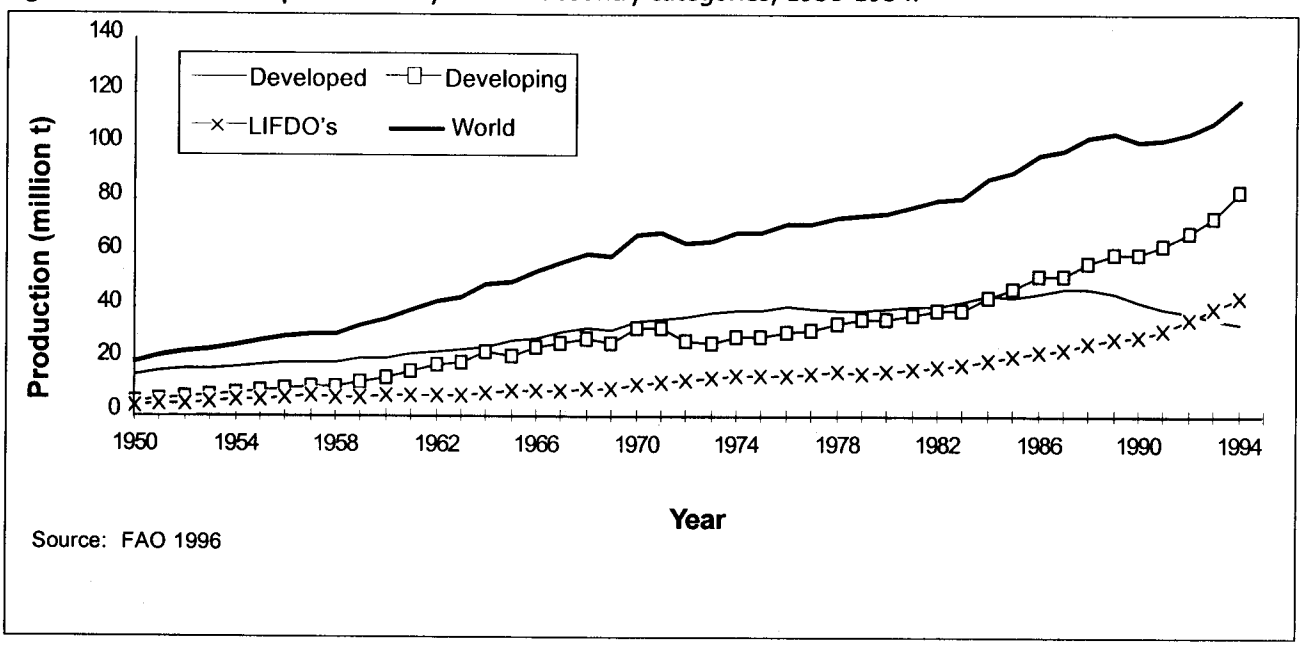
[2] According to FAO, the LIFDCs are those developing countries whose annual per capita net income is below $1,395 (1990 GDP) and are net importers of food with imports of basic foodstuff outweighing exports.

Table 1. Resource systems and their significance to fisheries.

Resource systems	Features	Fisheries significance
1. Ponds	• small waterbodies • usually human-made • located in irrigated or rainfed areas • held under individual or group ownerships • useful for water supply and household uses	• aquaculture at various intensities • trapping of wild fish
2. Lakes and reservoirs	• natural/artificial freshwater bodies • reservoirs are used for irrigation, hydro-electric power and water supply • natural lakes are located in tropics and sub-tropics, with the large ones located in Africa	• conventional or enhanced capture fisheries • fish ponds along lakeshores • cage culture • usually considered common property, but fishery and aquaculture uses are regulated through leasing or licensing
3. Rivers, floodplains and swamps	• subject to periodic or near permanent inundation and sediment deposition • highly influenced by terrestrial and land-based activities	• support substantial inland fisheries • enhanced fisheries • aquaculture (cage culture seasonal ponds) • common property and open access • in some cases commercial fishing is regulated by licensing or leasing
4. Estuaries, lagoons and mangroves	• semi-enclosed, shallow coastal waterbodies with connection to open sea • brackishwater (seawater is dilluted with freshwater from land drainage) • surrounded by mangroves	• supports small-scale coastal fisheries • enhanced fisheries • cage and pen culture • nursery area for fish and penaeid shrimp • pond culture through conversion of mangroves and swamps
5. Coral reefs	• located in continental and island shelves dominated by reef building corals	• intensive fishing often using methods that destroys the living corals • usually exploited by adjacent coastal communities • management through community-based effort is a priority
6. Soft-bottom shelves	• relatively shallow (up to 10-200 m deep) areas surrounding the continents	• both small-scale and large-scale marine fisheries • deployment of excessively large fleets for catching demersal stocks • overfishing and conflicts with small-scale fisheries
7. Upwelling shelves	• nutrient-rich water is brought to the surface of sea from deep layers through the effects of strong winds and earth's rotation • fertile seawater supports large population of pelagic fish, sea birds and sea mammals	• medium to large-scale industrial fishing vessels • fisheries dominated by few species of small (anchovies and sardines) and large (bonitos, mackerels) pelagic fish • most productive aquatic system, but subject to high fluctuation by changes in environmental conditions
8. Open oceans	• located beyond 200 m deep	• large-scale fisheries • mainly oceanic resources such as tuna and large squids are fished • dominated by developed country fleets

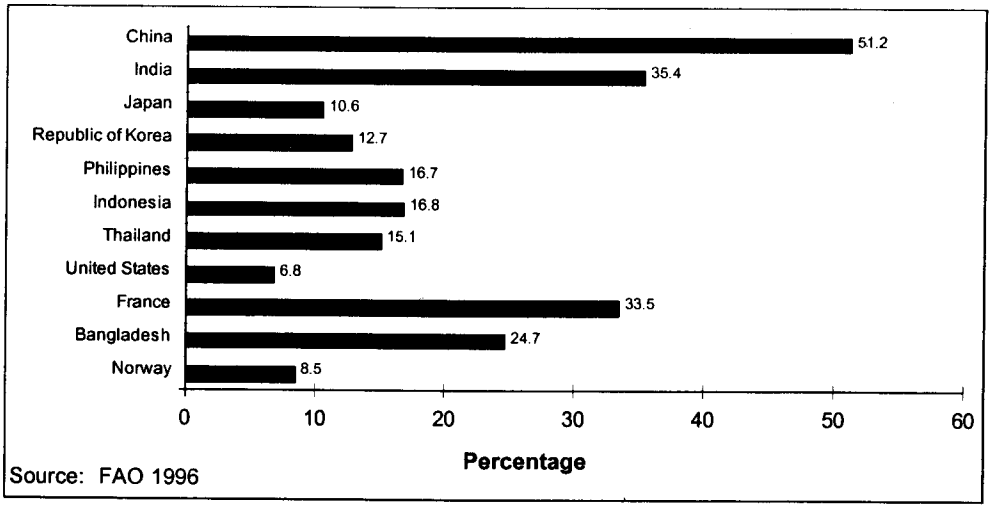
Adapted from ICLARM (1992).

Figure 2. Trends in fish production by different country categories, 1950-1954.



Note:
1. This total production of aquatic organisms includes plants.
2. The following organisms included in the FSTAT 1996 were excluded from the production data presented in the figure: corals, pearls, mother-of-pearl, sponges, bluewhales, finwhales, spermwhales, pilotwhales, crocodiles, alligators, eared seals and haired seals.

Figure 3. Contribution of cultured finfish and shellfish to national fishery production in major aquaculture-producing countries, 1994.



Use of Diverse Resource Systems

Another significant development is the expansion of culture practices into a wide range of aquatic environments. Aquaculture is now practiced in (i) small-scale fish ponds and ricefields - fish farming in perennial and seasonal waterbodies; (ii) cages and pens placed in lakes, reservoirs and waterways; (iii) large-scale fish ponds mostly located in coastal and mangrove areas; and (iv) open seas for ranching of fish, shellfish and seaweed. In addition, regular or periodic stocking of hatchery reared fry and fingerlings in coastal waters, rivers, floodplains and lakes, known as culture-based or enhanced fisheries, is also a part of aquaculture operations. However, the bulk of aquaculture production comes

from pond-based farming systems, practicing semi-intensive polyculture, which supply low priced food fish for household consumption, especially in India and China.

Input Use and Productivity

Input use and productivity in aquaculture showed a wide variation across resource systems, type of practice (e.g., subsistence and commercial), type of species, geographic areas and socioeconomic condition of the farmers. The last factor had been a major determining factor limiting increased input use by poor farmers in the developing world. Increase of primary productivity of ponds, through the use of fertilizers, manures and supplementary feeding with waste products and byproducts of plant and animal origins, dominated developing country aquaculture during the past decade. Culture practices for high value species such as shrimp or finfish were developed around intensive feeding with commercial feed ingredients (e.g., fishmeal).

Unlike many crop and livestock technologies where fixed rates of input use are considered a norm for achieving profitable production, many aquaculture practices in the developing world, particularly at the level of small farmers, use varying levels of inputs and maintain flexibility with respect to substitution among the various inputs. The rate of input use is, however, a major productivity factor that shows large differences between culture systems, cultured species and production environments (Table 2). In Egypt polyculture pond systems characterized by low to moderate production inputs derived from local sources have production rates ranging from 500 to 5 000 kg/ha/

Table 2. Comparative productivity of selected aquaculture systems in India, Bangladesh, Philippines and Thailand.

Species	Gross yield/ ha (kg)	Variable cost (cost/kg)[a]	Currency[b]	Price/ kg	Culture system	Culture technology
INDIA[c]			Rupees			
Carp polyculture	5 900	14.00		22.00	Freshwater ponds	Semi-intensive
BANGLADESH			Taka			
Carp polyculture[d]	2 071	6.87		38.68	Ponds and ditches	Extensive (low cost on-farm inputs)
Nile tilapia monoculture[d]	2 208	6.57		28.25	Ponds and ditches	Extensive (low cost on-farm inputs)
Silver barb monoculture[d]	1 131	16.87		36.81	Ponds and ditches	Extensive (low cost on-farm inputs)
Silver barb monoculture[e]	815	14.10		36.78	Ditches	Extensive (low cost on-farm inputs)
Silver barb polyculture[e]	1 480	8.89		32.64	Ditches	Extensive (low cost on-farm inputs)
PHILIPPINES			Pesos			
Tilapia monoculture	1 050	19.50		44.72	Ponds	Extensive
Tilapia monoculture	18 940	12.74		45.76	Cages	Intensive
Milkfish monoculture	1 652	43.16		56.94	Ponds	Semi-intensive
Shrimp monoculture	1 500	95.94		139.88	Ponds	Semi-intensive
THAILAND			Baht			
Catfish	19 950	14.28		20.14	Fishponds	Intensive
Tilapia	5 560	5.10		11.47	Fishponds	Semi-intensive
Shrimp	4 119	79.56		142.29	Fishponds	Semi-intensive

[a] Variable cost includes material inputs only.
[b] US$1 = 29 Rupees, 40 Taka, 26 Pesos and 25 Baht.
[c] Veerina et al. (1993).
[d] Ahmed et al. (1995).
[e] Gupta and Rab (1994).
[f] Dey and Bimbao (1995).

Table 3. Cost and benefits (BDT·ha^{-1}) of fish farming in pond fish culture practiced within existing farming systems in Bangladesh (US$1 = BDT 37.00, 1991).

	Carp n=82	Tilapia n=16	Silver barb n=117
Production cost (BDT·ha^{-1})[a]	10 807	6 452	13 990
• cash	3 415	8 045	5 087
• noncash	14 222	14 497	19 077
• total			41 636
Gross income (BDT·ha^{-1})	80 111	62 373	22 561
Net income (BDT·ha^{-1})	65 888	47 876	27 647
Net cash income (BDT·ha^{-1})	69 303	55 921	
Return on investment	463%	330%	118%
Price of fish (BDT·kg^{-1})	38.68	28.25	36.81

[a] Includes only operating costs (nonlabor) such as fingerlings, material inputs (fertilizers, feed and harvesting cost).
n = sample size
Source: Ahmed et al. (1995).

year, depending on the level of production inputs and management (FAO 1997).

In the Asian context, carp polyculture can yield production rates ranging from a few hundred kilograms to several metric tons per hectare annually. Veerina et al. (1993) reported that traditional farming communities in some parts of Andhra Pradesh, India have successfully adopted semi-intensive fish farming where 94% of the fish ponds were previously used for agriculture. Average annual production of 6-8 t/ha were realized using organic and inorganic fertilizers and plant-based diet such as ricebran, cottonseed meal, deoiled bran and groundnut cake as supplementary feed.

Information dissemination and training schemes on flexible technological choices have significantly enhanced the productivity and rate of technology adoption, as well as participation by women in Bangladesh (Gupta and Rab 1994; Ahmed et al. 1995). Farmers were quick to adopt the technology and increased input use substantially. In Kapasia Thana under Gazipur district, the average production from homestead ponds increased 4 to 5 times following a technology transfer program through extension services. Higher levels of net income with rate of return on investment ranging from 118% to 463% were also realized (Table 3). This is despite the fact that only 56-74% of the potential production from the recommended technology was achieved (Table 4). The incidence of disease, low levels of input use (less than recommended amounts) and escape of fish due to flooding were responsible for this shortfall. Nearly 46% of the waterbodies were affected by a disease known as epizootic ulcerative syndrome (EUS). Input use ranged from 7% to 46% of the recommended levels for carp polyculture (Table 4).

Capture Fishery

After nearly three decades of steady growth, supplies from capture fisheries stabilized during the last decade with a total production reaching 90.7 million t in 1995. There was virtually no growth in production from natural stocks in coastal and nearshore areas and inland waters and floodplains because of overfishing and due to the degradation of the environment and destruction of fish habitats, such as wetlands, mangroves and coral reefs.

Coastal and Near-shore Fisheries

Coastal and near-shore fisheries continued to attract more and more labor and capital, particularly due to expanding populations and a shortage of employment opportunities in other sectors. Overfishing has become prevalent in capture fisheries

Table 4. Production and input use for pond fish culture practiced within existing farming systems in Bangladesh.

	Polyculture	Nile tilapia	Silver barb
Average production (kg/ha)	2 071	2 208	1 131
Target production (kg/ha)	3 705	2 964	1 976
Production achievement (%)	56%	74%	57%
Level of input use[a]	7-48%	48-99%	55-87%
Lime	42	99	55
Inorganic fertilizer	32	48	87
Manure	-	-	-
Cattle manure	46	80	86
Poultry manure	39	90	77
Oil cake	7	-[b]	-
Grass/vegetation	3	-	-
Compost	0	-	-
% of disease affected pond	37	0	63
% of flood affected pond	2	6	4
Culture period (months)	9	8	9

[a] Actual input use levels per hectare as percentage of suggested levels.
[b] Not recommended.
Source: Ahmed et al. (1995).

in both the developing and developed countries. It has become a severe problem in densely populated coastal areas in the developing countries and in the productive offshore areas in all parts of the world.

The exploitation patterns in many fishing areas have also undergone changes as a result of changes in the global economic context, institutional arrangements and legal instruments. A drastic reduction in distantwater fishing activities reduced the catch by the former centrally planned economies in eastern Europe and former USSR. This has affected the supply of low value pelagic fish to regions such as West Africa, prompting some countries to consider the option of developing national fishing fleets. On the other hand, there has been a significant redirection of effort towards high value resources to generate foreign exchange, particularly in the transitional economies of eastern Europe and some Latin American countries. For example, there has been a large increase in the catch of squid by Peru and Mexico due to a high demand in the Spanish market (FAO 1997).

In addition, coastal and near-shore fisheries have suffered from the impact of several external factors, such as pollution caused by industrial, urban and agricultural activities, habitat destruction caused by upland development, reclamation and mangrove clearing, and competition for use and access caused by urbanization and tourism. These factors have become issues of overriding importance for the sustainability of coastal and nearshore fisheries, although the fishery sector can do little about them on its own (FAO 1997).

Offshore and Deep Sea Fisheries

Despite the establishment of exclusive economic zones (EEZ) many developing countries do not have the capacity to exploit their resources, particularly small island developing countries in the Pacific and Caribbean. The Pacific island countries almost exclusively rely on foreign fishing vessels for the exploitation of valuable tuna resources within their EEZ. According to a recent World Bank report, the tuna resources owned by the small Pacific island countries are now under a severe threat of overfishing as a result of uncontrolled exploitation by foreign fishing vessels. The serious underreporting of tuna catches, the spread of illegal fishing and the practice of discarding large quantities of bycatch have become common phenomena in tuna fishing. Market-led growth has resulted

in all habitats being fully exploited in the region and elsewhere. Over the long term, the Pacific island countries will have to adopt a limited access policy for foreign vessels to deal with the potential pressure of overfishing (World Bank 1995).

Some of the developing countries of Asia, such as Vietnam and China, are pushing their vessels to offshore and deep sea areas in order to reduce pressure from overfished and overcrowded coastal fisheries and to meet the increasing domestic demand for fish. This is, however, happening without a full understanding of stock availability.

Fisheries based on straddling fish stocks and highly migratory fish stocks showed a substantial increase in production from 2 million t in 1950 to nearly 12 million t in 1989. The overexploitation and lack of a monitoring mechanism in these fisheries have drawn significant international attention in recent years. Institutional arrangements between distantwater fishing nations and the coastal states are currently being sought for conservation and management of the stocks as well as for resolving conflicts among fishing nations (FAO 1997).

Inland Water and Floodplain Fisheries

In Africa and in many parts of Asia, inland fisheries in lakes and river basins with extensive floodplains were traditionally the catchment that supplied fish to the local population. Large-scale abstraction of water, alteration of water environment and riverine hydrology, and the destruction of fish habitats as a result of land-based activities, have caused these fisheries to degenerate and lose their economic and food security potential. In many developing countries, inland and floodplain fisheries still provide a significant proportion of subsistence supply of fish that does not go through the market. Because of a poor statistical data and the difficulty in measuring subsistence production, the extent of decline in the catch and its effect on local fish supplies remains undetermined.

Many countries have resorted to stock enhancement and culture-based fisheries development, including cage aquaculture, in their inland waters as an alternative means of increasing fish production. Many developing countries increased their investment in large-scale restocking programs to increase freshwater fish production with some success. Increases in freshwater fish production in Bangladesh in recent years have been partly attributed to fisheries enhancement (FAO 1997). Fish supply from enhanced fishery sources, however, raises the issues of property rights and equity, sustainable fingerling supply and biodiversity impacts. The development of cage aquaculture has also brought further damage to natural fisheries by destroying breeding grounds and displacing poor fishers and farmers.

Critical Issues in Aquaculture and Capture Fisheries

Aquaculture

Ecological Inputs and Environmental Integrity

Many aquaculture practices have not proved to be as efficient a means of protein production as was originally expected. Some have led to serious environmental degradation, e.g., shrimp mariculture, intensive cage culture, culture-based fisheries and restocking in lakes (Pullin 1993; Berg et al. 1996). The lure of quick profit encouraged the intensification of some of these culture systems, without any regard for the damaging ecological and environmental consequences.

In examining the aquaculture potential in Lake Kariba, Zimbabwe, Berg et al. (1996) found that intensive cage culture in the lake, despite its high production per unit of cage area, is a less viable option than semi-intensive pond aquaculture on land along the lakeshore. Since cages are open subsystems placed in the aquatic environment, the potential negative environmental effects are higher than those of land-based pond systems. In a pond there is less direct interaction with the open water ecosystem and most of the wastes can be trapped within the pond system itself. Intensive cage farming appropriates a substantially larger ecosystem area for producing its food and processing its waste.

The same applies to coastal shrimp farming. Moreover, as the scale of production increases, it damages or destroys the stock of environmental goods produced by the system, e.g., fish stocks, space for inshore fisheries and services such as oxygen production and waste assimilation. Conversion of mangroves for shrimp and fishponds, collection of shrimp and finfish fry and use of cyanide for collecting grouper fry from coastal waters have produced severe environmental degradation in a number of countries such as the Philippines, Indonesia, Vietnam and Thailand in Southeast Asia, and Ecuador and Honduras in Latin America. These factors are changing the community structure, reducing capture fishery recruitment and threatening ecosystem balance in the coastal area.

Reliance on Fishmeal for Feed

Feed is a vital production input in aquaculture. Locally produced or imported fishmeal is a major source of this input. Nearly 31.5 million t of fish (28% of total production) were used for fishmeal production in 1995 (FAO 1997). The demand for fishmeal is high for both aquaculture and livestock farming. Southeast Asian and east Asian countries accounted for more than half the total imports of over 4 million t of fishmeal in 1994. China alone imported 690 000 t in 1994. Development of alternative low cost sources of nutrients is a critical factor to the growth of aquaculture.

In some areas, local supplies of fishmeal are also available from the catch of less valuable pelagic fish from the large lakes to feed more valuable species such as catfish, carp and tilapia. In Lake Kariba, Zimbabwe, kapenta (*Limnothrissa miodon*) is used for the production of fishmeal in pellets to feed farmed tilapia in intensive cage culture systems. From an economic point of view this is feasible as the price for tilapia is much higher than that of kapenta. However, from the point of view of local food and protein requirements, this is an inappropriate conversion as about 4 kg of kapenta is required for the production of 1 kg of farmed fish. Similar feed conversion rates are prevalent in most of the intensive aquaculture systems practiced around the world.

Disease and Pollution Problems

With the large-scale movement and transfer of fish around the world, the problem of disease has become critical. In coastal aquaculture, the spread of disease has caused large fluctuations in production in recent years. In pond-based semi-intensive aquaculture, disease has also become a major risk factor causing significant production loss for pond operators (Veerina et al. 1993; Ahmed and Rab 1995). Ahmed et al. (1995) reported that production from disease-affected carp polyculture ponds were only 46% of the production from disease-free ponds. In addition, intensive coastal aquaculture continues to cause nutrient loading, accumulation of chemicals, oxygen depletion and stimulation of blooms in the aquatic environment.

Inland and Marine Capture Fisheries

Environmental Degradation and Loss of Critical Habitats

Estuaries and coastal vegetation such as mangroves, wetlands, river-basins, floodplains, lagoons and lakes are suffering from the impacts of pollution, water withdrawal for human use and land reclamation. Coral reefs and seagrass beds are also under increasing threat from physical destruction, siltation and sedimentation (Table 5). The need for protection of these aquatic systems in coastal zones and inland catchment areas is well recognized. The framework for action, adopted by the United Nations Environmental Programme's (UNEP) Global Program of Action for the Protection of Marine Environment from Land-based Activities in Washington D.C. in November 1995, has called for urgent action by all nations. However, in the developing countries, this may remain unaddressed because of lack of resources and a lack of political pressure (FAO 1997).

Overfishing and Excess Capacity

Small-scale fisheries in coastal and inland areas in developing countries find regulatory measures

on input and output (e.g., effort control and catch quotas) of little relevance in reducing overfishing due to excess capacity labor and capital. Equity is an important factor in dealing with the issue of controlling access. Conflicts over fishery use rights and their distribution have grown over the decades. National fisheries management plans could not create alternative or supplemental employment for the redundant work force as well as buy out the farmers who are tied up in assets and investments. Government actions that often favored commercial and industrial fishers contributed further to the conflict. Many countries are now drawing on community initiatives to solve this problem and are willing to give local fishers and citizens' groups a greater voice and responsibility. However, resources are already considerably diminished and an imbalance in the resource to population ratio has occurred in many areas. Communities are now expected to help conserve and rebuild a degraded resource for future generations. In addition, communities may have to forego income earning opportunities by restraining their fishing efforts. Reduction in excess capacity through alternative and supplementary means of livelihood will still have to be found for these coastal communities.

Bycatch and Discards

Some of the fishing methods, such as trawling, produce a high rate of bycatch of up to 90%. This is mostly discarded at sea. The fishing industry worldwide is under severe pressure to reduce the production of bycatch and discards. Reduction in bycatch will require changes in fishing methods and gear techniques. The fishing industry is reluctant to use improved gear or devices because of their higher cost and negative impact on fishing efficiency. In addition, because of low economic value there is still a lack of incentive to bring the bycatch ashore. Landing quotas and restrictions on catch in many countries have also encouraged fishing vessels to discard the low value catch at sea.

Policy and Management

The sustainability of capture fisheries resources is a global issue. The existing centralized management systems in most developing countries are not able to regulate fisheries over widely scattered fishing grounds. Yet management is required to address the problems of overfishing and overcapacity (excess labor and capital), the issues of bycatch and discarding, environmental degradation of catchment and coastal areas and the uncertainty and risk associated with assessing and determining the potential catch. In developing countries, population pressures and a lack of alternative employment opportunities, together with the inability or reluctance of governments to take necessary conservation and management decisions, have resulted in severely overfished coastal and inland resources with catch rates, fish sizes and fishers' incomes all declining (FAO 1997).

Table 5. Major sources of degradation of critical fish habitats and environments.

Type of habitat	Source of degradation
Coastal and estuarine	• Industrial, urban and agricultural pollution • Land fill, damming and diversion of rivers • Clearance of mangroves • Sedimentation
Coral reefs and seagrass beds	• Overfishing, destructive and harmful fishing • Sedimentation • Nutrient enrichment of reef waters from terrestrial runoff
Floodplains and river basins	• Drainage, flood control and irrigation • Damming and diversion of rivers • Wholesale change, fragmentation and removal of wetlands

In aquaculture, policies in most of the developing countries have focused on private sector participation in production, input supply and marketing. This has brought benefits to the sector in terms of efficiency and competitiveness (Muir 1995). Countries like China and Vietnam have shown tremendous progress in terms of growth resulting from the private entrepreneurship and market oriented policies. However, in many countries the legal framework and suitable institutions are still lacking to deal with resource allocation, infrastructure and extension support, and land and water use, and to protect and safeguard the small operators. A major management issue concerning aquaculture is the integration of the aquaculture sector into overall management of natural resources both from the point of view of resource use competition as well as protecting quality of aquatic resources suitable for aquaculture production (Muir 1995).

Management Options for Capture Fisheries

Fishing nations are considering a number of options to reduce excess capacity and improve management. Contrary to the regulatory approach to management, options such as property rights system, common property management and access control are becoming increasingly popular.

Many developed countries have created fishing rights systems such as effort quotas, individual transferable quotas (ITQs) and limited entry into fisheries. Others are adopting new approaches in co-management and community-based management. However, very few developing countries have taken steps to implement comprehensive and effective fisheries conservation and management measures in areas under their national jurisdiction. Argentina, Chile, Namibia and Malaysia are among those few countries that have taken steps (FAO 1997). The policy instruments used include: ITQs, buy-back schemes, and modifications to rights of access (such as "closed areas"). According to FAO (1997), the situation has improved and the industry has become more competitive in some of these countries.

Fishing Rights Systems and Developing Countries

Systems such as ITQs that change the nature of resource ownership by converting a publicly owned and used resource into a publicly owned but privately used resource may lead to increased cooperation among user groups and their acceptance of some of the responsibilities of management (FAO 1997). Developing countries, however, face a special dilemma with respect to the management of their fisheries, dominated as they are by subsistence and small-scale commercial fishers. The problem of relocation and redeployment of fishers and part-time users of the fishery such as farmers who would be displaced by a limited entry regime has become a major constraint. Also, the cost of implementing the management schemes is quite high in relation to the resources available in many of these countries, and such investments are often seen as taking away resources which could be utilized by the other sectors of the economy. Furthermore, most developing countries have adopted structural adjustment policies in recent years. The capacity of the governments in these countries to finance and implement various measures endorsed by the international community are very limited. On the other hand, failure to limit entry into overexploited subsistence and small-scale fisheries will cause further destruction of these fisheries and contribute to long-term impoverishment of communities dependent on them for their livelihoods (FAO 1997).

Potential for Community-based Management

In view of the limited capacity of the centralized systems to manage the problem and their inability to establish limited rights, the concept of co-management and other forms of community-based management are seen as options in some fisheries in the developing countries (Pinkerton 1989; Pomeroy and Williams 1994; Pomeroy and Pido 1995). ICLARM has undertaken a project that will evaluate the application and potential of

co-management options in managing inland and coastal fisheries (Pomeroy 1993; Kuperan and Abdullah 1994). Some countries such as Vietnam and Malawi have adopted co-management as an official policy. In others such as the Philippines and Bangladesh, it is being pursued selectively as an interim measure through local and community initiatives or through outside assistance, with the active involvement of NGOs (Ahmed et al. 1997). Several case studies of existing co-management arrangements in Asia and Africa have been completed. Many of these co-management arrangements are still at the stage of developing mechanisms for resource management partnerships whereby authority and responsibility for fisheries management can be shared between various levels of government and the local fishing community.

A general observation that can be made here is that if user groups are homogenous and the strength of community participation can be utilized to enhance the benefits from the resources, including linkages with other rural sectors, both cooperation and management improvements can be greater. However, many of the existing initiatives in this area have been supported by external assistance and their long-term sustainability is still a major concern (Ahmed et al. 1997). The commitment of governments to policies and programs of decentralization is an important factor in the success of co-management arrangements. Of equal importance is the development of legal, administrative and institutional arrangements to complement contemporary political, economic, social and cultural structures (Pomeroy 1995).

Effects of Macroeconomic Policy Measures

Macroeconomic adjustment programs being implemented by many developing countries may have resulted in several consequences for fisheries, although there is no comprehensive analysis of this. Several factors suggest that the consequences have not been uniform across different groups within the fisheries sector.

Privatization and Decentralization

This has offered new and promising opportunities for aquaculture development in a number of countries. China's fisheries sector growth, particularly aquaculture, came principally from a shift to a market economy and a policy which encouraged private sector development. In Vietnam, changes in land tenure and opening of market have encouraged farm households to invest and manage fish ponds for greater production and profits. In Bangladesh, privatization and private sector development have been responsible for the rapid growth of aquaculture over the last decade. In the Latin American countries, however, these policies did very little to improve the entrepreneurial capacity of small-scale rural fish farmers because the existing institutional structure favors commercial entrepreneurs.

Opening of the Economy

Elimination or reduction of import tariffs and other barriers to trade reduced the cost of imports for the fishing companies and for the processing sector. This made the sector more competitive in international markets. However, the benefit went mainly to industrial and export-oriented fisheries and aquaculture sector, with small-scale fisheries and rural aquaculture seeing only marginal gains.

Financial Reforms

These reforms resulted in lower interest rates which was beneficial for processing companies and large-scale industrial fisheries. Small-scale fisheries and fish farmers rarely have access to the credit market, especially in Latin American and African countries, because of their socioeconomic status and the existing credit institutions.

Foreign Investment

Foreign investment has focused mainly on export industries to take advantage of higher prices in the international markets. There has been little investment

in production of fish for domestic markets, particularly in subSaharan Africa and Latin America where the disposable income of domestic consumers is low and not expected to grow very rapidly.

Determinants of Growth and Scope for Production Increase

Cost and price are the two key factors determining the supply of any goods or service. Fisheries are not an exception. For a given level of demand, the cost of production influences the supply. However, the level of exploitable stocks in the world oceans will limit the scope for expanding the production from capture fisheries in line with cost and price changes. Paradoxically, a decrease in cost or an increase in the price of fish will reduce the supply of fish in the long run by pushing the fishing industry to operate beyond the maximum sustainable yield through an expansion of fishing effort (Gordon 1954; Copes 1970; Clark 1976). Given the current trends in price, economic incentives for an increased investment in both capture fisheries and aquaculture will remain high.

Major Determinants of Fisheries Supply

Price, input availability, technology, infrastructure and support services are the major factors influencing the growth of fisheries and aquaculture. In addition, the role of a number of nonprice factors will also be crucial in determining supply, particularly from aquaculture.

Price

Demand will continue to outpace supply resulting in a continued increase in real prices, both locally and internationally. The supply of fish species that are of high value and targeted to upscale and export markets will be more responsive to price. Freer trade regimes will enable fish products to tap new and diversified markets and will stimulate further growth. Higher prices will also be a determining factor for the commercial culture of high value and low input species such as giant clams, sea cucumbers and pearls.

Input Availability and Cost

As production from aquaculture expands, the supply of inputs will impose limitations. This will raise the long-run average costs for the industry. Given the current level of technology, the expansion in aggregate output is likely to be limited by the availability of suitable land, space, water supply and feed. Inputs such as labor and capital are less specific to aquaculture and the culture industry is unlikely to be large enough to influence the overall demand for these inputs (Worrall 1995).

1. *Land and water:* Limited availability of suitable land and water inputs are likely to impose increasing long-run marginal costs for the growing aquaculture industry. Moreover, increasing competition from other uses for the limited land and water resources will force aquaculture to expand on to less productive sites, requiring a greater input of other factors of production to maintain output. Imposition of restrictions, conservation and market-based pricing for water will increase the cost of water used in aquaculture.
2. *Feed cost:* Feed cost and feed availability will be a critical factor determining the growth of aquaculture. However, the limitations of food supply for farmed fish will vary according to the food requirements of cultured species and the production system. Most commercial species, such as catfish, are predominantly carnivorous and require a high protein diet, e.g., fishmeal. Since these inputs are relatively specific and limited in supply, they will impose increasing costs on an expanding aquaculture industry. The world price for feed is increasing and is already beyond the ability of low income producers to pay. The formulation of low cost and plant based feed can remove this constraint, particularly for the smallholder producers who sell their products to low income consumers. Culture systems such as integrated aquaculture-agriculture are less dependent on formulated feed.

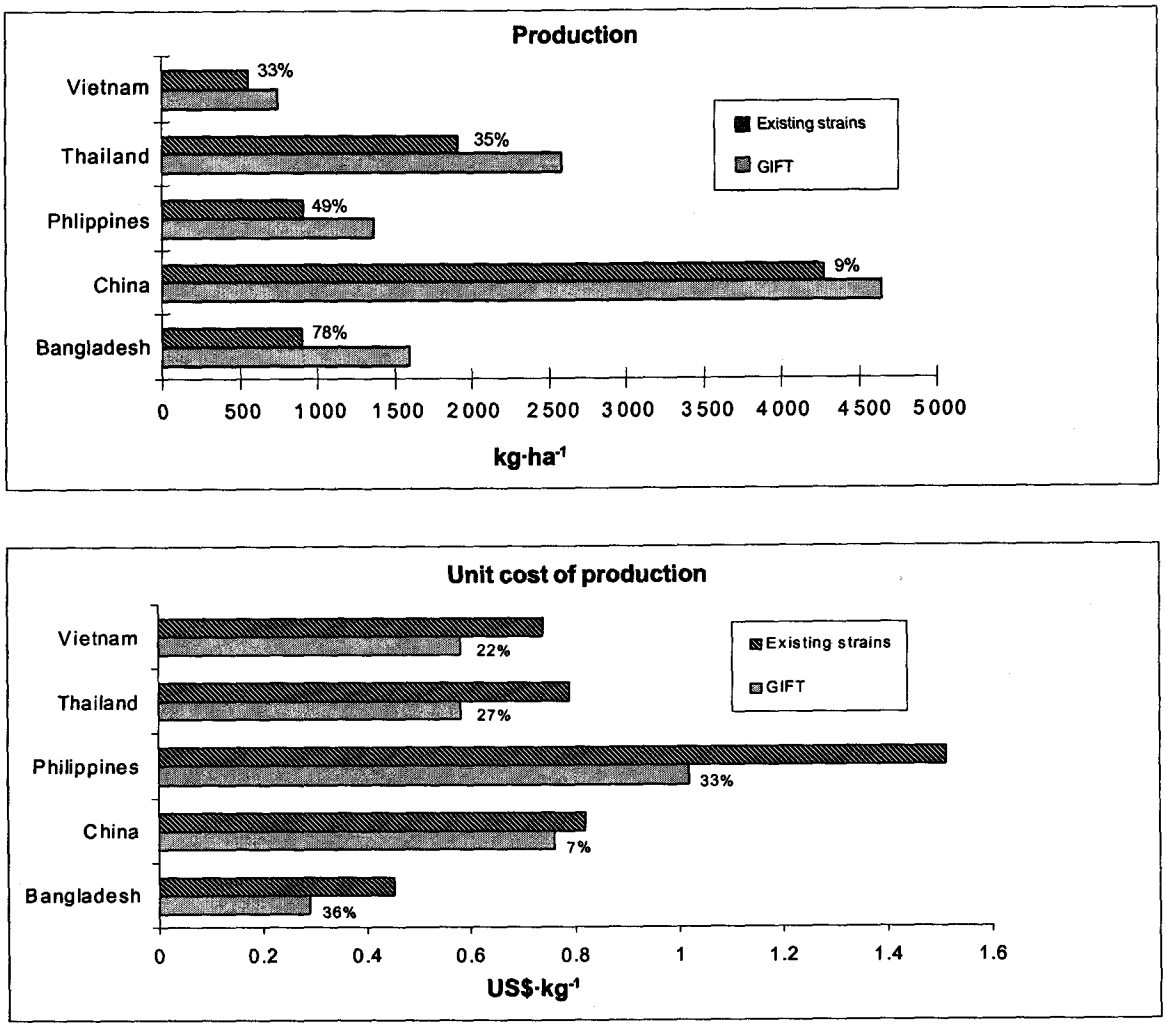
Technological Development

Breeding technology and the development of various feeding, pond fertilizing and pond management regimes have contributed to the expansion of aquaculture. Further research and innovation will result from higher prices and expanding markets. Improvements in the productivity are also expected from the development of genetically improved breeds of important farmed fish species. Aquaculture has benefited little from genetic improvements. ICLARM's initial work on tilapia indicates that the use of genetically improved breeds can provide an increase in productivity (Eknath et al. 1993; Dey and Eknath 1996) (Fig. 4).

Infrastructure and Other Support

Nonprice factors which include research, extension and information services, will be the major determinants of supply in the short and medium term. Access to land and water resources and access to capital, credit and markets by small farmers and fishers will accelerate the growth and supply from both aquaculture and culture-based fisheries.

Figure 4. Differences in productivity ($kg \cdot ha^{-1}$) and cash cost ($US\$ \cdot kg^{-1}$) between GIFT (genetically improved farmed tilapia) and existing tilapia strains in five Asian countries.



Source: DEGITA On-farm results, unpublished preliminary data, 1996.

Improvement of Governance Systems

The setting up of participatory processes that will ensure that farmers and fishers have a say in decisions regarding access to resource, inputs, infrastructure and markets will provide economic incentives and security to the fish growers. Improving the transparency and accountability of governments and decentralization of power to rural communities will be a necessary condition for creating the institutional and economic environment necessary for devolution and wider participation in fisheries. In many countries this will need to be reinforced through removal of corruption within government and political hierarchies.

Privatization and Entrepreneurship

In China a major structural shift in fisheries supply occurred with the movement towards a free market which began in 1978. Full or near full liberalization occurred by 1985. This created private markets for resources and inputs as well as for the sale and distribution of fish and fish products. In Bangladesh, aquaculture development was initially promoted by the government through the supply of seeds from state owned fish seed farms in the seventies. By the mid 1980s it was almost entirely in the hands of the private sector. In both cases the growth process was accelerated with the liberalization of markets and private sector development. Changes in land tenure in favor of private access had an encouraging effect on the growth of Vietnam's fisheries sector, particularly aquaculture.

Scope

Capture Fisheries

As already stated, an increased investment in direct fishing activities is not likely to increase the supply from capture fisheries. However, a moderate increase of catch in capture fisheries can be achieved if degraded resources are rehabilitated, underdeveloped resources in all oceans are exploited, agreed limits on catch through management methods are implemented and discards and wastage are reduced. An increase of at least 10 million t is possible from marine capture fisheries through the above measures (FAO 1997). This will require significant international, national and regional cooperation, cooperation between governments and industry and the participation of NGOs and consumer groups. Habitat restoration, enhanced and culture-based fisheries, protection from land-based activities and increasing local participation in management are expected to provide scope for increasing production of inland fisheries.

Coastal and inland fisheries: Reduction of excess capacity through multisectoral economic development policies and implementation of integrated coastal zone management (ICZM) have the potential to rehabilitate degraded resources and bring about increased supply in the long run. The ability of the new management approaches such as co-management and community-based management to remove excess fishing effort and damaging practices off the coastal and inland waters will also be a critical determinant of supply from these sources.

Offshore fisheries: Many developing countries are currently pushing for offshore and deepsea fishing due to overfishing and overcrowded situation in the coastal and inshore fisheries. As stated earlier, conditions of stocks are presently not well understood in many areas. Investment in research on assessment of stocks will provide a higher prospect for sustainable increase in the supply from offshore fisheries expansion by the developing countries. Otherwise, there is an imminent danger of building up excess capacity which will soon become redundant.

Aquaculture

Aquaculture is expected to bridge the gap between the demand and supply of fish. The scope for the growth of aquaculture lies in its ability to provide a source of income as well as food, and to diversify the production base of local agricultural systems (FAO 1997). According to FAO, it is possible to increase fish supply from aquaculture to 39 million t by 2010 under favorable conditions. The incentives for growth in low income countries

outside Asia will come from easier access to wealthy consumers in high income countries and by encouraging entrepreneurship through policy support. Effort reduction and other measures to rebuild capture fisheries will also provide room for the growth of aquaculture. A recent review (Kapetsky et al. 1996) suggested that nine Latin American countries have over 40% of the land area suitable for low level small-scale Nile tilapia farming, providing significant opportunities for an increase in production from aquaculture in the region. Technological improvements in the following factors could also create a considerable scope for increase in aquaculture production:

Diversified feed sources: Supplementary feeding using local ingredients, including farm and fishery wastes and byproducts, dominated major production systems in aquaculture. The scope for increased production lies in the ability to draw on local feed sources, particularly plant sources. The use of soymeal in China and deoiled bran, cottonseed meal and groundnut cake in India as supplementary feed costs less than imported fishmeal. The use of substitutes is also expected to bring down the price of fishmeal.

Genetic improvement and quality seed supply: Genetic improvements are expected to provide a substantial increase in productivity and growth of the sector (Dunham 1995). Private sector participation is expected to increase in this area as the high demand and increasing prices for fish are an incentive to invest in better quality and supply of seed. In the meantime, seed supply must be stable and the genetic quality of broodstocks should be maintained.

Expansion of the culture system: There is a potential for increase in fish supply from inland waters, reservoirs, natural lakes and ricefields through enhanced fisheries and culture-based production, especially where land and freshwater supply for pond-based aquaculture is limited. The devolution of resource management to the local and community level can facilitate the expansion of these types of practices.

Species mix: There has been substantial improvements in the primary productivity of pond-based semi-intensive aquaculture through mixing of species. The feeding requirements of different species are also an important consideration in the selection of species for culture. However, market prices and consumer preferences play an important role in the choice of species that are cultivated.

Policy Issues for Developing Countries

The discussion in the previous section raises several policy questions related to food, environment and economic security. The central question for food and economic security is whether the benefits of growth reach the poor. The related question is whether the system provides a long-term basis for production while maintaining and conserving the natural resource base for food production.

Strengthening Food Security

In order to feed the poor over the long term, both fishing and fish farming have to be sustainable. Increasing the access of the rural poor to productive resources is a more reliable guarantee of food security than increases in purchasing power. It is not enough to promote the development of low cost products to strengthen food security. This has to be supported by policies that allow the poor and small operators to have access to resources and markets. They should be the primary beneficiaries of resource management and productivity improvements in capture fisheries and aquaculture. This implies a competitive and fair access to resources and means of productions, an improvement in the capacity to maintain a productive resource base and the availability of affordable and sustainable technologies.

Substantial policy support will be needed to build the capacity of fish culturists and fishers for the expansion of production, enhancement of stock and restoration of habitats. In common property resource systems, community-based management can provide a means for governments to allocate and protect access rights of the poorer groups (Pomeroy 1995). In coastal communities where the depletion of natural stocks has reduced the overall economic potential, the possibility of generating

additional income may stem from diversified markets for aquatic products. This can be done through the exploitation of low input/high value output species such as clams, oysters, sea cucumbers and pearls.

Creating Competitiveness for the Smallholder Operators

How do you benefit the smallholder operators? Should technology improvements be designed for the small producers or should policy support increase the competitiveness of the technology and production systems held by them? These are also major policy questions. In augmenting the production of small farmers it is necessary to develop technology or species that fit the circumstances of the poor farmers, e.g., the low capacity to invest in external inputs. However, developing or designing technology for a particular target group may not be cost effective in many circumstances. It may be more beneficial in the long run to implement policies that will give them access to outside inputs such as credit, infrastructure and information. This could help small farmers to raise their production more quickly and more substantially than with the development of a low cost, low external input technology alone.

In small-scale fisheries a shift to a more appropriate technology such as large mesh gear may likewise affect the competitiveness of the fishers due to additional cost. Policies are needed to protect the cost effectiveness of selective technologies that will promote the sustainability of the resources.

Impact of World Trade Organization (WTO)

Further liberalization of trade resulting from mechanisms under WTO will divert the flow of fish and fish products as well as production inputs to markets with a higher purchasing power. However, the effects on trade volume and destinations will remain uncertain because of the impact of environmental concerns on international trade. The efforts by some environmental groups to ecolabel fishery products such as tuna and shrimp and certify fishery management systems could affect fish trade and fishery management, if they receive wide support.

Evaluation of Policy Instruments

In many developing countries, the current policy structure needs to be evaluated for its economic, social and ecological costs. The potential shift of land to high value aquaculture production should be evaluated for its effects on agriculture, subsistence fishery and low value fish farming by small holders. In many developing countries, high value fish targeted for the export market continues to receive substantial policy support and incentives such as cheap land leases, credit supply, and low tariff on imported inputs and infrastructure. It competes for resources that are used for the production or harvesting of low value food fish for local consumption by the poorer groups. Likewise, many commercial fisheries are subsidized through deliberate governmental policies on inputs, such as fuel and machineries. In the Philippines, for instance, commercial fishers were prime beneficiaries of fuel subsidy scheme in San Miguel Bay fisheries throughout the seventies and early eighties which also led to over expansion of fishing effort and overfishing in the Bay. Corrective measures are needed for the negative effects on the income and food security of low income and poorer producers and consumers.

Land and Water Use Optimization

Land and water are multisectoral resources and both are becoming increasingly scarce. The great challenge facing the developing countries in the 21st century is to maintain land and water quality while meeting the growing demand for land and water resources. Aquaculture will have to compete with other sectors, including agriculture, for land area and water supply.

Massive subsidies and distorted incentives have encouraged wasteful use of water in the past, particularly in agriculture and urban use, and caused degradation of soils in irrigated areas and depletion of ground water (Rosegrant 1997). The cost of developing new water sources in the future will

be much higher. Thus, scarcity of water can become a constraint to the growth of aquaculture. It is necessary to develop a strategy for reducing water use in aquaculture systems and promoting an efficient and optimal use of water. An integrated approach to management of land, watershed, catchments and river basin will be a more sustainable solution to optimize resource use.

Intensification of Production from Freshwater Ponds

An increased production of food from existing cultivated land is seen as an important means of alleviating poverty and relieving pressure on natural resources (Pinstrup-Andersen and Pandya-Lorch 1994). While capture fishery yields seem to have reached their limit, there is a considerable potential for increasing aquaculture production (Williams 1996). Semi-intensive polyculture practiced in land-based systems is the main source of supply of low priced food fish for household consumption. From the point of view of environmental and ecological sustainability, this system has proved to be more promising and, in many ways, mimics natural ecosystem functions (Folke and Kautsky 1992). Policies are needed to promote such systems to provide enhanced food security. Currently production from freshwater pond farms is quite low, especially from those held by resource poor farmers. Production intensification and higher productivity are required for sustaining these operations as the opportunity cost of land and water will increase with increasing competition from other uses like housing, industry and large-scale aquaculture.

Culture-based Fishery Development

In view of the depletion of natural stocks and a shortage of land and water for expanding aquaculture, culture-based fishery is becoming important as a means of augmenting the productivity of natural waters or producing additional benefits from artificial lakes and reservoirs. Institutional arrangements for access and use of resources will be an important determinant of investment in and growth of culture-based fisheries. Subsidies and cost recovery have become critical policy issues in restocking programs and culture-based fisheries in many parts of the world, as these programs are financed by public funds. All the centrally planned economies of eastern Europe used to manage their inland fisheries through publicly funded stocking and fertilization programs. The practice has been discontinued in many countries due to economic difficulties, resulting in a substantial decline in production from these fisheries.

Integrated Aquaculture-Agriculture Systems for Resource-poor Farmers

Small farmers, particularly in the rice growing areas of the developing world, are potentially a vast source of fish supply from integrated aquaculture-agriculture systems (Williams 1996). This subsistence oriented operation is part of the food security of the poorer households. Production from the integrated system needs to be augmented through promotion and mass production of species that can be produced at a relatively low cost while employing all household members, including women. Evidence suggests that intensive information dissemination and training programs on flexible technological choices can significantly enhance the rate of aquaculture technology adoption by the existing farming systems (Ahmed et al. 1995). However, issues concerning access to resources and security of tenure will require policy support and research investment (Williams 1996).

Conclusions

Since the world has not been able to deal with the open access nature of exploitation in most fisheries, the present high demand and high price situation will only result in a lower supply in the long term. This will reduce fish consumption by the low income consumers, reducing their food security. Management measures such as licensing, quotas and other forms of control needed to rebuild stocks and reduce effort, provided they are properly implemented, will also reduce world supply in the

short run. This will mean that fish will become even less affordable for the poor. Even if fishing effort is controlled to the level of maximum sustainable yield (MSY) by means of a license or tax, increasing demand will raise the price (Ye and Beddington 1996). With liberalized trade, competition for the limited supply will be even higher. This will definitely have a negative effect on low income consumers. On the other hand, the high price of fish will encourage a greater investment in fishing effort. This will make the implemention of regulatory measures twice as difficult.

Control of overfishing in capture fisheries is not compatible with food security and the requirement of a greater supply of foodfish for the poor. Therefore, the problem of overfishing and the problem of high demand need to be addressed simultaneously. Increasing the supply of substitutes such as aquaculture products is regarded by many people as an important option for dealing with the conflicting problems of overfishing and the increasing demand for fish (Worrall 1995; Ye and Beddington 1996). An increase in the supply of aquaculture products will reduce both the demand and price of capture fisheries products. This could reduce the investment and effort in capture fisheries. Traditional measures for capture fisheries management did not consider demand as an important factor. Policy alternatives must look at the possibilities of reduction in the cost of aquaculture production and of increasing the supply of substitutes to capture fisheries products (Worrall 1995).

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References

Ahmed, M., A.D. Capistrano and M. Hossain. 1997. Experience of parthership models for the co-management of Bangladesh fisheries. Fish. Manage. Ecol. 4(3):233-248.

Ahmed, A.U. and Y. Shams. 1994. Demand elasticities in rural Bangladesh: an application of the AIDS model. Bangladesh Dev. Stud. 22(1).

Ahmed M. and M.A. Rab. 1995. Factors affecting outbreaks of epizootic ulcerative syndrome in farmed fish in Bangladesh. J. Fish. Dis. 18:263-271.

Ahmed M., M.A. Rab and M.P. Bimbao. 1995. Aquaculture technology adoption in Kapasia Thana, Bangladesh: some preliminary results from farm record-keeping data. ICLARM Tech. Rep. 44, 43 p.

Berg, H., P. Michésen, M. Troell, C. Folke and N. Kautsky. 1996. Managing aquaculture for sustainability in tropical Lake Kariba, Zimbabwe. Ecol. Econ. 18:141-159.

Clark, C.W. 1976. Mathematical bioeconomics: the optimal management of renewable resources. Wiley-Interscience, New York.

Copes, P. 1970. The backward bending supply curve of the fishing industry. Scot. J. Pol. Econ. 17:69-77.

Dey, M.M. and G.B. Bimbao. 1995. Policy imperatives for sustainable aquaculture development in Asia: lessons from Bangladesh, the Philippines and Thailand. Paper presented at the Regional Workshop on Aquaculture Sustainability and Environment, 6-12 October, Beijing, China.

Dey, M.M. and A.E. Eknath. 1996. Current trends in tilapia industry and the significance of genetically improved tilapia breeds. Paper presented at the 3rd INFOFISH-AQUATECH International Conference on Aquaculture, 25-27 September 1996, Kuala Lumpur, Malaysia.

Dunham, R.A. 1995. The contribution of genetically improved aquatic organisms to global food security. International Conference on Sustainable Contribution of Fisheries to Food Security, 4-9 December 1995, Kyoto, Japan.

Eknath, A.E., M.M. Tayamen, M.S. Palada-de Vera, J.C. Danting, R.A. Reyes, E.E. Dionisio, J.B. Capili, H.L.

Bolivar, T.A. Abella, A.V. Circa, H.B. Bentsen, B. Gjerde, T. Gjedrem and R.S.V. Pullin. 1993. Genetic improvement of farmed tilapias: the growth performance of eight strains of *Oreochromis niloticus* tested in different farm environments. Aquaculture 111(1/4):171-188.

FAO. 1996. Fisheries and aquaculture in Latin America and the Caribbean: situation and outlook in 1996. FAO Fish. Circ. 921. FAO, 54 p.

FAO. 1997. State of the world fisheries 1996. FAO, Rome, Italy.

Folke, C. and N. Kautsky. 1992. Aquaculture with its environment: prospects for sustainability. Ocean Coast. Manage. 17:5-24.

Gordon, H.S. 1954. The economic theory of common property resource: the fishery. J. Pol. Econ. 62(2):124-142.

Gupta, M.V. and M.A. Rab. 1994. Adoption and economics of silver barb (*Puntius gonionotus*) culture in seasonal waters in Bangladesh. ICLARM Tech. Rep. 41, 39 p.

ICLARM. 1992. ICLARM's strategy for international research on living aquatic resources management. ICLARM, Manila, Philippines. 79 p. + Appendix 30 p.

Kapetsky, J.M., S. Nath and J.P. Bolte. 1996. Inland fish farming potential in Latin America: an overview of the study and a preview of the results. FAO Aquacult. Newsl. 13:18-21.

Kuperan, K. and N.M.R. Abdullah. 1994. Small-scale coastal fisheries and co-management. Mar. Pol. 18(4):306-313.

Muir, J.F. 1995. Aquaculture development trends: perspectives for food security. Paper presented at the International Conference on Sustainable Contribution of Fisheries to Food Security, 4-9 December 1995, Kyoto, Japan.

Pinkerton, E. 1989. Introduction: attaining better fisheries management through co-management - prospects, problems, and propositions. *In* E. Pinkerton (ed.) Cooperative management of local fisheries: new directions for improved management and community development. University of British Columbia Press, Vancouver, Canada.

Pinstrup-Andersen, P. and R. Pandya-Lorch. 1994. Poverty, agricultural intensification, and the environment. Paper prepared for the 10th Annual General Meeting of the Pakistan Society of Development Economists, 2-5 April, Islamabad, Pakistan.

Pomeroy, R.S. 1993. A research framework for coastal fisheries co-management institutions. Naga, ICLARM Q. 16(1):14-16.

Pomeroy, R.S. 1995. Community-based and co-management institutions for sustainable coastal fisheries management in Southeast Asia. Ocean Coast. Manage. 27(3):143-162.

Pomeroy, R.S. and M.D. Pido. 1995. Initiatives towards fisheries co-management in the Philippines: the case of San Miguel Bay. Mar. Pol. 19(3):213-226.

Pomeroy, R.S. and M.J. Williams. 1994. Fisheries co-management and small-scale fisheries: a policy brief. International Center for Living Aquatic Resources Management, Manila, Philippines.

Pullin, R.S.V. 1993. An overview of environmental issues in developing-country aquaculture, p. 1-19. *In* R.S.V. Pullin, H. Rosenthal and J.L. Maclean (eds.) Environment and aquaculture in developing countries. ICLARM Conf. Proc. 31, 359 p.

Rosegrant, M.W. 1997. Water resources in the twenty-first century: challenges and implications for action. FAO Discuss. Pap. 20, 27 p.

Veerina, S.S., M.C. Nandeesha and K. Gopal Rao. 1993. Status and technology of Indian major carp farming in Andhra Pradesh, India. Asian Fisheries Society, Mangalore, India. 52 p.

Williams, M.J. 1996. The transition in the contribution of living aquatic resources to food security. FAO Discuss. Pap. 13, 41 p.

World Bank. 1995. Pacific island economies: building a resilient economic base for the twenty-first century. World Bank, Washington, D.C. 144 p.

Worrall, S.J. 1995. Aquaculture and ocean fishery regulation. Sem. Pap. 95-10. Center for International Economic Studies, University of Adelaide, Australia. 28 p.

Ye, Y. and J.R. Beddington. 1996. Bioeconomic interactions between the capture fisheries and aquaculture. Mar. Res. Econ. 11:105-123.

COMMENTS

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The paper by Dr. Ahmed covers virtually all the relevant issues concerning fish supply in developing countries, including the diversity of resource systems, the role of ecological inputs and environmental integrity, disease and pollution problems in aquaculture, overfishing and lack of property rights, the impact of increasing world trade in fish, and others. The challenge facing policymakers is overwhelming and the complexity of the system requires much careful thinking, measuring and interdisciplinary cooperation. To put the problem within a formal framework, I suggest that we go back to basics and consider the traditional backward-bending supply curve of a fishery. This will allow us to focus on the minimum data requirements relative to data currently available. The model can be extended to account for the potential contribution of aquaculture to the limited capture fishery supply. Further elaboration of the model would permit the analysis of externalities associated with both activities (capture fisheries and aquaculture) and would form a basis for policy analysis. Issues such as the effect of rising fish prices, unemployment in fishing communities, food security and possible management strategies can be studied. I do not advocate basing the management of fish supply solely on a model as simple as the backward-bending supply curve, but I emphasize that we should not lose sight of the large body of theory which is available and which can provide a solid foundation to our efforts. Thus, the basic question is: are the minimum data required to plan the development and conservation of fishery resources (including aquaculture) currently met? If the answer is "no" the relevant question then becomes: how should we proceed to ensure that these are available in the future?

COMMENTS

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I would like to congratulate the author for providing a very comprehensive overview on the supply of fish and its prospects for the developing countries. The paper started out with an overall picture and challenges facing the fishery sector worldwide and in particular the developing countries. The strength and problems highly likely to be seen in this sector were correctly pointed out by the author, although they are somewhat pessimistic. Not much can be added to this detailed paper, except for some explanation needed in some sub-topics to further clarify them.

Let me begin by first questioning the long standing belief about aquaculture as being a substitute for marine fisheries. Although aquaculture produces fish that are almost similar to the marine fishes and is thus seen as a close substitute to ease the pressure on the already overfished marine fish, they have to be treated as two "differentiated" products. Little is known about the acceptability and demand for aquaculture products in developing countries. It was taken for granted that people in LIFDCs, being the biggest producers of aquaculture fish, would tend to consume an equally high quantity of the products. With the exception of very small-scale producers in Africa, the Indian subcontinent and parts of east Asia who produce aquaculture fish for their own consumption, the majority of aquaculture operations worldwide tend to be highly commercialized. Most of the products are meant to generate foreign exchange for many developing countries and provide high value food for the wealthy consumers, reducing their availability to the rural poor in the former countries. Since aquaculture operations are carried out by big enterprises, profits come before the food security question. To paint a rosy picture for aquaculture as an alternative to ensure accessibility of fish by the poor can be quite misleading.

The author also correctly pointed out some of the possible effects of changing macroeconomic environments in many developing countries. The drive towards privatization and opening up of the economies of many of these countries will undoubtedly produce some desired results towards socioeconomic development, but they can also be counterproductive in the natural resource sectors, fisheries included. Aquaculture production had increased tremendously as a result of privatization, but it was geared towards export markets. On the one hand, it improves a country's balance of payment, but on the other it deprives the accessibility to the product by local consumers. The impact of privatization on the marine capture fishery sector, however, is less well understood. If privatization means bigger investments in more efficient fishing technology, its effects can be disastrous on fish supplies in the future. The overcapitalization in fishing capacity if unchecked will inevitably lead to "capital stuffing" and irreversible effects on fish stocks. The proposition of privatization in both aquaculture and marine fisheries must, therefore, be treated with extreme care as it does not address well the food security problem in many developing countries.

Another interesting point highlighted in the paper is with regards to the opening up of economies of many developing countries and possible impacts of World Trade Organization's (WTO) agreement. While this initiative looks very attractive on paper as it encourages free flow of commodities from one country to another, it is not without its "traps". WTO can be considered a "double-edged

sword" agreement. While it calls for freer trade through trade liberalization policies, it also imposes a nontariff barrier in the form of "ecolabelling" requirements. The recent trade embargo on China's shrimp exports for failing to include turtle-excluder devices (TED) on the fishing gear is a testimony to a so-called free trade with nontariff, ecolabelling barrier. Unless and until such disagreements can be overcome, one should not be so dependent on WTO as a possible vehicle for arresting the problem of increasing demand and lower fish supplies worldwide.

Finding alternative solutions like intensifying the existing aquaculture production technology and optimal utilization of local feed and input ingredients, therefore, seems to be the more practical ways in the shorter term of improving fish supplies to the rural poor, if the products are readily acceptable to them. Similarly, enhancement of underexploited marine fishery resources and proper management through ICZM and co-management are probably the more appropriate policy approaches towards harnessing marine fish supplies in the future. Food policy research should, therefore, focus on these pertinent issues in the future before embarking on more ambitious topics, which would provide minimal impact on the current food needs of the rural poor throughout the world. Given the scarce resources that we have, some clear priority should be established both on the shorter and longer term research activities.

IV. POLICY ISSUES RELATED TO FOOD SECURITY

Policy Issues on Fisheries in Relation to Food and Nutrition Security

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THILSTED, S.H. and N. ROOS. 1999. Policy issues on fisheries in relation to food and nutrition security, p. 61-69. *In* M. Ahmed, C. Delgado, S. Sverdrup-Jensen and R.A.V. Santos (eds.) Fisheries policy research in developing countries: issues, priorities and needs. ICLARM Conf. Proc. 60, 112 p.

Abstract

Fish is an important food in low income countries, adding diversity to diets dominated by staple grains and contributing intake of essential nutrients. Small fish are particularly important for food and nutrition security in developing countries, especially in light of the high prevalence of micronutrient deficiency. Small fish are consumed whole, with bones and organs, and are a rich source of minerals and vitamins, such as calcium, iron, zinc and vitamin A. Small fish are cheaper, easily available, well-liked and a part of the everyday diet of poor population groups. The increasing use of small fish in fishmeal production reduces their availability for the poor. Changes in fish production patterns and processing, which decrease the role of women in these activities, can lead to decreased fish intake by their families. Studies on the different fish species consumed and their nutrient content are needed to assess the contribution of fish to nutrient intake. Development of fish production systems, which include local and diverse fish species, including small fish species, can improve food and nutrition security. Governments and international institutions can strengthen the importance of fish for food and nutrition security by ensuring that the Kyoto Declaration and Code of Conduct for Responsible Fisheries are implemented.

Introduction

Food security is defined as a condition when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (FAO 1996a). Nutrition security is defined as a condition which combines food, health and care for a healthy life (Ramalingaswami 1994). Since the International Conference on Nutrition in Rome in 1992, the term food and nutrition security is commonly used to focus on the role food plays in supplying energy and nutrients.

In low income countries, staples such as rice, wheat, maize and cassava make up the bulk of the food consumed, supplying the majority of energy and nutrients. However, there are some essential

nutrients which are not found in staples or found only in small quantities, for example, essential fatty acids, iron, iodine, zinc, calcium, vitamin A and vitamin C. These nutrients must be supplied by foods that are consumed with the staples, such as fish and vegetables. It is important that these foods have high densities of essential nutrients as they make up only a small quantity of the total food consumed.

Whereas big and small fish contain the same amount of protein, small fish contain relatively higher amounts of minerals as they are consumed whole, including bones. Some small fish species also contain large amounts of vitamin A. The contribution of small fish to food and nutrition security is especially important, taking into account the magnitude of micronutrient deficiencies. For example, it is estimated that globally more than 13 million people suffer from night blindness or permanent blindness and 2 150 milllion from iron deficiency (WHO 1992).

The Importance of Fisheries for Food and Nutrition Security

The importance of fisheries for food and nutrition security will be illustrated by presenting relevant data and case studies within different components: fish species diversity; importance of small fish; fish accessibility; fish intake; knowledge and perceptions of fish; women in fisheries; and nutrient content analysis of fish species. It should be noted that the literature on these is extremely sparse.

Species Diversity

In promoting a high diversity of fish species, there are two important aspects that should be considered. Some fish species, but not all species may be accessible to the poorer sectors of the population. Fish species may contain different nutrients and amounts of nutrients. Table 1 shows the relative importance of different fish species in an area of Bangladesh (ISPAN 1995). Various indigenous small fish species such as puti (*Puntius* sp.), taki (*Channa punctatus*), singh (*Heteropneustes fossilis*), chanda (*Chanda* sp.) and mola (*Amblypharyngodon mola*) ranked high according to the number of days fish is eaten in the household and number of households consuming fish. Ranked by amount of fish eaten, the big cultured species, silver carp (*Hypophthalmicthys molitrix*) and rui (*Labeo rohita*) were placed relatively high, as number 6 and 7, respectively. When ranked according to the number of days the fish is eaten in the household, the cultured tilapia (*Oreochromis niloticus*) and rui ranked as number 16 and 18, respectively. Ranked according to the number of households consuming the different fish species, the cultured species rui, tilapia and mrigal (*Cirrhinus mrigala*) appeared as numbers 19, 20 and 21, respectively. These rankings reflect the fact that many rural households consume small quantities of small fish frequently. Small quantities of small fish seemed to be an important part of the diet for many, while big species seemed to reach fewer people.

Recognizing the value of fish diversity, ICLARM and the University of Malawi have screened and identified indigenous fish species that can be cultivated under small-scale farming conditions (Brummett 1993). Small indigenous tilapia and barbus species were found to meet small-scale farmers' demands since they reproduced easily in ponds, produced large quantities of small fish which were marketable in the local markets and could be sold in small quantities. In Bangladesh, there is also some growing interest in small indigenous species. In 1996, a seminar was held on small indigenous fish species (SIS) culture in Bangladesh, and many papers on SIS which are commonly consumed were presented (IFADEP 1996).

SIS as a Source of Minerals and Vitamins

Table 2 shows the vitamin A, calcium and iron contents of some small and big fish species from Bangladesh (Thilsted et al. 1997). All small fish contain large amounts of calcium, while the edible parts of big fish contain little calcium. Some small fish species, mola, darkina (*Esomus danricus*) and dhela (*Rohtee cotio*) contain large amounts of vitamin A. The edible parts of big fish, both adults and

Table 1. Fish species in Bangladesh ranked by different key indicators (cultured species are underlined).

Amount eaten			Number of days/household			Number o	
Ranking	Local name	Scientific name	Ranking	Local name	Scientific name	Ranking	Local na
1	Puti	*Puntius* sp.	1	Puti	*Puntius* sp.	1	Puti
2	Hilsha	*Hilsa ilisha*	2	Gura chingri	*?*	2	Gura chir
3	Taki	*Channa punctatus*	3	Taki	*Channa punctatus*	3	Taki
4	Gura chingri	*?*	4	Tengra	*Mystus vittatus*	4	Tengra
5	Singh	*Heteropneustes fossilis*	5	Singh	*Heteropneustes fossilis*	5	Chanda
6	Silver carp	*Hypophthalmichthys molitrix*	6	Koi	*Anabas testudineus*	6	Mola
7	Rui	*Labeo rohita*	7	Hilsha	*Hilsa ilisha*	7	Hilsha
8	Koi	*Anabas testudineus*	8	Chanda	*Chanda* sp.	8	Singh
9	Tengra	*Mystus vittatus*	9	Mola	*Amblypharyngodon mola*	9	Kholisha
10	Tilapia	*Oreochromis niloticus*	10	Guchi baim	*Mastacembelus pancalus*	10	Koi
11	Guchi baim	*Mastacembelus pancalus*	11	Kholisha	*Colisa fasciatus*	11	Guchi bai
12	Mola	*Amblypharyngodon mola*	12	Gutum	*Lepidocephalus guntea*	12	Gutum
13	Boal	*Wallago attu*	13	Chatka chingri	*?*	13	Bailla
14	Chanda	*Chanda* sp	14	Bailla	*Glossogobius giuris*	14	Chapilla
15	Kholisha	*Colisa fasciatus*	15	Chapilla	*Gudusia chapra*	15	Chatka ch
16	Boicha	*Colisa lalius*	16	Tilapia	*Oreochromis niloticus*	16	Foli
17	Shoil	*Channa striatus*	17	Foli	*Notopterus notopterus*	17	Darkina
18	Mrigal	*Cirrhinus mrigala*	18	Rui	*Labeo rohita*	18	Boicha
19	Foli	*Notopterus notopterus*	19	Darkina	*Esomus danricus*	19	Rui
20	Chapilla	*Gudusia chapra*	20	Boicha	*Colisa lalius*	20	Tilapia
21	Bailla	*Glossogobius giuris*	21	Boal	*Wallago attu*	21	Mrigal
22	Chatka chingri	*?*	22	Silver carp	*Hypophthalmichthys molitrix*	22	Boal
23	Catla	*Catla catla*	23	Mrigal	*Cirrhinus mrigala*	23	Magur
24	Kachki	*Corica soborna*	24	Kachki	*Corica soborna*	24	Chela
25	Chital	*?*	25	Magur	*Clarius batrachus*	25	Silver car
26	Gutum	*Lepidocephalus guntea*	26	Shoil	*Channa striatus*	26	Kachki
27	Kali baush	*Labeo calbasu*	27	Pabda	*Ompak pabda*	27	Batashi
28	Cheua (red)	*?*	28	Kali baush	*Labeo calbasu*	28	Bojori
29	Magur	*Clarius batrachus*	29	Chela	*Chela cachius*	29	Pabda
30	Aair	*Mystus aor*	30	Bojori	*Mystus tengra*	30	Shoil
31	Bara baim	*Macrognathus aculeatus*	31	Cheau (red)	*?*	31	Kali Baus
32	Darkina	*Esomus danricus*	32	Bara baim	*Macrognathus aculeatus*	32	Kaika
33	Carpio	*Cyprinus carpio*	33	Batashi	*Batasio batasio*	33	Bara baim
34	Bheda	*Nandus nandus*	34	Bheda	*Nandus nandus*	34	Catla
35	Bonjori	*Mystus tengra*	35	Catla	*Catla catla*	35	Cheua (re
36	Pabda	*Ompak pabda*	36	Kaika	*Xenentodon cancila*	36	Bheda
37	Cheua (white)	*?*	37	Aair	*Mystus aor*	37	Aair

Table 2. Vitamin A, calcium and iron contents in small and big Bangladeshi fish species, per 100 g raw edible parts.

Fish species	Vitamin A (mg)	Calcium (mg)	Iron (mg)
SMALL FISH, WHOLE			
Mola (*Amblypharyngodon mola*)	1 960	1 071	7
Darkina (*Esomus danricus*)	1 457	-	-
Dhela (*Rohtee cotio*)	937	1 260	-
Chanda (*Chanda* sp.)	341	1 162	-
Kaski (*Corica soborna*)	93	-	-
Puti (*Puntius* sp.)	37	1 059	-
BIG FISH, ADULT			
Hilsa (*Hilsa ilisha*)	69	126	3
Rui (*Labeo rohita*)	27	317	-
Silver carp (*Hypophthalmichthys molitrix*)	17	268	-
BIG FISH, WHOLE JUVENILE			
Tilapia (*Oreochromis niloticus*)	19	-	5
Silver carp (*Hypophthalmichthys molitrix*)	13	-	-

- not measured

juvenile, contain very little vitamin A, suggesting that vitamin A content varies widely among fish species. Presumably, the iron and zinc contents of small fish are also high.

In small fish, vitamin A is present as retinol and anhydroretinol which are readily absorbed and utilized in humans; while in vegetables, vitamin A is found as β-carotene which is not readily absorbed and is destroyed to some extent by cooking. Small fish is an excellent source of calcium especially in countries like Bangladesh where milk and milk products make up only a small amount of the diet. Recent bioavailability studies conducted in both rats and humans showed that small fish was as good as milk as a source of calcium (Larsen et al. 1998; Hansen et al., in press). In humans, the fractional calcium absorption was 24 ± 6% from small fish and 22 ± 6% from milk. Besides being a rich source of haem iron, small fish also has an enhancing effect on the availability of non haem iron from other foods in a meal, even though the mechanism of this effect has not been established (Hallberg et al. 1993).

The importance of fish as a source of minerals and vitamins can be shown by comparing intakes with the values for Recommended Dietary Allowances (RDA) published by the National Research Council, USA (NRC 1989). Table 3 shows the contribution of different fish species to RDA for vitamin A, calcium and iron in a 4-6 year old child consuming 23 g fish, as this was the daily fish intake found in the last national consumption survey in rural Bangladesh in 1981-82 (Ahmed and Hassan 1983). Ninety percent of the RDA for vitamin A was supplied by mola, while an equivalent amount of silver carp only contributed 1% of the RDA.

Table 4 shows the estimated portion sizes of small and big fish from surveys conducted in Ghana and Malawi as well as the contribution to the FAO/WHO recommended intakes of calcium and zinc in 4-6 year old girls (FAO/WHO 1974; Ferguson et al. 1995). The small fish contributed larger proportions of the recommended intakes of calcium and zinc than the big fish.

Accessibility of Fish for Poor Rural Households

There are very few data on the effect of increased fish production on fish consumption at the household level. The following examples illustrate that increased fish production does not necessarily improve the access to fish by poor rural households.

Small pelagic fish landed in Peru and Chile make up 20% of the global fish and 70% of the global landings of small pelagic fish. Nearly all the landed small pelagic fish in Peru and Chile are used in the

Table 3. Contribution of fish species to RDA* for vitamin A, calcium and iron in a 4-6 year-old child consuming 23 g fish (expressed as %).

Fish species	Calcium	Vitamin A	Iron
SMALL INDIGENOUS FISH, WHOLE			
Mola (*Amblypharyngodon mola*)	90	31	16
Dhela (*Rohtee cotio*)	43	36	-
Puti (*Puntius* sp)	2	30	-
LARGE FISH, ADULT			
Rui (*Labeo rohita*)	1	8	-
Silver carp (*Hypophthalmichtys molitrix*)	1	9	-

* RDA for 4-6 year old girls: calcium 800 mg/day, vitamin A 500 mg retinol/day, iron 10 mg/day
- not measured

Table 4. Contribution of small and big fish to recommended intakes* of calcium and zinc in 4-6 year-old girls.

Fish species	Calcium (mg/100 g raw)	Zinc	Portion size for 4-6 year-old girls (g)	Calcium (% of recommended intakes in portion)	Zinc
MALAWI					
Small species	548	3.0	51	35	15.0
Big species	380	1.3	61	31	8.5
GHANA					
Small species (anchovy and herring)	975	3.6	18	22	6.5
Large species (tuna and mackerel)	37	1.3	18	1	2.5

* FAO/WHO recommended intakes for children: calcium 400-500 mg/day, zinc 3.9-6.9 mg/day (basal and normative zinc requirements, assuming moderate zinc availability).

fishmeal industry and exported to be used in animal feeds, so that very little is left for human consumption (FAO 1996).

In Lake Victoria, Africa, fish production has increased ten fold over the past 15 years and at the same time fish species diversity has been reduced to three main species: one small fish, dagaa (*Rasteneobola argentum*) and two big fish, Nile perch (*Lates niloticus*) and tilapia (various species, e.g. *Oreochromis niloticus*) (Abila and Jansen 1997). An export-oriented fish processing industry has also developed, replacing the locally based industry. Fish processing companies buy all landed Nile perch of good quality for export, utilizing 35-50% of the fish and leaving skeletons with some flesh on. The fish skeleton has been an important source of food for the local population who could not afford to buy the whole big fish. But with the development of the fishmeal industry for animal feed production, the skeletons are no longer accessible to the rural poor. At the same time, the small fish dagaa which is consumed either fresh or sun dried by the local population is being utilized by the fish meal industry, making it also less accessible to the rural poor. These changes in the fishery sector in Lake Victoria suggest that accessibility of fish by the local population, especially the poor, has decreased.

The following example illustrates that increased fish production, including indigenous species, can be beneficial for poor rural households. In an area in Bangladesh, reestablishment of fish migration routes with connection to floodplains, leading to restoration of the fish habitat, increased the total fish production five fold. As shown in Fig. 1, the proportion of fish caught that was consumed almost doubled for the landless and small farmers post restoration.

Figure 1. Fish consumption in different socioeconomic groups before and after restoration of a fish habitat in Bangladesh.

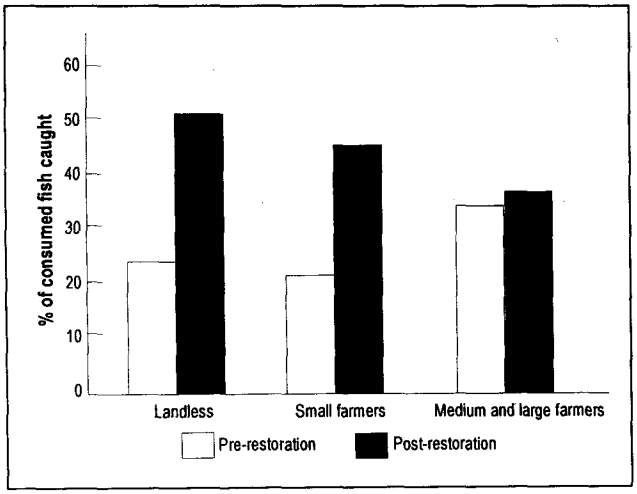


Figure 2. Consumption of fish species before and after restoration of a fish habitat in Bangladesh.

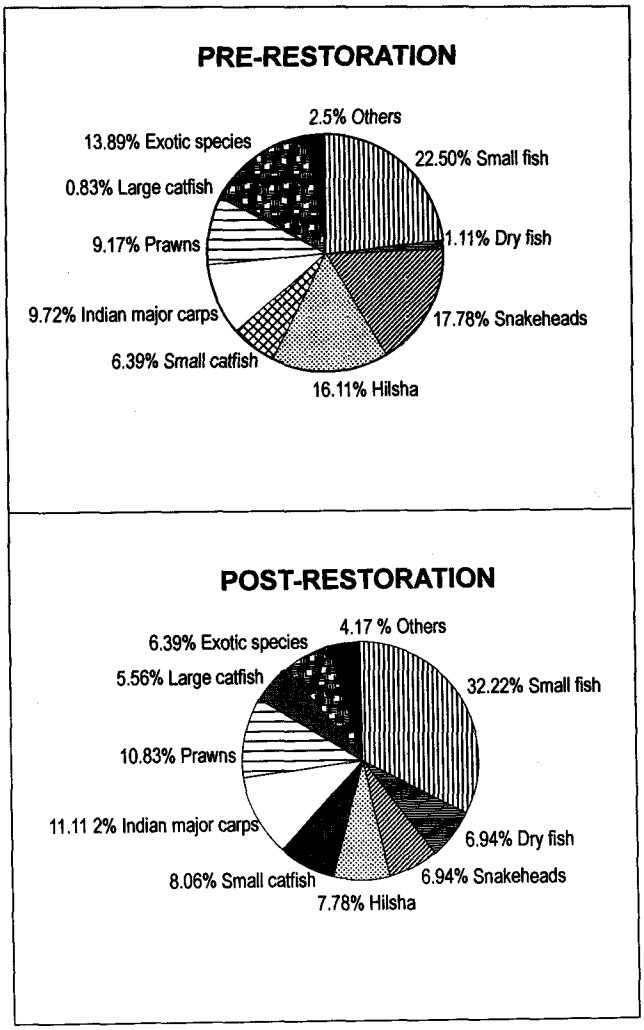


Fig. 2 shows that the proportions of the different fish species consumed changed post restoration with considerable increases in small fish and dried fish (predominantly small fish) (CNRS 1996). These values suggested that efforts which increased local fish production, including small fish, led to greater accessibility of fish for poorer households.

Use of local conservation methods can also influence the accessibility of fish. In an area in Zimbabwe, where consumption of fish is small, the main products consumed are dried kapenta, bream and frozen mackerel imported from Namibia (ALCOM 1995). The number of rural consumers eating dried kapenta was more than double that of urban consumers. Both urban and rural consumers reported that dried kapenta was bought for its taste and because it was cheap. However, only rural consumers reported that dried kapenta was bought also because it was readily available. This suggested that accessibility of dried fish might be important in areas where fresh and frozen fish were not easily available.

Intrahousehold Distribution of Fish Intake

There is very little and conflicting data with respect to intrahousehold distribution of fish intake.

In a survey conducted in a rural area of Bangladesh, it was reported that pregnant women, followed by school children and children under two years of age, consumed the least numbers of fish species compared to other household members. This suggested that the total fish intake in these three groups might have been lower than that of other household members. Recent surveys conducted in three rural areas of Bangladesh showed similar fish intake in relation to energy intake in both females and males of all age groups (IFPRI, BIDS and INFS 1997). In a one year survey covering 15 000 households carried out bimonthly in all regions of Bangladesh, the number of 2-5 year old children consuming fish in the prior week was recorded (HKI 1997). It was found that the percentage of children consuming fish was similar for both sexes. However the frequencies and amounts

of fish eaten were not recorded. Data from a food consumption survey conducted in a Bangladeshi village in 1995 showed that fish intake was calculated relative to the intake of the head of household. Females had a lower intake than males in all age groups, except 0-6 year old children (Thilsted 1997).

In order to elucidate the importance of fish for food and nutrition security of different population groups, it is necessary to have precise data for intrahousehold distribution of fish intake, including information on the different fish species and seasonal variation.

Local Knowledge and Perceptions of Fish Species

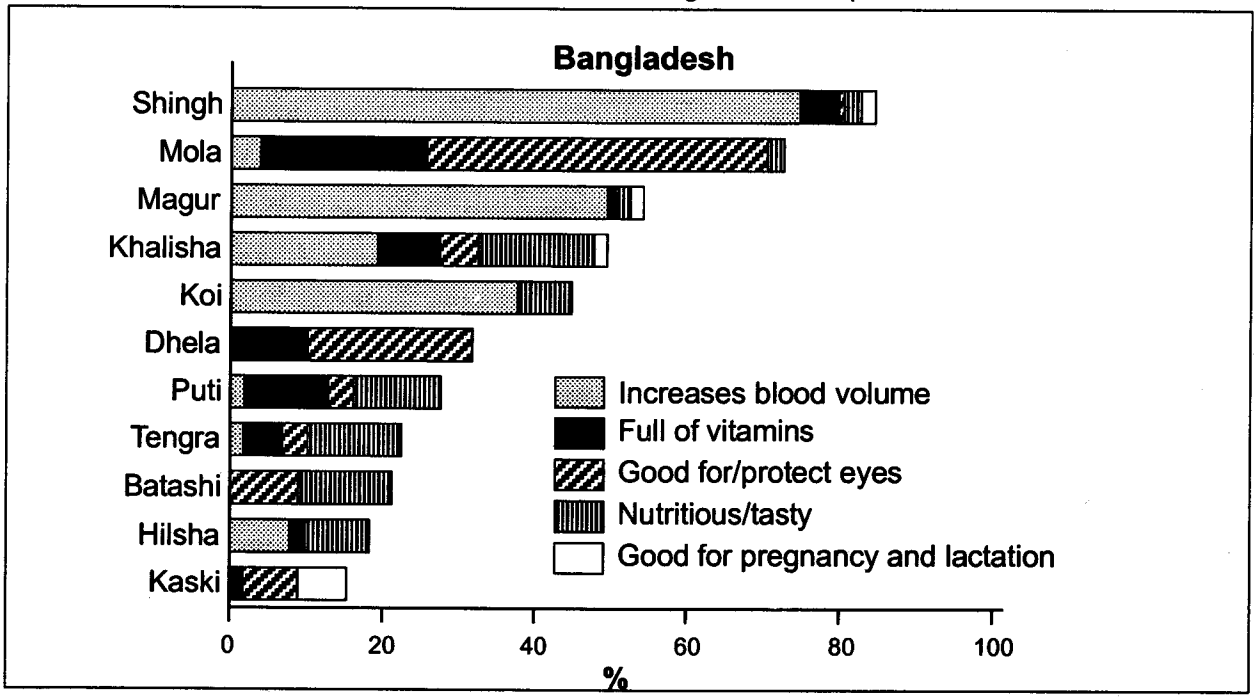
Fig. 3 shows the highly diverse perceptions of the importance of various indigenous fish species for health and well being, expressed by Bangladeshi women in a village survey (Thilsted and Hassan 1997). The small indigenous species, mola and dhela, which were reported by many women as being good for/protects the eyes have been found to have high vitamin A content (Table 2). It may be worthwhile investigating if fish species which increase blood volume have a high iron content. Local knowledge and perceptions of fish must be drawn on if efforts to increase fish production and intake are to be viable and sustainable.

Role of Women in Fisheries

Around Lake Victoria, traditional fish mongers and fish processors are often women from poor households. With the above mentioned development in the fishery sector, women have lost employment and income. Also, they spend more time on landing beaches, far from home and stay with their children in temporary settlements of poor condition. More fish mongers are single heads of households (Abila and Jansen 1997). Taking into consideration the positive effect that income earned by females has on food and nutrition security and the detrimental effect of poor social conditions, the increased production of fish in Lake Victoria may have a negative impact on food and nutrition security of the local, poor population.

The role women play in fisheries is often overlooked. In aquaculture in Asia, women are often responsible for looking after and fertilizing the pond and feeding the fish, while men take care of

Figure 3. Perceptions of 119 rural women on selected Bangladeshi fish species.



activities outside the household, such as buying fingerlings, harvesting and marketing fish. However, in some aquaculture projects, information and training are given only to men and are not shared by women. This can be counterproductive for both fish production and intake.

In a survey on subsistence fishing in Bangladesh, 15% of the people engaged in fishing were women, of which 75% were under 17 years of age. Thus protection and promotion of subsistence fishing by young females may play a role in increasing household fish consumption.

Nutrient Contents of Fish Species

There is little data on the nutrient composition of different fish species. The few values found for nutrient contents of fish species in food composition tables are subject to uncertainty regarding the analytical methods used, the number of samples analyzed, seasonal variation and cooking losses. In addition, some of the values are incorrect. More reliable values for the nutrient contents of the edible parts of commonly consumed fish species are needed in order to assess the contribution of different species to nutrient intakes.

Conclusions

The following recommendations related to policy issues on fisheries in relation to food and nutrition security should be given high priority:

- develop production systems that make use of local and diverse fish species, including small fish species;
- increase the use of bycatch and fish products for human consumption;
- balance government policies for fish for local consumption and fish export;
- increase the accessibility of diverse species, including small fish, especially for poor households;
- protect women in fisheries;
- strengthen research on the nutritional value of commonly consumed fish species;
- collect and make use of reliable data on fish consumption patterns;
- improve low cost technologies for fish processing; and
- assist governments to abide by the Kyoto Declaration and Plan of Action (1995) and the Code of Conduct for Responsible Fisheries (1995).

References

Abila, R.O. and E.G. Jansen. 1997. From global to local markets: the fish processing and exporting industry in the Kenyan part of Lake Victoria-some preliminary findings on its structure, strategies and socio-economic impacts. Paper presented at the 3rd International Fisheries Conference, 9-11 April 1997, Cape Town.

Ahmed, K. and N. Hassan. 1983. Nutrition survey of rural Bangladesh 1981-1982. Institute of Nutrition and Food Science, University of Dhaka, Bangladesh.

ALCOM (Aquaculture for Local Community Development Programme, FAO). 1995. The market for fish and fish products in Zimbabwe. ALCOM Field Document No. 34, Harare.

Brummett, R.E. 1993. Preserving and assessing the culture potential of indigenous Malawian fishes. ALCOM News, 12-14 October 1993.

CNRS (Center for Natural Resource Studies). 1996. Community-based fisheries management and habitat restoration project. Annual report (July 1995-June 1996). CNRS, Dhaka.

FAO/WHO (Food and Agriculture Organization of the United Nations/World Health Organization). 1974. Handbook on human nutritional requirements. FAO, Rome.

FAO (Food and Agriculture Organization of the United Nations). 1995. Code of conduct for responsible fisheries. FAO, Rome.

FAO. 1996a. Rome Declaration on World Food Security and World Food Summit Plan of Action. FAO, Rome.

FAO. 1996b. Fisheries and aquaculture in Latin America and the Caribbean: situation and outlook. FAO, Rome.

Ferguson E.L., R.S. Gibson, C. Opare-Obisaw, S. Ounpuu and C. Lamba. 1995. Dietary strategies for improving

the zinc nutrition of rural southern Malawian and Ghanian children. Ecol. Food Nutr. 34:33-47.

Goverment of Japan. 1995. The Kyoto Declaration and Plan of Action. International Conference on the Sustainable Contribution of Fisheries to Food Security. Fisheries Agency, Government of Japan.

Hallberg, L., B. Sandström and P.J. Aggett. 1993. Iron, zinc and other trace elements. *In* J.S Garrow and W.P.T. James (eds.) Human nutrition and dietetics. Churchill Livingstone.

Hansen, M., S.H. Thilsted, B. Sandström, K. Kongsbak, T. Larsen, M. Jensen and S.S. Sørensen. Calcium absorption from small soft-boned fish. J. Trace Elements Health Dis. (In press).

HKI (Helen Keller International), Bangladesh.1997. Unpublished data.

IFADEP (Integrated Food Assisted Development Project). 1996. Small indigenous fish species (SIS) culture in Bangladesh. Abstracts. Seminar held at the University of Rajshahi, Bangladesh, 12 December 1996.

IFPRI (International Food Policy Research Institute), BIDS (Bangladesh Institute of Development Studies) and INFS (Institute of Nutrition and Food Science), University of Dhaka. 1997. Adoption of commercial vegetable and polyculture fish production in Bangladesh: impacts on income, household resource allocation, and nutrition. A progress report on sample selection and a discussion of preliminary tables from the first of four rounds of household surveys.

ISPAN (Irrigation Support Project for Asia and the Near East). 1995. Potential impacts of flood control on the biological diversity and nutritional value of subsistence fisheries in Bangladesh. Bangladesh Flood Action Plan (FAP 16) Environmental Study, Virginia.

Larsen, T., S.H. Thilsted, K. Kongsbak and M. Hansen. 1998. Small fish as a rich calcium source. (Submitted)

NRC (National Research Council). 1989. Recommended dietary allowances. National Academy Press, Washington, D.C.

Ramalingaswami, V. 1994. New global perspectives to overcoming malnutrition. *In* M.L. Walquist, A.S. Truswell, R. Smith and P.J. Nestel (eds.) Proceedings of the XV International Congress of Nutrition: Nutrition in a Sustainable Environment. Smith-Gordon.

Thilsted, S.H., N. Roos and N. Hassan. 1997. The role of small indigenous fish species in food and nutrition security in Bangladesh. Naga, ICLARM Q. Supplement July-December 1997 :13-15.

Thilsted, S.H. and N. Hassan. 1997. Unpublished data.

Thilsted, S.H. 1997. Unpublished data.

WHO (World Health Organization). 1992. National strategies for overcoming micronutrient malnutrition. Draft resolution proposed by Rapporteurs of the Executive Board. 89th Session, WHO, Geneva.

COMMENTS

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The paper is an important research report on the role of small indigenous fish in the nutrition security of poor households. It draws attention to the need for fisheries scientists and policymakers to collaborate with local people to learn more about indigenous species and their uses, in order to enhance their production for food security. The focus on indigenous fish is also significant for its contribution to biodiversity. The policy environment which is bound to affect developments in the capture and utilization of small indigenous fish, however, does not receive adequate attention.

The authors strike a major chord by presenting very convincing information on the nutritional advantage of small indigenous fish in the provision of micronutrients. One of the important observations made is the superior absorption of calcium from small fish, compared to large fish. This is primarily because small fish are eaten whole with the bones, unlike large fish. In the light of this, it is regretted that research and policy agenda in developing nations often ignore the need to enhance capacity for developing small indigenous species, thus jeopardizing the nutritional needs of the poor in particular.

To further enhance the policy relevance of the paper, the authors should comment more on the socioeconomic framework of fisheries management, distribution and utilization in developing countries. In subSaharan Africa there is a clear indication that fisheries contribution to improved nutrition is not only dependent on catch or type of fish, but also on the technologies available for preservation and storage. There are also questions of affordability. The authors take it for granted that small indigenous fish are affordable, which may not necessarily be the case. At the same time, lack of information on nutrition, and food taboos are likely to limit the access of the poor to the nutritional advantage of small indigenous fish. Sometimes women and children are directly targeted in food taboos which increases their vulnerability to nutritional disorders.

Issues of a local or international political nature are not adequately covered in the paper. These need to be addressed to place the paper more in the current regulatory and promotional frameworks that are being negotiated between countries. A few of the issues that need clarification by the authors are indicated below:

1. The likely impact of the fishmeal industry on the availability and affordability of small indigenous fish for human consumption and how poor people's interests can be safeguarded without unduly stifling economic initiatives;
2. The implications of the promotion of small indigenous fish for local policies on mesh size; and
3. Ways in which fisheries co-management is likely to influence small indigenous fish industry.

COMMENTS

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The paper of Dr. Shakuntala Thilsted and Ms. Nanna Roos is a significant one. I would only note that, protein is an essential, but not a limiting nutrient per se. Vulnerable groups such as pregnant and lactating women and small children cannot get enough protein (or energy) from a high energy but low density cereal or tuber-based diet as can adults. They would benefit from a denser diet containing fish. There is also a large literature on polyunsaturated fatty acid's being required for brain development. The role of men during harvest of fisheries in ponds should also be recognized.

Policy Issues Deriving from the Impact of Fisheries on Food Security and the Environment in Developing Countries

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SVERDRUP-JENSEN, S. 1999. Policy issues deriving from the impact of fisheries on food security and the environment in developing countries, p. 73-91. *In* M. Ahmed, C. Delgado, S. Sverdrup-Jensen and R.A.V. Santos (eds.) Fisheries policy research in developing countries: issues, priorities and needs. ICLARM Conf. Proc. 60, 112 p.

Abstract

On the basis of FAO projections of world supply of fish for human consumption from marine and inland capture fisheries and aquaculture, the potential and constraints to increasing production are discussed. Special focus is placed on the environmental constraints and the implications for food security of poor people in developing countries. Critical policy issues related to environmental problems and food security concerns are noted and policy measures presented for discussion.

"From ancient times, fishing has been a major source of food for humanity and a provider of employment and economic benefits to those engaged in this activity. The wealth of aquatic resources was assumed to be an unlimited gift of nature. However, with increasing knowledge and the dynamic development of fisheries after the second world war, this myth has faded in face of the realization that aquatic resources, although renewable are not infinite and need to be properly managed, if their contribution to the nutritional, economic and social well-being of the growing world's population is to be sustained". (FAO Code of Conduct for Responsible Fisheries 1995)

Introduction

The fisheries sector plays an important role in food security. Perhaps more important is its role in the provision of employment opportunities, especially in rural areas, and its contribution to economic growth.

The per caput amount of fish available for human consumption, which has been almost constantly increasing since 1950, has leveled off in recent years at about 13.6 kg. The reasons are population growth and deterioration in the production potential of the resources. In contrast to agriculture, where threats to the expansion of output are likely to be met by intensification of agricultural practices, the finite nature of fisheries resources limits the opportunities for further intensification of the exploitation for marine and most inland capture

fisheries. Intensification of production is technically and economically feasible with aquaculture and, to some extent, inland capture fisheries.

In 1995, the total world supply of fish for human consumption was estimated at 80 million t, of which 52 million t was from marine fisheries, 7 million t from inland fisheries and 21 million t from aquaculture. Of this total about 35 million t (44%) were consumed in developing countries and 45 million t (56%) in the developed countries. A noticeable feature of the supply situation since about 1980 is the marked increase in catches by the developing countries. During the 1970s, developing countries contributed a little less than half the total catches. This increased to 2/3 in 1993. Developing countries in Asia, especially China, have contributed much of the increase from both capture fisheries and aquaculture production.

For the developing countries as a whole, fish makes up about 19% of the total consumption of animal protein. In many developing countries in Asia, Africa and Latin America, fisheries are important for the food availability of populations living in coastal areas and along rivers and lakes. Fisheries are very important for many island populations, particularly in the Pacific and Indian Oceans. Fish appears to be significantly more important in the diet of the population of low income food deficit countries (LIFDCs) than it is in the non-LIFDCs, even if the amount of available fish per caput is lower in the former.

The fisheries sector also contributes indirectly to food security through income generation from production, processing and distribution. It is likely that about 100 million people are partly or wholly economically dependant upon it. Most of these are relatively poor people in developing countries. Fisheries are also an important source of foreign exchange earnings. Net exports of fishery products by developing countries were more than 16 billion in 1994, higher than coffee, banana, tea, meat and rice. The share of the developing countries in fish trade was 51%.

Increases in the real price of most medium to high-priced fish in the world market through much of the 1980s and extending into the 1990s indicate an increase in demand relative to supply. The main exception to this are small pelagic species produced by aquaculture, and fish landed in areas where there is little trade and/or low population increase. The increases in real prices together with the availability of subsidies in many countries have stimulated investments in industrial and semi-industrial capture fisheries and are part of the reason for the over-capitalization of the sector. In geographical areas with population increase, displacement of labor from traditional occupations and lack of employment opportunities, fisheries have become the occupation of last resort when there are no formal barriers to entry. As a result, the global fishing effort capacity far exceeds the capacity needed for harvesting available resources.

The consequences have often been declining incomes, overexploitation of fish stocks and degradation of coastal zone environments. This is a threat to population groups dependent on fisheries for their living and to the economic and social well-being of countries where fisheries play a significant role within the economy.

Outlook to 2010

Under optimistic assumptions, the levelling off of the marine catches for human consumption may be reversed by the adoption of wise management strategies and the increased utilization of small pelagic species for food. Recent FAO estimates indicate a potential increase in catches in the range of 20% of the 1991-93 average supplies. The national economic benefits generated in the sector may be even more because the increase in catches would predominantly be high-value species. A reduction in operating costs and investments would contribute.

A large proportion of the catch of inland fisheries is for subsistence and is mainly consumed locally. Projections of potential supply are difficult to make because of significant underreporting of actual catches. In many parts of the world, inland fisheries are under threat because of environmental degradation and/or overfishing. However, if measures are taken to protect the environmental

integrity of inland waters, substantial increase in total production would be possible, particularly from additional introductions and stocking of waterbodies.

Aquaculture offers considerable potential for future expansion. Noteworthy is the potential for traditional production systems such as polyculture, brackishwater farms and coastal marine farms. This potential is based on technological improvements, genetic improvement of cultured species, improvements in feeds, disease management, reproduction control, and environmental management.

The most optimistic projection of total fish supplies in 2010 indicates a 50% increase compared to 1995 (Table 1).

The demand for fish for human consumption is likely to grow up to 2010 both as a result of population growth and income growth. The strength of these two forces will vary significantly from region to region. FAO projection of total demand in 2010 is in the range of 110-120 million t.

Marine capture fisheries are the main source of fish for human consumption, providing about 2/3 of reported global supplies. In addition, almost all fish used for reduction to fishmeal and fish oil is of marine origin (40% of total marine catches). Marine fishing takes place in all oceans and seas of the world.

Marine capture fisheries involve a number of activities/operations which are undertaken at a wide variety of technological levels, ranging from low input fishing from unmotorized dugout canoes from the open beach to industrial operations far offshore involving huge, capital intensive and technically advanced fishing vessels with access to advanced port infrastructure. Marine capture fisheries involve people from the widest spectrum of socioeconomic backgrounds, ranging from resource poor individuals and groups fishing for subsistence to owners of large, multinational, vertically integrated fishing enterprises.

Table 1. World supply of fish for human consumption, 1995 and projections for 2010.

	1995	2010
	(million t)	
Marine capture fisheries	52	62
Inland capture fisheries	7	11
Aquaculture	21	39
Reduction in discards and postharvest losses	-	3-8
TOTAL	80	115-120

Source: FAO

The significance of small-scale artisanal fisheries in the supply of marine fish for food is considerable, as they account for the major part of the fish landed for direct human consumption in developing countries. The contribution of small-scale fisheries to income and employment, especially in areas where there is no alternative employment, is also considerable, with at least 100 million people wholly or partly economically dependent upon it.

Reported marine catches have increased by a factor of five over the last 50 years. The growth has been achieved through a combination of two factors: firstly, there has been more fishing activity with additional people entering the fisheries and larger vessels and fleets being built; secondly, efficiency has dramatically improved through the continuous development of harvesting technology.

The most obvious examples of technological innovation have been seen in the industrial fishing fleets. In the 1960s and early 1970s, powerful new fleets were built which could operate far from base, using highly efficient gear such as the pelagic trawl and the purse seine, and processing the catch on board in some cases.

The general extension of fishing limits following the United Nations Conference on the Law of the Sea (UNCLOS), reduced the fishing opportunities for distant-water fleets and turned attention to middle distance fisheries within national limits. Nevertheless, the fishing power of the fleets continued to increase.

There has been a significant degree of over investment in fishing vessels, together with the increasing efficiency of each vessel through various applications of technology. This has led to the situation where most marine fish stocks are fully exploited or overfished. Technology has also had some impact on small-scale artisanal fisheries. However innovations in this sector have been relatively

simple. Coupled with increased participation in fisheries, the innovations have greatly increased artisanal fishing pressure. The increased participation is partly due to population growth, but also developments in agriculture and other sectors have caused displaced people to turn to the sea for their livelihood. That they have often been able to do so is in part due to the fact that the coastal fisheries have generally been managed within an open access regime. The resulting increased fishing pressure from small-scale artisanal fisheries has caused many of the stocks on which the artisanal fisheries depend to show the same signs of overexploitation as in the industrialized fishing sector.

Production from Marine Fisheries

Reported landings from marine capture fisheries reached a peak of 84.3 million t in 1994. Of this, 50 million t were available for human consumption. This figure has remained fairly stable in recent years. The global figures mask the continuing decline that has taken place since the late 1980s in the landings of demersal fish species that are relatively high priced. Supplies of pelagic fish species have been increasing, and in 1994 they accounted for more than 60% of the total marine fish landings.

The decline in the demersal catches relates primarily to Alaska pollock and Atlantic cod, whereas the catches of other demersal species have remained fairly stable at about 12.5 million t per year. Catches of tunas, squids and crustaceans have increased slightly in recent years.

All continents showed increases in catches from the marine environment up to the end of the 1980s. Since then they have stayed about the same or have decreased. The largest decreases have been in catches by Japan, down by 43% over the decade to 1993, and by countries in the former USSR, also down by 43% over the decade.

Potentials for Increasing Production from Marine Capture Fisheries

Previous optimistic FAO estimates of the potential contribution of marine capture fisheries to human consumption in 2010 was at 55 million t[1] out of a total marine catch of 83 million t.

Recent detailed analyses of data on marine catches[2] and fish stocks have led to a reassessment of the potential of marine fisheries and paint a more optimistic picture of the possible supplies. Provided there is widespread management of major fish stocks and significant parts of the marine environments, the revised estimate comes at 62 million t for human consumption (Table 2). On the other hand, if appropriate management measures are not implemented within a fairly short timeframe, marine fish supplies may drop to about 40 million t.

Some of the analyses undertaken suggest that additional increases in marine catches may be possible as many marine fisheries are based on stocks that are increasing or decreasing in response to environmental or ecosystem changes.

The potential increase in the marine catches relates first and foremost to the possible recouping of "losses" owing to overfishing of marine fish stocks and increased catches from developing marine fisheries[3].

Table 2. Supplies of marine fish for direct human consumption, 1991-93 and projections for 2010.

	Annual average 1991-93	2010
	(million t)	
Crustaceans	4	5
Cephalopods	2	3
Other molluscs	6	6
Small pelagics	31	35
Tunas, etc.	4	4
High value demersals	11	15
Low value demersals	19	24
Reduction to fishmeal	(28)	(30)
TOTAL	50	62

Source: FAO Fisheries Department

[1] FAO: Safeguarding future fish supplies: key policy issues and measures. International Conference on the Sustainable Contribution of Fisheries to Food Security, Kyoto, Japan, 4-9 December 1995.
[2] R.J.R. Grainger and S.M. Garcia 1996. Chronicles of marine fishery landings (1950-1994): trend analysis and fisheries potential, FAO Fish. Tech. Pap. 359.
[3] Fisheries showing increasing yields.

The recouped catches may to a large extent comprise high value demersal species in the Atlantic Ocean and lower valued demersal species in the Pacific Ocean. Fisheries development of some significance is only likely to take place in the Indian Ocean, particularly on offshore resources.

There is also some potential for increasing the catches of small pelagics from the central Atlantic. However, the demand situation for these low value species does not encourage increased production at the present cost levels. In the past, many African countries were supplied these species by fishing vessels from USSR at prices well below real production costs. As the purchasing power in many African countries is not likely to rise much by 2010, only cost reductions associated with technological innovations could lead to increased commercial exploitation of these resources.

Constraints to Increases in Marine Capture Fisheries

The constraints to increased output from marine capture fisheries can, to a large extent, be related to inappropriate fisheries management, be it poor resource management or unwise management of the structural development of the fisheries sector. Constraints related to environmental conditions most often originate outside the fisheries sector.

Resource Management

In 1950, no marine fish stocks were known to be overfished. Since then overfishing has increasingly become a problem. In 1994, FAO estimated that almost 70% of those stocks of marine fisheries for which assessments were available were fully exploited, overfished or otherwise in urgent need of management. The greater part of the threatened stocks are of higher priced, long living species. Stocks of small pelagic, lower priced species, such as sardines, anchovies, herring, etc., are also under threat in certain areas.

Overfishing is a long established feature in many of the oldest fishing grounds of the northern hemisphere, e.g., in the North Sea, the North Pacific and North Atlantic. It also reaches serious levels in coastal areas where there are high population densities and scarce alternative employment opportunities. This is the case in many coastal areas of Asia, in some African countries, in parts of Latin America and in many small island developing states. Overfishing by local fishers has often been aggravated by fishing fleets from industrialized countries operating within the Exclusive Economic Zones of many developing countries, mainly under fishing agreements.

The amount of unwanted catches returned back to the sea as discards is estimated at 25% of the total marine catches or above 20 million t per annum. This problem is particularly associated with industrial and semi-industrial marine fisheries. Most of the discarded fish is dead. Discards may be the result of fishers' assessment of the economics of bringing unavoidable bycatch ashore or may even be required by management regulation.

Sector Structure Management

The situation is deteriorating in many areas with a continuing increase in the number and capacity of vessels, although the rate of increase of new construction has diminished since 1990. This development has often been supported by various national subsidy schemes. Many of the vessels taken out of the fleets of the former USSR and East European countries as a result of their transition and also many vessels withdrawn from the distant-water fleets of some other countries are continuing to fish under new ownership. Some countries, e.g., China, are continuing to expand their distant-water fishing operations.

There is a considerable danger that overfishing in coastal areas will also continue to worsen. In many developing countries, population pressure and few alternative employment opportunities, when coupled with the absence of effective fisheries management, will increase the attraction of fisheries as the employment of last resort. This will build up fleet capacity and increase fishing effort.

Environmental Aspects

In most coastal countries, the productivity of the marine fisheries is being adversely affected by an increasing demand for coastal space and resources. More often than not, this competition is reflected in the degradation of the marine environment. This may be generated either by the fisheries sector itself or, more frequently and usually with a larger impact, outside the fisheries sector.

The damage to fish habitat caused by the fisheries sector can be significant. Among the principal causes are: trawling, which may adversely affect certain habitats and bottom fauna; the use of dynamite and other destructive fishing techniques; aquatic pollution caused by intensive coastal aquaculture and the destruction of coastal wetland and mangrove areas by aquaculture pond construction.

Fish habitats are being rapidly degraded in many parts of the world by industrial, urban and agricultural pollution, pollution from ships, landfill, damming and diversion of rivers, sedimentation, resource mining, deforestation in the hinterland, etc. In some areas, the destruction of fish habitats has become the prime cause of the reduction of fish abundance. Such degradation results in loss of the economic value of the goods and services provided by the affected ecosystems and also loss of biodiversity and genetic resources. Related to this is the spatial conflict, where fishers are displaced from their traditional areas by coastal developments like urbanization and tourism.

Implications for Food Security of Poor People in Developing Countries

The potential to recoup losses of demersal fish species relates mostly to developed countries and has little implication for the food security of poor people in developing countries except that they may expect relatively lower prices on their competing export of fish products.

The potential to increase the catches of small low value pelagic fish in the central Atlantic may have more direct implication for the food security particularly of urban poor people in (West) Africa. The species in question are most economically caught, handled and distributed in large quantities and are thus suitable for big urban markets.

As coastal fish resources are already overexploited by artisanal and industrial fishing vessels and there is strong pressure to enter the fisheries, no improvement in food security should be expected from these sources. Effective resource management could prevent further deterioration or even reverse the situation with time.

Resolution of conflicts between industrial and artisanal fishers can increase the share of resources that are available to small-scale operators fishing for subsistence or serving local markets, and thus increase rural food security. Also a reallocation of fishing rights and quotas from foreign vessels fishing under licence agreements to national fishers would contribute.

The collection and sale at local markets of bycatch that is alternatively discarded can make a significant contribution to the supply of cheap fish at rural and urban markets. Much fish is discarded from trawlers operating in nearshore waters of developing countries. This fish can be collected at the fishing grounds by local canoes/boats at low costs.

In most developing countries, subsistence fishing in marine waters is increasingly giving way to fishing which generates money income. The integration of fisheries into the formal economy of the society is normally considered beneficial to fishers and their dependants. However, money income earned by (male) fishers may not necessarily be spent on (more or better) food for women and children. There are, unfortunately, plenty of examples where the transition from subsistence to market-oriented fishing has actually reduced the food security of those dependent on the fishers.

Involvement of fishers and other stakeholders at the local level in the management of coastal fisheries may in many cases be the only feasible way to establish rules and regulations that are actually complied with. However, a series of conditions would have to be met to make the outcome of co-management between government authorities and resource users successful in terms of sustainability, equity and efficiency. In coastal areas where there

are no natural physical boundaries within which exclusive user rights can be established, it seems to be difficult to establish decentralized management arrangements. Most cases of co-management arrangements in place in coastal areas relates to fisheries in lagoons, estuaries or bays.

Reduction of the postharvest losses caused by bad practices for fish handling and preservation would increase the supply of fish on the coastal markets and also markets in the hinterlands. The technical solutions are well known. What is missing is appropriate infrastructure facilities, information, training and economic incentives which would motivate producers to focus on product quality.

Marine fish which were previously consumed locally in developing countries now find their way to the fish markets in the developing countries as a consequence of trade liberalization, reduced transportation costs and also the strong global concentration in the fish trade business. This trend will continue and it is likely that the associated price increase for high value fish species will also push the price of low value species upward. In countries where there are only modest, if any, increases in the purchasing power of the people, the globalization of fish trade may lead to reduced food security in terms of access to fish. This is likely in many parts of subSaharan Africa in years to come.

Inland Fisheries

General Sector Characteristics

Inland capture fisheries are complex in nature and involve a wide variety of activities undertaken by people from a wide spectrum of socioeconomic backgrounds. The main fishing areas are rivers and their basins (often associated with extensive floodplains in the tropics), lakes, reservoirs, irrigation and drainage canals and a variety of seasonal or permanent waterbodies. African freshwater resources are dominated by major rivers and floodplains and the Great Lakes. In South America, lakes are less important but the region has the largest of the world's river basins. Asia has a number of impressive river systems but artificial impoundment, especially large reservoirs, are more prominent than in Africa or South America. In Europe, North America and other developed countries, freshwater resources are varied, but many rivers have regulated flows and fisheries management systems are becoming increasingly governed by recreational considerations.

Fishing methods are dominated by labor-intensive gears used on an individual basis or by small groups. High efficiency commercial gears are rare. The high level of artisanal and informal activity leads to a high degree of participation and includes a significant number of women and children in some areas.

Notwithstanding the importance of the informal sectors in inland fisheries, there are also a significant number of important commercial/artisanal fisheries. Fisheries in some of the larger open water regions, for example, are taking on an appearance associated with industrial marine capture fisheries. Management requirements for these are developing in a similar fashion as for the marine sector.

Freshwater fish is predominantly consumed in its entirety by local communities. The produce is rarely exported and there are practically no discards and minimal wastage. In many countries there are no marine fisheries and all current and potential production is entirely from freshwater fisheries.

Production from Inland Fisheries

Reported production of inland capture fisheries increased steadily from 1984 to a peak at 7 million t in 1995. However, a large proportion of fishing activity, particularly subsistence fishing, is seriously unreported. Actual catches may be at least twice the reported figure. Therefore, assessments based solely on reported catches may be misleading. The production is almost entirely composed of finfish, with small amounts of crustaceans and molluscs.

The 2% annual reported growth in production from inland capture fisheries over the period 1984-1992 conceals considerable regional differences. The trend over Europe and the former USSR has been predominantly negative, principally due to

declining habitat quality and overexploitation of stocks. In Asia and Africa, there have been significant increases in production. These increases have been achieved against rather different backgrounds. In Africa, increases have come largely from the capture fisheries of the Great Lakes and rivers and now approach their predicted maximum of some 2.2 million t. The erratic rainfall over the continent during the past decade has caused considerable decimation of reservoirs and smaller waterbodies, thereby reducing their contribution. The main increase in fish production in Asia has been in China. This has largely been the result of a policy of intensive stocking of large reservoirs built during the recent period of rapid economic development.

Potentials for Increasing Inland Fisheries

Management of Natural Resources

Accurate assessments of the resource situation are obscured by the rapid responses of many freshwater fish stocks to fluctuating environmental conditions even more so than with marine fisheries. A fishery may be overexploited in one season and, with the same fishing effort, may be underexploited the next. In some highly productive systems (e.g., where production levels are closely associated with flood regimes), fishable resources have been known to double or triple from one season to another. Inland fisheries also often show marked natural variations between years. However, the consensus is that most inland fisheries are now fully exploited, in some cases overexploited, and, there are few large inland fisheries with a large potential for significant expansion.

In general, the majority of inland fisheries are difficult to manage through controls on exploitation. Sustaining or increasing catches through improved management shows less potential than in the marine sector. Exceptions may be in areas where fishing activities are more centralized, visible and controllable, such as in reservoirs or larger lakes. With the majority of inland fisheries, there is a large participation and, hence, a wide and flexible distribution of effort. A high proportion of participants fish part-time, often as a secondary and/or seasonal activity. These factors result in many inland fisheries being relatively self-managing in comparison to marine fisheries, since resource availability and exploitation are linked. The stocks themselves are often much more resilient to large changes in mortality than with many marine species because natural calamities are common in freshwater compared with more stable marine environments.

In areas where improved management can help sustain or increase catches, progress can often be made if fisheries authorities accept co-management systems and see their own role as being facilitators, advisors and monitors as opposed to being primarily regulators. In inland fisheries, externally imposed regulation is often ineffective because of high enforcement costs.

Some stocks are evidently declining beyond the limits imposed by natural environmental cycles. This particularly applies to many river fisheries. In almost every case, the decline has been shown to be predominantly due to changes in the aquatic environment brought about by human activities, such as physical interference through engineering works or decline in water quality due to pollution and impacts of agricultural activities on catchment. However, some development can result in new fishing areas becoming available, e.g., reservoirs built primarily for irrigation or hydropower.

There is potential for increasing catches at the local level by rehabilitating freshwater habitats and, hence, the fisheries they support. This has already lead to improved fisheries in many countries and is being considered as a serious option in many others.

Sector Structure Management

In general, the scope for increasing the catches through improvement in technology are limited in inland fisheries. New technology and infrastructure have been introduced into most areas where these can be applied. Most modern, high efficiency gears are not suitable for use in the

diverse habitats and conditions that characterize inland fisheries.

Perhaps the greatest potential for increasing catches from inland waters is by applying and/or improving culture enhancement techniques. These stocking activities offer particular promise for small waterbodies and reservoirs and are already contributing to a major proportion of the catch from inland waters in many regions, particularly in Asia. The divisions between capture and culture activities will rapidly fade and in many regions have already gone.

Estimates of biological potential indicate that for most areas this will not be a major constraint. However, the socioeconomic potential and constraints vary considerably between regions. Estimates of realistic increases in production that can be achieved through intensified stocking activities are in excess of 5 million t per annum from existing waterbodies. New reservoirs will present further opportunities for increased production. If stocking activities are intensified and/or combined with the enhancement of primary production (through, for example, nutrient enrichment of water), increases in production may be well in excess of this.

Improving production through culture enhanced fisheries has several attractions: existing water resources are used; low resource input systems are involved; using species low in the food chain can help maximize the biological efficiency of production; increased participation; beneficiaries are often low-income, resource-poor communities; no pollution; and, limited management inputs into the rearing process. Increases in production do not require any major technological changes. Most importantly, the management requirements for increased production through stocking are unlikely to result in conflicts of interest since the process involves enhancing existing activities. Therefore, the prospects for achieving this increased production are good.

However, there will be constraints to private sector involvement in increasing production from stocking until issues relating to ownership of, or access rights to the (enhanced) fish resources are addressed. Many of the major areas where increased production from stocking is anticipated are open access. In many cases the public authorities will be required to take the major initiative and provide the major investment (or underwrite private sector investments). This differs from more intensive aquaculture activities which might be driven more by the private sector. In the longer term, private sector management, including co-management approaches should be encouraged by resolving resource use or access rights issues on a fair and equitable basis.

Integrated Management

Channelization, water extraction, impoundment of rivers, habitat degradation and water pollution pose major threats to inland fisheries in almost all areas. Improved management of these influences, therefore, can help sustain existing catches and increase catches where trends can be reversed. Addressing these problems requires that fisheries administrators participate with peers from other sectors in integrated basin management and represent the interests of their sector (including giving due attention to low income groups and those communities facing the prospect of food insecurity). In the context of inland fisheries, sector-integrated management policies are most appropriate if conducted on a lake or river-wide basis.

Decisions relating to the allocation of water resources need to incorporate multiple use considerations. For this to occur on a fair and equitable basis and on sound economic grounds, governments need to gather more information on the current value and utilization of freshwater habitats. Where projects will have major impacts on fish resources, governments need to make clear and unambiguous decisions on whether or not they wish to keep the resources in question. Such issues must often be considered in stark and realistic terms. In some cases, technical inputs into political decisionmaking processes could be improved if analyses of the available options were made on the basis of cross-sectoral impartiality.

Constraints to Increase in Production from Inland Fisheries

Conflicts of Interest

Inland fishers continue to face strong competition for the right to use natural resources. The greatest threat to sustainability of inland fisheries arise from outside the sector itself. This is particularly true for riverine fisheries where hydroelectric, navigational and other developments together with pollution often displace fishers or alter natural conditions in such a manner that fish production declines or cannot be developed. The lack of integrated approaches to river basin management and the lack of attention to the importance of inland fisheries in planning and development activities is a major constraint to sustaining production from the sector.

In order for inland fisheries to be given due consideration in the overall development context, it is necessary to have quantitative data on the subsector. The lack of such data results in two major problems. Firstly, because data are lacking, planners often assume that inland fisheries activities are insignificant. Secondly, without data it is difficult for fisheries administrators to promote their sector relative to agriculture, industry and commerce where economic data, forecasts and analyses are generally more readily available. There is an urgent need to improve basic data on inland fisheries in order to improve prospects for integrated management. In particular there is a need to assess the extent of participation in, and importance of, inland fisheries activities in quantifiable economic terms.

Pollution and Habitat Degradation

The biggest constraint to sustaining current yields from freshwater fisheries is pollution and habitat degradation. The trend for aquatic habitat degradation and increasing water pollution as population increases and countries develop and/or industrialize is followed by increased attention to environmental concerns and rehabilitation as they become wealthier. These are likely to be the major influences in the short to medium term. The effects on total catches from freshwaters will depend very much on the rate of decline compared to the rate at which emerging opportunities for increased production are seized.

Floodplain areas represent one of the most productive and sustainable fishing areas in any catchment. However, they are often seen as "wastelands" and are considered suitable areas to drain and convert to agriculture or urban building. This not only destroys the fisheries, but also tends to disrupt the dynamics of the water flow system with unwanted side effects like floods and erosion downstream.

Alteration in water flows through channelization and impoundments can seriously disrupt the natural production cycles of rivers at both the site of the impoundment and downstream. Production can be significantly reduced in the lower reaches of rivers following dam construction upstream. In particular, migration patterns of riverine fishes are vulnerable to dam construction. Such negative impacts can be reduced by proper planning, construction techniques and flow control regimes. However, the construction of large reservoirs can also present significant opportunities for new fisheries. These often have substantial potential yields particularly when production is enhanced.

Pollution of rivers from urban developments, industrialization and agriculture intensification can have serious negative impacts on inland fisheries resources. Not only do catches decrease but biodiversity could also be reduced. Aquaculture production in cage culture systems in rivers and lakes is known to have created pollution problems such as the spread of disease. Many of the smaller waterbodies are known to have been badly affected, especially when subject to effluent from urban centers and industrial developments. In many cases, fisheries are known to have collapsed or disappeared. In others, a modest degree of nutrient enrichment appears to have enhanced production, although it is generally associated with reductions in biodiversity. The situation in the larger lakes is

of more concern. For example, the African great lakes are less exposed to the effects of industrialization than some of the larger waterbodies in other regions. However, they are subject to pollution from urbanization, agricultural development and associated catchment degradation. The degree of resilience of these ecosystems to environmental pertubations is unknown.

Implications for the Food Security of Poor People in Developing Countries

Inland fisheries are characterized by a high degree of participation particularly of low income groups including women and children. This is the most important aspect of inland fisheries in relation to food security. The extent of the participation is grossly underestimated in official fisheries statistics.

The significance of freshwater catches to food security is well in excess of what production figures suggest. The high proportion of local consumption and limited wastage indicates the value of the product for local communities. In some regions, inland waters produce a relatively high value product and the relevance of the catch to food security stems from its commodity value. In many other regions, freshwater fish represents an essential and often irreplaceable source of high-quality, cheap animal protein crucial to the balance of diets in marginally food secure communities.

There is limited scope for increase in production from freshwater capture fisheries, and the application of resource management through effort control strategies may only have marginal impact on fish resources in rivers and floodplains. The risk is that poor people become the victims of management policies which have limited impact on the resources. As there are negligible amounts of discards in inland fisheries, there is little scope to increase production through this resource. However, there is some potential to reduce postharvest losses through appropriate technological development. Insect pests in particular are a problem in some areas, especially where fish is dried without salting.

Habitat rehabilitation and fishery enhancement could significantly increase the production of freshwater fish for local consumption and thus food security in rural areas. There is a risk that this could lead to the displacement of poor people fishing for subsistence if user rights are given to better off groups. To safeguard and increase food security of poor people, it is important that their access to the resources is ensured.

The lack of data on the importance of inland fisheries for the food security and livelihood of millions of rural people implies that fishery may not be given the priority that the sector deserves in the competition for the right to use inland water resources. Recognition of the importance of the sector and the application of integrated planning and management of river basins, lakes and other inland waterbodies would contribute substantially to the long-term food security of these people.

Aquaculture

General Sector Characteristics

Aquaculture is intimately connected with water and its availability, and can be defined in association with the aquatic habitat, including surrounding land areas that it occupies or uses. Traditionally, aquaculture has been classified as freshwater, marine or brackishwater. In 1995, almost 70% of all aquaculture production (excluding plants) was from freshwater, the remaining 30% from marine and brackishwaters. The latter accounted for 45% of the value of aquaculture production.

There exists two primary forms of aquaculture systems: (a) land-based systems are holding units established on land with water arranged to be held or to pass through, and (b) water-based systems are holding units immersed within a waterbody and tend to be controlled by the waterbody itself. They are particularly sensitive to waterbody characteristics and environmental forces.

Aquaculture production comprises fish, crustaceans, molluscs, aquatic plants and others. There are wide ranging differences in species characteristics in terms of method and cost of culture, and types of

market (whether they contribute to local food supply and the economy) or are traded internationally.

System intensity, typically described in terms of intensive and extensive culture, is similar in overall concept to equivalent terms in agriculture. In a broad continuum, extensive systems are those which are closest to natural fisheries, require minimal inputs and offer relatively low yields, while intensive systems require a large amount of inputs to maintain an artificial culture environment with high yields.

Aquaculture production is undertaken at many levels ranging from the small-scale family operation, often integrated with agriculture production, to the large-scale specialized industrial enterprise. The scale and organizational features will vary with the species and production environment, as well as the stage of development and the financial/economic conditions of the subsector. In general terms, relationships can be described between system, scale, and organizational features, though these may not be definitive. It is more common for large-scale organizations to have varying degrees of integration, be associated with more intensive, managed systems. Individual or family enterprises are less intensive and on a smaller scale.

Production

Global Production

Production from aquaculture has increased significantly over recent decades and can be expected to develop and expand further. A number of factors underlie this trend, chief of which are the increased market demand for aquaculture products, and the increasing scientific, technological and entrepreneurial skills in managing species life cycles, and production environments and in meeting market and commercial objectives. Institutional and development support has also played an important role. It has brought access to key skills and resources as well as investment capital. Aquaculture has developed in almost all regions of the world and is steadily becoming a more important contributor to output in developing countries. These countries now produce more than 3/4 of the total world aquaculture production. Total world aquaculture production and value is detailed in Table 3.

In terms of quantity and value, the most important category is fish. Carps are by far the most important with a production level of approximately 7 million t in 1994. This was more than half of the total culture fish production, though considerably lower in value terms. Production of other freshwater fish has remained relatively static over the previous decade. The salmonid and tilapia groups have both had a steady increase in production. The production of diadromous fish has declined while the production of high-value marine species has increased, most markedly for seabreams.

Although the level of crustacean production remains quite low compared to that of other species groups, their value is now second to that of fish. The four main crustacean subgroups are: marine shrimps; freshwater shrimp or prawns; crayfish; and other crustacean. In 1994, the level of production was relatively low for all types. Some 90% of the world crustacean output consists of marine shrimps and related species.

Table 3. Aquaculture production and value in 1994 by major species groups.

Species group	Volume, ('000 t)	% by volume	Value (US$'000)	% by value
Fish	13 035	51.2	21 389	53.7
Crustacean	1 069	4.2	7 209	18.1
Molluscs	4 379	17.2	4 859	12.2
Aquatic plants	6 900	27.1	6 054	15.2
Other	77	0.3	319	0.8
TOTAL	25 460	100.0	39 830	100.0

Source: FAO 1994

The mollusc group can be separated into five major divisions: mussels; oysters; clams; scallops; and 'other' molluscs. Within this group, scallops account for the greatest share of annual production.

Inland waters account for 96% of the volume and 85% of the value of cultured fish production. Marine waters account for 4% of the volume and 15% of the value. For crustaceans, the inland waters support only 6% of the volume and 4% of value of production.

Regional Production

In 1992, 84% of the volume of world aquaculture production was in Asia, mainly China, India, Japan, Indonesia and Thailand. China clearly dominates with a 57% share of the output. Most countries in the region have shown a steady increase in production with occasional fluctuations. The region with the next largest aquaculture production is Europe with an 8% share.

Although there has been a strong, sometimes dramatic, increase in production in Asia, there have been sizeable short-term fluctuations in output. These have ranged from the production cycles in the catfish industry in Thailand in the 1980s to the heavy but localized impact of disease in inland aquaculture in the region from the mid-1980s onwards. There have been more dramatic reversals in the fish culture sector in Taiwan in the mid to late 1980s and in shrimp culture in Taiwan, Indonesia, Thailand (late 1980s) and China (early 1990s), all of which have been associated with poor environmental conditions, disease and poor production performance.

Production levels are not as high in South America (2.3% of world production by volume in 1995), but aquaculture is expanding in the region, and in terms of value the region has a greater share than North America (4.7% of total world value). This is largely accounted for by the dominance of shrimp culture in the tropical countries of the region. With the expansion of aquaculture in more temperate areas, a wider variety of species may be expected. The biggest producers in the region are Ecuador, Chile, Brazil and Colombia. There is a distinct difference in the species focus in each country. In Equador, over 95% of the production consists of crustaceans; Chile has a large production of salmonids, molluscs and aquatic plants; whereas production in Brazil and Colombia is focused on freshwater fish.

Given its size and the demands for fish products, Africa produces a very small proportion of world aquaculture output (0.5%). About 80% is produced by just two countries, Egypt (tilapia, carp, mullet) and Nigeria (tilapia, carp, catfish). Countries in Africa, particularly in the subSahel region, practice aquaculture on a small-scale, usually simple, low-input, freshwater pond culture.

Trends in Aquaculture Production

General

Aquaculture has moved steadily from extensive semi-natural methods based on static or tidal ponds, lagoons and shellfish beds, towards modern, intensive practices using managed ponds, tanks, raceways, cages, rafts and longlines with many new areas and environments becoming involved. With the pace of development, the growing competition for markets and resources, and the growing economic consequence of success or failure, structures of planning and development, and the legal and institutional framework in which they exist, have been increasingly challenged. They have been required to respond to the emerging needs of the sector, and create and maintain an appropriate climate for support, resource allocation, management and control.

Although basic resources may be available, aquaculture production has been modest in many areas, particularly where the need (in terms of GDP or nutritional status) seems most evident. Constraints appear to be social, economic and institutional rather than scientific/technical.

More recently, a number of areas have seen a rapid development of artisanal aquaculture associated with a range of development factors, including the rise of an active private sector, changing approaches to agricultural development and key technical change.

In areas where aquaculture has grown and where key subsectors have become prominent, the size and nature of the emerging industry and the scale of individual production units have started to raise questions concerning physical and economic development, resource demands and environmental protection.

In areas where commercial aquaculture has been the primary feature, varying degrees of concentration have occurred as smaller and less efficient producers have gone out of business and/or been absorbed by larger competitors. This has changed the social and economic characteristics of the sector.

Species

The role of individual species is of significance not only in their contribution to local and export markets and national and regional development, but also in terms of the potential for developing various production systems, for the use of resources and for management.

Carps dominate aquaculture production. The culture of species such as tilapia and catfish is also important in the developing countries. Current world production of tilapia and other cichlids is about 500 000 t, almost double the 1986 level. Countries where tilapia production is particularly important include Indonesia, China, Egypt, Philippines and Thailand. Catfish production remains relatively low with a production level of 90 000 t. The species is becoming more popular in aquaculture and production may increase in the future. The main producers are India and Thailand.

The most important species in the western world is Atlantic salmon. Aquaculture production accounts for 98.6% of the Atlantic salmon available on the world markets. Production has quadrupled to over 240 000 t in the last 10 years particularly fast growth in Europe and Latin America.

Shrimp is the main cultured crustacean representing 50% of world crustacean production by volume. By far the most important is the giant tiger prawn, with production increasing from 89 000 t in 1986 to 500 000 t in 1994, an annual growth rate of 27.8%.

Potentials for Increased Production from Aquaculture

Table 4 gives projections of the possible contribution of aquaculture to global fish supply by 2010 based on past trends in aquaculture production. Increase in production is expected in all species groups, though their relative contribution may change. The broad assumptions behind the projections are:

1. FRESHWATER FISH: Intensification of carp production; diversification with focus on multiple cropping and more efficient polycultures; widespread use of tilapias in extensive and intensive systems; expanded markets for tilapias in developed countries; and the introduction of new species to satisfy tastes of local markets.
2. DIADROMOUS FISH: Expansion of sturgeon production in the former USSR in intensive culture and in release programs.

Table 4. Aquaculture production in 1994 and projections of possible aquaculture production in 2010 (excluding aquatic plants).

	Production in 1994 (million t)	%	Projection 2010 (million t)	%
Freshwater fish	11.3	61	20	51
Diodromous fish	1.3	7	3	8
Marine fish	0.4	2	3	8
Crustacean	1.1	6	2	5
Molluscs	4.4	24	11	28
TOTAL	18.5	100	39	100

Source: FAO 1995

3. MARINE FISH: New technologies to support fast growth of the sector; new species becoming important; and expansion of trade in established species.
4. CRUSTACEA: Diversifying markets; new production opportunities for shrimp, lobster and other species; effective solutions for health management and environmental impact.
5. MOLLUSCS: Improved marketing and processing; opening larger markets; molluscs promoted as a part of integrated water quality management.

The production increase will be generally associated with improvements in production efficiency (through lower feed use and tailored production systems), improvements in product quality (through better broodstock, disease control and environmental management), lengthening of production seasons and product range (through broodstock selection, out of season spawning, specific genetic strains, single-sex stocks, etc.), and new biotechnology developments for improved stock performance (e.g., growth rate, reproductive control, disease resistance and trans-species gene transplantation).

In the small-scale sector, private involvement in hatchery and nursery operations will increase and active systems for fry distribution and marketing will develop. This counts especially for Asia. In other regions, there will continue to be a role for public institutions/projects in providing the enabling environment for aquaculture production.

Constraints to Increase in Aquaculture Production

Use Conflicts

Aquaculture development is increasingly constrained by reduced access to suitable land and good quality water. In many coastal areas, aquaculture has been an important area of development and change. These have frequently been areas of human settlement and interest. Often the same features which have locational advantage for aquaculture are highly desirable for other purposes. The development of aquaculture can be expected to create conflicts with other users of the resources. Increased aquaculture production will involve the use of more land and water resources. This could lead to conflict in poorer areas where land is scarce for other productive purposes and in more prosperous locations where scenic value and recreational benefits may be important. Although aquaculture can be located on poor quality land, unused or marginally useful for agricultural production or other purposes, this is not always the case. Many, if not most, tropical inland systems are built on arable land though marginal areas may sometimes be used where land is in short supply.

While water-based aquaculture does not use land directly, it occupies areas of lakes and rivers and resulting in similar problems of competition. The extent of conflict depends to a considerable degree on the nature of water management.

Clearly an integrated approach to resource allocation is ultimately required. This argues for better integration of aquaculture with agriculture and other industries.

Adoption at the Local Level

One of the most critical aspects of aquaculture development, particularly in areas which have not shown significant growth or uptake in the past, is that of adoption of aquaculture as an activity or of improvements to make it more viable and effective. In earlier stages of aquaculture development, it was recognized that extension would clearly have an important role to play, but it was widely assumed that the demonstrable benefits of aquaculture would require very little additional incentive for adoption. This view has proved to be very optimistic. The process of adoption is complicated and involves beliefs, attitudes to risks, ownership, knowledge, economic incentives, etc.

Human and Institutional Resources

Institutional support is often not adequate to meet the management requirements of the fast

growing aquaculture sector. The capability of public institutions to provide development support in extension and training, credit, research, etc., has been severely limited for a number of reasons. The shortage of well trained people affect the realization of the production potential and also support services.

Environmental Degradation

The bulk of aquaculture operations as practiced in developing countries cause minimal aquatic pollution while contributing significantly to food supply, income and employment. Pollution problems are mostly associated with intensive aquaculture systems, particularly in coastal areas.

The main negative environmental impact associated with coastal aquaculture is the destruction of mangrove forests and other important aquatic ecosystems for the construction of aquaculture ponds. Other problems relate to waste and nutrient loadings, e.g., output of solids, output of husbandry and disease management chemicals, the effects of waste materials on the adjacent benthos and the water column, their impacts on species and community diversity, and the possible stimulation of blooms. Other environmental problems include escaped stocks, risks of competition and genetic interaction with wild stocks and directly or indirectly reduced biodiversity. Predation by protected species can also cause damage to farmed stocks and may require controls without compromising conservation interests in the species involved.

A crucial problem for aquaculture development is the negative impact on the environment from other users. Aquaculture development is increasingly constrained by reduced access to suitable land and good quality water resources due to aquatic pollution and habitat degradation arising from activities outside the sector.

Expansion of aquaculture areas and intensification of aquaculture production can be managed so as to minimize risks of irreversible damage to the environment. In cases where there have been serious damage, these have been highly publicized with negative repercussions on aquaculture in general. There is a need to develop effective means for integrating the requirements of aquaculture with those of other sectors and develop approaches for integrated land and water use management in which aquaculture can take a complementary and positive rather than a negative and depleting role.

Disease

One of the major concerns in the production sector itself is that of disease and its effects. To varying degrees, the problems of disease are specifically related to aquaculture system and the husbandry methods employed. There have been widely publicized losses associated with disease and poor environments in Asia, primarily in the shrimp sector—in Taiwan, Thailand, and more recently in China. Recent heavy losses have also been noted in Sri Lanka and in Vietnam in the Mekong Delta, and there have been increasing problems on the west coast of India, and serious losses in Ecuador and Mexico.

Implications for the Food Security of Poor People in Developing Countries

In most cases, food security is not a major objective of present-day aquaculture production. It does, however, contribute to overall food supply and broadens the opportunities for income and food access. With appropriate identification of targets, there is a substantial potential for aquaculture to meet the needs of poorer sectors of society. However, this would require approaches from governments and donor agencies which are at the same time oriented at production, organization and demand.

Production-oriented approaches include integrated aquaculture with special focus on species for which there is a local demand (indigenous species, low price species). In this context, rice-fish culture has major development prospects in many developing tropical countries. The constraints on the wider adoption of integrated systems include lack of management skills and coordination, including

pest management, and other demands on local human, financial and material resources.

Improved polycultures would improve the local opportunities and provide a more flexible supply structure, but lack of management skills and understanding of benefits are major constraints as well as the local availability of seed stocks.

Small-scale hatcheries and nurseries and small-scale cage culture may provide opportunities for landless groups provided they are given (exclusive) access to small waterbodies. Management skills (including product quality and disease control), lack of financial and material resources, and risk aversion are also major constraints.

Many of the constraints mentioned can be overcome by appropriate organizational approaches by governments and development agencies. Rural collective responsibility credit systems (group schemes) improve the access of low-asset borrowers to the necessary financial resources. Formation of local producer groups can provide much needed organization, market and technical support functions if shared interests exist among group members and local leadership can be provided. Extension systems using small-scale traders and others as messengers may increase the spread of awareness and knowledge among potential beneficiaries. Governments could support privatization through the selling/leasing of (quality) state-owned hatcheries and development agencies could target infrastructure development to critical support areas and also focus their support on key groups, e.g., food security vulnerable groups.

Demand-oriented approaches would focus on market development through improvement of local and other marketing systems and improvements in product quality. However, major constraints to face in the development of the local markets in developing countries are the lack of purchasing power among consumers and culture-related market insensitivity to product improvements.

Fisheries Policy Issues

The combination of population increases and economic growth in conjunction with overfishing and degradation of aquatic environments will place an enormous strain on the fisheries sector if it is to sustain and increase its present contribution to the food security of poor people. However, effective policy action can result in significant gains both in food supply and in economic terms.

At the national level, policy interventions in support of fisheries vary according to national requirements and conditions, but all countries should pursue policies which aim at optimizing the contribution of fisheries to economic and social well-being. The countries that signed the "Kyoto Declaration and Plan of Action on the Sustainable Contribution of Fisheries to Food Security" in 1995, have agreed to "base policies, strategies and resource management and utilization for sustainable development of the fisheries sector on the following principles: (a) maintenance of ecological systems, (b) use of best scientific evidence available, (c) improvement in economic and social well-being, (d) inter- and intra-generational equity, and (e) application of the precautionary approach as referred to in the FAO Code of Conduct for Responsible Fisheries".

As the requirement for maintenance of ecological systems relates not only to the impact of the fisheries sector but also to the impact of other sectors on the food web and the habitats which support fish stocks, management concepts need to be broadened to include entire ecosystems and to take into account uncertainty and risk.

The key issues for fisheries policy vary from one country to another. In general, the following issues and policy measures are relevant in relation to the food security of poor people in developing countries.

Marine Capture Fisheries

Issues:

(a) Protection of heavily exploited and restoration of overexploited fish stocks to maintain or increase catches.
(b) Elimination of conflicts between groups of fishers.
(c) Reductions of discards.

(d) Avoidance of marine environment degradation and restoration of critical habitats.
(e) Reduction of postharvest wastage.

MEASURES:

- application of conventional management measures (mesh size regulation, minimum size at landing, closed areas/seasons, catch quotas, effort control, economic incentives/ disincentives) when relevant;
- decentralization of fisheries management, where appropriate, to ensure fishers' and other primary stakeholders' participation in the design and implementation of management measures; including effective monitoring, control and surveillance systems to ensure compliance with management arrangements;
- integrated coastal zone management;
- application of technologies for the preservation of fish and fish products.

Inland Capture Fisheries

ISSUES:

(a) Avoidance and abatement of water pollution, and avoidance/mitigation of adverse effects on fish habitats through alteration of water flows and qualities in rivers, lakes, floodplains, etc.
(b) Expansion of stocking and complementary measures to enhance yields.
(c) Introduction of effective fisheries management institutional arrangements and methods.

MEASURES:

- integrated catchment basin management;
- clarification of property and use rights;
- extension programs to advise fishers on appropriate stocking and harvesting techniques;
- private or public sector investments in hatcheries and stocking programs;
- decentralization of fisheries management, where appropriate, to ensure fishers' and other primary stakeholders' participation in the design and implementation of management measures.

Aquaculture

ISSUES:

(a) Integration of aquaculture into rural and agriculture development and water management.
(b) Protection of aquatic environments.
(c) Appropriate institutional/organizational infrastructure and capacity building.
(d) Introduction of technological improvements and disease management.
(e) Culture of indigenous species and low price species for local markets.

MEASURES:

- integrated development and management of catchment and coastal areas through establishment of cross-sectoral institutional mechanisms;
- establishment of mechanisms to facilitate the integration at the farm level of aquaculture with crop and livestock production;
- the wider application of semi-intensive production system and research to improve traditional aquaculture systems;
- research to encourage the diversification and genetic improvement of cultured species, and their introduction to farmers;
- research in low cost methods for aquaculture production of indigenous fish species and low price species;
- development of approaches motivating and enabling poor people to undertake small-scale aquaculture production aiming at local markets.

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COMMENTS

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The Sverdrup-Jensen paper does a good job of identifying policy issues relating to food security in developing countries. The author points out limits on the degree to which expansion of production can continue. He also notes problems common to all types of fisheries: excess labor, excess capital, declining incomes, overexploitation and environmental degradation.

Discussion of Three Fishery Sectors

The discussion is developed for three fishery sectors—marine capture fisheries, inland fisheries and aquaculture—integrated by the theme of fishery management.

Marine Capture Fisheries

In his description of marine capture fisheries, the author takes particular note of technological change which has resulted in increased efficiency of fish harvesting. More effective technology has combined with an increase in fisheries participation under open access systems of regulation, leading to difficulties in fishery sustainability. It is common throughout the world to see fisheries used as "residual resources" to absorb excess labor from other sectors, or "pawn resources" in negotiations on matters beyond fisheries. Sten emphasizes the importance of management reform and notes two major problems in capture fisheries: bycatch and discards, and environmental degradation.

Inland Fisheries

These fisheries are extremely important to food security in developing countries through their role in providing for local consumption. Inland fisheries show less potential for increased production through improved management because of wide participation and flexible patterns of fishing effort, but they do have opportunities for increased production through enhancement. Inland fisheries suffer from habitat degradation. Three major problems of intersectoral coordination are noted: conflicts of interest between sectors (for example, hydropower and irrigation), pollution and habitat degradation, and a lack of integrated management.

Aquaculture

World production is broken down into regional sectors, with trends in aquaculture production identified, including the varying degrees of industry concentration. A rapid rate of aquaculture development is challenging social, economic and institutional responses. Productivity increases are possible through increases in efficiency, increases in quality, and institutional integration to promote investment. Constraints to aquaculture development are also noted, including water,

Research Needs

Fisheries policy in all three fishery sectors is strained by population growth, economic growth, overfishing and habitat degradation. These problems have varying potentials to be fixed by policy reform. Particular policy reform issues and mitigation measures are identified for each fishery sector, and from this discussion one can identify many research needs related to the improvement of fishery management, which are in turn related to the larger issues of property rights and institutions designed to address the externalities that Sverdrup-Jensen identifies. The research needs have as their basis the necessary conditions for effective institutional function. Institutions must serve two important functions: they must protect the right of resource users, and they must protect resource productivity through correct behavioral incentives.

Some of the attributes of an institutional environment important to food security include the following functions. It must provide assurance to users, to reduce tenure uncertainty, allow the formation of credible commitments, and align private and social time horizons. It must create legitimate rules so that decision processes are understood and decision criteria are considered to be fair. It must be designed in a way that contains transactions costs at levels less than the benefits of management, and create distributions of transactions costs that are considered equitable. An institutional environment must promote adaptation to change, so that decisions reflect the current environment. Finally, institutions must allow the definition of appropriate boundaries for management so that the biological and ecological boundaries of a system are congruent with the economic, social and political boundaries.

It is important to point out that the question of institutional effectiveness is not dependent on a particular institutional structure, but is dependent on its ability to protect critical functions.

Research areas related to food security arise from the identification of these institutional functions. I will present some proposed research topics related to design questions, all of which have implications for improving the position of the poor who rely on fishery resources.

1. Institutional resilience: what are the necessary elements for institutional adaptation and sustainability in the face of constant change?
2. Embeddedness: how are fishery sectors integrated with the larger social and economic systems? How can the access of the poor to fishery resources be protected within these broader spheres?
3. Nesting: how can fishery management be designed to build consistency between various levels of authority, e.g., so macropolicies do not cause disruption in microlevel operations and management?
4. Linkages: how can monitoring and feedback systems be designed to provide a continuing connection between the human and ecological systems?
5. Efficiency: how can the costs of fishery management be reasonably contained? How can costs (including culturally specific costs) be fully represented in the local context?

6. Human capital: how can human capital be developed to provide for more effective participation in decisionmaking and therefore increase the legitimacy of management? How can outreach education be made more effective?
7. Path dependence: how does the history of institutional evolution in a particular setting influence the current position and future prospects?

Conclusion

In conclusion, I will note that there are two levels on which these research questions can be pursued. The first level is specific to a particular fishery system, so is embedded in that fishery's ecological, economic, political and social context. The second level is general and context free. At the general level, research would proceed to identify critical design elements and performance functions through a synthesis of research conducted in both developing and developed countries, and in both fishery and non-fishery areas.

V. GLOBAL AND REGIONAL PRIORITIES IN FISHERIES POLICY RESEARCH

Setting Regional and Global Priorities Targeted to Developing Countries: Discussion Summary[1]

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Abstract

Setting global and regional priorities in fisheries policy research requires scientific identification and assessment of options as well as the study of policymaking processes and policy environments. Criteria for selecting areas for policy research should foremost be made in relation to food security.

Introduction

In order to clarify the rationale for selecting (and eventually ranking) research areas, a definition of policy research is required (as well as the criteria used to rank them). A *policy* is a course of action (explicitly) adopted or pursued to achieve one or a set of objectives, taking into account available opportunities and constraints. Policymaking requires a choice among a set of alternative options on the basis of an objective assessment of their pros and cons. *Policy research* includes the scientific identification and assessment of these options as well as the study of policymaking processes and policy environments. It requires adequate upstream research on resources environments, technology, and the economic and social aspects of fisheries.

Fishery Policy Research Typologies

A fisheries policy research agenda could be approached in various ways. In the various presentations offered to the participants (see sections II - IV), a number of typologies were more or less explicitly suggested. For instance, by jurisdictional areas one can group policies in terms of national and international policies, where national policies cover both sectoral and intersectoral issues, while international policies deal with transboundary or transborder issues. On the other hand, policies can be specific to a particular production area or system, such as marine fisheries, inland fisheries, and aquaculture.

The analysis of the priorities in the three main production systems (marine fisheries, inland fisheries

[1] The present "summary" reflect as faithfully as possible the conclusions of the regional working groups on policy research priorities, as well as relevant information contained in the various presentations made during the workshop and the related debates.

and aquaculture) showed that, when properly expressed, most of the broad priority issues are common to the three systems and only a few specific differences exist. Nevertheless, research aimed at strengthening and improving policies for fisheries in developing countries need to integrate three main levels of consideration, such as: (i) filling the information gap from a disciplinary point of view; (ii) providing an understanding of the policymaking process; and (iii) identification of the main policy issues and challenges. From a disciplinary angle, fisheries policy research should consider among others the following issues: (i) eco-biological issues: overfishing, rehabilitation, endangered species, discards; (ii) economic issues: economic incentives and disincentives, trade, resource allocation; (iii) technological issues: "green" technologies, waste reduction; (iv) social, cultural, political issues: labor, gender, demography, conflict, access and allocation; and (v) institutional and legal issues: rights, organizations, legal frameworks, enforcement, transboundary negotiations.

In relation to the policymaking process, both research in support of policy (methodologies, assessments and option analysis) and research on policy (policy formation, processes and performance) are needed.

The major policy issues and challenges relate to: (i) food security: supply, access, safety; (ii) sustainability: development and threats to productive systems; (iii) poverty and growth; (iv) human resources development; (v) demography and urbanization; (vi) capacity building: infrastructures, markets; (vii) macro-economic constraints: exchange rates, trade regulations; and (viii) financial resources mobilization and international assistance.

Criteria for Establishing Priorities

Even though an issue-oriented typology might be able to help focus limited research resources on priority policy requirements, the list of relevant policy topics is such that the total research agenda is likely to be beyond the available research capacity at both the national and regional levels. Prioritization will therefore be necessary, for which criteria should be established. In theory, priority could be given to research having the *highest potential impact* (contribution to policy objectives). The methodologies to calculate this impact *ex ante* are pretty arduous. For national policy research, priorities are likely to be *context sensitive*, depending on the site, resource, fishery and country. At the regional and global levels, priorities are likely to be more generic and easily agreed to by consensus. At these levels, important international agreements have been adopted and ratified, and priority should be given to research helping governments to face their commitments. While it is recognized that upstream research and data collection are necessary and in most cases essential, priority consideration will be given below to the research that directly supports the analysis of policy options, policy processes and policy evaluation, in line with the definition of policy research given above.

Finally, it should also be noted that the main priority areas for action in relation to food security identified by the International Fisheries Policy Research Institute (IFPRI) apply equally to fisheries. These are: (i) strengthening capacity of governments and NGOs; (ii) investing in poor people; (iii) accelerating productivity in food production; (iv) assuring sound management of natural resources; (v) developing competitive markets; and (vi) expanding and realigning international development assistance.

Main Policy and Research Issues

While the pros and cons of the various policy research typologies and priority criteria discussed above can be argued depending on their main purpose, a policy-oriented typology will be more meaningful, as it would explicitly relate research priorities to key policy issues, ensure immediate understanding from policymakers, and promote the necessary multidisciplinary approach to policy research.

It is not easy, however, to arrive at a simple "linear" classification of research topics as the main policy issues identified for fisheries are often interrelated or overlapping. As a consequence, some topics could have been mentioned under more than

once policy issue. The policy agenda for fisheries in the 1990s is dominated by two major concerns recognized at the international level: (i) sustainable development (and responsible fishing) in the wake of UNCED[2]; and (ii) food security (in the wake of the World Food Summit[3], and Kyoto Conference[4]). These concerns need to be addressed at the national level together with the concerns for: (i) economic growth or optimization of the economic value of the fishery sector; as well as (ii) equity used distribution of benefits. An essential component of the policy research agenda would be development of analytical capacity to support policymaking (including performance analysis).

When addressing the broad policy aspects listed above, policymakers should be (and usually are) aware that the outcome of management and development options available to them depend on a number of factors and constraints (of sectoral or intersectoral, national or international nature) which are the subject for policy-oriented research. Examples are: (i) biological characteristics of the resource; (ii) the physical and chemical characteristics of their environment; (iii) the market forces which influence inputs and outputs prices; (iv) the technology available for harvesting, processing and distributing; (v) the social, cultural and institutional settings; (vi) the availability and use of information (scientific, market, etc.); and (vii) the societal requirements for environmental protection, equity, etc.

On the other hand, both sustainable development and food security will require a wide range of research to be conducted at both the national and international levels, often in close collaboration between the two levels of institutional settings. Research that relates mainly to sustainable development and responsible fishing will require a combination of the following aspects of various aquatic systems: (i) conservation of resources and the environment for future generations; (ii) optimizing economic value (and efficiency) of the sector; (iii) promoting improved and fair trade; (iv) regulating access to resources; (v) optimizing interactions between small-scale and industrial sectors; (vi) optimizing interactions with other sectors; (vii) improving governance; and (viii) accompanying socioeconomic transformation (Annex 1).

Likewise, important research on issues related to food security should focus on: (i) improving access to food; (ii) improving use of underused resources; (iii) reducing waste; (iv) enhancing natural productivity; and (v) developing aquaculture (Annex 2).

A review of the current level of information and the strength of national institutions concerned with fisheries suggests that significant effort will need to be made to develop policy research capacity. In particular, developing countries will need substantial support in the following areas: (i) collection of baseline information; (ii) improving long term monitoring and forecasts; (iii) research methodologies and analytical tools; and (iv) improving policy analysis (Annex 3).

Conclusions (Provisional)

The list of researchable issues is very long and further prioritization is required. The examination of various regional group reports do not indicate a strong regional differentiation of priorities for action or for research. This may be an indication that the action and research required to support it are still described at too high (too generic) a level. If that is the case, the present list offers (no more) than a broad framework within which more specific regional and national priorities could be defined using finer resolution and more specific descriptors.

In order to guide ICLARM and IFPRI as well as other organizations dealing with fishery research (such as FAO), it would be useful to select, from the present framework, a limited number of priorities on which to focus programs of work over the next few years.

[2] United Nations Conference on Environment and Sustainable Development, Rio de Janeiro, Brazil, June 1992.
[3] FAO World Food Summit, Rome, Italy, 13-17 November 1996.
[4] FAO/Japan International Conference on the Sustainable Contribution of Fisheries to Food Security, 4-9 December 1995.

Annex 1. Scope for policy research in fisheries related to sustainable development and responsible fishing.

Research issues	Relevant aquatic systems[1]
1. Conservation of the resources and the environment for future generations	
• develop habitat protection and rehabilitation strategies	M, I, A
• develop resource rebuilding strategies for depleted stocks	M, I
• improve protection of biodiversity (including endangered species, introductions)	M, I, A
• design precautionary approaches	
• experiment with ecosystem, multispecies management	M, I, A
• develop conservation strategies for water resources	M, I
• develop ecosystem-based management approaches	I, A
• reduce risk in fluctuating resources management	M, I
• analyze pressure on wild seeds	M, I
• analyze potential for a market driven (demand driven) management system	A M
• comparative analysis of management strategies	
• assess precautionary development/management strategies	M, I, A
◊ impact/procedures for Prior Consent Procedures (PCPs)	M, I, A
◊ impact/procedures for Prior Information Procedures (PIPs)	M, I, A
• study impacts of land-based activities and sources of pollution	M, I, A
2. Optimizing economic value and efficiency of the sector	
• develop capacity control and reduction strategies	M, I, A
• analyze effects of economic subsidies, incentives and disincentives	M M, A
• develop fisheries rehabilitation programs	M, I
• impact of economic globalization	M, I, A
• improve natural resources valuation	M, I, A
• analyze cost recovery strategies for management	M
• analyze price formation	M, I, A
3. Promoting improved and fair trade	M, I, A
• analyze regional and international trade opportunities	M, I, A
• analyze impact of environmental regulations on trade (non-tariff barriers)	M, I, A
• increase export value	M, I, A
• develop quality assurance	M, I, A
• analyze impacts of trade liberalization	M, I, A
• self-sufficiency policies vs. import-export balancing policies	
• analyze demand elasticities, substitutabilities	M, I, A
4. Regulating access to resources	M, A
• competition between artisanal and industrial sectors	M
• study interactions between national and foreign operators	M, I, A
• impact of access rules on gender issues	M, A
• analyze rent appropriation	M, I, A
• impact of access rules on intragenerational equity	M, I, A
• establish the bases for a rights-based fishery management system	M, I
• establish rights of access to water resources	
5. Optimizing interactions between small-scale and industrial sectors	M, I, A
• study market interactions (e.g., impact on price formation)	M, I, A
• identify potential synergies and conflict reduction measures	M, I, A
• study sector dynamics and relationships (labor and capital)	M, I, A
• develop differential investment strategies	M
• role and impact of fishing agreement with foreign fleets	M, I, A
• study compliance	M, I, A
• develop conflict resolution mechanisms	
6. Optimizing interactions with other sectors	
• competition between the fishery and other sectors (ICAM, etc.)	M, I, A
• integration of aquaculture with rural development and agriculture	A
• impacts of national economic and development policies	M, I, A

[1] M = marine; I = inland; A = aquaculture

Annex 1. continued...

Research issues	Relevant aquatic systems[1]
7. Improving governance	
• analyze partnership management opportunities/options	M, I
• analyze/support decentralization programs	M, I
• analyze effectiveness of regional commissions	M, I, A
• analyze requirements for sectoral integration	M, I, A
• analyze consequences/modalities for privatization	M, I, A
8. Accompanying socioeconomic transformation	
• study dynamics of labor force	M, I, A
• study impact of change on gender issues	M, I, A
• develop sectoral demographic studies (growth, migrations, urbanization)	M, I, A
• study/promote professional organizations	M, I, A
• study/forecast impacts of structural adjustments	M, I, A
• analyze/improve mechanisms for technology transfer	M, I, A
• comparative impacts of export vs. import-oriented policies	M, I, A
• support to fishers' education	M, I, A
• finding appropriate transitional pathways (minimizing social stress)	M, I, A

[1] M = marine; I = inland; A = aquaculture

Annex 2. Scope of policy research in fisheries related mainly to food security.

Research issues	Relevant aquatic systems[1]
1. Improving access to food	M, I, A
• study constraints to access to food	M, I, A
• analyze consumer preferences	M, I, A
• develop adapted products	M, I, A
• improve national trade	M, I, A
• role of international trade in national process, access to food	M, I, A
• impact of export policies on food availability (and buying power)	
2. Improving use of underused resources	M, A
• identify underused resources	M, A
• analyze autocentered development strategies	M
• analyze pros and cons of agreement with foreigners	M
• fishmeal for feeds vs. food for humans	M
• improve forecast/management of unstable/variable resources	
3. Reducing waste	M
• improve gear selectivity (reduce bycatch)	M
• improve use of bycatch, reduce discards (better processing)	M, I
• reduce other postharvest losses	
4. Enhancing natural productivity	I
• analyze impacts on biodiversity and environments	M
• analyzing impacts on ranching	M
• impacts of artificial reefs	A
5. Developing aquaculture	
• species introduction vs. selective breeding	
• land-based vs. water-based aquaculture	
• relations between water/habitat management and diseases	
• study resource-use conflicts	
• integration with other sectors	
• integration with agriculture and rural development	
• small-scale/subsistence vs. large-scale/commercial aquaculture	
• impacts of land and water tenure systems	
• self sufficient low input technologies vs. high import technologies	
• analysis of long-term societal impact	
• developing an enabling environment for aquaculture development	

[1] M = marine; I = inland; A = aquaculture

Annex 2 continued....

Research issues
• promoting applied research capacity
• management plans for aquaculture development
• studies on common property resources for aquaculture
• partnership in managing production systems
• role of governments in aquaculture infrastructures
• public-private interface, seed production, feed supply, etc.
• policy formation and implementation process
• role of NGOs in aquaculture development
• elements of risk in aquaculture

Annex 3. Scope and need for capacity building in fisheries policy research.

Research issues	Relevant aquatic systems[1]
1. Improving collection of baseline information	
• optimize statistical systems	M, I, A
• collect strategic data (particularly socioeconomics)	M, I, A
• improve household level data	M, I, A
• develop subsectoral sustainability indicators	M, I, A
2. Improving long-term monitoring and forecasts	
• project fishery supplies	M, I, A
• assess and monitor wild and enhanced resources	M, I, A
• assess and monitor aquaculture resources (water, land, feeds)	M, I, A
• project demand and market trends for fish and fishery products	M, I, A
• analyze demand elasticity and product substitutability	M, I, A
• analyze cultural constraints	
• interaction of aquaculture and capture fisheries on prices	M, I, A
• analyze international price trends and price formation	M, I, A
• project fishery management and planning institutional capacity	
• project environmental protection requirements	M, I, A
3. Development of research tools	
• databases and integrated information systems	M, I, A
• develop models and software (food consumption, availability, etc.)	M, I, A
4. Improving policy analysis	
• develop approaches for performance analysis	M, I, A
• analyze mechanisms for policymaking (participation, etc.)	M, I, A
• improve feedback mechanisms	M, I, A

[1] M = marine; I = inland; A = aquaculture

Priority Policy Research Agenda and Their Implementation*

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Abstract

Research topics prioritized for immediate implementation through international, regional and national partnerships are highlighted, and implementation strategy discussed.

Introduction

At the Hirtshals Consultation, consensus was reached among the participants on the criteria for identifying priority policy research topics/ agenda for developing countries to deal with the issues concerning (i) protecting and sustaining resources; (ii) achieving growth and equity; and (iii) strengthening food security. The first three editors present at the workshop subsequently collaborated to produce a list of the priorities based on the discussion by the participants. This list, which was originally profiled in Ahmed et al. 1997, and has received widespread support from participants since, is given below.

Recommended Topics for Fisheries Policy Research in Developing Countries

1. How fisheries affect and depend on the environment and its ecological integrity.

To take into account nonmarket factors and promote appropriate incentives to avoid distortions in and degradation of the resource base, research should focus on the economic valuation of fisheries resources and their supporting environment within an integrated framework of resource management. Conceptual and methodological work on improved natural resource valuation and natural resource accounting will be required.

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2. How to ensure sustainable governance of fisheries.

To deal with access rights and user conflicts in multiple use situations in developing country fisheries, research should focus on participation, liabilities, accountability, and decentralization of political and financial power. Systematic documentation and comparative assessment of models and processes of property-based, rights-based and community-based fisheries access are needed, in addition to the development of a methodological and analytical framework. The legal and institutional perspectives will also require substantial review and analysis.

3. How to improve policy awareness of the importance of fisheries development and factor fish into the global food model.

Recent developments in the world food model (produced by IFPRI) have led to an increased appreciation of the key role of meat and milk in food security worldwide, while fish has been omitted despite its overwhelming importance. To integrate aquatic resources into a world food supply and demand model, it is necessary to identify parameters for and make projections of fish supply, demand, consumption and prices in the future.

4. How do employment and labor flows in fisheries affect income and food security.

Research should focus on factors affecting labor flows in and out of fisheries, analysis of gender in fisheries and aquaculture, the role of income effects in food security, and the impact of structural adjustments within the sector, particularly on the optimal capital intensity of operations.

5. How does international trade in fish affect domestic consumption of fish and overall food security of the poor.

To analyze production and substitution possibilities and assess the costs and benefits of trade versus domestic use, research must focus on trade and market liberalization policies affecting production and distribution, including those of the World Trade Organization (WTO). The current hypothesis is that further growth of world trade in fish will occur under market liberalization and high value species will be exported from developing countries to the developed, while the share of lower value species in food supply in the developing countries will continue to increase.

6. How to integrate aquaculture into the overall management of natural resources to promote equity in resource use and protection of the aquatic environment.

To benefit small-scale producers in integrated aquaculture-agriculture systems, research should focus on policies affecting the domestic price of fish, fish exports, subsidies on the use of inputs (land and water), and environmental regulation. The study of land and water use policies, the analysis of full costs and returns of intersectoral resource allocation, and the optimizing of integrated aquaculture-agriculture production is required to guide policies for technology and management options. Farm level research will determine how policies can support an integrated aquaculture-agriculture system (IAAS), taking into account gender, seasonality and other factors affecting labor.

7. What policies are needed to support aquaculture development in Africa and Latin America.

What is the key to the growth of aquaculture in Africa and Latin America? Should aquaculture be geared toward exports or the domestic market? Both Africa and Latin America have lagged behind Asia in aquaculture development, perhaps for different reasons. Research is needed for assessment of markets, infrastructure and other factors affecting production, as well as on the production of high-value species for upscale and export markets. In Africa, research is needed to identify constraints to the adoption and diffusion of technologies and to determine the role of the market, input supply and infrastructure.

8. How should policy decisions be influenced.

To examine how strategies for collective action affect fisheries policy decisions, and how and why fishers have had a major influence on government policies.

9. What are the sources and determinants of risk and uncertainties in capture fisheries and aquaculture.

To quantify the sources and determinants of various risks, e.g., resources quality and environmental changes, production risk, disease risk and market risk.

10. What strategies and options needed for improving resource productivity and enhancing the supply of aquatic products.

To investigate alternatives such as stock enhancement, habitat restoration and fish farming in terms of their social, economic and environmental costs and returns.

Implementation Strategy

Implementation has four essential elements:

1. *Partnerships* among developing and developed country institutions, regional and international organizations; research institutions, national government departments and NGOs.
2. *Capacity building* through networking, research collaboration and training will be an essential means of promoting policy research and building national research capacity.
3. *Integrating fisheries issues into other sectoral issues* will involve linking the developments in the biophysical sphere affecting fisheries and aquaculture with other factors such as upstream land use effects and modification of hydrological functions. It will also involve analysis of fisheries economics within the broader context of interactions with other sectors and impacts on policy objectives outside a narrowly defined fishery sector.
4. *Linking research with impact assessment* is essential to ensure that the research and recommendations will lead to changes and improvements in government policies. It will (i) help decisionmakers in the government; (ii) build national capacity in policy research; and (iii) improve the research work of ICLARM and other international institutes.

Appendix 1

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Appendix 2

Program

Monday, 2 June

17:30-18:30	Reception at the North Sea Centre (across the street from Skaga Hotel)	
	Welcome address	*Mr. Knud Størup,* Mayor of Hirtshals and North Sea Centre Board, Chair
18:30-20:00	Dinner at the North Sea Centre	
	Welcome	*Sten Sverdrup-Jensen,* DG, IFM
20:00-22:00	Informal get together	

Tuesday, 3 June

9:00-10:00	Chair for inauguration Session	*Klaus Winkel,* Head, Department for Evaluation, Research and Documentation, Danish Ministry Foreign Affairs
	Welcoming remarks	*Sten Sverdrup-Jensen*, DG of IFM *Meryl Williams*, DG of ICLARM *Per Pinstrup-Andersen*, DG of IFPRI
	Inauguration	*Klaus Winkel*
10:00-10:30	Coffee break	
10:30-12:00	Keynote addresses	
	Chair	*Serge Garcia,* FAO
		Meryl Williams: Factoring fish into food security: policy issues
		Per Pinstrup-Andersen: Achieving food security for all: key policy issues for developing countries
12:00-13:30	Lunch	

SESSION 1

Policy issues related to fish demand and supply
Chair: *Jan David Jurgens,* Namibia

13:30-14:00	Paper 1	*Christopher Delgado,* IFPRI: Changing fish trade and demand in developing countries and their significance for policy research
14:00-15:00	Discussion	
	Panel discussant	*Cristina David*, Philippines
	Open forum	
15:00-15:30	Coffee	
15:30-16:00	Paper 2	*Mahfuzuddin Ahmed,* ICLARM: Policy issues deriving from the scope, determinants of growth, and changing structure of supply of fish and fishery products in developing countries
16:00-17:00	Discussion	
	Panel discussants	*Oscar Cacho*, Australia
		Nik Mustapha Raja Abdullah, Malaysia
	Open forum	
17.30-18.30	Transfer by bus to Skagen (famous old fishing community) (Bus departure from Skaga Hotel at 17:30)	
18:30-20:00	Dinner in Skagen at the restaurant "Pakhuset"	
20:00-21:00	Visit to Grenen, the northernmost tip of Denmark	
21:00-22:00	Transfer back to Hirtshals	

Wednesday, 4 June

7:00-8:00	Visit to Hirtshals Fish Auction (bus departure from Skaga Hotel at 07.00)	

SESSION 2

Policy issues related to food security
Chair: *John Kurien,* India

9:00-9:30	Paper 3	*Shakuntala Thilsted,* RVAU: Policy issues on fisheries in relation to food and nutrition security
9:30-10:30	Discussion	
	Panel discussants	*Peter Edwards*, AIT, Thailand *Ellen Bortei-Doku Aryeetey*, Ghana
	Open forum	
10:30-11:00	Coffee	
11:00-11:30	Paper 4	*Sten Sverdrup-Jensen,* IFM: Policy issues deriving from the impacts of fisheries on food security and the environment in developing countries
11:30-12:30	Discussion	
	Panel discussants	*Susan Hanna*, Oregon State University, USA *Max Agüero*, Chile
Open Forum		
12:30-14:00	Lunch	
14:00-15:00	**Press conference**	

SESSION 3

Global and regional priorities in fisheries policy research

15:00-15:15	*Peter Gardiner:* Introduction to expectations from group discussions on policy priorities	
15:15-15:30	Coffee	
15:30-17:00	Group discussions on policy priorities	
	Asia	*Doris Capistrano* (Group Leader)
	Africa	*Ezekiel Okemwa* (Group Leader)
	Latin America	*Max Agüero* (Group Leader)
	Plenary session	
	Chair: *Peter Gardiner*	
17:00-17:30	Reports of groups: *Group Leaders*	
17:30-18:00	Open forum	
18:30-20:00	Dinner at the North Sea Centre	
20:00-21:30	Visit to the North Sea Museum/Aquarium	

Thursday, 5 June

SESSION 3, continued
Chair: *Cristina David*

9:00-9:30	*Serge Garcia,* FAO: Summary and synthesis of regional and global policy priorities discussion
9:30-11:00	Discussion • Definition of the priority research issues at the global, regional and national levels • Which of these priority research issues can best be addressed by international research?
11:00-11:30	Coffee
11:30-13:00	Group discussion
13:00-14:00	Lunch
14:00-15:00	Group discussion (continued)

SESSION 4

Setting the Agenda for Research
Chair: *Christopher Delgado*

15:00-16:00	Presentation of regional research priorities by Group Leaders Discussion and adoption of the agenda for research
16:00-16:30	Coffee

SESSION 5

Conclusion
Chair: *Meryl J. Williams,* ICLARM

16:30-17:30	*Sten Sverdrup-Jensen,* IFM: Partnership and collaboration • Strengths and weaknesses of national and international partners in tackling priority issues • Mechanisms for collaboration and strengthening capacity *Per Pinstrup-Andersen*, IFPRI: Synthesis • Global and regional researchable issues • Order of priorities: regional and national vs. sectoral and household *Meryl J. Williams,* ICLARM: Summary and conclusion
18:00-20:00	Cocktail party at the residence of Sten Sverdrup-Jensen for those who stay overnight in Hirtshals (Bus departure from Skaga Hotel at 18:00)

Participants of the International Consultation on Fisheries Policy Research in Developing Countries: Issues, Priorities and Needs, North Sea Centre, Hirtshals, Denmark, 2-5 June 1997

From left to right:

Front row: T. Tana, N. Abdullah, A. Diaz de Leon, A. Takesy, E. Bortei-Doku Aryeetey, D. Capistrano, H. Thong, S. Khan, J. Kurien, K.C. Chong, M. Agüero, C. David

Second row: O. Cacho, S. Sverdrup-Jensen, M. Ahmed, J. Jurgens, S. Thilsted, C. Delgado, M. Williams, J. Li, S. Hanna, E. Okemwa

Third row: P. Pinstrup-Andersen, J. Veitayaki, P. Gardiner, M. Torell, S. Garcia, O. Ndiaye, D. Greboval, P. Edwards, N. Roos, G. Kirkwood, A.K. Norman, S. Donda

Fisheries policy research in developing countries: issues, priorities and needs. M. Ahmed, C. Delgado, S. Sverdrup-Jensen and R.A.V. Santos, Editors. 1999. ICLARM Conf. Proc. 60, 112 p.

Titles of Related Interest

Fisheries co-management and small-scale fisheries: a policy brief. 1994. R.S. Pomeroy and M.J. Williams. ICLARM, Manila, Philippines. 15 p.

A brief for fisheries policy research in developing countries. 1997. M. Ahmed, C. Delgado and S. Sverdrup-Jensen. ICLARM, Manila, Philippines. 16 p.

The INGA Planning Meeting. 1997. Manila resolution: strengthening partnerships to advance the science of fish breeding and genetics and development of national fish breeding programs. ICLARM Conf. Proc. 54, 12 p.

Toward guidelines on running multi-country, multi-site projects. 1997. M. Ahmed, R.A.V. Santos, M.C. Balgos, C.M.V. Casal, L.R. Garces and M.L. Tungala. ICLARM Conf. Proc. 55, 13 p.

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