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FAN

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Harvesting of extensive carp pond in Bangladesh (photo courtesy of NACA)

Common carp on a carp farm in Java, Indonesia (photo courtesy of NACA)

CONTENTS

The FAO Aquaculture Newsletter (FAN) is issued three times a year by the Inland Water Resources and Aquaculture Service, Fishery Resources Division, of FAO's Fisheries Department, Rome, Italy. It presents articles and views from the FAO aquaculture programme and discusses various aspects of aquaculture as seen from the perspective of both Headquarters and the field programme. Articles are contributed by FAO staff from within and outside the Fisheries Department, from FAO regional offices and field projects, by FAO consultants and, occasionally, by invitation from other sources. The FAN is distributed free of charge to various institutions, scientists, planners and managers in Member Countries and has a current circulation of about 3,000 copies. It is also available on the FAO internet Home Page: http://www.fao.org/waicent/faoinfo/fishery/newslet/newslet.htm

EDITORIAL

A Precautionary Approach to ________ (*please fill in the blank).*

The Precautionary Approach is becoming a well known and well used phrase in international fora dealing with sustainable development and conservation. It is a cornerstone for major international instruments such as the UN Convention on the Law of the Sea, the Convention on Biological Diversity, and the Code of Conduct for Responsible Fisheries. However, as common as this phrase is becoming, there are differences in perception as to what this approach really means. Conservation groups seem to think it means that the polluter pays and that the developer must prove that development activities will not harm the environment. The Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) judged that it is *non-fishing* nations that must demonstrate that fishing does have an impact – is this non-precautionary or simply logical? There must be some basis (hopefully scientific) for thinking there is a problem before potentially costly economic changes are made.

The Government of Sweden and FAO convened a technical meeting in 1995 to outline guidelines and the elements of a precautionary approach to fisheries management and species introduction. These elements have broad application to other areas that must balance use and conservation. The North Atlantic Salmon Conservation Organization (NASCO) recently applied the elements to aquaculture of Atlantic Salmon. The elements work as a means to organize regulations, standards, management, and research for almost any development activity; they force managers or policy makers to think about what is known and unknown, what is practical and what is impractical, and then to plot a course of action accordingly.

The basic elements of *a* precautionary approach are:

- Lack of full scientific certainty as to the effects of development should not be used as a reason to put off management and conservation efforts.
- Reference points should be established to help determine desirable situations and undesirable impacts.
- Pre-agreed actions or contingency plans should be identified and implemented in a timely manner when limit reference points are approached, or when adverse impacts are apparent.
- Priority should be given to maintaining the productive capacity of the resource where there is uncertainty as to the impact of development.
- The impacts of a development plan should be reversible within the time frame of 2 – 3 decades;
- The burden of proof should be placed according to the above requirements and standard of proof should be commensurate with risks and benefits.

Thus, this approach is very much a dynamic process that involves planning, monitoring, evaluation, and adaptation; it represents a partnership where everyone knows the rules and obligations. The approach should not be seen as an excuse for not addressing scientific uncertainty. The establishment of reference points is critical and will point out where much of the uncertainty lies, what to monitor, and where further study is needed. Discussions with NASCO revealed that there are no reference points for allowable levels of genetic introgression between farmed and wild stocks of Atlantic salmon. This sounds a challenge for geneticists and population biologists to get together to produce some guidelines. Since the international community is calling for a precautionary approach, it seems logical that they should help fund such work.

Try applying this approach to your favorite development activity. Are the potential impacts known? *Probably*. Are the reference points known? *Probably not*. Are mechanisms in place to monitor, evaluate and then change the system if needed? *Hopefully, they can be*. Let us hear from you.

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FOOD SAFETY AND PRODUCTS FROM AQUACULTURE[1]

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Introduction

Over the past decade, we have begun to see the supply of food fish from capture fisheries levelling out, and have witnessed a rapid expansion in aquaculture production. The fisheries sector is undergoing the same transition as the food animal production sector, in that man no longer hunts for meat: in future years, we will rely to a far greater extent on farmed fish as a source of protein foods of high nutritional value. Epidemiological evidence of foodborne diseases suggests that fish harvested from open oceans can be generally regarded as safe and nutritious foods, provided that these are chilled quickly and handled properly. Products from aquaculture on the other hand have sometimes been associated with certain food safety issues, as the risk of contamination of products by chemical and biological agents is greater in freshwater and coastal ecosystems than in the open seas.

Food safety issues associated with aquaculture products will differ from region to region and from habitat to habitat and will vary according to the method of production, management practices and environmental conditions. Foodborne parasitic infections, foodborne disease associated with pathogenic bacteria, residues of agro-chemicals, veterinary drugs and heavy metal contamination have all been identified as potential hazards of aquaculture products. The origins of such food safety concerns are diverse, ranging from inappropriate aquacultural practices, environmental pollution and cultural habits of food preparation and consumption. Thus, with the increasing contribution of aquaculture to food fish supplies and to regional and international trade, proper assessment and regulation of any food safety concerns are becoming increasingly important.

Against this background, FAO and WHO, together with the Network of Aquaculture Centres in Asia - Pacific (NACA) organized a Study Group of experts to consider food safety issues associated with farmed finfish and crustaceans, particularly those associated with biological and chemical contamination. The organizers recognized the complexity of the tasks of preventing and controlling food safety hazards associated with products from aquaculture and thus invited experts from 15 countries from a broad range of disciplines and backgrounds. The meeting considered the identification and quantification of hazards and how to implement measures for control of potential food safety hazards, including current national and international programmes.

This article is based on the report of and material presented at the Joint FAO/NACA/ WHO Study Group on Food Safety Issues Associated with Products from Aquaculture[2] held on 22nd-26th August 1997 in Bangkok, Thailand. The authors were co-secretaries of the meeting.

[1] See also related news in FAN No. 17, December 1997, p. 23.

[2] The full report is in press and will be published later this year by WHO in the *Technical Report Series* (available from WHO, Distribution & Sales, CH-1211, Geneva 27, Switzerland).

Hazards and Risks

Inherent in all human activities, including activities related to food production, there are hazards and risks which may adversely affect human health, and aquaculture is no exception. In this context it is particularly important to recognize that there is a fundamental difference between hazard and risk. A hazard is a biological, chemical or physical agent in, or condition of, food, with the potential to cause harm. In contrast, risk is an estimate of the probability and severity of the adverse health effects in exposed populations, consequential to hazard(s) in food. Understanding the association between a reduction in hazards that may be associated with food, and the reduction in the risk to consumers of adverse health effects is of particular importance in the development of appropriate food safety measures. The hazards identified by the Study Group are summarized in Table 1.

these parasites are trematodiasis, cestodiasis, and nematodiasis.

Fishborne trematodiasis is an important disease in various parts of the world. Data from WHO (WHO, 1995) suggests that over 40 million people, mainly in eastern and southern Asia, are affected and more than 10% of the world population are at risk of infection. Freshwater capture fisheries are known to be an important source of infection, and little information is available on the role of farmed finfish and crustaceans in the spread of diseases associated with the ingestion of these parasites. The route of infection is through the ingestion of viable encysted metacercareae of parasites, which are present in the flesh of raw, inadequately cooked or minimally processed freshwater fish. The two major genera of importance for human health are *Clonorchis* and *Opisthorchis*, and of lesser importance *Paragonimus*, *Heterophyes* and *Metagonimus*.

Table 1. Possible food safety hazards in aquaculture products

Biological		**Chemical**	
Parasites	Parasites of public health significance: Trematodes, Nematodes, Cestodes *Clonorchis, Opisthorcis, Paragonimus*	*Agrochemicals:*	Disinfectants, pesticides, herbicides, algicides, fungicides, anti-oxidants (added in feeds)
		Veterinary drug residues:	Antibiotics, growth promoters (hormones), other feed additives from animal manures
Pathogenic bacteria:	*Salmonella, Shigella, E. Coli 0157, Vibrio cholerae, Vibrio parahaemolyticus, Vibrio vulnificus, Listeria monocytogenes, Clostridium botulinum*	*Heavy metals:*	Metals leached fom soil, from industrial wastes, from sewage or animal manures
Biological toxins:	Scrombrotoxin Ciguatoxin		

Biological Hazards

A large number of fish species, both marine and freshwater, may serve as a source of medically important parasites. Some of these parasites are highly pathogenic and the main cause of human infection is the consumption of raw or inadequately cooked fish. It was evident from the meeting that these infections are prevalent in only a few countries in the world and essentially among communities where eating raw or inadequately cooked fish is a cultural habit. Generally, fish are the intermediary hosts of these parasites, and man becomes the definitive host when the parasites are ingested. The principle human diseases caused by

Pathogenic bacteria can be introduced into fish ponds and watercourses by the intentional or unintentional addition of human and animal wastes. While evidence was presented at the Study Group that enteric bacteria and viruses rapidly die-off in well managed fish ponds, some evidence exists which suggests that enteric pathogens can survive and contaminate farmed products. Naturally occurring pathogens, such as *Vibrio parahaemolyticus* and *Vibrio cholerae* can contaminate aquaculture products, particularly in warm water climates, and have been implicated in fishborne illnesses.

Chemical hazards can be present in aquaculture products through exposure to certain compounds used in the aquaculture system itself and by acute and chronic pollution of waterways or sources of water used. A broad range of chemicals are used in aquaculture - chemical fertilizers are widely applied to semi-intensively managed ponds to stimulate phytoplankton blooms. Such fertilizers may be either organic or inorganic in nature and are usually water soluble. They can be applied as individual compounds, or they may be blended to provide a mixed fertilizer containing two or more compounds. Although some of these compounds may be considered as hazards in their own right, in view of the concentrations and methods of use, the Study Group concluded they pose minimal risk to food safety in aquaculture products when used appropriately. Similar conclusions were reached regarding a range of water treatment compounds used in aquaculture production.

The Study Group recognized that the use of antimicrobial agents in the aquatic environment is a cause for concern, both in terms of potential environmental risk and potential human health implications. The main concerns are associated with the unregulated sale and use of antibiotics as therapeutic agents, growth promoters and for increasing the efficiency of feed utilization in intensive and semi-intensive aquaculture systems. The hazards relate to veterinary drug residues and the development of antimicrobial resistance deriving from the use of antimicrobial agents.

However, limited data exists on the health risks associated with the use of antimicrobials in aquaculture, which precludes quantitative assessment of risk. Residues in products can be controlled by following recommended withdrawal times. The possible transfer of antimicrobial resistant pathogens to humans arising from the use of veterinary drugs in temperate water aquaculture was thought to be low, but maybe higher in tropical aquaculture, but only where antibiotics are used, because of higher temperatures and the survival of enteric human pathogens in fish ponds.

Food safety from fish farm to table

The role of the fish farmer is changing from merely raising fish to being an indispensable part of a chain for the production and delivery of safe, high quality products to the consumer. Hazards can be introduced into this food chain at the production stages, on the farm, and these can be spread during fish processing and preparation. Intervention strategies for assuring food safety are difficult to determine when microbial hazards cause human diseases but no diseases occur in fish, as in the case of some naturally occurring pathogenic *Vibrio* spp. or unavoidable contamination of fish ponds by *Salmonella* spp. in some aquaculture systems. Quantitative risk assessment is thought to be the most effective method of identifying contamination by microbial pathogens and this data could be used in making risk management decisions. Although this is an emerging discipline, data generated by microbial risk assessment can be used in the application of food safety assurance programmes based on the Hazards Analysis and Critical Control Point (HACCP) system. While the implementation of HACCP-based safety assurance programmes are well advanced in the fish processing sector, the application of such programmes at the fish farm, to enhance food safety, is in its infancy. The fish farming sector is not unique in this respect as there are few examples of the application of HACCP principles in animal husbandry because of the lack of scientific data regarding the appropriateness of on-farm control for pathogenic micro-organisms.

There is an international movement towards the adoption of the HACCP system in the seafood sector, with such major markets as the European Union and North America introducing mandatory requirements for HACCP implementation during fish processing. Such requirements will impact on the aquaculture sector with respect to raw material standards and products moving in international trade. The introduction of HACCP-based food safety assurance programmes, at fish farm level, poses a major challenge to the aquaculture sector. With the current state of knowledge, the introduction is practical, and is being applied in some intensive aquaculture systems, but not possible in small-scale fish farming systems that account for the bulk of global aquaculture production.

The report of the Study Group includes a generic model for the application of the HACCP system to aquaculture production.

Knowledge gaps and research needs

The Study Group concluded that there were considerable needs for information on food safety hazards associated with this rapidly expanding sector of food production. Such gaps in knowledge will hinder the process of risk assessment and the application of appropriate risk management strategies with respect to food safety assurance and products from aquaculture.

Biological hazards

Parasites

The Study Group recognized the importance of trematode and, to a lesser extent, cestode and nematode parasites as public health problems, particularly in Asia. It also recognized that little information is available on the role of farmed finfish in the spread of diseases associated with the ingestion of these parasites. Indeed, culture of fish under appropriate environmental and management regimes, unlike capture fisheries, offers a potentially important way to control this problem in some freshwater fishes.

Further research needs to be conducted on the epidemiology of trematode infections in cultured fish in relation to foodborne illness. Prior to establishing the comparative risk to human health from consumption of farmed and wild fish, it is necessary to determine the levels of trematode infection in farmed and wild fish and the influence of cultural practices of fish consumption. Research on the elimination of parasites in fish during processing should be given importance, particularly to determine the ability of the infective stages of these organisms to survive heat treatment. Freezing as a method to eliminate hazards associated with parasites in fish should be evaluated with respect to the possibility of allergic reactions and hypersensitivity. More work is required to quantify the levels of infection of farmed fish by parasites and to evaluate the contribution of aquaculture products to foodborne trematode infections.

Stocking fish ponds with wild caught fry or allowing wild fish to enter ponds is common practice in many areas. Epidemiological data should be obtained to evaluate the association of trematode infections in humans with such farming practices.

Bacteria

The Study Group concluded that unavoidable contamination of aquaculture products by foodborne pathogens, such as *Salmonella* and *Vibrio* can occur in some farming systems. Studies are required to apply molecular typing methods to distinguish between these and pathogens of human origin that may occur in products as a result of poor standards of hygiene during post-harvest handling and processing. There is also a need for methods to be developed for the detection of enteroviruses in aquaculture systems.

In view of the increasing importance of wastewater-fed aquaculture systems in developing countries, the potential for the growth and survival of human enteric pathogens, particularly newly emerging strains of *Escherichia coli,* needs to be investigated.

In light of international trade of foods, microbiological risk assessment methods are required in many areas of food production and processing. The Study Group noted that such work was underway in the Codex Committee on Food Hygiene and recommended following the Codex guidelines for the conduct of microbiological risk assessment for products from aquaculture.

The evaluation of such risks is constrained by the lack of quantitative data. Specific areas in aquaculture where the Study Group identified the application of risk assessment methods are the use of moist animal-based feeds (e.g. trash fish, bivalves, and slaughterhouse waste); the ecology of *Listeria* in salmon aquaculture; the risks to public health from antibiotic resistant bacteria developing as a result of applying antibiotics in aquaculture; integrated animal husbandry/fish farming; and wastewater fed systems.

Chemotherapeutants

The Study Group identified the following research needs for the safe and effective use of chemicals in aquaculture:

• With respect to antimicrobial resistance, internationally agreed-upon and validated methods to determine the minimum inhibitory concentration (MIC) are needed. Support from international bodies such as FAO and WHO would assist progress in this area.

• Agreed-upon and validated methods of residue analysis that do not impose excessive cost on consumers or producers are needed for compliance monitoring.

• Due to the limited number of approved veterinary medicines for use in intensive aquaculture in some countries, research is needed to enable products approved in one regulatory regime to be used in another without the cost of duplicate approval procedures.

• Certain types of integrated fish farming systems, where antibiotic-fed livestock are used, may pose a risk of antimicrobial resistance or unexpected residues in fish. The health implications of this type of artisanal production, combined with antimicrobial use is poorly understood and more information is needed before a proper assessment can be made.

Reference: WHO 1995. Control of food born trematode infections. Report of a WHO Study Group, Manila, Philippines, 18-26 October 1993. Geneva, WHO.)

MAIN CONCLUSIONS

The main conclusions from the meeting were that :

- aquaculture production will certainly become an increasingly important means of producing aquatic products for human consumption;
- there is a need for an integrated approach to properly identify and control hazards associated with products from aquaculture which requires close collaboration between the health, agriculture and aquaculture, food safety, and education sectors;
- food safety assurance measures should be included in fish farm management programmes and should form an integral part of the fish "farm-to-table" food safety continuum;
- the food safety assurance measures should be based on the Hazards Analysis and Critical Control Point (HACCP) system, although all participants recognized the difficulty in applying such measures to rural subsistence aquaculture;
- the risks to human health from chemicals used as fertilizers and water treatment compounds in aquaculture production are low;
- risks from chemotherapeutants used in aquaculture are associated with residues in edible portions of fish flesh and these can be significant, especially in countries where the sale and use of these compounds are uncontrolled;
- there is the added risk of antimicrobial resistance developing in the bacterial flora of fish farms and of such antibiotic resistant bacteria entering the food chain;
- pesticides required in aquaculture can pose food safety hazards; more information is needed on the types of compounds used, and studies should be conducted to determine if pond treatments with pesticides result in residue levels that are potentially harmful to human health;
- there is an urgent need to raise the awareness of the fish farming community, especially small-scale rural subsistence farmers, on management strategies for producing safe aquaculture products;
- education in the basic principles of food safety assurance should be integrated into existing regional and national training courses for aquaculture development and FAO/WHO are urged to provide leadership in developing education materials;
- fish-borne trematodiasis is an important disease in some parts of the world, causing morbidity and serious health complications. Basic research is required on the survival of encysted metacercareae of these parasites in edible portions of fish during traditional processing and preparation; FAO/WHO were requested to co-ordinate research in this area.

International Conference Suggests

Policies for the conservation and Sustainable Use of Aquatic Genetic Resources

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*The Inland Water Resources and Aquaculture Service and the Sustainable Development Department of FAO joined together with ICLARM and recently convened an international conference, **Towards Policies for Conservation and Sustainable Use of Aquatic Genetic Resources** in Bellagio, northern Italy. Along with written contributions and presentations, the participants of the conference produced the following "Bellagio Statement", that was forwarded to the 4th Conference of the Parties to the Convention on Biological Diversity. The statement represents a consensus from those attending and may also be of interest to other international fora working in the areas of conservation and sustainable use. Conference proceedings are being edited now for publication in 1999. The work of Roger Pullin and Christine Casal (ICLARM) in making this conference a success is greatly appreciated, as is the financial contribution of the Sustainable Development Department.*

Bellagio Statement

An International Conference, 'Towards Policies for Conservation and Sustainable Use of Aquatic Genetic Resources,' organized by the International Center for Living Aquatic Resources Management (ICLARM) in association with the Inland Water Resources and Aquaculture Service and the Sustainable Development Department of the Food and Agriculture Organization of the United Nations (FAO), was held at the Bellagio Conference and Study Center of the Rockefeller Foundation, Italy, from April 14 to 18, 1998. The participants from 14 countries, contributed, from their expertise in a wide range of disciplines (aquatic biology, aquaculture, genetics, governance of natural resources, fisheries, public awareness, intellectual property rights, law, etc.), a series of papers that will be published by ICLARM and FAO in a comprehensive proceedings volume. The participants discussed, at length, the present status of and likely requirements for policies for the conservation and sustainable use of aquatic genetic resources. Pending the full publication of these discussions, the participants agreed upon the following suggestions, of particular relevance to aquatic genetic resources, for action and areas of concern, that were forwarded to the Fourth meeting of the Conference of Parties meeting in Bratislava from 4 – 15 May, 1998.

More information is available from Devin M. Bartley (devin.bartley@fao.org).

Suggestions for Action

The provisions of the Convention on Biological Diversity with respect to aquatic genetic resources remain relatively undefined. The following actions are suggested to sharpen the focus of the Convention for this sector.

- Develop national curricula which integrate conservation and sustainable use of aquatic genetic resources into all levels of education.
- Clearly assign national responsibilities for conservation and sustainable use of aquatic genetic resources among institutions and agencies.
- Ensure international sharing of knowledge and methods through the Clearing House Mechanism and other appropriate mechanisms, including among local communities.
- Broaden the biosafety debate and future protocols to include alien species and genotypes.
- Operationalize the ecosystem approach including the incorporation of transboundary and cross-sectoral elements for the conservation and sustainable use of aquatic genetic resources.
- Develop policies and practices for access to and benefit-sharing (monetary and non-monetary) from aquatic genetic resources.

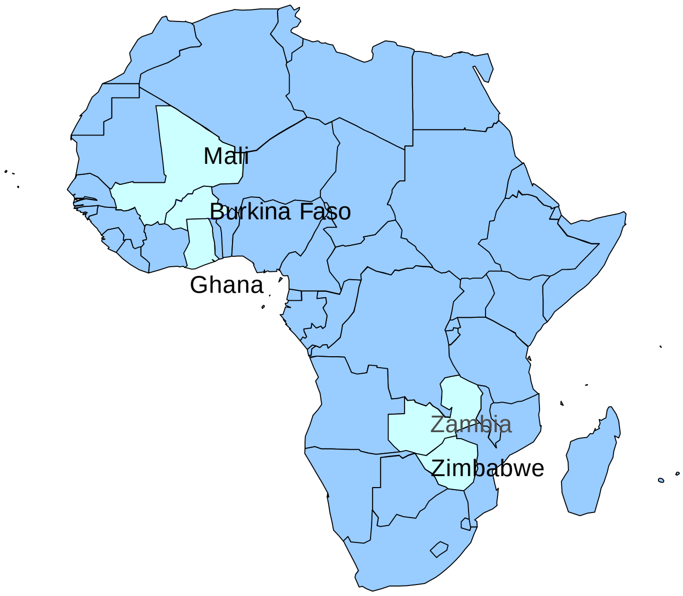
Areas of Concern

These are areas where there is a need to clarify the conceptual, social, scientific and political bases for taking action and for new initiatives with respect to aquatic genetic resources. It is recognized that these areas will involve collaboration of the Convention on Biological Diversity with other Conventions and mechanisms.

- How to establish international liability provisions for damage to or loss of aquatic genetic resources resulting from human interventions including, *inter alia,* habitat change, overharvesting, and the impacts of alien species and genotypes including living modified organisms.
- How to provide for the protection and reward of knowledge, innovations and practices of indigenous and local communities and individuals, and how to relate these provisions to intellectual property right regimes.
- How to apportion some of the benefits from the exploitation of aquatic genetic resources that are found outside national jurisdiction, such as straddling stocks, highly migratory fishes and high seas fish stocks, towards their conservation and sustainable use.
- Recognize that in the formulation of biosafety policy and regulations for living modified organisms, the characteristics of the organisms and of potentially accessible environments are more important considerations than the processes used to produce those organisms.

Front row from left to right: *Anil Gupta, Madadugu Gupta, Roberto Neira, Peter Smith, Carlos Correa, Dan Mires, Christina Leria, Rainer Froese.*
Second row left to right: *Elliot Entis, Yuan Wang, Anne Kapuscinski, Christine Casal, Eddie Abban, Peter Schei, Roger Pullin, Carey Fowler, Ruth Raymond, Devin Bartley.*
Back row left to right: *David Penman, Jan Kooiman, Brian Harvey, Robin Welcomme.*

INTEGRATION OF AQUACULTURE AND IRRIGATION



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THE IDENTIFICATION MISSION

As a follow-up to the Study on International Fisheries Research (SIFR, 1989-91), FAO, in collaboration with the Economic Commission for Africa and the European Union, launched in 1992 a regional study on aquaculture development and research in sub-Saharan Africa. The resulting synthesis of the information presented in 12 national reviews on development and research needs provided the basis for proposing an indicative **Action Plan for Aquaculture Research in sub-Saharan Africa** in 1994. Eight priority research programmes were identified among which **"Aquaculture in irrigation schemes"** and **"Small water body fisheries enhancement"** were included. These programmes would operate as networks and would be supported by an Aquatic Systems Information Network already proposed in 1997.

Since 1995, the FAO **Special Programme for Food Security** (SPFS) is gradually being implemented in several African countries. It includes an **irrigation component** which should develop and demonstrate appropriate irrigation technologies which can be effectively sustained by small-scale farmers. The SPFS also includes a diversification component including rural aquaculture. Small-scale aquaculture could be successfully integrated with irrigation whenever local conditions permit, resulting in a number of varied benefits from practical, social, economical and agricultural points of views.

In the context of sub-Saharan Africa, **small-water bodies** (SWB) are generally defined as small man-made impoundments of water built primarily for domestic use, livestock watering, and/or irrigation, where fish production is usually a secondary use. SWB fisheries differ significantly from natural lake fisheries and are susceptible to enhancement. Seasonally variable water levels and the resulting magnification of environmental variation, artificial assemblages of mainly riverine fish species in a lacustrine environment, and relatively small surface areas are all characteristics which may be exploited, through improved management and aquaculture techniques, to increase fish production.

Aware of such potential developments, the Inland Water Resources and Aquaculture Service of the FAO Fisheries Department organized in October 1997 an **identification mission** in sub-Saharan Africa with the following objectives:

- to visit some of the existing research institutions previously identified as potential contributors to a research network for the integration of aquaculture and irrigation, including fisheries enhancement in small irrigation reservoirs;
- to evaluate the resources available in each of these institutions to contribute to such a network;
- to ascertain existing interest and willingness to do so;
- to briefly review the status of aquaculture and irrigation development in each country visited;
- to identify possible ways for integration and related constraints;
- to identify potential founding-members of this new research network;
- to identify an approach for the initial establishment of such a network.

From 22 October to 21 November 1997, the mission visited various institutions concerned with fisheries and irrigation research and/or development in Ghana, Burkina Faso, Mali, Zambia and Zimbabwe. In each of them, it evaluated the potential participation of the visited country into a research network for the integration of aquaculture and irrigation on the basis of existing infrastructure and resources available to support research and development in the fields of aquaculture, small water bodies fishery enhancement and irrigation. Past experience in the integration of aquaculture into irrigation schemes was also reviewed.

GENERAL CONCLUSIONS

Aquaculture Research and Development

Aquaculture research infrastructure is still rather rudimentary in Burkina Faso, Mali and Zimbabwe, but is being strengthened in Ghana and Zambia with external assistance. Staff and financial resources are very limited in most countries, although in Zambia this situation could improve in the near future as a result of the training component of a new UNDP aquaculture project. In Ghana, aquaculture research will most probably receive increased attention following its integration within the Water Research Institute and the recent change in Government policy.

In general, government resources (infrastructure, staff, finances) are rather limited, particularly in Burkina Faso, Mali and Zimbabwe. Although some private initiatives exist in Mali (stocking of small reservoirs) and in Ghana, they are particularly developed in Zambia (fish farms and small reservoirs). Extension services have been reorganized in most countries where the "training and visit" system is applied by polyvalent extensionists (unified extension system).

In all countries, juvenile fish production cannot cope with demand. Wild juveniles of tilapias and African catfish are captured from reservoirs, floodplains and rivers by local fishermen mostly to stock small reservoirs. Annual aquaculture production is relatively low (80-150 t), except in Ghana (550t) and in Zambia (4,770t).

Small Water Bodies and their Fishery Enhancement

Fisheries enhancement in small water bodies (SWB) through stocking has been and/or is still being carried out in all the visited countries, mainly on the basis of private initiatives, either at village level (Mali and Ghana) or at farm level (Zambia and Zimbabwe). The current situation in the countries visited is as shown in the table below.

Country	Fisheries enhancement in small water bodies
Burkina Faso	More than 2 000 reservoirs, not all permanent Renewed interest in fisheries enhancement in reservoirs Very little resources to support development New project for 250 reservoirs under discussion
Mali	Numerous small reservoirs, floodplain depressions and earth-borrowing pits; generally seasonal Renewed interest in fisheries enhancement in reservoirs Primarily private initiatives
Ghana	Numerous small reservoirs and dugouts in northern regions Water Users Associations for their management Dam rehabilitation projects (in past, present and future)
Zambia	Mostly in Eastern and Southern Provinces, where experience with community management exists; private initiatives on large commercial farms
Zimbabwe	Many private initiatives on commercial farms Some activity in communal lands for local community management promotion

During the past five years in Zambia and Zimbabwe, the FAO Aquaculture for Local Community Development Programme (ALCOM) tested and developed methodologies for the rapid evaluation of SWB fishery potential and for community-based enhancement/ management of SWB fish resources. Guidelines are now being prepared which should prove useful for other countries.

Irrigation Potential and Development

- **Surface irrigation** with full or partial water control which offers the best possibilities for integrating aquaculture, in particular in large-scale irrigation schemes, is mostly developed in Mali. Zambia and Zimbabwe have each more than 20 000 ha of surface irrigated area, much more than Burkina Faso and Ghana. In this last country, the actually irrigated area is only 61 percent of the equipped area, although great efforts are now being made to rehabilitate old schemes.

- **Overhead irrigation** by sprinklers is particularly well developed in Zimbabwe and even in Zambia. This system is preferred because it uses water much more efficiently. For the same reason, **micro-irrigation** (drip) is being increasingly used in southern Africa.

- **Wetlands and/or inland valley bottoms** are particularly extended in Zambia where dambos are traditionally irrigated by hand and where the SPFS is actually concentrating its efforts. It has been shown that several possibilities exist to integrate small-scale fish farming in such areas. Burkina Faso and Zimbabwe (and probably Ghana) have also relatively extended wetlands used by smallholders. In Mali, such areas are limited to the south western part of the country.

- **Flood-dependent irrigation** is practised in Mali in the Niger River valley over a large area. Results have been disappointing in recent years following the reduced river peak flood level. There is little potential for integrating aquaculture in this type of irrigation.

- **Irrigation potential** is huge in Ghana and nearly four times greater than the potential in Mali and Zambia, the next countries with good potential. Smallest potential is found in Burkina Faso.

Integration of Aquaculture and Irrigation

Several types of integration of aquaculture in large irrigation schemes have been tried in Mali and further trials have been proposed recently. There is good experience also in Ghana where an integration policy has existed for some time. Even though several proposals for integration have been made in Burkina Faso at the Sourou irrigation scheme in the past, none have been implemented, although the enhancement of SWB fisheries has been practiced throughout the country for several years.

As far as traditional irrigation in wetlands is concerned, the Zambia SPFS is actively carrying out the most recent trials on small-scale fish farming integration into small-holder irrigation. This has been supported by a full time aquaculturist, with technical assistance from a consultant and ALCOM. In the other countries, aquaculture is under consideration, but the SPFS has still to get fully underway.

RECOMMENDATIONS FOR THE INITIAL ESTABLISHMENT OF THE NETWORK

Identification of Potential Initial Members of the Research Network

The mission identified national institutions that could initially make up the new research network, in each of the countries visited, except in Zimbabwe, where a regional development project has been proposed.

The recommended institutions are shown in Table 1.

Coordination with Existing African Networks

The new research network for aquaculture integration into irrigation schemes should cooperate closely with other networks active in Africa and specialized in irrigation, regional development or fisheries.

Future collaboration with these networks will be particularly useful for the organization of seminars/ workshops, for group training and for dissemination of information through existing channels such as newsletters and publications.

Establishment of the New Network

The mission proposed that the following successive steps be taken to establish the network:

1. An official invitation should be addressed by FAO to the Director of the selected institutions to participate in the Seminar proposed below.

2. Author's contracts should be issued for the preparation of **national reviews/syntheses,** according to a standard framework, by each of the institutions having expressed an interest to participate in the Seminar, with or without support from other institutions as necessary.

3. A **seminar** should be organized to:

- review development and research constraints existing in the participating countries, in particular following the outline agreed for the national reviews;
- discuss future organization responsibilities and functioning of the new network, in particular from the point of view of using two languages, English and French;
- agree on applied research priorities and a research programme for the new network to support the development of the integration of aquaculture and irrigation;
- recommend how such research could be carried out in the field in each of the involved countries, with particular attention to human and financial resources to be mobilized to this effect; and
- recommend best approaches to establishing linkages with other existing African networks of interest.

Participants in the seminar should include representatives from the selected countries, directly involved in research and/or development of irrigation, aquaculture and SWB fisheries. Representatives of other existing networks should also be invited to share their past experiences with networking and to stimulate future collaborative activities.

Potential Research Subjects for the New Network

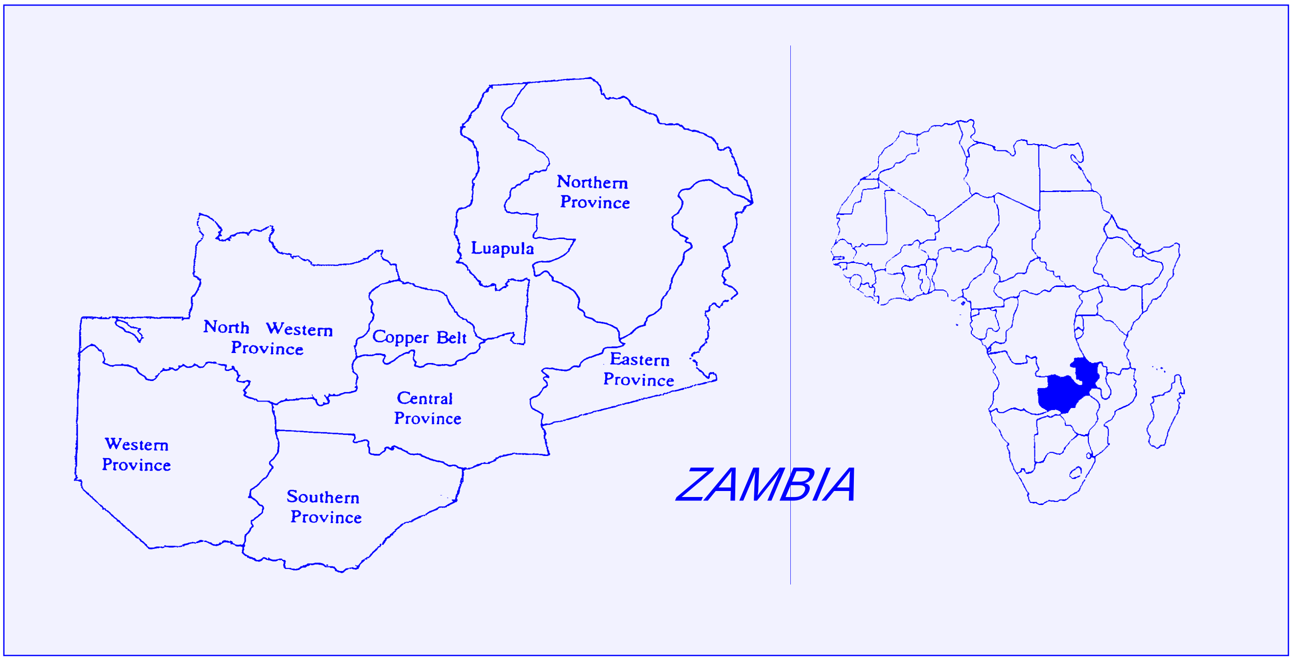
The mission suggested a series of research topics, addressing both general and particular aspects of aquaculture integrated into irrigation schemes. Specialized research was suggested for:

- undrainable fish farming structures;
- ponds with an unusually high water exchange rate;
- ponds built in waterlogged areas, in terrain depressions or in borrowing pits;
- fish farming in paddy fields;
- fish production in irrigation canals, either in pens or in floating cages;
- culture-based fisheries either in irrigation canals or in small irrigation reservoirs.

Table 1. Suggested founding members of the proposed network

Country/town	Selected institutions	Remarks
Burkina Faso Bobo-Dioulasso	Institut de Développement Rural (IDR)	• University institute responsible for training/research in agriculture, forestry and fisheries
Mali Bamako	Institut d'Economie Rurale (IER)	• Responsible for agricultural research, including forestry and fisheries • Development institutions to be closely associated with IER
Ghana Accra	Water Research Institute (WRI)	• Water and water-resources related research are integrated. • Aquaculture Research and Development Centre at Akosombo is part of WRI.
Zambia Chilanga/Lusaka	Mount Makulu Regional Agricultural Research Centre	• To be closely associated with Department of Fisheries (DOF/Research) • Part of National Agriculture Research Network, in same Ministry as DOF • Hosts SPFS and FARMESA[1] Programmes.
Zimbabwe Harare	ALCOM Regional Programme (SADC)	• To be closely associated with national research institutions (irrigation/fisheries) • Developing SADC water resources database • Good experience with networking through Programme's Information Service and SWB Units • Regional authority on small-scale aquaculture and SWB enhancement

[1] *Farm-level Applied Research Methods for East and Southern Africa (FARMESA)*



INTEGRATED AQUACULTURE AND IRRIGATION IN ZAMBIA

Christine Blehle
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INTRODUCTION

An objective of integration is to complement and not compete with other farming components. Farmers have to choose very carefully how to distribute available inputs among different farming components to reach maximum food security and income. The comparison of different farming components, as to required inputs (space, fertiliser, manure, feed, labour, etc.) and expected outputs, is essential to gain maximum yields from a farm. In the aquaculture component of the SPFS, we emphasize the integration of fish ponds to improve individual irrigation schemes for vegetable gardens and maize fields and to add a new farm product for consumption and marketing.

News from the FAO Special Programme for Food Security (SPFS)

Experiences of previous and current aquaculture projects implemented in Zambia were identified in a study on aquaculture activities in Zambia and considered in the execution of the aquaculture component of the SPFS. This study was strongly appreciated because it provided a forum for staff members of the Department of Fisheries to express their experiences, and adequately introduced the aquaculture component in July 1997.

When the aquaculture component commenced, close links between the Departments of Fisheries (DoF) and Irrigation (DoI) and the SPFS were established. Together we prepared a work plan for pond construction, stocking, management, data collection and analysis, and for training of farmers and staff of DoF and DoI to ensure the integration of the component into the agricultural restructuring programme [Agriculture Sector Investment Programme (ASIP)] of the Ministry of Agriculture in Zambia. Together with the farmers, the government staff and a consultant from the FAO Sub-regional Office in Harare, 12 preliminary pilot sites were selected in Central (3), Lusaka (4) and Southern Province (5). Activities in Southern Province are integrated into and implemented by the Small Water Bodies Programme of ALCOM (Aquaculture for Local Community Development Programme), Lusaka and Central Provinces are covered under the SPFS and are discussed below.

FIELD ACTIVITIES

Integration of Aquaculture and Irrigation

Ponds may function as additional water holding facilities allowing improved irrigation management and consequently increasing vegetable yields. It was found that where the water resource and transport mechanisms (e.g. treadle pumps) are shared amongst several farmers, each of them has only limited access to both, which may lead to under-irrigation especially during the nursery phase, when daily watering is necessary. If a farmer has a pond he/she can fill it whenever he/she has access to the water resource and transport technology and can irrigate with nutrient rich water from the pond (by bucket or siphon irrigation using the pond's outlet) during the following days. It should be kept in mind that the capacity of currently available treadle pumps has been found to be inadequate for the initial filling of a pond. The pond should instead be filled by gravity water flow from a diversion channel from a stream, spring or dam, or be constructed in a water logged area.

The following integration techniques were identified for the selected sites:

The pond is above the gardens on a slope (Figure 1). The pond can be filled with water from a diversion channel and/or furrow from a stream or dam and can function as an extra water holding facility during times when natural resources diminish. Gardens can be irrigated regularly with nutrient rich water from the pond by siphoning, using the ponds outlet (where available) or treadle pumps. The ponds can be drained for harvesting.

The pond is below the gardens on a slope with high water tables (Figure 2). The pond receives nutrient rich run off from the garden (caution: pond inlet has to be closed if there is some danger of pesticides or insecticides being drained from the gardens to the ponds!). The gardens can be irrigated from the pond using a treadle pump. Ponds like this may resemble an enlarged shallow well and have the same function besides producing fish. Here only partial drainage for harvesting is possible due to the high water table. Since the pond is fed by nutrient poor ground water, management should emphasize feeding and manuring.

The pond is in a flat dambo (waterlogged) area (Figure 3). Dambos are too wet for gardening but suitable for groundwater filled ponds. Elevated wide dikes of the pond are dryer and provide previously non-available space for gardening. In this case, labour requirements for pond construction are relatively high (in comparison to pond construction on a slope) and strong dikes have to be built to prevent the flooding of the pond during the rainy season. Management has to be adapted to the fact that these ponds are undrainable.

Table 1 provides a summary of where different techniques are implemented.

Training of Extension Staff, Camp Officers and Farmers

Twenty two extension staff of the DoF and DoI0 have been trained in integration of aquaculture and irrigation in three provinces during September 1997. Farmer's group meetings were conducted to introduce integrated aquaculture and to identify interested individuals at all sites. Farmers receive continuous technical advise from the SPFS and from extension officers of DoF and DoI. Camp Officers of the Department of Agriculture receive continuos training 'on the job' to allow the transfer of know-how to the farmers. During the training sessions we discuss with the farmers different components of

Figure 1

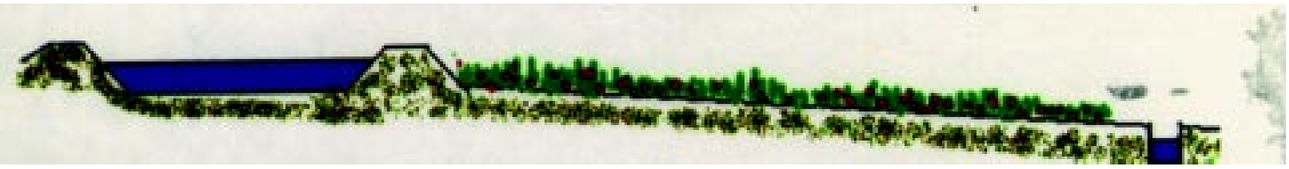
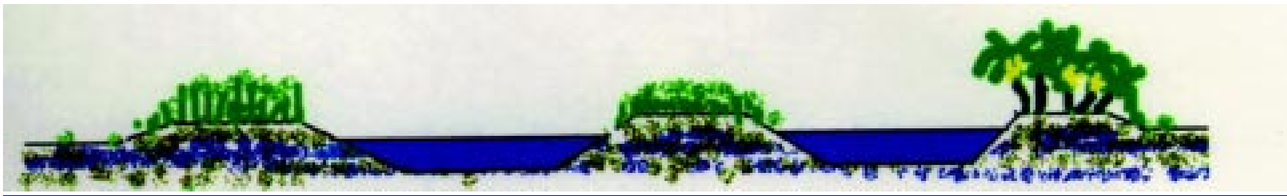


Figure 2

Figure 3



aquaculture and how and which data should be collected to allow a socio-economic impact analysis of integrated aquaculture after each harvesting season.

Currently we are using training material from FAO, ALCOM and as prepared for integrated aquaculture by the consultant of FAO, Sub-regional Office, Harare. Where appropriate, materials are reviewed, adapted and translated into local languages.

Field Visits

Close follow up of activities in the field through fortnightly visits allows us to accompany and advise farmers during their first experiences with a new activity. To emphasise integration our field teams consist of a staff member of each the DoF and DoI, the agricultural Camp Officer and the Fisheries Adviser of the SPFS.

We visited 64 gardens of individual farmers and evaluated the potential for fish farming together with the farmers. Most pond sites are located on gentle slopes and are suggested to be above the gardens (64%) in comparison to below (12%) and in the centre (24%) of the gardens. Water is mostly available from springs or streams (64%) or waterlogged areas (29%). Seven per cent of visited locations are in areas with shallow underground water. During individual visits, it was found that most farmers hesitate to use previous gardening plots for fish farming. Mostly plots unsuitable for gardening are considered for fish farming.

Additionally, we characterised sites considering their physical and geological environment, agricultural activities and markets of agricultural products. We prepared an integration design for each site, according to its characteristics, and performed a market survey on fish and crop prices.

Markets for Crops and Fish Prices at Different Sites

In Lusaka Province most communities are able to sell their products in the urban centres of Lusaka or Kafue. In Central Province markets are predominantly in the villages, along the main road between Mkushi and Serenje, in Mkushi and some in Ndola (see Table 2). The latter however is only accessible for high value crops due to relatively high transport costs.

In both Provinces, a comparison of prices for fresh and dried fish strongly recommends the marketing of fresh fish considering the relatively low price difference between the two products. In Lusaka Province prices ranged from 2000 Kw to 3000 Kw whereas in Central Province from 2750 Kw to 4000 Kw. Hence the urge to invest in a new crop with higher market prices is more pressing at sites in Central Province and explains a more immediate response of farmers in this area. When compared to tomato, cauliflower, rape and cabbage (between Kw 500 to 2000/kg) fish can be classified as a high value crop in the Central Province. Although it may not have the same significant advantage to other crops in Lusaka Province, its nutritional benefit being a protein resource was emphasized by the farmers. It was also pointed out by two farmers in Lusaka Province that, as they got older, they would like to invest in an activity which long term is less labour intensive than gardening.

Pond Construction

We produced agricultural calendars for each site to identify labour requirements in the gardens. Between October and March farmers are required to work in their fields to prepare and manage the crops during the rainy season, and, during April and May, they market their crops. Demand for labour in the garden is lowest from June to beginning of October. Our project started in July 1997 and, after the initial training phase, construction of the first ponds started in November, by families whose labour resources were adequate for both the gardens and the construction of fish ponds.

Seventeen farmers in Central Province and five farmers in Lusaka Province found soils to be suitable and commenced pond construction in November. By February, sixteen had finished their ponds and had received fingerlings promptly (see Table 3). Additionally, eleven farmers are testing their soils at different plots and will join our programme as soon as suitable sites are found. Another fifteen farmers expressed their interest to join our programme after the rainy season in April when labour requirements of gardening decrease. This will extend our pilot project from the present 16 farmers to a maximum of 52 farmers during the next half year.

Labour requirements and distribution for pond construction. Currently we have data on distribution of labour contribution of seven farmers from Central Province (see Table 4). In some cases, only men participate in pond construction, whereas in other cases the entire family participates. Within families, boys contribute almost half of the labour (49%), while men contribute a little more than a third and women and girls together 20%. On the basis of data so far collected, pond construction can be classified as 'men's work'. Further, the data indicates that pond construction in dambo areas requires significantly more labour (up to three times more) than construction on a slope. This, however, needs further confirmation from additional construction sites in dambos. Labour requirements for construction of ponds on slopes varies from 25 to 87 hours, whereas four of six ponds were constructed in 44 to 57 hours (average 50 hours), suggesting that the former two values may include some errors in data collection.

Table 1. Integration techniques at selected sites

Integration Technique	Lusaka Province	Central Province
Water logged area	Chipapa	Musofu
Ponds below gardens	Ngwerere	Musofu, Irumi, Chalata
Ponds above gardens	Ngwerere, Mwembeshi, Shantumbu	Chalata, Irumi

Table 2. Fish prices (Kwacha/kg, US$ 1 = Kw 1300) and markets at different sites (LP = Lusaka Province, CP = Central Province).

Site:	Fresh Fish	Dried Fish	Location of Markets
Shantumbu (LP)	2000.-	3000.-	Chilenje (suburb of Lusaka) and Lusaka Central
Chipapa (LP)	3000.-	3000.-	Kafue
Mbweshi (LP)	2000.-	3000.-	Mwebshi and Lusaka central
Ngwerere (LP)	2000.-	2000.-	Lusaka central
Musofu (CP)	4000.-	4000.-	Musofu and Ndola
Irumi (CP)	3000.-	3000.-	Irumi and Mkushi
Chalata (CP)	2750.-	2750.-	Chalata and main road to Serenje

Table 3. Status of present and future fish farmers in February 1998.

Finished ponds	**16**
Ponds under construction	**9**
Soil test (identification of suitable sites)	**11**
Farmers joining after the rainy season	**15**
Total	**52**

Table 4. Labour distribution (in hours) and requirements of fish pond construction in Central Province (children up to 13 years; adults above; el = employed labour; Total (excl.el) = Total excluding ponds constructed by employed labour). Labour requirements per pond were adjusted to a 100 m^2 pond.

Family:	Man	Woman	Boy	Girl	Total	Pond size (m^2)	Labour/ 100m^2 pond	Pond site
Mumba	54	7	65	24	150	100	150	dambo
Ndashe	54 el				54	100	54	slope
Totolo	36 el				36	144	25	slope
Mayanga	49	27	80		156	180	87	slope
Chipabila	20	14	47	5	86	150	57	slope
Tembo	112 el				112	256	44	slope
Simbeya	108 el				108	238	45	slope
Total (excl.el):	123	48	192	29				
Total (% excl.el)	31	12	49	8				

Identification of Fingerling Resources

We visited various governmental and private fish farms to identify tilapia fingerling resources for all fish farming sites. We identified six suitable private suppliers who are willing to adopt the governmental price in exchange for technical advice where needed. We emphasized that fingerling suppliers are easily accessible to our farmers, allowing them to fetch fingerlings independently from our transport. Meanwhile we emphasized the importance of our presence during fingerling distribution to ensure quality control.

Pond Management

Part of pond management is intended to allow farmers to compare between profits of gardening and integrated aquaculture. The importance of data collection during pond construction and management was explained and, together, we elaborated a data collection format. Some labour requirements data are already available (see above) whereas input management and reporting are to be analysed after the first harvest. Most farmers use vegetable leaves for feeding combined with some goat, chicken or, less often, cattle manure. We encourage farmers to increase inputs and apply any non-poisonous green material. Some farmers already identified a commonly occurring bush (English and scientific name to be determined) which is preferred and heavily consumed by tilapias.

Currently, management appears to be women's work. When developing a harvesting scheme, it will be important to allow the equal distribution of fish among those who are involved in pond construction and management to ensure adequate management and maintenance of the pond.

Data Base on Farmers

To facilitate efficient follow-up, we created a data base on activities of individual farmers. It is updated after each field visit and contains information on a farmer's site, water resource, soil, safety, the stage of pond construction, management and data collection.

FUTURE ACTIVITIES

In April, when the rainy season is likely to terminate and labour requirements in the gardens decrease, we expect an increase in participating farmers at current project sites. We will support them with technical advise in the implementation of integrated aquaculture and emphasize the transfer of know-how from farmers who joined our project last year to new farmers.

Farmers who are currently involved in the project will be able to drain and harvest their ponds in July or August. Until then farmers will continue to collect data of inputs and harvest to allow an evaluation of the impact of the aquaculture component on income and nutrition after the first harvest. Meanwhile different harvesting schemes such as continuous and total harvest will be discussed with the farmers to allow the equal distribution of fish and/or income among involved family members.

Results of different integration techniques should be available this year and should facilitate the extension of the project into other suitable sites and provinces in Zambia.

Mr. Chdobola and his family watching their pond filling up. The pond is situated in the centre of the garden to improve irrigation.

FAO's Assistance for the Responsible Movement of Live Aquatic Animals in Asia

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Spread of Aquatic Animal Pathogens in Asia

Aquaculture is the fastest developing food producing sector in the world, and Asia presently contributes more than 90% to the global production. However, disease outbreaks are a significant constraint to aquaculture production and trade and are affecting both the economic development and socio-economic return in many countries in the Asia-Pacific Region. The movement of live aquatic animals and the accompanying transfer of infectious microorganisms - some of them possible pathogens - is one of the major causes of recent disease outbreaks.

Efforts to develop a strategy against the international spread of aquatic animal pathogens in the Asia-Pacific Region have been underway for more than 20 years, under support from various donor agencies and regional and international organizations. Recent events on the international scene have caused increased interest among governments and intensified regional efforts to develop methods to prevent international disease transfers. Among these events are the World Trade Organization's "Agreement on the Application of Sanitary and Phytosanitary Measures," (SPS Agreement), which came into effect in January 1995 and establishes rules for human, animal and plant health measures affecting international trade, and several severe disease outbreaks which have occurred across much of the Region.

Quarantine and health certification strategies for aquatic animals in the Asia-Pacific Region have been difficult to develop due to many reasons. These include the huge volume of trade in cultured and ornamental species and the wide diversity of species and commodities traded; the widely differing attitudes and approaches, and importance placed on trade by individual countries, and the varying need to protect existing aquaculture and native faunas. There is also a general lack of knowledge about the value of aquaculture production vs. that for other commodities, the losses in production due to disease, the precise causes of these losses, and the origins of the pathogens which are deemed responsible. In many countries of the Region, there exist technical problems due to a lack of trained manpower, infrastructure, operating funds, and other related constraints. Together, these have made it difficult to see clear approaches and solutions, and have led to inertia. Whereas some countries did initiate some action, there has been no overall framework, or regional guidance.

FAO has been active in addressing the issue of international transfers of aquatic animal pathogens. The first step was the FAO/NACA/AAHRI/ACIAR Regional Workshop on Health and Quarantine Guidelines for the Responsible Movement (Introduction and Transfer) of Aquatic Organisms, which was held in 1996 in Bangkok (see *FAN*, No. 12, April 1996). This workshop led to the elaboration of a Strategy for the Development and Implementation of Health Certification and Quarantine Guidelines for the Responsible Movement of Aquatic Animals in the Asia-Pacific Region. Subsequent to the development of this strategy, and upon request by NACA, FAO approved a regional Technical Co-operation Project (TCP) in December 1997 (TCP/RAS/6714(A)) with the immediate objective of developing national and Asia regional technical guidelines on aquatic animal quarantine and health certification for the responsible movement of live aquatic animals. This project aims to develop national technical guidelines on quarantine and health certification of live aquatic animals for 20 countries, and formally agreed-upon and standardized technical guidelines on quarantine and health certification for live aquatic animals for the Asia-Pacific Region. The capacity of national aquatic animal quarantine and health certification authorities to exchange information on aquatic animal pathogens and recent disease outbreaks, undertake standardized diagnostic procedures, and improve disease control and disease prevention, will be strengthened through establishing relevant databases and training activities.

The project will collaborate closely with the World Organization for Animal Health (Office International des Epizooties - OIE), with the specific objective of establishing a reliable fish disease reporting system for OIE. A number of other agencies and organizations are involved in this Regional TCP Project. They are: UK Department for International Development (DFID), through the assistance to the Aquatic Animal Health Research Institute (AAHRI) and the South East Asia Aquatic Disease Control Project (SEAADCP) in Thailand; Government of Japan (Fishery Agency); Government of Australia, through the Department of Primary Industries and Energy (DPIE) and the Australian Centre for International Agriculture Research (ACIAR); and the Fish Health Section of the Asian Fisheries Society (FHS/AFS).

Towards Developing Asia Regional Technical Guidelines on Quarantine and Health Certification of Aquatic Animals

The proposed Asia Regional Technical Guidelines on Quarantine and Health Certification of Aquatic Animals, which are to be developed by the Regional TCP, will cover only live fishes, molluscs and crustaceans, both wild and those originating from aquaculture. Dead animals and their products will be excluded for the time being because of the greater difficulties and complexities presented by their trade. It is important to include wild populations, because these can be a source of serious pathogens affecting cultured stocks, e.g., there is strong indication that wild shrimp broodstock can be a source of white spot virus. Conversely, the trade in aquatic animals for aquaculture can inadvertently lead to the introduction of exotic pathogens that can seriously impact wild fish and shellfish populations.

There are significant differences in the status of aquatic animal quarantine and health certification in various countries of the Region. Some countries have developed systems for import quarantine and the necessary legislation to enforce them, whereas others have virtually no mechanisms in place to inspect, even visually, imported or exported live fish. Most countries fall in between, with visual inspection of live imports for signs of disease, but no quarantine *sensu stricto*. Similarly, some countries require detailed health certification from the exporting country whereas others do not, or issue their own health certificates after release of the animals from their quarantine station or after visual inspection.

"Health certification" for some countries means "clinically healthy" at the time of inspection, whereas for others it means the absence of specified disease agents in the consignment, but not necessarily in the source of the consignment (farm of origin, etc.). The majority of countries will issue export certificates according to the importing country's requirements. Some countries do not allow export without a certificate, regardless of whether or not the importing country poses this requirement. Despite the large discrepancies that currently exist between countries in policy, in operation of aquatic animal quarantine and health certification, and in the conceptual framework of quarantine in the wider sense (pre-border, border and post-border continuum), all countries have an acute sense of awareness of these issues, and the genuine wish to improve the situation.

The compilation of inventories and checklists of pathogens and parasites for the various countries of the Asia-Pacific Region is an essential preliminary step towards determining what species are present and determining their distributions. These data are necessary for evaluating risks associated with pathogen movement and for possible inclusion of pathogens on lists drawn up for notification and reporting purposes. The develop-ment of such information therefore is an essential part of the process of developing guidelines for national and regional quarantine and health certification.

Despite the existence of a considerable literature on aquatic animal diseases, the descriptions and distributions of the pathogens and parasites of aquatic animals in the Asia-Pacific Region are poorly documented. In the Philippines, for example, parasites have been recorded for less than 5% of the indigenous fish species, indicating that many new taxa remain to be described and that new host and distribution records will be common. Extensive disease or parasite surveys have been accomplished for only a few species, primarily those widely cultured in Asia. What information is available is widely scattered in the scientific literature. Few comprehensive checklists or monographs have been published. The bibliographies of the aquatic animal health literature published by the Asian Fisheries Society, Fish Health Section, provide a starting point for compiling lists of pathogens. An additional problem to be overcome is the existence of many inadequately described species, resulting in taxonomic confusion. There is a general lack of taxonomic expertise, both within Asia and, increasingly, world wide. Little work has been done on the viruses, due to the novelty of this field and the sophisticated equipment needed for culture and characterization. The bacteria of aquatic animals are better known, but work needs to be done to characterize strains and their distributions. For parasites, viruses and bacteria likewise there are few data proving - or excluding - their true 'pathogenic', i.e. disease causing, nature. It will inherently be difficult to decide between harmless commensals, opportunistic pathogens and true obligate disease agents. Clearly, any quarantine measures will have to consider this aspect as one of the many facets of risk analyses (see below).

The following countries participated in the first training workshop: Australia, Bangladesh, Cambodia, China, Hong Kong SAR, India, Indonesia, Iran, Japan, Lao PDR, Malaysia, Myanmar, Nepal, Pakistan, Philippines, R.O. Korea, Singapore, Sri Lanka, Thailand and Vietnam.

There is a strong need for countries that have linked aquatic systems, either through shared land borders or river systems to co-operate in the development and implementation of common reporting and certification methods. The issues raised by shared marine boundaries also need to be considered within the context of contingency planning and zoning.

Countries have a moral obligation to report outbreaks of listed diseases or significant unexplained mortality to other nations at risk, whether they be neighbours or importers of the live aquatic animal(s) affected. Reporting of new disease problems or sudden, unexplained mortality, or unusual pattern of mortality, is a major component of any health certification and quarantine process. Risk analysis procedures are essential in the process of developing regional guidelines. A simple risk analysis procedure would consist of four components: i) hazard identification, ii) risk assessment, iii) risk management and iv) risk communication. Hazard identification involves identifying the risks associated with the importation of a particular species, for example, introduction of certain viruses. Risk assessment covers the assessment of the risks involved, i.e. judging on a scientific basis whether the risks are high, moderate or negligible, bearing in mind that there will never be 'no risk' and that any quantitation of the risk will be very difficult. Information and database systems such as FAO's Aquatic Animal Pathogen and Quarantine Information System (AAPQIS) are important tools in both hazard identification and risk assessment. Risk management involves contingency planning and establishing procedures to identify the quarantine, health certification, control and eradication measures to be taken where necessary. Risk communication covers the communication of that risk to all responsible persons and agencies involved and to any others identified during the process as likely to be affected by the risk. The Asian Chapter of the FAO's AAPQIS, AAPQIS-Asia, which is currently being developed by FAO and NACA, will attempt to include, as far as possible, authentic records of pathogens and incidence of occurrence in the participating countries.

FAO/NACA/OIE Asia Regional Programme Activities

First Training Workshop

The First Training Workshop of the FAO/NACA/OIE Asia Regional Programme for the Development of Technical Guidelines on Quarantine and Health Certification, and Establishment of Information Systems for the Responsible Movement of Live Aquatic Animals in Asia was held at the NACA Headquarters, Bangkok, Thailand, from 16th-20th January, 1998. This workshop was the first activity of the FAO/NACA Regional TCP "Assistance for Responsible Movement of Live Aquatic Animals"

(TCP/RAS/6714(A)). The workshop was attended by National Co-ordinators (NCs) from 20 participating governments from the Asian region, members of the Regional Working Group and Technical Support Services (RWG/TSS) and observers from three concerned organizations.

A number of important issues related to achieving the project's objectives were discussed. They include the need for adequate regional and national data and information to permit the development of quarantine and health certification systems; the need to conduct pathogen transfer risk assessments and to improve and further develop pathogen reporting systems; needs related to regional and national infrastructure and development, capacity building, and training; institutional involvement and the need for regional harmonization.

Other matters highlighted by the workshop include:

• The importance of identifying areas that are free of shrimp white spot disease.
• The regional TCP should draft guidelines on the legal aspects of quarantine and health certification, which could then incorporated, over time, into national legislation, according to specific national requirements and circumstances.
• The strong desire to see regional co-operation on quarantine and health certification, and to move towards harmonization of approaches.
• The wide variation between countries in terms of existing capacity for diagnosis and disease reporting and legislation.
• The importance of effective and standardized diagnostic procedures for key diseases.
• The participation of the aquaculture "industry" in the process of developing certification and quarantine guidelines.
• Australia and many other countries in the Asia-Pacific Region are free of many of the important diseases found in other countries. These diseases, although not all listed by OIE, merit careful attention on the part of importing countries.
• Better knowledge of the epizootiology of aquatic animal diseases, especially those of "new" aquaculture species, is needed to facilitate the development of national and regional aquatic animal health programmes.
• Several countries in the region (Bangladesh, Cambodia, Pakistan, Sri Lanka) emphasized the need for assistance to initiate action towards developing national quarantine and health certification programmes, including the drafting or revision of appropriate legislation.
• Several countries recognized a need to develop linkages among national agencies, and to enhance regional collaboration, networking and information transfer.
• The need to establish regular disease surveillance programmes and mechanisms for data collection and disease reporting was recognized by many countries. In some cases, where little knowledge exists, national pathogen surveys may be required.
• The need to further develop capacity and infrastructure for aquatic animal research, quarantine and health certification, and health management was mentioned by almost all countries. These include the need to:

° establish national lead centres to act as central repositories for disease information,
° develop national master plans/ strategies,
° provide for technical training and human resource development,
° develop extension services and supporting materials,
° obtain donor funding for initial capacity building, and adequate annual budgets from national governments for continued operation,
° establish and/or up-grade aquatic animal disease institutes and laboratories, and
° improve diagnostic capabilities, including establishing detection methods and developing diagnostic kits using new technology.

Aquatic Animal Disease Reporting System for Asia

It was clearly revealed during the FAO/NACA/OIE first training workshop held in Bangkok that the reporting requirements to OIE on aquatic animal diseases (currently five finfish diseases and five diseases of molluscs) were not met by all countries in the Asia Region. Thus, it was impossible for OIE to disseminate information on aquatic animal health status in the region. OIE hoped that in the very near future, a reporting system called *Quarterly Aquatic Animal Disease Report* (by FAO/OIE/NACA) could be initiated and formalized.

A tentative list of reportable diseases for Asia, including OIE notifiable diseases and other significant diseases, has been developed by the Regional Working Group established for the implementation of the Regional Strategy. This list could serve as the basis for the quarterly reports, and can subsequently be modified as experience in aquatic animal disease reporting improves. The frequency of reporting will be once every three months. A reporting form has been developed by OIE, NACA, and FAO and will be sent to the NACA National Co-ordinators (NCs) or Chief Veterinary Officers (CVOs), in July 1998. The first quarterly reports will be submitted by countries in October 1998 OIE/NACA/FAO will prepare a quarterly report based on the returns, which will to be circulated to all participating countries in November 1998.

NOTES ON BIOSAFETY AND AQUATIC ECOSYSTEMS

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Fishery Resources Division

INTRODUCTION

International efforts are underway to develop regulations governing the use and transboundary movement of genetically modified organisms (GMOs) and living modified organisms (LMOs)[1]. Foremost in this regard are the negotiations of the International Convention on Biological Diversity's (CBD) Ad hoc Working Group on Biosafety, which are designed to create internationally binding protocols on biosafety. FAO has worked and continues to work closely with the CBD and others on issues relevant to the sustainable use and conservation of aquatic genetic resources. National legislation and guidelines are also being developed, such as the Performance Standards for Safely Conducting Research with Genetically Modified Fish and Shellfish that were created by a working group organized by the US Department of Agriculture (*http://www.nbiap.vt.edu/perfstands/psmain.html*).

Biosafety, as currently discussed in the CBD, refers to environmental and human health safeguards concerning living modified organisms produced by modern biotechnology, especially biotechnology related to gene-transfer or transgenics. In the aquaculture sector, gene-transfer is still not commercially viable, but there are several pilot projects and research programmes in many parts of the world that are developing commercially important transgenic fish, such as salmon, catfish, carps, and tilapia. However, other biotechnologies, such as chromosome manipulation, sex-reversal, hybridization, and conventional selective breeding are becoming more widespread in aquaculture. In light of the fact that most aquatic biological diversity still resides in natural populations, all biotechnologies have the *potential*, both to improve greatly production, because of the "unimproved" state of wild aquatic species, and to impact adversely those wild resources. Thus a narrow scope of the current biosafety protocols. i.e. focusing primarily on transgenics, should be carefully considered. All of the wild relatives of domesticated aquatic species are still found in nature; biosafety protocols, or similar regulations, should eventually strive to protect these resources while allowing for the development of aquaculture and international trade.

The use of introduced species and genotypes is also a practice that can greatly increase production, but also has the potential to damage natural genetic diversity and ecosystems. In the CBD, "introduced species" are referred to as "alien species" and the term refers to species that are introduced into an area where they do not naturally occur, e.g. the movement of rainbow trout, *Oncorhynchus mykiss,* from North America to Europe. "Alien genotypes" is another phrase that is being used in international fora and would include in addition to alien species, those genetically differentiated populations that are transferred from one part of their natural distribution to another, e.g. the movement of rainbow trout from California to British Colombia. Hybridization of two local species that do not naturally hybridize would also create an alien genotype, e.g. the hybridization of *Colossoma* and *Piaractus* in Venezuela.

Biosafety in the following section refers only to environmental safeguards. Safeguards concerning human health fall under the domain of the FAO/WHO Codex Alimentarius Commission, the Agreement on the Application of Sanitary and Phytosanitary Measures, and the Agreement on Technical Barriers to Trade of the WTO.

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[1] The definition of LMOs and GMOs is somewhat controversial. The Convention on Biological Diversity uses an internationally accepted definition of LMO as an organism that has been modified by modern biotechnology; the International Council for the Exploration of the Sea uses the European Union's definition of GMOs to include organisms in which the genetic material has been altered anthropogenically by means of gene or cell technologies.

Table 1. FAO instruments relating to biosafety and alien species

Instrument	Area of emphasis	Comments
FAO Code of Conduct for Responsible Fisheries	Sustainable use and conservation of living aquatic resources	Voluntary code on general issues of responsible fisheries
ICES/EIFAC Code of Practice on the Introduction and Transfer of Marine Organisms	Purposeful introduction of marine (ICES) and inland (EIFAC) species and GMOS	General code of practice created for developed areas, but is being accepted in principle in developing areas.
FAO/Sweden Precautionary Approach to Fisheries, FI Technical Papers 350/1 and 2	Precautionary approach to capture fisheries and species introductions	Defines in a rigorous manner what the precautionary approach means
FAO/ICLARM Bellagio Conference, "Towards Policies for Conservation and Sustainable Use of Aquatic Genetic Resources"	Policy development for aquatic genetic resources	Produced consensus statements on i) the need to expand eventually biosafey protocols and ii) to consider phenotypic change and receiving environment in assessing risk from LMOs.
FAO Technical Guidelines No. 5 – Aquaculture Development	Responsible development of aquaculture and culture based fisheries	Facilitates implementation of Article 9 of the CCRF
FAO Field Programme: "Assistance in the Preparation of a Legal Framework for Responsible Aquaculture Practices" (TCP/MAL/6611)	Responsible aquaculture development and code of conduct for cage culture and shrimp culture in Malaysia	A section of this TCP is devoted to formulating guidelines on LMOs and alien species of marine shrimp.
Assistance for Responsible Movement of Live Aquatic Organisms" (TCP/RAS/6714(A)	Technical guidelines and information system for quarantine and health certification	In co-operation with Network of Aquaculture Centres in Asia-Pacific, International Office of Epizootics, and other agencies, the project will reduce the risk of spreading aquatic pathogens with species transfers.
Database of Introductions of Aquatic Species (DIAS)	Introduced aquatic species	Database, available on WWW and disk, that documents reasons for, and impacts of introduced aquatic species *http://www.fao.org/waicent/faoinfo/fishery/statist/fisoft/dias/index.htm*

INSTRUMENTS

The FAO Fisheries Department supports the responsible use of biotechnologies and alien species. The primary instruments for this support are the FAO Code of Conduct for Responsible Fisheries (CCRF) and a series of guidelines and codes of practice governing the movement of alien aquatic species (Table 1). Foremost among the latter are the International Council for the Exploration of the Sea/European Inland Fisheries Advisory Commission (ICES/EIFCA) codes of practice on aquatic introductions. These codes of practice have been adopted in principle by FAO and FAO regional fishery bodies. FAO and others are working to facilitate their implementation (Table 1).

The FAO Code of Conduct for Responsible Fisheries was adopted in 1995 by the 28th Session of the FAO Conference and provides a framework for the sustainable use and conservation of aquatic biodiversity. The Code contains Articles on:

- General Principles
- Fisheries Management
- Fishing Operations
- Aquaculture Development
- Integration of Fisheries into Coastal Area Management
- Post-harvest Practices and Trade
- Fisheries Research

Aquaculture is a primary reason for the purposeful introduction of aquatic alien species, as well as being the main motivation for the use of living modified organisms. Article Nine of the CCRF, on Aquaculture Development, deals specifically with these topics: Article 9.2 on the "Responsible development of aquaculture including culture based fisheries with transboundary aquatic ecosystems", and 9.3 on the "Use of aquatic genetic resources for the purpose of aquaculture, including culture-based fisheries" apply. FAO has produced Technical Guidelines on Aquaculture Development to facilitate the implementation of Article 9 of the CCRF.

FAO is now actively assisting countries promote and implement the CCRF. For example, a Technical Co-operation Programme project in Malaysia, TCP/MAL/6611 “Assistance in the Preparation of a Legal Framework for Responsible Aquaculture Practices”, will facilitate creation and implementation of a code of conduct for responsible cage culture and shrimp culture that follows on from the CCRF and contains elements on use of alien species and living modified organisms. Recognizing that pathogens also may accompany movement of alien species, a regional TCP in Asia, “Assistance for Responsible Movement of Live Aquatic Organisms” (TCP/RAS/6714(A)) has been established to create an information system and guidelines on quarantine and health certification of aquatic animals (see related article p . 19).

To assess potential environmental and socio-economic impacts of alien species, a Database on Introductions of Aquatic Species (DIAS) has been established as a searchable database on th FAO WAICENT *http://www.fao.org/waicent/faoinfo/fishery/statist/fisoft/dias/index.htm*.

The database will be periodically updated and eventually modified to include living modified organisms.

CONTROVERSIES

The scope of the biosafety protocols currently being negotiated by the CBD and procedures for risk assessment are controversial subject areas. Regarding the scope, segments of the aquaculture industry wants to restrict the protocols to primarily transgenics and to leave other genetic modifications unregulated, or at least less regulated. Similarly, alien species would not be covered by the protocols. Efforts to restrict the scope of the protocols are motivated by concern about possible over-regulation of common practice, which would hinder aquaculture trade and development. In addition, there is the feeling by some that gene-transfer technologies are inherently more risky than other genetic manipulations and the impacts less well known, or unknown.

Counter to this is the belief that all organisms that have had their genome modified, e.g. hybrids, polyploids, sex-reversed animals, and domesticated species, as well as alien species, have the *potential* to harm aquatic ecosystems and should be subject to biosafety protocols. Furthermore, many molecular geneticists working on transgenics claim that it is not justified to target a single technology , such as transgenics, when other practices also have the potential to cause environmental harm.

Thus we are brought into a debate on whether to regulate a technology or the result of the technology, i.e. regulation based on the process or on the product. A recent international conference sponsored by the Sustainable Development Department and the Inland Water Resources and Aquaculture Service of FAO and the International Center for Living Aquatic Resources Management (Bellagio Conference; see Table 1) agreed that the primary consideration in risk assessment concerning genetic modifications should be the phenotypic change that the technology has imparted to an organism, and not what technology was used to impart the change. Furthermore, the receiving environment, or potentially affected environment, is crucial in risk assessment; a organism that presents no threat in one environment, may be hazardous in another. Practices of genetic modification associated with more scientific uncertainty as to the phenotypic change that they impart on the organism should be regulated and monitored more closely, as efforts are made to improve scientific information and reduce uncertainty.

A further complication is being addressed by the CBD’s Ad hoc Working Group on Biosafety, namely that there are discussions to regulate the products of living modified organisms, e.g. fermented products that have been developed from genetically modified micro-organisms. These concerns are more closely associated with human health aspects, and as such, are being addressed by Codex Alimentarius. Tilapia are being genetically engineered to produce insulin for treatment of diabetes in humans – would the trade or transport of the insulin be subjected to the biosafety protocols, even though it may be identical to human insulin?

CONCLUSION

It is not the intention of this note to try to change the ongoing negotiations of the Ad hoc Working Group on Biosafety, but to highlight important issues related to the responsible use of biotechnologies and alien species and point to areas where the Fisheries Department of FAO can offer expertise and assistance. Readers that are aware of specific cases of successes or problems derived from the use of biotechnologies and living modified organisms are encouraged to contact the Fisheries Department so that we may benefit from your experiences and help pass the information along.

This is the second and final article based on an FAO mission to Iran (constituted by Dr. Devin Bartley and Dr. Krishen Rana of the FAO Fisheries Department) to help SHILAT evaluate stocking pogrammes and the management of aquatic genetic resources in aquaculture.

IRAN PROMOTES AQUACULTURE DEVELOPMENT

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INTRODUCTION

At present, the average per capita fish consumption in the Islamic Republic of Iran (IRI) is low, at around 4.5 kg compared with the world average of 13.5 kg. To increase average consumption to the desired 6.5 kg level by the year 2020, the total fishery output in the IRI would need to increase from 382,000 metric tonnes (mt) in 1995 to 670,000 mt. At present, the Caspian Sea region and other inland waters produce around 60,000 and 59,000 mt of fish, respectively. The plan, however, is to increase production from these water bodies to 420,000 mt by 2020 to satisfy the projected per capita consumption. Accordingly, the IRI has identified fisheries, in particular aquaculture, as a high priority area for stabilizing and increasing fish production; more specifically, to:

- narrow the national variation in per capita fish consumption which currently ranges from below 1kg/yr. in Central Provinces to over 20kg/yr in coastal provinces,
- raise apparent per capita fish consumption to 6.5kg,
- sustain and increase the employment security of the fisherfolk, particularly in the Northern Provinces, and
- diversify the economy and increase non-oil exports.

Developments in capture fisheries have been published in a previous issue of *FAN*. The purpose if this article is to highlight recent issues and forthcoming challenges related to aquaculture development in IRI.

BACKGROUND TO AQUACULTURE DEVELOPMENT

Aquaculture development in the IRI started in the early 1970's with technical assistance from the Soviet Union for the artificial propagation of sturgeon (Acipenseridae) fingerlings for restocking the Caspian Sea. Since then, the capacity to mass produce other Caspian sea species such the mahi sephid (*Rutilus frisii kutum*), Caspian trout (*Salmo trutta caspius*), bream (*Abramis brama*), pike-perch (*Stizostedion lucioperca*), rainbow trout (*Oncorhynchus mykiss)* and cyprinids for restocking other suitable inland water bodies was rapidly acquired by SHILAT, the Iranian Fisheries Company charged with developing national programmes for development, management, and conservation of aquatic resources for fisheries and aquaculture.

Reproductive and seed rearing technologies and infrastructure has been disseminated to private farmers in an effort at privatization and strengthening of the sector. Aquaculture has since expanded to culture of food fish in raceways (trout) and ponds (cyprinids). Other species are also being targeted for future culture. Development projects on the farming of penaeid shrimp (*Peneaus semisulcatus* and *P. indicus*) in the Gulf region and along the southeastern area of the Caspian Sea are currently underway. The IRI have also initiated projects to evaluate the feasibility of culturing *Artemia* cyst, grouper, pearl oyster, and aquatic plants.

CURRENT STATUS OF AQUACULTURE PRODUCTION

The Government has been successful in its efforts to raise aquaculture output and this is reflected in the overall expansion rate of the sector at 8.2 %/yr during 1990-1996. To date, five species contribute to aquaculture output in the IRI (Figure 1). In 1996, production amounted to 30,000 mt, valued at US$ 306.6 million. Production of the major species, rainbow trout, *Onchorincus mykiss*, silver carp, *Aristichthys molitrix*, and bighead, *A. nobilis,* increased at 27, 11 and 7 %/yr between 1991 and1996. The Chinese carps: silver carp, grass carp, (*Ctenopharyngodon idella*) and bighead carp, and common carp dominated production. In 1996, the two groups accounted for 93% (28,000 mt) of reported aquaculture production. Following the introduction of Chinese carps in the 70s, there has been a shift from traditional common carp monoculture to polyculture of Chinese and common carp. The increasing production of silver carp reflects the higher stocking ratio of this phytoplankton feeder in the polyculture system despite its lower retail market price (R2,500- 3,000/kg in 1995) (3,000 Rials = 1 US$) compared to grass carp (R5,000-6,000 in 1995).

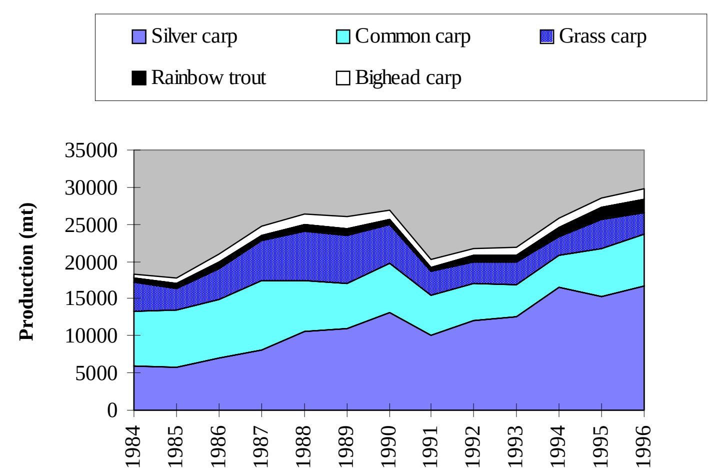


Figure 1. Aquaculture Production in Iran

INCENTIVES FOR EXPANDING AQUACULTURE

Iran is actively pursuing a holistic approach for aquaculture development, building on one of its key strengths--technology for mass artificial propagation of seed and infrastructure for restocking inland and coastal waters. To promote aquaculture as an independent economic activity, the IRI has taken several initial steps to encourage private sector involvement. These include:

- making the private sector solely responsible for fingerling production for ongrowing,
- providing low interest loans,
- subsidizing feed ingredients for feed production,
- providing low price fingerlings from state hatcheries,
- granting twenty-year tax exemption for farms,
- providing low priced or free land with service, such as roads and canals for shrimp farms, and
- mounting effective public promotion initiatives to increase fish consumption, particularly in the Central region of the IRI, where fish eating habits are not well established.

These recent initiatives of the Government have proved successful in attracting private investment in both the seed production and ongrowing segments of the sector. In 1996, around 20 private cyprinid and 10 private trout fingerling production hatcheries were operational. In case of rainbow trout, 80 private ongrowing farms were operational in 12 provinces. Between 1992 and 1996, the area under rainbow trout production increased from 80,000 to 166,000 m^2 (raceway area) and production increased from 775 to 1,900 mt.

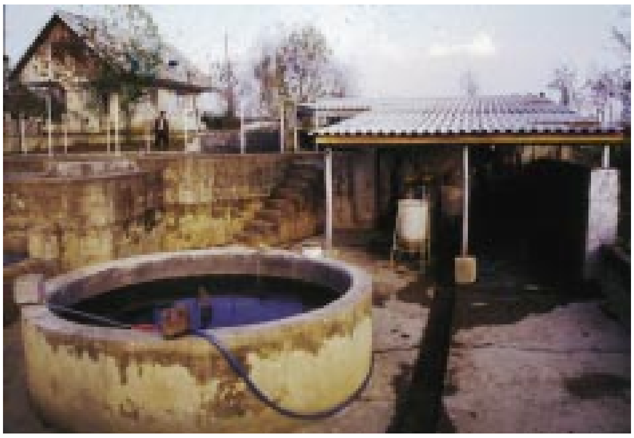
CURRENT SITUATION AND CAPACITY

Production of major species groups

The culture of carps, trouts and marine shrimp currently form the basis of Iranian aquaculture.

Carps

Carps are primary farmed in three main provinces: Gilan, Mazandaran and Khuzestan. Production of carp seed for grow-out by private industry is now primarily done by the private sector. Carp broodstock selection is usually based on head-size, color, and gill structure (surface and shape of filter) and adults are usually used for 3-4 years and then replaced. A key factor in the successful transfer of seed production to the private sector was the switch from the Hungarian method of seed production using small incubators and small spawning tanks in which



Chinese design carp hatchery on private carp farm. Circular concrete tanks for spawning and collecting spawn and conical shaped incubators (in background), used for rearing Chinese carp spawn.

Highly engineered farm in the north of Iran using flow through raceway system for ongrowing rainbow trout.

handling mortalities were high to the Chinese method of using concrete circular tanks fitted with egg collecting devices for spawning and egg collection/incubation, in which intervention in the spawning process is minimal.

Carps are ongrown to market size in production systems that vary from simple ponds managed on a part-time basis to capital intensive and professionally engineered and constructed farms managed on a full time basis. In 1994 there were around 2,583 registered warmwater fish farms in the country, with a combined pond water surface of approximately 8,000 ha. In Gilan Province alone there are about 12 private carp hatcheries and 2,200 ongrowing carp farms with around 3,500 ha of ponds.

The bighead, silver, grass and common carp are predominantly reared under semi-intensive static polyculture conditions, in which organic and inorganic fertilizers and supplementary feeds are commonly used. In such systems, carps are produced in a one year culture cycle. Carp fingerlings (5-10g) are stocked at between 2,000- 6,000/ha in March-April. Lower densities are stocked when larger sized marketable fish are required. Ponds are fertilized with urea (135-1500 kg/ha/yr), ammonium phosphate (80-575 kg/ha/yr) and manure (3-10 mt/ha/yr) and fish are fed a supplementary diet consisting of a variety of grains (100-6,000 kg/ha/yr). Some farmers practice intensive monoculture of common carps in aerated ponds and use high protein (30-40 %) pelleted feed. Marketable fish are harvested between November-February and production varies between 1.6 to 5.5 mt/ha.

Rainbow trout

Culture of rainbow trout is restricted to the cooler northern areas of the country and the Alborz and Zagros mountain ranges. Typically, rainbow trout farms are small (below 50 mt/yr) but some have a potential for producing 50 - 200 mt/yr. Most of the farms use the raceway system of production. SHILAT has conducted a specific training course for civil engineers to meet the challenges of constructing and managing such production systems.

Seed production and intensive ongrowing of rainbow trout in IRI is well developed using standard methods of breeding, larval rearing and aerated grow-out raceways. Currently, many of the farms import eyed eggs from Scotland and Norway and use these eggs as source of brood stock when mature. In 1995, SHILAT imported 1 million eyed eggs from Scotland. Survival rate to eyed egg stage of 80%, and 70% to alevin stage is common, and in 1996 some 10 million fingerlings were produced by the private sector.

For ongrowing, trout are fed on commercial pellets of varying sizes produced by Chineh, the only feed manufacturer in IRI and supported by the State. The conversion efficiency of manufactured pelleted feed is in the order of 1 : 1.1 - 1.4 (wet : dry weight basis). Some farmers manufacture their own moist diets on-farm for broodstock, larval rearing and grow-out. The culture period to market size (about 30 cm in length and at least 225 g in weight) varies depending on water temperature. Slow growth rate, principally due to water temperatures as low as 2ºC in the north, results in a 14 month production cycle, whereas the warmer more constant water temperatures (ca13ºC) around Tehran reduces the culture cycle to 9 months. Risk of disease introduction, rising production costs and growing knowledge base in IRI is likely to result in the banning of any further importation of eyed eggs into the country.

Marine shrimp

Penaeid culture in the southern provinces along the Gulf and Sea of Oman has been identified by the IRI, since 1992, as a means of generating non-oil export earnings. To date some 200,000 ha of marginal agricultural lands have been allocated for shrimp farming. In addition to these lands, the IRI is promoting pond culture of Penaeids (*Peneaus semisulcatus* and *P. indicus*) using large tracks of marginal agricultural land on the eastern shores of the Caspian Sea in Gorgan and Gonbad Province as a means of providing alternative employment in the north.

At present six development sites totaling 18,000 ha, out of the 200,000 allocated to shrimp farming, have been identified and about 4,000 ha are scheduled to be developed in the current Five year plan. In the southern provinces the government is developing each site by building the necessary infrastructure; the developed areas will be ceded to potential aquafarmers (20ha/farm). Shrimp farming is centered on the development of species indigenous to the Gulf, particularly *Penaeus semisulcatus* and *P. indicus*. The private sector in IRI produced 93 % of the 136 mt of shrimp in 1995 and achieved yields of 7.4 mt/ha. In the Caspian sea region, production yield of 4 mt/ha has been reported. To ensure sustained high productivity, the Government is also developing plans to regulate the sub-sector and provide training, loans, feed and seed.

Artemia

The potential to produce high valued *Artemia* cysts and biomass in the hyper-saline (100-150ppt) Uromia Lake to procure live feed for the expanding penaeid farming and for export is being actively explored. The lake, which has an area of 6000 km^2 and has the potential to produce 300 tonnes cysts. A pilot processing plant had already been established on the lake shores and, in 1996, 20 mt of cysts were produced (pers. Comm. Mr Abdolhay).

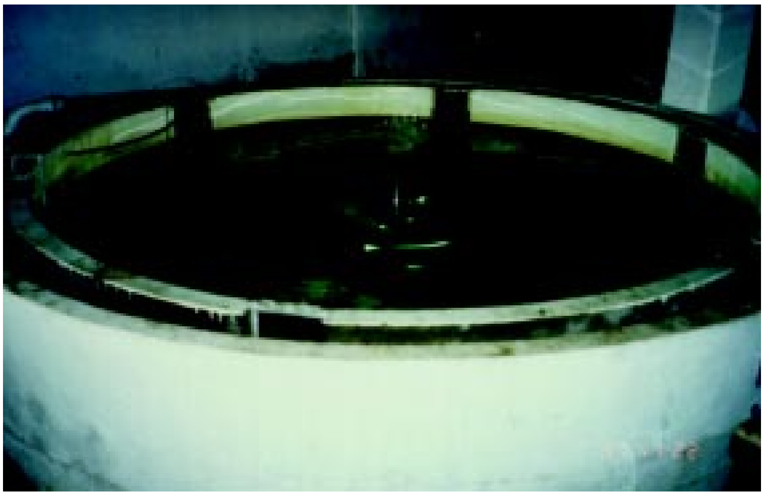
POTENTIAL FOR FURTHER DEVELOPMENT

Hatchery technology exists in Iran for the several species that are only used in restocking programmes. Therefore, potential exists to develop these species as domesticated farmed fish. Table 1 lists some of these potential candidate species. Although species of sturgeon are the obvious species for culture, their slow growth rate is a hindrance and there are efforts to use faster growing species or hybrids. There is also interest in utilizing bream, *Abramis brama,* in polyculture systems, but this species has shown poor tolerance to low oxygen. Further efforts to find more suitable stock or to improve genetically the local bream so that it could tolerate polyculture conditions should be pursued. This species has a higher market value than Chinese carps and would be expected to also increase the value of aquaculture production. Mahi sephid may be a candidate for saline soils unsuitable for agriculture. However, research on how to culture the species past the juvenile stage is required. A UNDP/FAO mission on “Development of National Strategy for Aquaculture Shrimp Management” (IRA/97/020/A/08/12) is currently underway.

Although aquaculture development is relatively new, the IRI has made significant progress in promoting aquaculture as an independent food producing activity. They have :

- allocated natural resources for aquaculture development for controlled expansion,
- taken steps to improve processing, marketing, and related infrastructure,
- invested in strengthening human capacity, and
- successfully raised demand for aquatic products, especially trout.

To maintain and extend this progress, however, several constraints need to addressed on an ongoing basis. Efforts are needed to:



Circular tanks used for rearing sturgeon fry for restocking programme. Note multiple screens to minimize blockage and possible overflow.

- secure all year round supply of high quality trout seed,
- provide technical information on production systems and their management,
- provide training and dissemination of information on reproductive biology and genetics, broodstock management techniques, feed and feeding technologies,
- broaden the availability of credit facilities,
- refocus research and training programmes.,
- strengthen the extension service,
- facilitate procurement of equipment,
- improve transportation for fish to distant markets, and
- improve the manufacture artificial feed.

The FAO mission of Dr. Bartley and Dr. Rana have identified specific activities to meet some of the immediate challenges to aquaculture development in the IRI. These included the development of a national broodstock programme for rainbow trout and other species to:

- produce stocks better suited for local conditions and manage stocks to maintain genetic integrity in the light of potential ban on importation of eyed trout eggs,
- produce all female triploid trout,
- develop photoperiod manipulation technologies at selected SHILAT and private sites to secure all year round eyed egg production,
- provide training courses on broodstock management and genetics, and
- develop ex-situ conservation measures to protect current and future developments in selection programmes.

The prognosis of aquaculture in the IRI is very good. The Government is taking steps to elaborate a national aquaculture development plan in support of the sector and is creating a positive enabling environment for the sustained development of aquaculture.

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Table 1. Some species for potential aquaculture development in Northern Iran

Species	Current status	Prospects	Constraints
Mahi sephid	State supported restocking programme only; 7 million 1g fingerlings released into Caspian Sea in 1997	Good market price 15,000 rials/kg compared to 3,000 for silver carp; can tolerate brackish water/soils	Growth rate slower than carp and difficult to culture past the 40 – 50g stage in freshwater; no trials in brackish water
Bream	State supported restocking programme; over last 8 years ca. 70 – 80 million fingerlings released into Anzali lagoon	Spawns naturally in ponds and is tolerant to brackish water/soils. May be a candidate for polyculture with Chinese carps; potential candidate for genetic improvement.	The stocking programme is based on descendants from a single pair mating 8 years ago; intolerance of low oxygen resulted in poor pond performance.
Caspian trout	State supported restocking programme.	Possible cage culture in Caspian Sea or inland areas.	Slow growth rate and high summer temperatures (28° C) in Caspian Sea limit survival and production.
Sturgeon	Five species native to Caspian Sea; Siberian sturgeon and "bester" hybrid.	Currently only restocking in Iran; however Siberian sturgeon and "bester" are produced in Russia. There is interest in utilizing inland waters for sturgeon culture in to support conservation efforts as well as to increase production	Extremely slow growth of most species. Those favorable to aquaculture, e.g. Siberian and "bester" are exotic to Iran and their use should be carefully considered following appropriate Codes of Practice on introductions and fish health.
Marine shrimp (*Penaeus semisulcatus*)	Production in Gulf, but recently expanded to Gorgan and Gonbad Province on Caspian Sea where 4.5 mt/ha is seen	Reports by others have suggested poor returns on investment in shrimp aquaculture as practiced in the south (COFREPECHE, 1997); however information from SHILAT on Caspian Sea culture is more optimistic; may be able to take advantage of marginal areas along Caspian Sea	According to COFREPECHE (1997), limited supply of PL's and slow growth and low marketability of indigenous *P. semisulcatus*, with which farmers are required to work.

PROJECTS AND OTHER ACTIVITIES...

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CUBA

The third field mission of the FIMLAP project took place from 8 to 19 June 1998 (see related article in *FAN* No.15, p. 27). This mission carried out a more detailed technical and economic analysis of production (fish culture) results, based on a set of data better than that available during the second mission. A two-day workshop was organized to discuss the mission's conclusions. Participants (both technicians and economists) came from the main farms of the country as well as from the institutions responsible for aquaculture research and development. The mission also met with the Vice-Minister of Fisheries in charge of aquaculture production, for further discussions of the recommendations and follow up proposals.

The main observations raised by the second mission, centered on the over-ambitious and risky nature of the adopted strategy, taking into account the present situation of the country and the innovative (for the country) nature of the recently adopted administrative-accounting system. The third mission's technical conclusions were based on more detailed information from a new production cycle. Two main technical packages were adopted for fish culture in earthen ponds, one based on monoculture of tilapia (*Oreochromis aureus)* at high densities (160,000/ha), irregularly fed with poor quality locally produced feed, and the second on polyculture of tilapia (*Oreochromis aureus*), silver carp (*Hypophtalmichthys molitrix*), bighead carp (*Arystichthys nobilis*), grass carp (*Ctenopharyngodon idella*) and common carp (*Cyprinus carpio*), with variable densities and species ratios. Commercial feed plus some grass, and other agricultural by-products were used in polyculture trials. Fertilization with cowdung and other organic wastes was also practised. The techno-economic evaluation has shown that, in all cases but one, the activity was not economically viable. As could be expected, results were more negative for monoculture than for polyculture.

Availability of feeds and appropriate feeding strategies appeared to be key problems. A TCP project dealing with nutrition and feeding in fish culture has recently started in Cuba, and it is expected to offer alternative non-conventional methods for feeding cultured fishes at lower costs. The more appropriate strategy for the prevailing conditions requires a predominance of herbivorous and planktivorous carps in the cultured species mix. Other technical changes proposed were:

- Lower stocking densities should be used to avoid the use of drugs for hormone sex reversal, which may limit the marketability of the product.
- When possible, a four-step culture scheme should be followed: pre-nursery, nursery, pre-growing and growing. The first step, pre-nursery, from fry to 10 g fingerling, would significantly reduce the present cost of this production input. Manual sexing could be done between nursery and pre-growing phase.
- Production cycles should be staggered to ensure a continuous market supply through the year.
- Grass carp proportion should be increased in polyculture, to benefit from its capacity to transform grass into fish flesh and to also generate fertilizer for the ponds.
- *Oreochromis aureus* should be gradually replaced by faster growing Nile tilapia, *O. niloticus*.
- Work on genetic improvement of tilapia should be reactivated (two TCP projects on this subject have been executed in 1985 and 1994) to ensure better stock for culture.

Concerning economic and financial aspects, two features need to be taken into account: (i) economic and financial management of fish production facilities (fish farms, processing plants, etc.) are decentralized to the provincial level (12 provinces); and (ii) there is a policy to promote the economic and financial self sufficiency of the provincial production complexes. This economic and institutional set up requires more advanced technical and methodological tools for use by the central office of the Ministerio de la Industria Pesquera (MIP) to permit adequate management control of, and enable timely technical advice to the decentralized units. MIP has developed an accounting system for the decentralized units and for single aquaculture farms. The system meets modern accounting criteria, and if correctly implemented, will provide appropriate information for corporate management control. There is, however, a need for more in-depth training of personnel, until the system is completely understood and has become an operational norm. There is also a need to provide the key staff of the management control system with more thorough information on microeconomics, and economic and financial analysis.

MEDITERRANEAN AQUACULTURE NETWORKS NEWS

SIPAM

SIPAM Software and data.

As a follow-up on the Salerno meeting (see *FAN* No.17, p.18), a prototype of an improved version of the software that was prepared by the Institute of Marine Biology of Crete, Greece, named release 2.0, has been tested by FAO and the SIPAM Regional Centre. The main modifications concern reference tables, R & D programme (to create an automatic link between R & D programmes and Bibliography), data entry (to allow data entry for more than one location within a country), help manual and reporting. The final version will soon be distributed to the National Co-ordinators. The SIPAM Regional Centre is also working on the improvement of the reference tables.

As planned in the SIPAM and SELAM programmes of work for 1998, a joint meeting SIPAM - SELAM meeting took place in February 1998, at FAO Headquarters, with the participation of FEAP (Federation of European Aquaculture Producers), CIHEAM, the SIPAM Regional Centre staff and FAO staff, to discuss a possible agreement to utilize data on aquaculture marketing collected by the FEAP on a specialized data base, and the structure of the SIPAM marketing data base. An agreement was reached to extract data from the FEAP data base (to be later approved at a FEAP General Assembly meeting) in exchange for some of the data of interest to the producers contained in SIPAM. It was also agreed that the GLOBEFISH data base prepared by FAO headquarters should be analysed for eventual downloading of information. Agreement was also reached on a survey of existing capabilities for aquaculture marketing in the Mediterranean to be undertaken jointly with SELAM. Mr. P. Paquotte visited Rome for the second time in July 1998, on behalf of the SELAM network, where he worked in collaboration with Ms. C. Iandoli (ICRAM) and FAO staff to analyse the information contained in GLOBEFISH and to finalize the design of the structure of the marketing data base for SIPAM. The forms for the survey to be carried out by CIHEAM were prepared at the same time.

The 3rd issue of the SIPAM Regional Data Base was distributed recently to network members. It includes 5,738 records. For the time being, the Regional Data Base will be issued on a quarterly basis.

Mission to SIPAM member Countries

SIPAM has entered a phase in which functional national SIPAM networks have to be established and consolidated. Following earlier visits to other countries, the SIPAM Regional Co-ordinator visited Turkey last December. He made a number of useful contacts with both the public sector, including the National Research Institute (TUBITAK), the Ministry of Agriculture and Rural Affairs (MARA), and the private sector — both producers' associations and individual producers (marine aquaculture), around the Bodrum area.

SELAM and TECAM Networks

Recent activities of the two networks managed by CIHEAM included the following:

- the *Workshop on Aquaculture Planning in Mediterranean Countries*, held in Tangier (Morocco), 12 to 14 March 1998. This workshop was jointly organized by the Mediterranean Agronomic Institute of Zaragoza (CIHEAM - IAMZ), the FAO Fisheries Department and Institut National de la Recherche Halieutique (INRH) (CASABLANCA, MOROCCO). A total of 49 experts from 9 Mediterranean countries (Cyprus, France, Italy, Israel, Malta, Morocco, Spain, Tunisia, Turkey) and representatives from CIHEAM and FAO attended the workshop.

- the *Advanced Course on Mediterranean Aquaculture : New Techniques for Marine Hatcheries*, held in Mazarron (Spain), 23 February to 6 March 1998. The course was jointly organized by the Mediterranean Agronomic Institute of Zaragoza (CIHEAM - IAMZ), and the Spanish Institute of Oceanography (IEO) with the collaboration of the FAO Fisheries Department. A total of 27 participants from 12 Mediterranean countries (Algeria, Cyprus, Egypt, Greece, Italy, Lebanon, Malta, Morocco, Portugal, Spain, Tunisia, and Turkey),

- the *Workshop on Aquaculture Feed Manufacturing Practice within the Mediterranean Region*, held in Reus (Spain) from 25 to 27 March 1998. An extensive report on the results of these activities will be included in the next *FAN* issue.

AD-HOC EXPERT MEETING RECOMMENDS CRITERIA AND INDICATORS OF SUSTAINABLE SHRIMP CULTURE FOR COUNTRY-LEVEL REPORTING

The Bangkok FAO Technical Consultation on Policies for Sustainable Shrimp Culture, 8 to 11 December 1997[1], recommended, *inter alia*, that FAO specifically request governments of countries engaged in shrimp culture to report on progress in implementing the Code of Conduct for Responsible Fisheries in relation to shrimp culture activities to the Committee on Fisheries (COFI). The Consultation also recommended that FAO convene a meeting of technical experts to develop appropriate criteria and indicators to assess progress made in the process of national shrimp culture development.

In pursuance of this recommendation, FAO held an ad-hoc expert group meeting in FAO HQ, Rome, Italy, from 28 to 30 April 1998. The participants included government experts involved in planning and management of shrimp culture, academics with broad experience in sustainability issues of shrimp culture and serving as consultants to important industry and environmental NGOs, and experts from three inter-governmental organizations including FAO.

The meeting noted that indicators must be practical and cost-effective, and ideally integrated within existing data collection programmes; this usually called for a small number of well-designed indicators which are clearly linked to specific criteria, and which have properly defined objectives. It did prioritize and prepare a recommended short-list of the criteria and indicators of sustainable shrimp culture which could form the basis for regular reporting by countries to COFI. The indicators are multi-disciplinary and far-reaching, covering eco-system and bio-physical, economic and social, and legal and institutional aspects of shrimp culture. However, the meeting stressed that these criteria and indicators related to the national level and did not encompass farm-level and local-level indicators which were inappropriate for the envisaged reporting exercise. It also noted that the regular collation of these indicators would greatly benefit the planning and management of shrimp culture development.

The meeting concluded that it would be premature at this stage to request governments to report actual data on those indicators to the next session of COFI, 15-19 February 1999. Instead, it elaborated a questionnaire to allow governments to review and comment on the recommended indicators and on their present and future ability to acquire the related data and information. Moreover, the meeting decided that in this questionnaire, governments should be given the opportunity to indicate the nature of assistance deemed desirable to adopt a comprehensive statistical system for their shrimp culture sub-sectors in view of the inadequacies of many existing systems and of the high socio-economic importance and specific management and development requirements of shrimp culture.

The report of the meeting is being published as FAO Fisheries Report No. 582 in English, French and Spanish. The English version will soon be available on the Home Page of the FAO Fisheries Department at: *http://www.fao.org/fi*

[1] The report in English and Spanish has been published as *FAO Fisheries Report* No. 572. A summary of the proceedings of the Consultation has been provide in *FAN* No. 18.

FAO AND NACA TO COOPERATE IN CONFERENCE ON AQUACULTURE

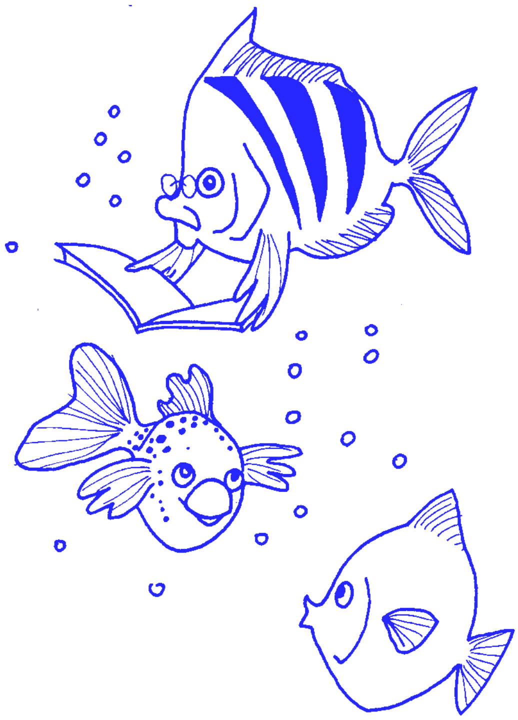
FAO will cooperate with NACA in organizing the ***Conference on Aquaculture in the Third Millennium***, to be held on 21-26 February 2000, in Bangkok, Thailand. The Conference will take place nearly a quarter century after the first global technical conference on aquaculture organized by FAO in cooperation with the Government of Japan in Kyoto, in 1976.

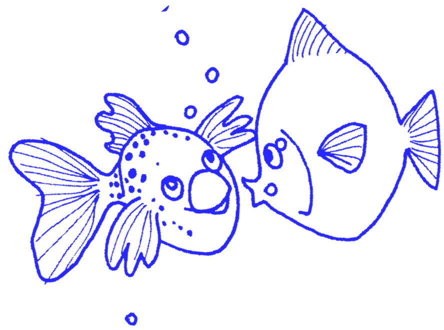
The Conference aims to attain a consensus on perspectives and future trends in aquaculture, and to develop strategies to address emerging opportunities and constraints, including a plan of action for regional and inter-regional cooperation. The Conference will consist of eight sessions, namely:

1. Overview of status and future trends in aquaculture development and management
2. Sustainable aquaculture technology
3. Food security and aquaculture
4. Information and monitoring
5. Quality, marketing and trade
6. Financing aquaculture development and management
7. Policies for sustainable aquaculture
8. Concluding session: policy, strategies and action plan

Agreement to cooperate in the Conference was reached through an exchange of letters between FAO's Assistant Director General for Fisheries, Mr. M. Hayashi, and NACA Coordinator and Conference Secretary General, Mr.Hassanai Kongkeo. FAO will participate in the Conference steering, programme and editorial committees, and assist NACA in organizing the sessions, identifying technical reviewers, developing review papers, including perspectives and future trends in aquaculture for regions other than Asia-Pacific, and in publishing the Conference report and proceedings. These details were discussed at the July 21-22 meeting of the Conference Steering Committee.

An aquaculture technology, trade and seafood show will be held in parallel with the Conference.





NEW FAO PUBLICATIONS

Ziad H. Shehadeh[1] and P. Choudhury[2]
[1]Fishery Resources Division,
[2]FAO Regional Office for Asia and the Pacific

Karim, M. 1997. A Review of Aquaculture Extension Services in Bangladesh. *RAP Publication* 1997/35. Bangkok, RAP, 1997. 54 p.

Bangladesh, a country of 143,999 sq km and with a population of about 130 million people, lies in the north-eastern part of South Asia. The flat delta is traversed by a network of 230 rivers; their tributaries flood most of the country during the monsoon season (June-September).

It is a country of fish-eating people with very diverse and rich fish faunas. It has vast water resources. The fisheries consist of inland capture, marine capture and inland aquaculture. Aquaculture production of 264,190 mt represents about 24 percent of the total fisheries production of over 1.0 million mt. During the last decade, aquaculture production has increased by over 100 percent. The fisheries sector is very important to the national economy as it generates over US$ 300 million in foreign exchange, mainly through export of cultured shrimp, in addition to its contribution to national food security. The aquaculture sub-sector has very good potential for further development.

Recognising the importance of aquaculture in the national economy, the government of Bangladesh has provided generous funding support for the development of aquaculture. Special emphasis has been given to the establishment of an effective and efficient aquaculture extension services for small fish farmers. The Trickle-Down Extension method introduced by FAO/UNDP projects has proven to be very successfully. Under this system, successful fish farmers act as Result Demonstration Farmers (RDF), serving as volunteer extension agents, and transfer culture technologies to the neighbouring Fellow Fish Farmers (FFF). The results of the pilot project have been so successful that the Government is now implementing a nation-wide project on aquaculture extension.

Edwards, P. and Demaine, H. 1997. Rural Aquaculture: Overview and Framework for Country Reviews. *RAP Publication* 1997/36. Bangkok, RAP, 1997. 61 p.

This introductory volume to a series of national reviews on the role of aquaculture in rural development comprises a global overview of rural aquaculture, and guidelines for individual country reviews. Rural aquaculture is defined as the farming of aquatic organisms by small-scale farming households using mainly extensive and semi-intensive husbandry for household consumption and/or income. Aquaculture originated over two millennia ago but it remains a relatively minor agricultural activity globally in comparison to agronomy and animal husbandry. Considerable promotion is required for aquaculture to fulfil its potential to provide significantly increased food, employment and income for the rapidly growing population of developing countries. Contrary to popular belief, this applies to most countries of Asia as well as to Africa and Latin America. A systems approach is required to effectively promote rural aquaculture. Conceptual frameworks are recommended to facilitate understanding of interrelated factors involved in socially and environmentally sustainable aquaculture production systems, outline the means to assess the potential of aquaculture to contribute to rural development, as well as the means to promote it where and when appropriate. The major constraints facing the promotion of aquaculture are often not technical. Rather they are the limited ability of developing countries to assimilate and adapt existing technology for rural aquaculture where it does occur, and limited local capacity in education, research and development.

Aguilar-Manjarrez, J. and Nath, S. S. 1998. A strategic reassessment of fish farming potential in Africa. *CIFA Technical Paper* No. 32. Rome, FAO. 170p.

This is an update of an earlier assessment of warm-water fish farming potential in Africa[1]. The objective was to assess locations and areal expanses that have potential for warm-water and temperate -water fish farming in continental Africa. A number of refinements have been have been on the earlier study, the most important of which was that new data allowed a sevenfold increase in resolution over that used in the previous Africa study, and a twofold increase on that of the Latin America study[2] (i.e. to 3 arc minutes, equivalent to 5 km x 5 km grids at the equator), making the present results more usable for assessing fish farming potential at the national level. A bio-energetics model was incorporated into the GIS to predict, for the first time, fish yields across Africa. A gridded water temperature data set was used as input to a bioenergetics model to predict number of crops per year for the following three species: Nile tilapia (*Oreochromis niloticus*) African catfish (*Clarias gariepinus*) and common carp (*Cyprinus carpio*). Analytical approaches similar to those used in the earlier study were used, but different specifications were employed for small-scale and commercial farming scenarios to reflect the types of culture practices found in Africa. Moreover, the fish growth simulation model used for the Latin America study[2] was refined to enable consideration of feed quality and high fish biomass in ponds.

The fish farming potential estimates for the three species together show that about 37% of the African surface contains areas with at least some potential for small-scale farming, and 43% for commercial farming. Moreover, 15% of the same areas have the highest suitability score, and suggest that for small-scale fish farming, from 1.3 to 1.7 crops/year of Nile tilapia, 1.9 to 24 crops/year of African catfish and 1.2 to 1.5 crops/ year for common carp can be achieved in these areas. Estimates for commercial farming range from 1.6 to 2.0 crops/year of Nile tilapia, 1.3 to 1.7 crops/year of African catfish and 1.2 to 1.5 crops/year of common carp.

From a country viewpoint, the results are generally positive. For small-scale farming of the three species, 11 countries are suitable in 15% or more of their national area. The corresponding results for commercial farming were that 16 countries scored very suitable in 50% or more of their national area.

Farm location data from Zimbabwe, Kenya, Uganda and Malawi were used to verify the GIS-based predictions of fish farming potential, from the standpoint of the farming system models combined with fish yields. This verification procedure indicated that the models used in the study are in general fairly accurate for strategic planning of aquaculture development.

[1] Kapetsky, J. M. 1994. A strategic assessment of warm water fish farming potential in Africa. *CIFA Technical Paper* No. 27. Rome, FAO. 67p.

[2] Kapetsky, J. M. And S. S. Nath. 1997. A strategic assessment of the potential for freshwater farming in Latin America. *FAO COPESCAL Technical Paper* No. 16. Rome, FAO. 124p.

Kapetsky, J. M. and Nath, S. S. 1997. Una evaluación estratégica de la potencialidad para la piscicultura dulceacuícola en America Latina. *COPESCAL Documento Técnico* No. 10. Rome, FAO. 125p.

This is the Spanish version of the document, originally published in English[2]. For a full review, the reader is referred to *FAN* No. 17, December 1997, p. 26.

[2] Kapetsky, J. M. And S. S. Nath. 1997. A strategic assessment of the potential for freshwater farming in Latin America. *FAO COPESCAL Technical Paper* No. 16. Rome, FAO. 124p.

FAO. 1998. Report of the Bangkok FAO Technical Consultation on Policies for Sustainable Shrimp Culture. Bangkok, Thailand, 8-11 December 1997. *FAO Fisheries Report* No. 572. Rome, FAO. 31p.

The Bangkok FAO Technical Consultation on Policies for Sustainable Shrimp Culture, Bangkok, Thailand, produced a consensus that sustainable shrimp culture is practised and is a desirable and achievable goal which should be pursued. There is ample reason for considering shrimp culture, when practised in a sustainable fashion, as an acceptable means of achieving such varied national goals as food production, employment and generation of foreign exchange. Achievement of sustainable shrimp culture is dependent on effective government policy and regulatory actions, as well as the co-operation of industry in utilizing sound technology in its planning, development and operations. Noting that appropriate government responsibilities regarding aquaculture are outlined in the Code of Conduct for Responsible Fisheries (CCRF), adopted by the FAO Council in 1995, the Consultation recommended a range of desirable principles to be followed in the establishment of legal, institutional and consultative frameworks and government policies for sustainable shrimp culture. Moreover, it noted that the CCRF provided an appropriate framework for the development of additional codes or guidelines applicable to shrimp culture.

The Consultation recommended a number of specific areas for future research including economic incentives and carrying capacity of coastal ecosystems for shrimp culture. Further, it recommended that FAO convene expert meetings to elaborate best practices for shrimp culture, desirable elements of the legal and regulatory frameworks for coastal aquaculture and the criteria and indicators for monitoring sustainability of shrimp culture. Regarding the latter, the Consultation recommended that FAO specifically request governments of FAO member countries engaged in shrimp culture to report on progress in implementing the CCRF in relation to shrimp culture activities of the FAO Committee on Fisheries at its next and subsequent sessions. *(See also related article in FAN No. 18, April 1998, p.12-15).*

FAO. 1998. Report of the Advisory Committee on Fisheries Research. Rome, Italy, 25-28 November 1997. *FAO Fisheries Report*. No. 571. Rome, FAO. 36p.

The First Session of the Advisory Committee on Fisheries Research (ACFR) was held in Rome from 25-28 November 1997. The ACFR agreed that, in order to promote international applied research in fisheries, FAO should maintain and enhance (a) infrastructure such as data collection, libraries and other information services, (b) a critical mass of expertise on the staff, (c) broad knowledge of fisheries and related disciplines, (d) knowledge of, and good relationships with, potential research partners, and (e) credibility through peer reviewed publications in mainstream scientific literature. The Committee stressed that its primary role would be to deal with general principles while its subsidiary bodies, such as working parties, may consider technical matters referred to them by ACFR. In this regard, the Committee would, in the course of its tenure, undertake a systematic appraisal of FAO's programmes and also promote a strategic planning exercise for research activities. Taking account of the current world fisheries situation, global programmes and issues that affect fisheries and the current FAO programme that relates to fishery research, the ACFR identified research topics that need to be emphasized in the future in order to fill critical gaps. The research topics do not constitute an exhaustive list as it was impractical for the Committee to conduct the systematic review and analysis required to prepare such a list. The Committee also recognized that some of the scientific gaps and changes in emphasis suggested by the Committee are already being addressed by FAO. The Committee's identification of scientific research topics highlighted the need for a shift in emphasis from a programme of research that, in the past, had been predominantly concerned with fishery resources to a future programme with substantial emphasis on the human dimension of fisheries. The ACFR proposed the establishment of three Working Parties to undertake in-depth studies on Implications of Globalization on Trade and Distribution of Benefits, Status Reporting Methodology and Data Needs, and New Research Methods: Traditional Knowledge and Approaches. Six other possible topics, to be addressed by Working Groups, were also identified. Finally, the ACFR noted that FAO's role as the honest broker, particularly on sensitive issues, and endorsed the Technical Consultations that were planned on sustainable shrimp aquaculture, sustainability indicators, the management of fishing capacity, shark conservation and management, incidental catch of seabirds and gear selectivity.

Petr, T. (Ed.). 1998. Inland fishery enhancements. Papers presented at the FAO/DFID Expert Consultation on Inland Fishery Enhancements. Dhaka, Bangladesh, 7-11 April 1997. *FAO Fisheries Technical Paper*. No. 374. Rome, FAO. 463p.

This document brings together the twenty-eight papers presented at the Expert Consultation on Inland Fishery Enhancements, Dhaka, Bangladesh, 7-11 April 1997. The Expert Consultation was jointly organized by FAO and the Department for International Development of the United Kingdom and hosted by the Government of Bangladesh (see FAN No. 16, p.9, for related article). Those interested in the complete overview of the Expert Consultation are invited to obtain the Report of the Expert Consultation on Inland Fishery Enhancements, *FAO Fisheries Report* No. 559, published in 1997. For orientation and for the convenience of readers, the Background and Conclusions Sections of the *Report* are set out in the Appendix of this document.

The major objective of the Expert Consultation was to promote better understanding of how the various factors involved in implementing inland fisheries enhancement programmes must fit together to achieve success. Accordingly, the papers span a broad range of topics including technical, socio-economic, cultural and administrative aspects. Enhancements are addressed globally in terms of techniques, geographic constraints, problems of information gathering and of monitoring, and genetics. Because of its relative importance as an enhancement technique, stocking received much attention, including strategies, modelling and prediction of results, health management and fitness of stocked fish as well as stocking experiences by types of water bodies. Cage culture was dealt with in terms of its importance, promotion through extension, and limitations. Other papers broadly covered social and economic benefits and their distribution, institutions, and self-and participatory management. Country reviews, dealing very broadly with enhancements, are also included.

This Technical Paper is a companion to the Report of the Expert Consultation on Inland Fishery Enhancements, *FAO Fisheries Report* No. 559, that deals with the administrative aspects of the meeting and sets out the conclusions and recommendations of the participants.