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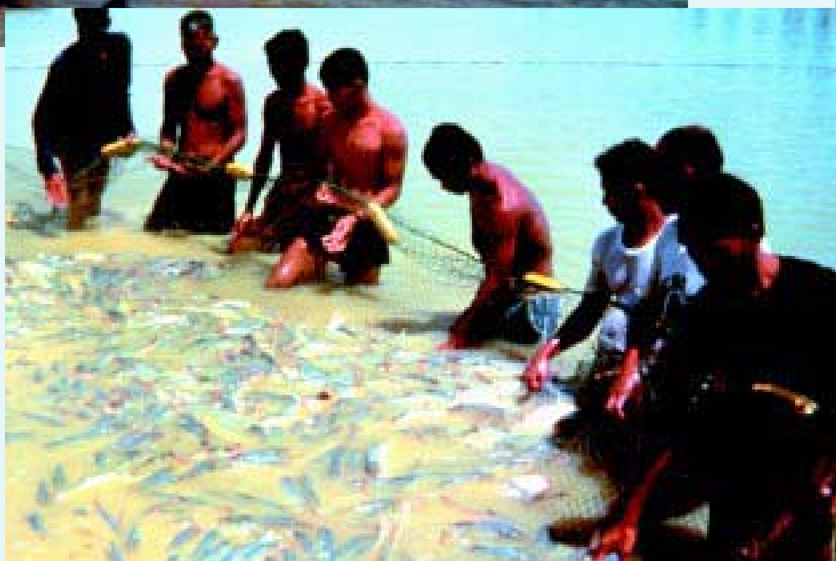

Harvest day: Village Pond Programme, Thailand, (Photos courtesy of Dr. C. Virapat).

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Aquaculture in Rural Livelihood Development:
From Development Principles to Practical Action

The eradication of food insecurity and rural poverty is a key objective of the FAO, and this theme features prominently as the first element of the organization's Corporate Strategy for the period 2000-2015. The new programme continues and adds to previous initiatives by the FAO, such as the Special Programme for Food Security (SPFS), the Telefood Programme and special assistance to countries in the context of the Technical Cooperation Programme. We hope it will also include start-up support for the proposed FAO-NACA regional programme on Aquaculture for Sustainable Rural Livelihood Development (SARLD), endorsed by the Ad Hoc Working Group of Experts on Rural Aquaculture of the Asia-Pacific Fisheries Commission (APFIC), as well as its equivalent, ALCOM, in southern Africa.

The World Food Summit Plan of Action (1996) elaborates the commitments, objectives and actions needed to eradicate poverty and food insecurity. In pursuit of Summit objectives, evolving rural development strategies are in very close agreement on key elements. They seek, among others, to: *strengthen the process of country strategy formulation, with broad-based national stakeholder involvement; renew emphasis on research and dissemination and on new approaches to both; insure strong community and local-level involvement in the design and implementation of projects, and in the management of common community resources; insure gender equality and empowerment of women; and promote a gradual development process, beginning with smaller projects and pilot activities designed to expand as experience and implementation capacity grow.*

With the specific focus on poverty alleviation broadly accepted and understood in public fora, the challenge is to convert these development principles into practical and reliable strategies for action. Here, we are at the beginning of a long process, which calls for national commitment and creative techniques and methods, as well as the willingness to try new, sometimes unconventional approaches. Changes at the policy and institutional level are needed in most cases; it is difficult to implement new strategies with dated institutional arrangements and cultures. Here, with the contraction of the government's role in development in many countries, we are faced with questions of who does what, who pays for what and how to proceed in the absence of appropriate institutional arrangements.

Aquaculture is an entry point for reducing poverty and improving rural livelihoods under appropriate circumstances. Recent fora and pilot projects have shown that the contribution of aquaculture, as a component of a complex rural livelihood system, should be assessed in the context of the farm-household, and the community – their aims, problems and potential; or what they have, what they have access to and what they need. Strategies for this purpose have emerged recently and continue to evolve. We need to increase the awareness of planners, managers and policy makers of the potential contributions of aquaculture, both direct and indirect; there has been little coordinated effort to this end. We must also document successful approaches and methodologies, and lessons learnt, to help guide future research and development planning. To facilitate this task, there is need for clarity and realism in project objectives, the means for their achievement and their measurement. Project analytic frameworks are increasingly important to all concerned.

Several agencies have focused on the improvement of project analysis and design and have developed methods that permit more thorough diagnostic work earlier in the project cycle and greater flexibility in project implementation. But, often, insufficient funds are allocated, especially in bankable projects, to put these priniciples into effective action. There are also major political challenges in setting relevant R&D agendas and policies, by balancing top-down and field-based inputs and providing mechanisms for full participation by all stakeholders. Project design and content has been altered, almost 15 years ago, by incorporation of some basic elements, such as the concept of systems; the household economy and survival strategies; household dynamics and gender relations; people's participation; etc. But, to put these into practice, we still need to move more effectively to get out of the compartmentalization that has been characteristic of technical assistance into a more holistic approach based on full participation of all stakeholders at every stage of the project cycle.

Incorporation of aquaculture into poverty alleviation programmes obviously still faces many challenges, but progress is being made on many fronts and there is no lack of R&D opportunities if the political will is there. The proposed SARLD programme aimes to provide a vehicle for Asian regional cooperation to promote and catalyze the further development of aquaculture for sustainable rural livelihoods through a voluntary network of national institutions and field projects. The programme is worthy of attention by assistance agencies.

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CONTENTS

This paper was presented as document COFI/99/2 to the 23rd Session of the FAO Committee on Fisheries, 15-19 February 1999. It was prepared by U. Barg, D. Bartley, J. Kapetsky, M. Pedini, B. Satia, U. Wijkstrom and R. Willmann of the FAO Fisheries Department.
(Illustrations have been added)

INTEGRATED RESOURCE MANAGEMENT

for sustainable inland fish production

INLAND FISH PRODUCTION: SITUATION AND CONTEXT

Overview of production

In 1996, the reported production from inland waters amounted to more than 23 million tonnes (t), with contributions of 7.5 and 15.5 million t from capture fisheries and aquaculture, respectively. Yields from fisheries, especially subsistence fisheries, being greatly under-reported, may be twice the indicated figures. Fisheries yields in terms of total volume are highest in Asia, but are also important in Africa. Recreational fisheries are economically important in Europe and North America, and the trend is for an increase in their importance elsewhere. Fishery enhancement techniques, especially stocking of natural and artificial water bodies, long the mainstay of recreational fisheries, are contributing to a major proportion of the catch for food, particularly in Asia. The bulk of aquaculture production comes from Asia, derived mainly from extensive and semi-intensive farming of lower-value herbivorous and omnivorous fish species.

Inland fish production and food security

Inland fish production provides significant contributions to animal protein supplies in many rural areas. In some regions freshwater fish represent an essential, often irreplaceable source of high quality and cheap animal protein crucial to the balance of diets in marginally food secure communities. Most inland fish produce is consumed locally, marketed domestically, and often contributes to the subsistence and livelihood of poor people. Increasingly, some inland fish products are also traded internationally generating additional wealth. The degree of participation, including a significant number of women and children, in fishing and fish farming can be high in some rural communities, and fish production often is undertaken in addition to agricultural or other activities.

Food production and resource degradation

All food producing sectors, including fisheries and aquaculture, are facing problems of environmental degradation and increasing land and water scarcity. The agricultural sector as a whole is facing increasing competition for water resources from industrialization and urbanization, and from growing requirements for safe drinking water supplies. These issues are particularly critical in many developing countries, given their high dependence on agriculture for food and income generation. Recent global assessments on freshwater resources and related international meetings including recent Sessions of the UN Commission on Sustainable Development, confirmed that some regions are or will be facing serious water shortages[1, 2]. One third of the world's population lives in countries experiencing moderate or high water stress. Demand by, and competition among various sectors for water - in terms of quantity and quality - will increase significantly, and politically difficult decisions on allocation and pricing of water uses, removal of subsidies, pollution control, and other measures have been suggested to avoid an imminent water crisis.

KEY CHALLENGES

In most countries the main challenges to maintaining and enhancing inland fish production and associated social and economic benefits, are:

- degradation of aquatic resources and environments,
- increasing competition for resources, and
- insufficient institutional and political recognition.

Degradation of aquatic resources and environment

Industrialization, urbanization, deforestation, mining, and agricultural land and water uses often cause degradation of aquatic environments, which is the greatest threat to inland fish production[3]. Fishery resources are being affected by destruction and fragmentation of aquatic habitats, aquatic pollution due to release of industrial and urban effluents and run-off of agro-chemicals, impoundment and channelization of water bodies, excessive water abstraction or diversion, soil erosion and manipulation of hydrological characteristics of rivers, lakes and flood plains [4, 5]. Recent reviews[6] indicate that land degradation, forest loss and degradation, biodiversity loss and habitat degradation, and scarcity and pollution of freshwater are all increasing in Africa, Asia-Pacific, Latin America and the Caribbean and West Asia. In other regions, especially in more developed areas, these stresses continue at high levels.

Environmental stresses are particularly severe in those watersheds which are already substantially modified or degraded[7]. Pressures on Asian watersheds are intensifying, which causes concern because they correspond to the most important areas of inland fish production globally. Global trends in freshwater fish faunas indicate that many faunas are in serious decline[8], with losses being highest in industrialized countries, followed by regions with arid or Mediterranean climates, tropical regions with large human populations and, big rivers[9]. There is increasing awareness about the urgent need to protect living aquatic resources in inland waters, and the focus of attention includes the requirement for conservation and sustainable use of aquatic genetic resources. In order to address threats to freshwater biodiversity, increasing international efforts are ongoing including those which are being promoted within the framework of the Convention on Biological Diversity.

Artisanal fishermen in the Mekong Delta

Increasing competition for resources

Inland fish producers will face increasing competition for resources from other sectors. In addition to competing demands for water and land, it is important to recognize the heavy reliance of aquaculture and culture-based fisheries on nutrient inputs required for feeding and fertilizing. Many aquafarmers utilize agricultural by-products and fertilizers for which competition will also increase with agriculturists producing more efficiently and with less waste. Overall, competition for resources will - in the long term - have beneficial effects on inland fish production, given the expectation that competition will result in increasing efficiency in resource use, production, and processing and marketing of inland fish.

However, there will be cases where resources until now available for inland fish production will be utilized by other resource users who prove to be more competitive. It can be expected that, in such cases, inland fish production will be affected first by reduced access to water which will no longer be available in appropriate quality and quantity. A major challenge will be to guarantee open and fair competition for resources so that aquaculture and inland fisheries can gain access to resources and maintain their production. This will require that the use of resources by other sectors is no longer subsidized. Nevertheless, social conditions can make subsidies valid management instruments even if they shift given resource use away from an economically preferable optimum. Likewise, environmental concerns may require policy interventions which, while economically sub-optimal, aim at conserving habitats and living aquatic resources.

Insufficient institutional and political recognition

One of the main impediments to increasing inland fish production is that fishery/aquaculture administrators worldwide find it difficult to defend the interests of their sector. Decisions over developments affecting fisheries, aquaculture and aquatic environments are often made with no consideration of these sectors, basically for lack of trustworthy economic assessments of present value in the case of inland fisheries and for lack of projections of potential value in the case of aquaculture and enhanced inland fisheries.

Most policy makers in other sectors are not aware of the importance of inland fish production for food supplies and income generation. This sector is often not properly represented or empowered within existing institutional frameworks. Most inland fish producers suffer from the absence or inadequacy of (i) defined rights of their specific practices, and (ii) institutional support, whether public or private. This results in difficulties in obtaining credits, accessing information and attracting efforts of capacity-building, including training and extension, in addition to low investments into the sector. Given the lack of political power, the interests and needs of fish producers are often neglected or ignored, particularly at local levels.

MEASURES TO MASTER THE CHALLENGES

The above challenges in most cases cannot be addressed by fishery stakeholders alone, particularly since many of the problems are generated outside the fisheries sector. Integration, especially better coordination of planning and management of resources shared by fisheries and other users, is required in order to facilitate sustainable inland fish production. Fishery administrators and stakeholders should seek opportunities to participate in the formulation and implementation of integration measures.

The table below provides an overview of basic management issues and of possible policies and instruments of integration which may be employed, preferably as a combination of selected interventions rather than as single measures, to address challenges to inland fish production.

Better integration of fish production into agricultural production

Integrated approaches to resource management are challenging, but provide significant avenues to enhancing fish production. In particular, there is a need for enhanced integration of inland fisheries and aquaculture into agricultural development planning, especially regarding practices and decisions of water and land management. Many opportunities exist for increasing efficiency in resource use and adding value to shared resources. There are various levels and areas where integration measures for enhanced fish production are possible or desirable, for example:

at the farm level:
increased nutrient recycling through utilization of by-products and wastes from different types of production of livestock or crops in integrated agriculture-aquaculture systems is possible, but is, even in Asia, not common. Significant scope exists for enhancing fish production by promoting these systems among small-scale farmers. Other options include utilization of wastewaters, fish production in small-scale irrigation schemes, rice-fish farming (also being promoted in integrated pest management), and improved utilization of available feed ingredients.

at the community level:
through intensified stocking of natural and man-made water bodies, especially reservoirs, most of which are not utilized for fish production. Additional measures may include fertilization, predator control, habitat improvements, and cage culture. Benefits from stocking herbivorous species may include maintenance of water quality and control of aquatic weeds in irrigation channels and reservoirs.

at state and national levels:

- through consultation of fishery experts in the construction and operation of reservoirs and irrigation schemes.
- through combined efforts by environmental and fishery agencies to prevent and reverse environmental degradation and to rehabilitate aquatic habitats and increase fish yields.

Possible policies and instruments of integration

Issues	Economic incentives	Legal and institutional framework	Regulatory instruments
⇨ Decrases in availabitity of lan, water and assimilative capacity of the environment . Open access characteristic of resources . Multi-disciplinary of management issues . Mis-match between administrative and management units . Multiple resources-dependency of communities	. Sound subsidies . Polluter pays principle . Tradable use or property rights . User fees	. Coherent legislation . Delegation of management authority . Mechanisms for consultation and participation . Codes of practice . Intersectoral coordination . Management of ecosystems and resource use of areas/ regions (eco-regional coordination) . Integrated extension and training services	. Land use planning and zoning . Water use planning and allocation . Licensing/auctions . Allocation on the basis of environmental and social impact assessment . Effluent and emmission standards

- through extensive organization of community-based management of common property resources, e.g. reservoir fisheries.
- through increased participation of fish producers and fisheries administrators in policy and decision making over allocation and use of water and land resources, at local and river basin levels. through awareness and capacity building for participatory planning and integrated management.

Possible measures by fishery administrations

Integration of fish production and increased participation of fishery stakeholders in resource management and planning will require major efforts by national fishery administrations, *inter alia*, to:

- increase awareness of the value of inland fishresources and benefits of inland fish production. Significantly more quantifiable information is needed on:
  - status, trends and biodiversity of inland fishery resources,
  - current production and potential increases from capture fisheries, enhancements and aquaculture,
  - socio-economic situation of fish producers,
  - resource utilization techniques, and
  - distribution/consumption of products;
- enhance human resource development and technical/financial assistance in support of inland fish producers, with a view to promoting more efficient use of limited resources available;
- strengthen role and capacities of fishery/aquaculture authorities for resource assessment, sectoral planning and participation in inter-sectoral cooperation and coordination;
- reallocate or adjust existing institutional resources in order to establish new partnerships between fishery/aquaculture stakeholders and agriculturists, water developers, and environmental agencies;
- provide consultative frameworks for local communities, private sector associations and social and environmental interest groups, with a view to enhancing devolution of resource management responsibilities
- enhance capacities for integrated management of land and water resources at watershed and local levels, and
- promote commitment by policy makers to sustaining inland fish production using as a basis the relevant sections of the Code of Conduct for Responsible Fisheries and their technical guidelines.

CONCLUSIONS

Basic features of good integrated resource management (IRM) include the formation of extensive partnerships and the close involvement of local interests. Fishery and aquaculture stakeholders, both public and private, may therefore pursue actions which aim to:

- empower local interests to plan and to implement conservation of the environment for fisheries;
- protect resources and environment for fisheries and aquaculture by actively seeking partnerships with relevant government and non-government organizations (including commercial entities) that also seek to manage resources and the environment; and
- promote capacity building on aspects of IRM.

IRM can begin with improved cross-sectoral cooperation among the agriculture, forestry and fisheries sub-sectors. However, there may be a need for additional technical assistance and policy guidance on IRM for sustainable production of fish and other food in watershed areas. Such IRM efforts are often also required at international, especially regional levels, and further assistance may be necessary in regional decision-making for the transboundary management of shared river and lake basins.

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2. United Nations (Economic and Social Council).1998. *Strategic Approaches to Freshwater Management.* Report of the Secretary General (E/CN.17/1998/2) to the Sixth Session of the Commission on Sustainable Development, New York, 20 April - 1 May 1998.

3. Coates, D. 1995. *Inland capture fisheries and enhancement: status, constraints and prospects for food security*. KC/FI/95/TECH/3. 82 p. Contribution to the International Conference on the Sustainable Contribution of Fisheries to Food Security, Kyoto, Japan, 4-9 December 1995, organized by the Government of Japan, in collaboration with the Food and Agriculture Organization of the United Nations (FAO).

4. Petr, T. & Morris, M. (eds.). 1995. Indo-Pacific Fishery Commission. Papers contributed to the Regional Symposium on Sustainable Development of Inland Fisheries under Environmental Constraints. Bangkok, Thailand, 19-21 October 1994, and Country Reports presented at the Sixth Session of the IPFC Working Party of Experts on Inland Fisheries. Bangkok, Thailand, 17-21 October 1994. *FAO Fish.Rep*., No.512 (Suppl.). 262 pp.

5 Barg, U., Dunn, I.G., Petr, T. & Welcomme, R.L. 1997. Inland fisheries. *In* A.K. Biswas (ed*.) Water Resources: Environmental Planning, Management and development*, p.439-476. New York, McGraw-Hill. 737 pp.

6. UNEP, Global State of the Environment Report 1997.

7. Ravenga, C. *et al*. 1998*. Watersheds of the world. Ecological value and vulnerability.* A joint publication of the World Resources Institute and the Worldwatch Institute, Washington, USA.

8. FAO. 1998. Report of the First Session of the Advisory Committee on Fisheries Research. Rome, Italy, 25-28 November 1997. *FAO Fish. Rep. (571)*. 36 pp.

9. Leidy, R.A. & Moyle, P.B. 1998*.* Conservation status of the world's fish fauna: an overview. *In* P.L. Fiedler, and P.M. Kareiva, eds. *Conservation biology*, Second Edition, p. 187-227. Chapman and Hall, New York.

Fertilizing paddy in integrated rice-fish farming; Green Northeast Programme, Thailand. (Photo courtesy of Dr. C. Virapat).

FAO FISHERIES RESEARCH ADVISORY COMMITTEE

MAIN OUTCOME OF THE SECOND SESSION

FAO, Rome,

6-9 December 1999

1. The Advisory Committee on Fisheries Research (ACFR) held its Second Session in Rome from 6-9 December 1999. The Committee examined its work since the First Session, undertook an appraisal of FAO's fisheries research-related programmes and elaborated the Committee's work for the inter-sessional period (1999-2000).

2. The Committee noted the successful inter-sessional period in particular, the results of the Meeting of FAO and non-FAO regional fishery bodies and arrangements and the conduct of and preparation of reports by the three Working Parties instructed at the First Session.

3. The Committee acknowledged that the development of and adoption of the three International Plans of Action (IPOA) on the Management of Fishing Capacity, the Conservation and Management of Sharks and the Reduction of Incidental Catch of Seabirds in Longline Fisheries at the Twenty-third Session of the Committee on Fisheries (COFI), was a significant way to promote collaborative action on important issues, and commended the positive role that international scientific consultation and collaboration had played in the development of these IPOAs.

4. The Committee reviewed its role within FAO's recently adopted Strategic Framework (2000-2015) and the Fisheries Department's Medium-Term Perspectives and underscored the need to extract and consider the research priorities that stem from these.

5. The Committee appreciated the efforts of the Fisheries Department to report on research-related activities and acknowledged the importance and quality of the work and the great extent of the product. It reiterated that the Fisheries Department must prioritize its work or the overall high standard for quality that it has received to date will be jeopardized.

6. The Committee emphasized the importance for FAO staff to continue to function as high-level professionals by participating in international meetings and to publish in peer-reviewed journals.

7. The Committee acknowledged the emphasis by staff to create tools to compile information time series in support of a very wide range of analyses, including the preparation of SOFIA, Resource Reviews and to provide the public with access to the global fisheries database. It recommended that priority should be given to including socio-economic data, including information on aquaculture and marine and freshwater small-scale fisheries. The Committee encouraged the Fisheries Department to continue to develop and widely disseminate tools to assist less-developed countries in participating in statistical programmes.

8. The Committee recognized that the major advances in the technology for managing and delivering information embraced by the Fisheries Department has been a very positive step. However, it also noted that particular consideration should be given to making sure the information is well suited to the needs of people in less-developed countries concerned with small-scale fisheries and aquaculture.

9. The Committee suggested that the future role of ACFR should include the identification of periodic specialized and technically oriented reviews and to offer recommendations on ways that these should be concluded, including their objectives, terms of reference and participants.

10. The Committee identified a number of key research areas, which merited emphasis. These include the methodological, analytical and descriptive research into the nature and applicability of fishing rights and the benefits that can be gained from their application in fisheries management, the development of a framework for setting of medium-term research priorities, in particular for small scale marine and freshwater capture fisheries and small scale aquaculture in developing countries, as well as the extension of studies on fleet trends including methodological studies to smaller vessels focusing on a limited sample of countries where better data is available.

11. The Committee agreed to recommend to the Director-General continuation of the activities of the three Working Parties, including the revised and enhanced directions for the Working Party on Implications of Globalization on Trade and Distribution of Benefits. In particular, the Committee emphasized the importance of establishing an International Plan of Action for Status and Trends Reporting in Fisheries as a means to enhancing advice to the Director-General and COFI of the most up-to-date and accurate view of the prospects for maintaining or enhancing fish production.

12. Finally, the Committee noted that the emphasis for the next session would be on a review of its intersessional activities, a review of small-scale fisheries including inland fisheries and aquaculture, review and finalization of the draft International Plan of Action for Status and Trends Reporting for Fisheries and contribution to Fisheries Department Research Programme and Project priority setting.

INTERNATIONAL INSTRUMENTS FOR THE RESPONSIBLE USE OF GENETICALLY MODIFIED AQUATIC ORGANISMS

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"Doubtless God could have made a better berry, but doubtless God never did."

Now humans can make a better berry !

Mr. Isaak Walton in his classic book on fishing (The Compleat Angler, 1593 – 1683) attributes the above quote to a Dr. Boteler who was very fond of strawberries. We now have the technology to make a better berry - the anti-freeze protein gene from the winter flounder has been inserted into strawberries and other crops to help them tolerate cold temperatures. Is this a "better" berry? What are the benefits and risks? Will genetic modification be useful and accepted in aquaculture? When and for whom? International organizations must address a variety of questions in this area. The following article is based on a presentation the author made at WAS 1999.

Introduction

Genetic modification of aquatic species has the potential to increase greatly both the quantity and quality of products from aquaculture. Traditional animal breeding, chromosome-set manipulation, and hybridization have already made significant contributions to aquaculture production, and their contribution is expected to increase as aquatic species become more domesticated and as breeding and genetic technology continue to improve. Experimental and pilot projects on transgenic organisms have demonstrated that growth rate can be improved dramatically (Figure 1); other commercially important traits can be improved as well. Although no transgenic aquatic species are available to the consumer at present, some feel that transgenic fish will be on the market within the next few years.

However, there is a concern in aquaculture, as in other food producing sectors, that transgenic technology poses risks and therefore must be carefully monitored and regulated to ensure that environmental and human health are not endangered. Consequently, international legislation, guidelines, and codes of conduct have been, or are being, established to address these issues.

Exactly what a genetically modified organism(GMO) is, appears difficult to define (see Box 1).

International instruments, some legally binding and others voluntary, cover a broad range of issues associated with GMOs in aquaculture: →the introduction (transboundary movements) and release into the environment, →international trade, →human health, →labelling, →intellectual property rights, →and ethics.

Box 1. NOMENCLATURE

Q: When is an organism whose genetic structure has been modified, not a genetically modified organism?

A: When people may eat them.

A common nomenclature will be crucial in establishing legislation and policy for the responsible use of genetically modified organisms. However, this is proving to be a formidable task. The Fourth meeting of the International Association of Geneticists in Aquaculture refused to draft a technical definition (pers. ob.); the CBD is still trying to develop a definition of LMO. The tendency in international legal bodies and industry is to restrict GMOs to transgenics, whereas some voluntary instruments adopt a wider definition that includes other genetic modifications such as hybridization, chromosome manipulations, sex reversal, and selective breeding. Some definitions of GMOs follow:

ICES - "An organism in which the genetic material has been altered anthropogenically by means of gene or cell technologies. Such technologies include isolation, characterization , and modification of genes and their introduction into living cells or viruses of DNA as well as techniques for the production involving cells with new combinations of genetic material by the fusion of two or more cells" (ICES 1995).

USDA states that their Performance Standards on conducting research on GMOs apply to the following organisms:
1. "Deliberate Gene Changes – including changes in genes, transposable elements, non-coding DNA (including regulatory sequences), synthetic DNA sequences, and mitochondrial DNA;
2. Deliberate Chromosome Manipulations – including manipulation of chromosome numbers and chromosome fragments; and
3. Deliberate Interspecific Hybidization (except for non-applicable species discussed below) –referring to human induced hybridization between taxonomically distinct species". To clarify further, the USDA states that *non-applicable organisms* are intraspecific selectively bred species, and widespread and well known interspecific hybrids that don't cause adverse ecological effects.

CBD (GMOs have become LMOs in the language of the CBD) - "Living modified organism" means any living organism that possesses a novel combination of genetic material obtained through the use of modern biotechnology. "Living organism" means any biological entity capable of transferring or replicating genetic material, including sterile organisms, viruses and viroids. "Modern bio-technology" means the application of: (i) In vitro nucleic acid techniques, including recombinant DNA and direct injection of nucleic acid into cells or organelles, (ii) fusion of cells beyond the taxonomic family, that overcome natural physiological reproductive or recombination barriers and that are not techniques used in traditional breeding and selection.

EU "An organism in which the genetic material has been altered in a way that does not occur naturally by mating and/or natural recombination" (EEC 1990). "Genetically modified micro-organisms are organisms in which genetic material has been purposely altered through genetic engineering in a way that does not occur naturally."

The purpose of this note is to describe briefly the main instruments that deal with the use of GMOs and their implications for aquaculture development. Much of what is presented below comes from the plant sector, but aquaculture may expect similar processes, opportunities and problems in the further development of aquatic GMOs. It will be prudent to follow what is going on in the crop and livestock sectors.

Figure 1. *Transgenic chinook salmon from New Zealand King Salmon Company's land-based research facility. The top 3 fish are transgenics, 11 months old with an average weight of 850g, whereas the bottom fish is their non-transgenic sibling of the same age, weight 280g. Photo by Seumas Walker.*

Import and release into the environment

The import of a GMO and its release into the environment is covered by sections of the European Community Directives, UN Recommendations on the Transport of Dangerous Goods (1995), the Convention on Biological Diversity (CBD), the FAO Code of Conduct for Responsible Fisheries (CCRF), and the International Council for the Exploration of the Sea (ICES). The risks discussed in this section pertain mainly to those to the environment (human health issues are discussed below).

Common elements of the legislation or guidelines include; licensing for field trials on and release of GMOs, notification that a GMO is being exported/imported and released (also known as "advanced informed agreement") and an environmental impact assessment. Members of the EU were supposed to incorporate uniform licensing procedures for testing and sale of GMOs in national legislation; if a GMO was licensed in one country, field testing, release and sale should be allowed in the other countries as well. However, genetically modified (gm) maize which was approved in France, was not adopted in Austria and Luxembourg and when the government changed in France, so did the approval for commercial releases of gm maize.

EC Directive 94/15/EC/ of 15 April, 1994, adapting to technical progress for the first time Council Directive 90/220/EEC/ on the deliberate release in the environment of genetically modified organisms, requires notification that a GMO is to be released. The directive also lists requirements for impact assessment, control and risk assessment. It is interesting to note that notification requirements are different for higher plants and other organisms and that release includes placement on the market.

The CBD, which has the largest number of Parties of any international instrument at 175, calls for the establishment of "means to regulate, manage or control the risks associated with the use and release of LMOs ... which are likely to have adverse environmental impacts ..." (Article 8g). In addition, it calls for legislative, policy or administrative measures to support bio-technological research, especially in those countries that provide genetic resources (Article 19). Furthermore, Article 19 (3) directs Parties to consider the need and modalities for internationally binding protocols on the safe transfer, handling and use of LMOs that may have adverse effect on the conservation and sustainable use of biological diversity. The negotiation of these protocols is currently underway (http://www.biodiv.org/biosafe/).*

Article 9.3 of the CCRF addresses the "Use of aquatic genetic resources for the purposes of aquaculture including culture-based fisheries". This article calls for:

- conservation of genetic diversity and ecosystem integrity;
- minimization of the risks from non-native species and genetically altered stocks;
- creation and implementation of relevant codes of practice and procedures, and
- adoption of "appropriate" practices in the genetic improvement and selection of broodstock and their progeny.

Article 9.2.3 advises, " States should consult with their neighbouring States, as appropriate, before introducing non-indigenous species into transboundary aquatic eco-systems", and the FAO Technical Guidelines on Aquaculture Development states, "Consultation on the introduction of genetically modified organisms should also be pursued. The definition of 'non-indigenous', in broadest sense of the term, should include organisms that are the product of domestication, selective breeding, chromosome manipulation, hybridization, sex-reversal, and gene transfer".

ICES[1] has added a section on GMOs to its guidelines for species introductions. Thus, GMOs are acknowledged to be a form of non-native species; in many international fora, alien species and alien genotypes are terms used to signify organisms that do not naturally occur in a given area. Like the CCRF, the ICES protocols are voluntary, but they have been adopted in principle by numerous regional fishery bodies, by the International Network for Genetics in Aquaculture (ICLARM secretariat), and by national governments such as the Philippines.

Aquaculturists contemplating the use of GMOs should be aware of and follow notification and assessment requirements. Even when not required by law, such practices are prudent and will help promote an image of responsibility.

Trade

Trade issues are extremely complex, politically charged, and cover a variety of components, such as patenting and labelling requirements. The main instrument governing international trade is the World Trade Organization, created in 1995 following the Uraguay Round of trade negotiations. With 134 Member Countries, it is the body responsible for administering international trade and resolving disputes for most of the world's trading nations. The Center for International Environmental Law (CIEL) noted that due to the "interlocking relationships between trade and other issues, including environmental protection, WTO activities now have more extensive ramifications." (CIEL 1999 - http://www.igc.apc.org/ciel/shmptur.html). The purpose of the WTO is to promote trade liberalization that includes non-discrimination, and ensuring that the conditions for trade are stable, predictable and transparent. Components of the WTO in relation to GMOs are the removal of trade barriers, the requirements for intellectual property protection, e.g. patenting, and labelling requirements.

Intellectual property rights

WTO set up the first global system for intellectual property rights (IPR) on biological diversity, with specific reference to plants, to protect the inventors and developers of a product and to foster innovation. The relevant section of WTO is the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) that requires Members to form intellectual property rights on, inter alia, certain food and living organisms. TRIPS Article 27(3)(b) allows for the patenting of life forms, and requires that systems for IPR be developed by 2000 in developing countries and by 2005 in least-developed countries. Article 27 of TRIPS says the inventions it recognizes must meet the criteria of novelty, inventiveness (non-obvious) and industrial applicability (use-fulness). TRIPS countries have *discretion* on whether to protect plants or animals with patents or *sui generis* system and whether to recognize such patents.

DG XII of the European Commission has *nearly* similar requirements for IPR, except that the EC states that "plant and animal varieties and essentially biological processes for the production of plants or animals, including crossing or selection, are not patentable". Biotechnological inventions now are better protected in the EU due to common rules for patent law as set out in the new Directive 98/44/EC (http://europa.eu.int/). But neither plant and animal species nor biological processes for their production are covered by the legislation as they are essentially biological and not

Box 2. Different perspectives on patenting in fish vs plants

The patenting process is supposed, *inter alia,* to promote innovation. Monsanto has recently sought patents on a genetic modification that renders seeds nonviable when a specific chemical that activates a series of genes is sprayed on them. The general name for this process is Genetic Use Restriction Technologies and it helps companies like Monsanto protect their product (genetically improved seeds) from being used without permission on compensation to Monsanto. Because many farmers in developing areas need to save seeds for the next season, this particular technology was embroiled in controversy and seen by many to be a threat to world food security. The technology was given the emotive name of Terminator Technology and the outcry against such a practice was so strong that Monsanto has said it will not commercialize the technology.

However, such a genetic modification might be extremely advantageous for farmed fish. Through the patenting process and the disclosure of the genetic manipulations involved, we now have a model for gene activation and deactivation that may be used in other sectors, such as aquaculture. Modifying an exotic farmed fish or shellfish so that it could not reproduce in the wild would help reduce many of the environmental concerns facing aquaculture today. This is not to be seen as an endorsement for GMOs, but rather another perspective on the patenting issue.

biotechnological processes. For ethical reasons, the directive bans patenting of human cloning, the use of human embryos for industrial or commercial purposes, the manipulation of human genetic identity as well as the discovery of natural substances.

Patenting and intellectual property protection are so complicated that international instruments dealing with the issue are in conflict. The WTO and the USA allow patenting of living organisms whereas the EC does not (http://www.uspto.gov/web/offices/pac/doc/general/what.htm). Aquaculturists should be aware of the potential controversies associated with patenting GMOs and how this may affect marketing, property rights, and trade in certain areas.

Human health and food quality

For the consumer of gm products, human health is probably the most important issue. Here there is a tremendous lack of knowledge and understanding. People who regularly consume the enzyme chymosin from gm bacteria in their parmesan cheese (the natural source is from calf stomach), or probably have no objection to genetically engineered insulin for diabetes, state they would never eat a gm fish nor let their children eat one. There are health concerns and these must be addressed in a reasonable manner (see also section on ethics below). Internationally, it is the EU and the Codex Alimentarius Commission (CAC) that take the lead roles.

CAC was formed as an inter-governmental body by FAO and the World Health Organisation; its current membership is 163 countries. The scope of Codex Standards includes all food safety considerations, description of essential food hygiene and quality characteristics, labelling, methods of analysis and sampling, and systems for inspection and certification. Codex standards, guidelines and other recom-mendations are not binding on Member States, but are a point of reference in international law (General Assembly Resolution 39/248; Agreement on the Application of Sanitary and Phytosanitary Measures; Agreement on Technical Barriers to Trade). At present, risk analysis is considered to be an integral part of the decision-making process of Codex.

At its most recent 23rd Session (July 1999), the CAC established an Ad Hoc Intergovernmental Task Force on Foods Derived from Biotechnology with the objective of developing standards, guidelines or recommendations for foods derived from biotechnology or traits introduced into food by biotechnology, on the basis of scientific evidence, risk analysis and having regard to other legitimate factors relevant to the health of consumers and the promotion of fair trade practices.

The Commission also preliminarily adopted an amendment to the General Standard for the Labelling of Prepackaged Foods as related to the labelling of foods obtained through biotechnology dealing with foods substantially different from usual foods. The general issue of the labelling of other foods is still under discussion (see below).

The 1997 EU Novel Foods and Novel Food Ingredients Regulation 258/97 forces mandatory pre-market approval for all foods without a history of consumption in the EU. For "substantial equivalent" foods simple notification is all that is required (fast track procedure).

Labelling

Labelling of GMOs or products from GMOs is also an extremely contentious issue as exemplified by the current trade conflicts between Europe and the US over labelling of genetically modified crops such as corn and soybeans. Some think that thinks labelling is impractical and would be ambiguous in any case (Williams 1998[2]), whereas Europe believes that it is necessary for informed consumer choice and to prevent a public relations disaster.

A major concept in labelling is that of "substantially equivalent" which means that if the GMO or product is equivalent to the non-GMO counterpart then no extra legislation or oversight is needed. In 1997 the EU Novel Foods Regulation made labelling of gm food, or food obtained from GMOs mandatory if they were not substantially equivalent to existing products. Further, recognition must be given to mixtures of gm and non-gm crops (e.g. US soybeans).

The CAC document, Proposed Draft Recommendations For The Labelling Of Foods Obtained Through Biotechnology states, "When a food produced by biotechnology is not substantially equivalent to any existing food in the food supply and no conventional comparator exists, the labelling shall indicate clearly the nature of the product, its nutritional composition, its intended use and any other essential characteristic necessary to provide a clear description of the product". However, there was no justification in terms of food safety for specific labelling of foods that were substantially equivalent to conventional foods, as there was no evidence of any specific health hazards. The labelling of GMOs in food is still a controversial subject with which the Codex Commission is currently dealing.

Labels can be an effective market force as in the example of "dolphin friendly tuna" and "organic something". However, how much information should go onto a label and the authenticity of labels will be difficult matters to resolve.

In many developed countries, products with "organic farming" labels or certifications are becoming popular and fill a specific market niche where consumers will pay a premium price for such products. The International Federation of Organic Agriculture Movements (IFOAM) has produced standards required for their certification[3]. For organic certification, vaccines are allowed, but genetically engineered vaccines are not; feeds may not contain GMOs nor their products; triploids and genetically engineered species or breeds are also not allowed.

Although no gm fish or shellfish are now on the market, fish meal may contain genetically modified soy beans; the EU and Japan are requiring labelling on this feed. According to reports on an internet discussion group on shrimp (shrimp-owner@onelist.com or http://www.onelist.com), the feed industry is looking carefully at reactions around the world to this requirement and even looking for replacements to soya in feeds.

Ethics

FAO has recently created a Committee on Ethics in Food and Agriculture, whereas UNESCO established an International Bioethics Committee (IBC) and an intergovernmental committee to examine its advice and recommendations. According to the IBC "Bioethics, as an awareness of the implications of the advances made in the life and health sciences, in particular genetics and molecular biology, is the basis of an ever-growing debate which transcends borders, since the concerns it expresses inevitably take on an international dimension."

DG XII of the EU has a common research sub-area ELSA (Ethical, Legal and Social Aspects of the Life Sciences and Technologies) where "transdisciplinary approaches to selected topics for the current programmes are promoting research on : legal protection of biotechnology inventions, biodiversity and regulatory framework for biological research; fundamental and applied values in biomedicine, embryo and fetus protection, personal data protection, resource allocation in health care, data bases and ethics committees; animal welfare, food safety, pesticides and crop protection, consumer attitudes and sustainable agriculture and fisheries."

The field of ethics is extremely broad and many international organizations are working on aspects of the subject, but under different terminology. For example the CCRF, the CBD, CAC *et al*. address many of these ethical issues. Concerning GMOs, in addition to the above, ethical questions arise as to whether humans have the right to modify natural creations. Ethics enters the patenting arena where inventions that are contrary to public morality are disallowed. However what is moral to one society may be viewed differently in others. The Prince of Wales believes that, "(genetic modification) takes mankind into realms that belong to God, and to God alone"[4]. However, I expect many vegetarians eat Parmesan cheese without knowing that it is made with calf intestine. Would genetic modification make cheese "more ethical" to this group? The process of raising animals to eat them is unethical to many societies, and in vitro fertilization was controversial when the first test-tube baby was born in 1978.

Concluding remarks

Aquatic GMOs will eventually also come under the mandate of the FAO Commission on Genetic Resources for Food and Agriculture (CGRFA), the only permanent United Nations inter-governmental forum dealing specifically with matters related to the conservation and utilization of genetic resources for food and agriculture, and related technologies. In 1997, the Commission established working groups on plant genetic resources and on farm animal genetic resources. However, fishery genetic resources, *per se*, have not yet been incorporated into the Commission's work. The CGRFA is also preparing for negotiations on a Code of Conduct on Biotechnology, including a component on IPR.

Gene technology applied to food production is poorly understood by the public. With the confusing array of claims, counter claims, and scientific disagreement that is present in the media, the public has lost some faith in scientists and the government as honest brokers. A recent article in Science (Nov 5, 1999) also attributes this loss of faith to the "commercialization" of science, where industry supports academics and sits on government advisory boards. In Canada there is legislation to transfer responsibility for food safety from the Health Department to the Agriculture Department which is seen by some as being a direct conflict of interest.

In light of the above, the public is more susceptible to emotive appeals and will follow information they think is more reliable. International conventions and organizations must recognize this, provide fora for informed discussions and strive to raise awareness and knowledge of genetic modifications, their opportunities, limitations and risks.

Acknowledgements

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[1] *ICES. 1995. ICES Code of practice on the introductions and transfers of marine organisms. International Council for the exploration of the Sea- Copenhagen, Denmark. 5p.*

[2] *Williams, N. 1998. Agricultural biotech faces backlash in Europe. Science 281: 768 – 771.*

[3] *IFOAM. 1998. Basic Standards for Organic Production and Processing. IFOAM Okozentrum Imsbach, D-66636 Tholey-Theley, Germany.*

[4] *See note 2.*

* *Author's note: As Fan 23 went to press an Extraordinary Meeting of the Conference of the CBD January 2000, had just adopted the biosafety protocols known as the "Cartagena Protocol". Implications of this protocal will be addressed in the future issues of FAN.*

Farmers spawning common carp in rice paddies (Xieng Khouang province)

Small-scale Rural Aquaculture in LAO PDR

(Part II) [1]

Provincial Aquaculture Development Project (LAO/97/007)

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[1] See Part I in *FAN* No. 22, August 1999

AQUACULTURE AND FISHERIES (Cont'd)

Disease

One of the attractions of fish culture, that has been expressed on several occasions, is that fish are not susceptible to the epizootics that occasionally strike livestock in villages. Haemorrhagic septicaemia, swine fever, Newcastle disease and fowl cholera occur frequently in Lao PDR and vaccination is still relatively uncommon due to cost and accessibility to quality vaccines.

During interviews with farmers regarding fish mortality, ulceration and mortality of wild fish (particularly snakeheads and catfish) is commonly mentioned. This is consistent with EUS symptoms. This appears to occur annually during changes between the cool and hot seasons. The responses from farmers surveyed regarding fish mortalities shows approximately 28 percent had directly observed fish mortalities in their ponds (Table 7).

During 1998, mortalities of cultured Indian carps and silver barb in farmers ponds have been reported from Sayaboury and Oudomxay provinces by project staff. The impact of fish disease on aquaculture and fisheries on rural populations is presently unquantified. However, the importance of fish and aquatic products in rural Lao subsistence livelihoods warrants further investigation.

Table 7. Reported fish mortality from survey of LAO/97/007 target provinces	
Cause of fish mortality	**Number of respondents**
Unspecified mortality	40
Unspecified disease	29
Ulcerated bodies	14
Red spots	5
Spots	4
Red scales	1
Predation	2
Mortality at stocking	2
Water too hot	2
Low oxygen	3
Insufficient water	2
No disease returned	269
Total	**373**

Source: LAO/97/007 survey data

Rice-fish culture

Rice cultivation is widespread in the form of rainfed, irrigated (wet rice) and hill rice (dry rice). In many parts of the country the terrain is mountainous requiring terracing of rice fields. Rice is mostly cultivated on a one-crop per year basis, but in areas where irrigation has been developed two crops per year are possible. Rice paddy fisheries and the collection of aquatic animals during the rainy season are important activities in the country and form an important part of the national diet. Rice-fish culture is practised in several provinces and a variety of systems are used, according to the agro-climatic characteristics of the area.

Upland rice-fish

Upland rainfed and irrigated rice fields require terracing which limit the size of individual paddy fields. Farmers are reluctant to cut channels or construct refuges in these fields due to the subsequent loss of production area. In some areas, water is supplied to the paddies from small diversion irrigation systems. Where this is present the requirement for deep water and refuges is reduced d ue to the continual replacement of water in the paddy. The upland areas are also cooler than lowlands and so high temperatures in the paddy water are less of a problem.

Where irrigation is present (usually from stream diversion), rice fish culture is more successful, principally due to the increased availability of fish fry. Typically, *Cyprinus carpio* and *Carassius auratus* are produced and these spawn naturally in the rice fields and adjoining ponds. Since the farmers can produce their own fish seed, this activity is popular since cash is not required. Few modifications are performed on the ponds other than the raising of walls.

Fish produced in this system can be harvested and transferred to adjoining ponds for on growing. This increases the marketability of the fish and income can be generated from the activity provided the farm is close to the provincial or district market.

Where rice fish culture is practised in rainfed fields, the only modification made is the raising of the walls to increase water depth. In some cases, a small channel will be constructed to facilitate fish capture. Typical growing periods are 90-100 days. Since the size of the fish harvested increases with the size stocked, farmers prefer to stock larger (5 - 10g) fish. Smaller fish are stocked in some cases due to the cheaper price. Stocking densities (*Cyprinus carpio, Carassius auratus* and *Tilapia sp.*) are typically low, reflecting the high price of fish fingerlings and the limited amount of money available to the farmers. Since most farmers do not generate cash, the purchase of fish fingerlings is frequently not possible. The fish produced from this system is mostly consumed in the home; this is another limitation to the system since no income is generated. Farmers that are able to sell their produce are more able to reinvest in subsequent crops.

There is little reliable data available concerning production levels from rice-fish culture in Lao PDR, but productions of 31 - 640 $kg.ha^{-1}.crop^{-1}$ have been reported for upland rice-fish production systems. Median production is estimated at 153 $kg.ha^{-1}.crop^{-1}$ with average individual farmer production of 43 $kg.crop^{-1}$.

Information collected from 84 farmer trials in Xieng Khouang (Table 8) during 1991 – 1994 (data recalculated from LAO/89/003) returned overall average yields of 199 $kg.ha^{-1}.crop^{-1}$ (s.d. = 129 $kg.ha^{-1}.crop^{-1}$). The variation appears to be due largely to the size of fingerling stocked at the beginning of production and not on stocking density. Low yield paddies were stocked with fish of 2 - 5 cm fingerlings, while the highest producing paddies were stocked with 5 - 10 cm fish. The median area cultivated per farmer was 0.15 ha. This gave an average yield of 43 kg per family (s.d.= 49 kg). Median stocking densities were 0.42 $fish.m^{-2}$ and median survival overall was 71 percent.

Recent survey data from Xieng Khouang have verified these production figures with an average productivity of 148 $\pm$ 173 $kg.ha^{-1}.crop^{-1}$ at average stocking density of 0.5 $fingerlings.m^2$ (LAO/97/007 survey data). Fingerling stocking size was not recorded but lack of availability of large fingerlings suggests that fish of approximately 3 cm were stocked.

Initial farmer trials (4 farmers), as part of LAO/97/007 activities in Oudomxay (1998), returned yields of 100-429 $kg.ha^{-1}$ with a growing period of 60 – 160 days.

Lowland rice-fish

Lowland areas of Lao PDR are mostly confined to the Mekong River plain. Rice fields are larger here but there are constraints with availability of water for rice-fish culture. Where soils are relatively impermeable, rice-fish culture can be practised in rainfed rice fields.

Table 8. Rice-fish production in Xieng Khouang Province (1991-1994)

	Median	Average ± s.d.
Paddy area (ha)	0.15	0.23 ± 0.22
Individual Production (kg/farmer)	21	43 ± 49
Productivity (kg/ha)	153	199 ± 129
Stocking density	0.42	0.47 ± 0.27
Days of culture	90	98 ± 28
Size of harvest (g)	59	75 ± 54
Estimated survival (%)	71	77 ± 54

Source: Data recalculated from LAO/89/003

There is a limited amount of irrigated rice production in Lao PDR and these areas are ideal for the development of rice-fish systems provided there is no excessive use of chemicals.

The production system does not involve on growing in ponds, due to the lack of water following the rice production season. Since there is little water available during the dry season, the maintenance of broodstock fish is difficult during the dry season, this prevents farmers from producing their own fingerlings. The lowland areas are warmer and growth rates are higher than in the cooler uplands.

Constraints

Rice fish culture is popular with farmers due to the integrated nature of the system, however there are some constraints. Theft of fish from fields is common since the fields are not close to the house; this is less of a problem in the case of household ponds. Theft has reportedly decreased with the large-scale take-up of rice-fish culture in some villages.

Flooding is a serious problem in some areas. Due to the mountainous nature of Laos, the runoff following rainfall is high and can cause problems in some areas. Fish loss following flooding has deterred some farmers from pursuing rice-fish culture. In other cases, fish are washed out of upper paddies into lower areas resulting in bonus crops for farmers at the lower part of a terraced rice system.

Due to the lack of large livestock culture and limited amounts of feed for livestock, the production of manure is limited. This has limited pond production of fish but may not constrain rice fish culture. Cattle and buffalo in the fields consume rice straw and natural manuring ensues. This removes the labour aspect of manure collection and transport that is required by pond culture.

Pesticides are not widely employed in upland areas and rainfed rice cultivation due to their high cost. However, they are increasingly being used in the lowland irrigated areas and this is a potential risk in the future.

The lack of cash economy and the high cost and limited availability of fish fingerlings (20 - 100 Kip each) during the stocking season currently limits the number of farmers able to perform rice-fish culture. LAO/97/007 is promoting fingerling production by farmers for stocking into rice-fish systems in upland areas.

GENDER AND SOCIO-ECONOMIC ISSUES IN AQUACULTURE IN LAO PDR

A two-month gender and socio-economic study in Lao PDR was performed during 1998 as part of LAO/97/007 activities. During the course of the study, both upland and lowland project areas were visited. Groups interviewed as part of the study included: fish farmers groups, women's groups, extension staff and Agriculture Promotion Bank staff. Ethnicity of rural Lao farmers is an additional issue since the ethnic diversity of the country is so broad.

Socio-economics

General awareness of aquaculture is raised by the presence of extension activities within a village; however, farmers often adopt a precautionary approach to starting activities on their own. Many expressed the need to observe successful, reliable aquaculture in their village before risking investment of labour or money.

The majority of men and women fish farmers interviewed conducted aquaculture primarily for household food security, with income generation as an added bonus only where surplus fish were produced. Fish production for food security is considered to require low labour intensity once established.

Income generation from fish production may also incur higher labour demand and appears to be possible only in families with a high degree of food security. Since LAO/97/007 requires farmers to have a fishpond or suitable paddy land to take part in project activities, there is a tendency to select farmers with adequate land. Marginalized groups, such as the landless or those without land suitable for pond construction, are unable, or unlikely, to be included in project activities. It should be noted, however, that landless rural poor in Lao PDR are not as common as in other countries.

Market demand for fish is high throughout Lao PDR, with the highest prices obtained in provincial markets. Where fish are sold, women control the cash income from the selling of fish at the pond site and in the market, although consultation with their husbands on household expenditure is common. Income distribution within the household is relatively equitable, so income generated from aquaculture is likely to benefit entire households. There are some differences between ethnic groups regarding management of household incomes.

The Agriculture Promotion Bank (APB) is the only source of formal credit for rural farmers, and overall, the group-lending scheme of the APB offers an opportunity for women as collateral requirements have been removed. The APB itself does not yet accept that aquaculture is a sufficiently low risk activity to allow extension of credit to farmers groups. This is partly due to the tendency for farmers to consume their production rather than take it to market. This attitude may change due to high fish prices and increasing rural access to local markets.

Fingerling production shows a good potential as an income generating activity. Few farmers are likely to be able to enter this activity immediately after training. Fingerling production is suitable for farmers that already have ponds and some previous experience of fish culture. Fingerling production in net cages is now established as a successful technology and LAO/97/007 will pursue this with more experienced farmers. Only experienced (e.g. > 3 years) and relatively better-off men and women farmers are likely to be able to engage in mini-hatchery enterprizes.

The important role of fish in rural food security is diminished by concentration on solely economic criteria when assessing feasibility.

Gender

Both women and men are involved in aquaculture, although they may have different roles at different stages of the fish production cycle. There are few cultural constraints to women's participation in most aquaculture activities. The distance of the aquaculture operation from the house was a constraint to many women in engaging in aquaculture activities. Other domestic chores often conflict with the requirement for feeding and management of fishponds.

While men often make the major decisions concerning the production system, the production from ponds also depends on the time and effort allocated by women and children for pond management and for feeding of the fish. Men are usually responsible for routine feeding and harvesting the overall yield; women are often responsible for harvesting fish for household consumption. Children often assist with feeding. Due to the demands from domestic chores and child rearing, younger women (under 40) are less able to become involved in aquaculture activities.

While in theory women have access to aquaculture training and extension, in practice access can often be limited because of gender biases in extension services. Existing village fish farmer groups are largely composed of men and there is scope for inclusion of more women fish farmers in such groups. In many cases, women could not be involved in training due to household commitments or lack of awareness of the possibility of attending training courses. The establishment of women fish farmer groups and gender sensitive aquaculture promotion should be pursued either through existing extension structures or through organizations such as Lao Women's Union. Whilst often not involved directly in fish culture, the decision to start the activity was often prompted or supported by women in the household.

Ethnicity

LAO/97/007 is working with 12 ethnic groups (distinguished by name). In many cases the response to survey questions did not include details regarding ethnicity, rather the broader categories of Lao Loum, Lao Theung and Lao Soung (lowland, slope and highland dwelling ethnic groups). The ethnicity of the farmers in LAO/97/007 is presented in the Table 9. In many cases the ethnicity of respondents is not returned specifically but using the more general three categories into which all ethnic groups are broadly classified. The northern ethnic groups of Thai and Leu are considered by the Lao government to be Lao Loum (Lowland Lao - although many live in the valleys of mountainous regions) due to the similarity in lifestyles, although ethnically they are quite distinct.

Since aquaculture suits lowland and other areas where there is access to wet rice production, there is a natural tendency for Lao Loum, Leu and the Thai ethnic groups to farm fish. The Thai tribes in particular have long tradition of fish culture. Extension of aquaculture to the Lao Soung and Lao Theung tribes is often constrained by topography and their indigenous farming systems (upland dry rice cultivation). Where these groups have migrated into lowland areas there is great potential for the development of aquaculture and these groups seem to be receptive, providing rice cultivation area is not compromised. In some upland provinces (*e.g.* Luang Namtha & Phongxali) upland Lao have started fish culture and it is becoming increasingly popular. The priority in these areas is to improve fry supply and extend basic fry production techniques (the principle species cultivated is the common carp).

Ethnicity is an issue with respect to access to extension training in some areas. Geographically remote areas become even more marginalized when there is a language or cultural barrier between farmers and government staff. This is particularly the case with women in these areas who often do not speak the national language (Lao).

SUMMARY OF SUSTAINABILITY ISSUES RELATING TO RURAL AQUACULTURE IN LAO PDR

The sustainability issues that concern small-scale aquaculture in rural Lao PDR can be broadly divided into the following categories:

1. Input constraints

- Shortage of fish fingerlings
- Competition for manure
- Competition for bran and agricultural by-products from other livestock activities
- Lime unavailability/high cost in many areas
- Farmer tendency to minimize economic risk by limiting purchased inputs
- Integrated fish culture with livestock uncommon due to lack of penned livestock.

2. Infrastructure and institutions

- Poor roads and lack of access to markets
- Reliance on hand constructed ponds
- Lack of machinery for pond construction
- Livestock and Fisheries extension service poorly developed and under-funded
- Is government able to continue extension activity once project has finished?
- Provincial tendency to focus on peri-urban aquaculture (due to accessibility, private entrepreneur involvement, higher input status, access to markets)
- Low productivity of Government hatcheries
- Private hatcheries not yet established
- Agricultural Promotion Bank credit system undeveloped and difficult to access

3. Economic development

- Market economy is poorly developed outside of towns.
- Rural economy largely subsistence.
- Access to long term credit is imited.
- Fish culture can generate income or food for household. In some instances, farmers use both roles.
- Production of fish during dry season exploits high price.

4. Environmental factors

- Most fishponds are seasonal due to 6-month dry season.
- Seasonal stocking causes peak demand during a short period – existing hatcheries are unable to supply this demand.

Table 9. Ethnic group/tribe of respondent households to LAO/97/007 survey

	%
Highland Lao	6
Hmong	7
Midland Lao	20
Gathou	3
Sooway	4
Ahlak	1
Khamou	6
Lowland Lao	74
Thai Dam	7
Poowan	18
Thai Deng	1
Leu	9

- Ponds are shallow and dry quickly; high temperatures may be a problem. Productivity is constrained.
- Availability of flat land for pond construction is limited.
- Monsoon season can cause rapid flooding and loss of fish.
- Barrage ponds (dammed streams) in mountain areas may be damaged by spate water run-off.
- Highland areas are difficult to access.
- Population is more dispersed than in other Asian countries.

Terraced rice paddies that have been converted to fishponds (Xieng Khouang province)

A FRAMEWORK FOR ASSESSING THE IMPACT OF SMALL-SCALE RURAL AQUACULTURE PROJECTS ON POVERTY ALLEVIATION AND FOOD SECURITY

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This article is a condensed version of a paper entitled "Approaches, methods and indicators for assessing the impact of small-scale rural aquaculture projects for poverty alleviation and food security" presented at the FAO/APFIC Meeting of the Ad Hoc Working Group of Experts on Rural Aquaculture, 20-22 October 1999, Bangkok, Thailand.

INTRODUCTION

Aquaculture has been identified as the fastest growing food production sector in the world, with the annual growth rate increasing from 5 percent in 1990-91 to around 14 percent in 1994-95 (FAO 1997). Much of the reported increases in production came from small-scale aquaculture in low-income food deficit countries where the demand for aquatic products is expected to continue increasing. While an annual growth of 14 percent in aquaculture appears impressive, most of it is in China. Outside China, it is only 4.4 percent for other other countries in Asia, indicating a potential for further development of the sector. Aquaculture development has not realized its potential in many developing countries as the need for integrating aquaculture development into overall comprehensive rural development programs has not been appreciated. While it is generally accepted that aquaculture projects (excluding shrimp aquaculture and some other forms of intensive aquaculture such as intensive carp culture) in the region have had positive impacts, there is little empirical data to indicate the extent of the impact. Rigorous evaluation of the technical, economic, ecological and social impact of aquaculture is often not available or is limited. A FAO-NACA (Network of Aquaculture Centers in Asia and Pacific) survey identified weak institutional and enabling mechanisms for the lack of efficient application of improved aquaculture technologies in most countries of the Asia-Pacific region (Bueno 1999).

The paper is a brief discussion on the approaches and methods for assessing the impact of rural aquaculture projects on food security and poverty alleviation.

APPROACHES AND METHODS

Impact assessment is often looked at as a one time exercise at the end of the activity/project. To be effective, it must be conducted at various stages of the project development/implementation–adoption–impact continuum (Ahmed *et al*. 1999). A project(s) should begin with a clear identification of opportunities for aquaculture development in the target area, of the target population, and the potential for impact at various levels (on the adopting households, non-adopting households, community, consumers, region, country). These identified opportunities and impacts need to be continuously monitored, evaluated and refined, using milestones laid out in the project proposals/ documents.

Following Ahmed *et al*. (1999), Bantilan (1996) and Bantilan and Rayan (1996), a three-stage framework for assessing the impact of rural aquaculture projects is proposed (Table 1). It is, however, important to note that the method to be used and the sources of information and feedback for different projects vary at each stage of the framework.

The impact assessment in stage 1 (planning stage) of the framework is an *ex ante* assessment of a new project. It requires information on the demand (user's need) and supply (potential outcomes) aspects of the project. Surveys of producers and consumers on the current and future needs of existing and potential beneficiaries will provide information on the demand aspects of project outputs, while assessment of potential outcome (supply aspects) of the project needs to be based on the experience and judgment of experts. Biases inherent in these judgments and

Table 1. Impact assessment framework and methods

	STAGE 1	STAGE 2	STAGE 2
STAGES	PROJECT FORMULATION →	ADOPTION →	IMPACT
EVALUATION TECHNIQUES	*Ex ante* impact assessment and priority setting	Monitoring and evaluation	*Ex post* impact assessment
BASIC ACTIVITIES	- Assess needs of target area, resources and users - Establish baseline on target areas and users/ beneficiaries - Identify technical options - Identify policy and institutional environ-ment - Estimate probability of success and adoption - Select criteria and define indicators for impact assesment	- Identify methods of evaluation - Review socioeconomic policy and institutional environment - Assess and evaluate technology/output - Assess users' feedback - Assess adoption - Monitor performance against criteria and indicators	- Characterize adoptors and beneficiaries - Quantity impacts - Validate future plans
METHODS/ MATERIALS	- Baseline data - Users need assessment - Expert opinion and qualitative judment on potential impact	- Analysis of users's perspectives - On-farm trials/ evaluation - Adoption analysis - Social, economic and environmental cost-benefit analysis	- Adoption, performance lags and gaps analysis - Measurements of outputs and impacts - Comparision between potential and realized outputs and impacts

estimates need be taken into consideration as the project progresses. Benchmark information reflecting historical trends (e.g. yield, technological, social, demographic, economic, institutional and environmental) in the area of project concern and secondary data from national statistics and plans will serve as reference points in deriving and analyzing the *ex ante* potential.

The assessment of impact at the adoption stage (stage 2) will be more rigorous than the previous one as it involves measurement of the impact of a known technology.

Monitoring and evaluation methods will be used to examine the potential impact of a project outcome, e.g. a validated technology ready for dissemination, in terms of the indicators selected. Of foremost interest at this stage of the of the continuum (stage 2), is the determination of: whether or not the project approaches/ technologies/ methods/products are being adopted and are benefiting the target groups; policy and institutional changes/support needed, if any, for adoption; how information and policy recommendations are influencing decision makers; and how these ultimately improve the welfare of various target groups. These considerations involve the determination of adoption rates and the quantification of socioeconomic and institutional factors influencing farm production and consumption, including responsiveness of producers and consumers to changes in prices.

A full analysis of the impact of project output will only be available with *ex post* assessment of the adoption or dissemination of the project outcomes/technologies. Field surveys and secondary information will provide the actual/extent of impact of the project. The rate and extent of adoption of technology and the policy and institutional environment can provide measures for gaps between *ex ante* estimates and ex post realization. *Ex post* impact will never be a complete measure nor will the impact be limited to a fixed time period. The impact of a certain technology/project can go beyond the time frame of the analysis and provide spillover benefits for a wider area than initially expected. *Ex post* impact assessment of projects aimed at poverty alleviation and food security should also assess the impact of the project on farming systems, sustainability, environment, equity and gender issues. Lack of adoption/impact of a project could also be due to an inadequate institutional framework and policies that deter the adoption and impact. Hence institutional arrangements need to be studied and appropriate suggestions made where necessary, to realize the objectives of the project.

IMPACT INDICATORS

Improvements in technology and their adoption eventually improve household, community, region and national welfare in terms of productivity, income enhancement, input savings, food and nutrition security, self-sufficiency, employment generation and, at times, export enhancement. It is also essential to ascertain that the increase in production as a result of the project is sustainable, focused on the poor and addresses gender equity. The impact of rural aquaculture projects could be broadly categorized as socioeconomic, ecological and institutional (Table 2).

Socioeconomic indicators are: efficiency, contribution to food security, employment generation and acceptability of technologies/project outputs. Improvements in efficiency can take several forms: increased production; decrease in production cost; improvement in quality; increase in profitability and income; higher surplus for consumers and producers; and increased exports. The essential indicators of food security are the availability of food and the ability to acquire it.

With regard to environmental (ecological) impacts, it is necessary to assess whether the project(s): (i) improved the resource base or resulted in degradation, and (ii) whether the increased production is sustainable over the long-term. An aquaculture project invariably effects (for better or for worse) the natural resource base and, hence, the need to assess the effects of such projects on soil and water quality, biodiversity, and the overall environment.

It is important to assess the extent to which the aquaculture project(s) strengthened the capacity of farmers, farmer's organizations and national aquaculture R & D institutions and assisted in policy changes where necessary.

EXAMPLES OF IMPACT ASSESSMENT

McAllister (1988), Pullin (1989,1993) and Ruddle (1993) have conceptualized the impact of aquaculture projects and suggested a holistic ecological approach. A few studies, some of which have been mentioned here, were conducted to analyze the impact of rural aquaculture projects. ICLARM (1998) analyzed the potential impact of the introduction of improved Nile tilapia, popularly known as GIFT fish, in terms of yield, cost reduction, profit enhancement, consumer prices and access in five Asian countries (Bangladesh, China, Philippines, Thailand and Vietnam). The assessment was conducted through on-station and on-farm trials, and through surveys of producers, consumers and markets. The results revealed that the adoption of GIFT increased production by 24 percent (People's Republic of China) to 67 percent (Bangladesh), reduced cost of production by 20-30 percent, increased production profitability and that the benefits would go mainly to the lower and middle income producers and consumers of fish (ICLARM 1998; Dey 1999).

Gupta *et al*. (1998, 1999) undertook studies to assess the impact of the integration of aquaculture with rice-fish farming in medium high lands during the irrigated and rainfed seasons and the introduction of low-input pond aquaculture in floodprone ecosystems in Bangladesh. Baseline surveys were undertaken in the project areas prior to the introduction of new technologies as well as two years after the completion of the projects to assess the adoption of technologies by the farmers and impact if any, on household income and nutrition. These studies indicated that in both cases the farmers have adopted the technologies and some have even improved/intensified the technologies. In the case of integrated rice-fish farming, farm income has increased by 65 percent, while there has been a tripling of household consumption of fish in the case of farmers adopting low-input aquaculture practices introduced in the floodprone ecosystem. In both cases, the studies revealed that relatively well off farmers took advantage of the new technologies, indicating the need for institutional support for poor farmers to benefit from the technologies.

Table 2. Impact indicators for rural aquaculture projects

TYPE OF IMPACT	INDICATORS		
	Household	**Community**	**Region/nation**
Socioeconomic			
Efficiency	· Resource productivity · Total fish production · Profitability of aquaculture · Input saving · Income from aquaculture . Farm income	· Increased production · Input saving · Increased income from aquaculture · Producers' welfare (surplus) · Consumers' welfare (surplus)	· Increased production · Increased income from aquaculture · Consumers' surplus · Producers' surplus Increased export and decreased importation
Food and nutrition security	· Food consumption by household members . Fish consumption by household members	· Food and fish consumption by income class, rural/urban	
Employment	. Labour use by gender and age groups	· Employment opportunity by gender group	
Acceptability	. Compatibility with existing farming system, resource endowment, as well as local culture and customs		
Environmental	· Soil quality · Water quality · Risk to indigenous species/biodiversity · Discharge into natural environment - chemical, organic and physical · Recycling and integration with other farm enterprises · Sustainability of output		
Institutional	· Farmers'skill	· Increased capacity of farmers' organizations	· Strength of national institutions

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An Incremental, Farmer-Participatory Approach to the Development of Aquaculture Technology in Malawi[1]

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INTRODUCTION

Increasing population pressure in SubSaharan Africa has led to over-utilization of land and a subsequent decline in actual and potential agricultural productivity. Putting more land under cultivation will only exacerbate the decline of environmental quality which is already occurring (Brummett, 1994). Increasing intensity of production systems is therefore essential.

In Malawi, over 80 percent of the population is composed of small scale farmers. The farms which this group operates average about 1.5 ha and produce as many as twenty crops, in various sorts of rotation and integration, over the course of the year. In addition, the farms are highly variable from place to place, depending upon a wide variety of social, economic and environmental circumstances. This group of farmers has, in general, failed to benefit from "green revolution" agricultural innovations which were developed by research teams largely focused on commercial monocropping systems.

New methods for increasing the efficiency, productivity and sustainability of small scale farming systems must be found, and a logical first step is the development of improved methods for problem analysis and technology development aimed specifically at small scale farmers. A realistic alternative to traditional technology development and transfer has been utilized by the International Center for Living Aquatic Resources Management (ICLARM) to integrate pond fish culture into low-input farming systems in Malawi.

Integrated Resource Management

Integrated resource management (IRM) is the use of waste products from one agricultural enterprise to fuel another, thus creating economic, environmental and productivity synergisms which improve overall farm efficiency and profitability. IRM systems have been shown to operate effectively in test cases in Malawi (Brummett and Noble, 1995a), Ghana (Prein, 1995) and the Philippines (Lightfoot and Pullin, 1995). In addition to immediate improvements in farm function, longer term ecological benefits such as reduced soil erosion and increased tree cover are predicted (Lightfoot and Pullin, 1995).

To create the maximum impact of these systems, however, requires that farmers have a holistic vision of their farm which permits the efficient management of resources. Unfortunately, many small scale farmers rely more on tradition than on any systematic approach to farming in making resource allocation decisions. Brummett and Noble (1995a) found, for example, that many farm enterprises are carried from year to year despite continually losing, or earning only negligible amounts of money.

Both the complexity of small farms and the conservatism of small scale farmers serve to dramatically increase the number of factors which must be weighed in decision-making. The simple reliance upon production and net return calculations which most agriculture researchers use to promote their technologies hence often falls short of convincing small scale farmers. The tools and methods of IRM (c.f., Lightfoot and Noble, 1993; Brummett and Noble, 1995b; Prein, 1995) are designed to take the complex reality of small scale farms into consideration when designing improved farming systems.

The concept of IRM goes beyond simple integration and technology transfer. The adoption by farmers of improved techniques may, in the short term, increase farm profitability and food production. However, unless these farmers can adopt also a spirit of innovation

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and a general attitude of openness to improved farming methods, the gain will be lost over time as population continues to grow. Small scale farms must therefore evolve if they are to continuously improve their performance and become economically and ecologically viable and sustainable.

FARMER-SCIENTIST RESEARCH PARTNERSHIPS (FSRP)

Poorly educated small scale farmers, operating from within the perspective of a rural ecosystem which incorporates a large number of unquantifiable social and environmental factors, often have difficulty explaining their situation clearly to researchers. At the same time, researchers too often use their advanced schooling to focus on the details of maximizing the output from their special crop. A first step in designing new, more appropriate technologies and in giving farmers the mental tools they need to adopt a more progressive approach to farming is the development of mechanisms for the interactive exchange of information and ideas between farmers and researchers.

Resource Flow Diagramming

In designing research projects aimed at the development of more appropriate technologies for small scale farmers, ICLARM uses resource flow diagramming (Lightfoot and Noble, 1993) to provide the basis for communication between farmers and researchers. The diagramming exercise begins with an interview during which the proposed activities are presented to farmers and their feedback is solicited. Over the course of the discussions, farmers who are truly interested in participating in collaborative research can be separated from those who wish only to be part of a development activity (Harrison, 1995). Following these initial discussions, a walking tour of the farm allows researchers to roughly characterize the farm for inclusion or exclusion from particular studies.

Once farmers who are both interested and fit the experimental design are identified, resource flow diagramming is used to characterize the farms in terms of their resource base. It also provides a means for giving the farmers a systematic perspective on their farming system which they may have never had before and which might arguably be a prerequisite for efficient farmer experimentation (Lightfoot and Noble, 1993).

After the main features of the farming system are noted, farmers are asked to describe how the various enterprises depicted relate to each other. This is done by connecting the various enterprises with arrows to show the direction of resource movement. If, for example, stovers from a maize crop are used to mulch a vegetable garden, a flow arrow is drawn on the map to connect the maize and vegetable plots with an arrowhead indicating the direction of the resource movement (in this case towards the vegetables). Materials which are eaten by the families would be connected to the house with an arrow. Materials which are sold would be connected with an external market. Cash (generally in the form of payments for labor or money gained through sale of produce), fertilizers and animal feeds are included as resource flows which connect the farm to the local economy. For greater detail, values can be attached to flows to give them a quantitative dimension (Lightfoot and Noble, 1993).

Once complete, the map shows the various farm enterprise systems and the movement of resources around the farm and into the surrounding economy (Figure 1). Depending upon the purpose to which it is to be put, details of soil type, slope and water resources can be easily added. Such mapping provides the researcher with a detailed picture of the diversity and distribution of land, soil and water resources from the perspective of the farmer. Farmers gain a perspective, often for the first time, of their own farm's relationship to the surrounding rural community and its agroecological environment.

Farmer-Led Experimentation

Having established a map showing the enterprises and resource flows on the farm, the farmer is requested to imagine a scenario where a new or modified enterprise is incorporated into the farming system. In the case of ICLARM, researchers were trying to introduce the idea of IRM through the incorporation of a fish pond into the existing farming system. Once the new idea has been presented in general terms, the resource flow diagram is then re-drawn to show the theoretical relationships between the new activity and existing ones. The re-drawing of the map gives the researchers the opportunity to discuss the specific details of IRM.

An interesting point to note on the drawing is that only the fishpond has links with other resource systems and enterprises which do not pass through the household or an external market. Fish ponds have a particularly high capacity for using and transforming agricultural wastes without creating pest or human health problems (Lightfoot *et al.*, 1993).

The theoretical farming system model created during the re-drawing session is used by farmers and researchers as a guide for conducting applied experiments. In the case of integrated agriculture-aquaculture, the farmer constructs the pond in a site selected in consultation with the researcher (to make sure that it will, for example, fill with water). Other than general advice, no inputs to pond construction are provided by the researcher. Once the pond is constructed and full of water, the researcher must provide the fingerlings for fish stocking. This is done to ensure that the quantity and quality of seed is known and controlled. The farmer then uses the resource flow diagram to manage the farm. The farmer records the amounts of materials which flow along the different pathways and notes any deviations from the design.

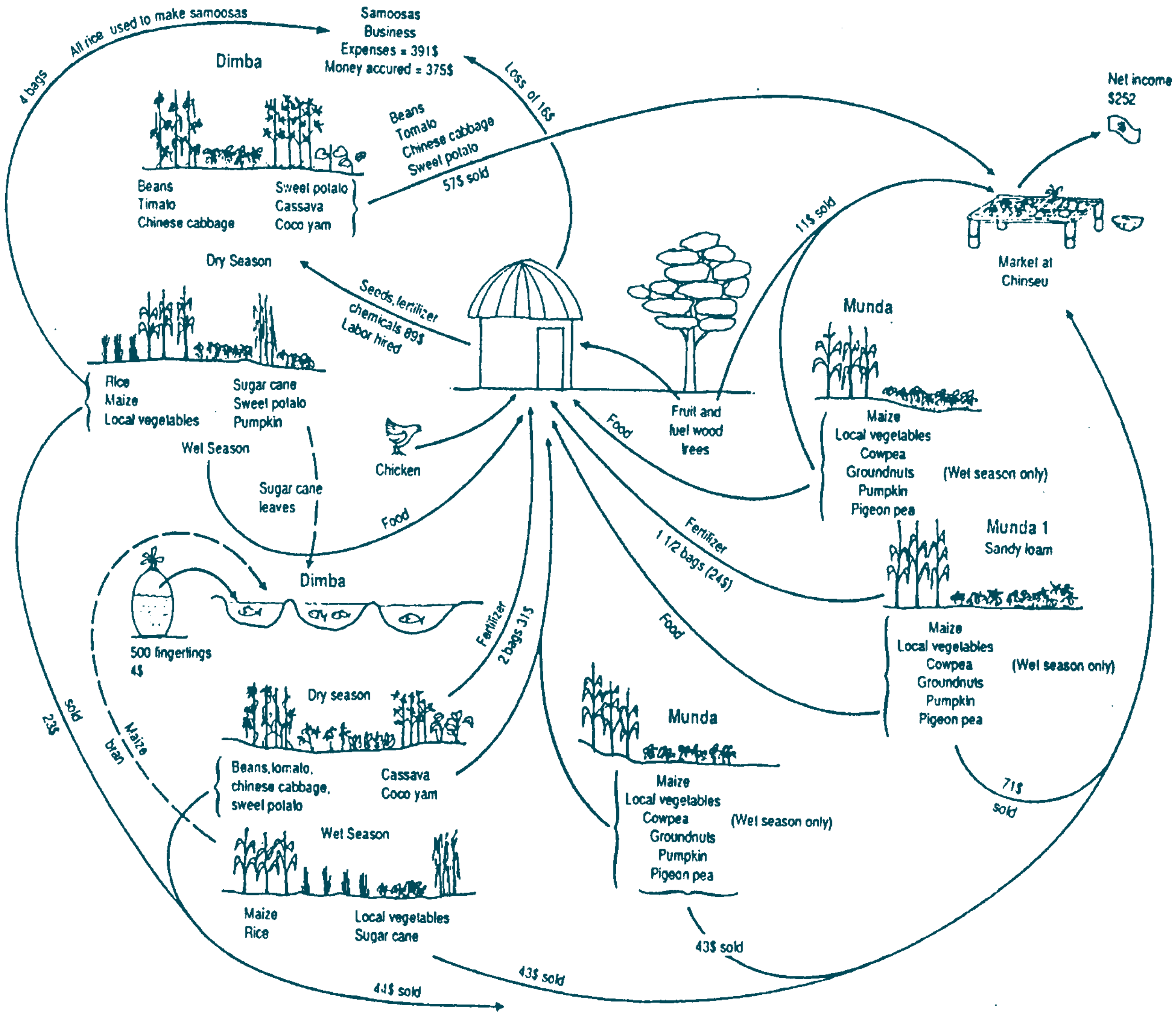


Figure 1. Resource map Zomba District, Malawi (Brummet and Noble 1995b)

Replicated simulations are established on the experiment station to control (in the scientific sense) the experiments being conducted on-farm. Every week, samples of on-farm inputs are collected, dried and analyzed. This data is then loaded into PondSim, an ICLARM-developed spreadsheet which reduces the inputs used by farmers to dry matter, organic matter, nitrogen and phosphorus terms. Through a comparison of this data with observations made on-farm, inputs and management practices used by farmers can be mimicked on the experimental station.

This system provides the statistical comparisons needed to make general statements about farm management strategies. It also gives the researchers an opportunity to experience, at a personal level, the problems faced by farmers. This helps in providing insight to potential new technologies and, maybe more importantly, provides the shared experience necessary to the creation of a more positive mutual understanding between scientist-researcher and farmer-researcher. Such a relationship is one of the keys to a more realistic and fruitful research and development methodology (Figure 2).

Technology Development

As Figure 2 illustrates, the conduct of farmer-led experimentation presents the opportunity to perform on-station research and development which is inherently appropriate to the farmer's situation. In classical approaches, potential management strategies are compared to some sort of best case scenario. Researchers tend to choose systems for study which push the productivity of the fish pond without regard for whether or not farmers really have access to the inputs necessary to use the technologies developed on their farms.

In the Farmer-Scientist Research Partnership approach, the data gathered during the weekly visits, as mentioned above, is used to establish scientific controls of on-farm studies conducted by farmers. These controls are also used by scientists on the experiment station to conduct studies of improved systems. For example, if a farmer elects to test the use of chopped maize stover as a pond input, the researchers establish a maize stover control which simulates the on-farm treatments. Then the researchers design other treatments which are also controlled by the same ponds which control the on-farm study. Such treatments might include the use of different presentation strategies for the maize stover such as grinding, composting etc.

When the growing season is over, all ponds both on-farm and on-station are harvested and the results analyzed and compared. The outcome is presented to the farmer for discussion. Sometimes, this requires the use of ingenious methods to clearly demonstrate to the farmers what has happened and care must be taken to avoid confusion (Hopkins, 1988). Group discussions among participating farmers are often useful (Lightfoot and Noble, 1993).

Based on the results of both the farmer's and researcher's studies, farmers are requested to re-draw their resource flow diagrams again to show how the system will be managed in the following year. Depending upon the objectives of the research program, this cycle can be repeated and may, over time, help to develop in farmers a new ability to systematically analyze problems and empirically search for solutions.

ICLARM's approach utilizes the resource base and constraints faced by farmers to establish control conditions and works from there to modify the production system. Productivities of systems developed in this way are, of course, much lower than those designed by classical methods. There are also problems with communication, trust and misunderstanding motivations which must be overcome (Harrison, 1995; Noble, 1995). However, the results are much closer to those which farmers can actually expect to achieve. At the same time, doing the research with the farmer's situation firmly in mind gives researchers a much clearer idea as to what might be possible within the context of the complete farming system than does the classical approach of focusing on the fish alone. Building new farming systems from the ground up in this way also gives the farmers a sense of propriety over new technology which facilitates its evolution into more sophisticated and productive forms (Chikafumbwa, 1995). The relationship established with the farming community as a result of this sort of exercise can also facilitate the collection of longer-term monitoring data on technology adoption and impact.

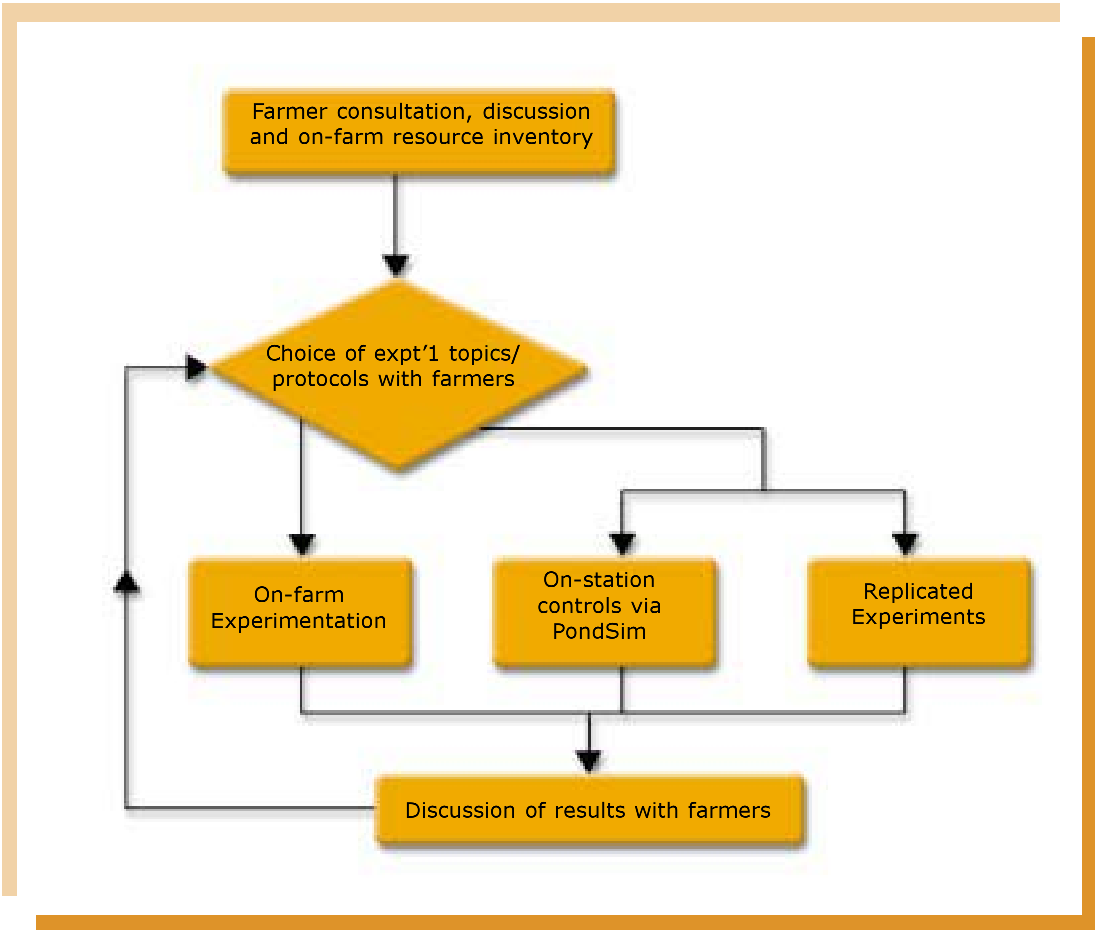


Figure 2. A flow diagram illustrating in general terms the Farmer-Scientist Research Partnership technology development and transfer methodology. PondSim is a farm management simulation tool developed by ICLARM.

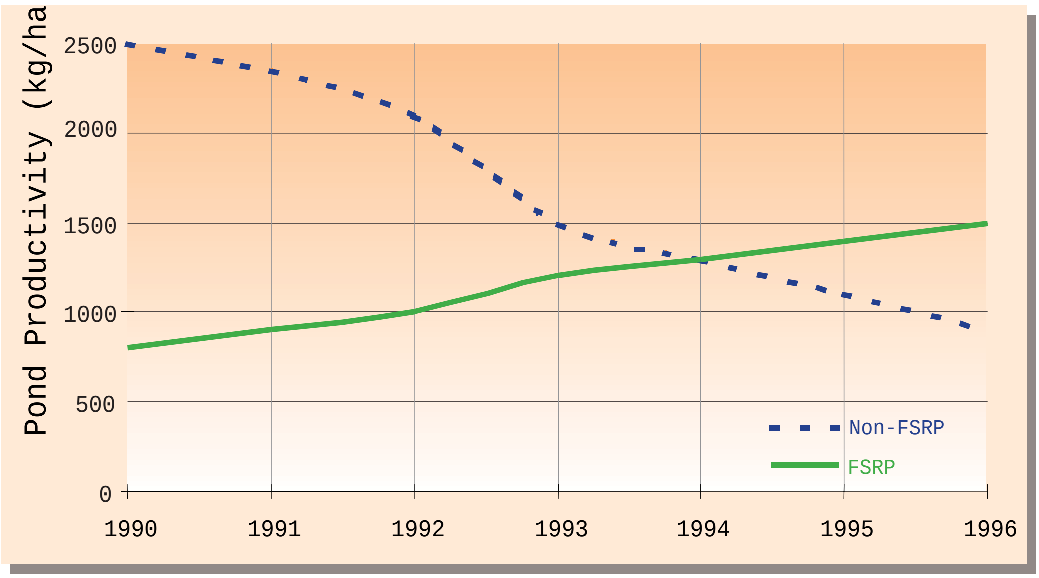
CONCLUDING REMARKS

ICLARM uses the farmer-scientist research method to study small scale farming systems and devise innovative approaches to problems which constrain agricultural productivity. The farmers themselves use the outputs of the method for more than just one season of research. In the words of one farmer with whom ICLARM has worked for several seasons: "Participating in the research project has been helpful because I have learned how to keep records of activities and now know how my farm enterprises are being run in terms of labor cost and input costs. I now realize which enterprises are bringing more money to the family and which ones are not helpful."

Although not specifically designed to transfer technology, the adoption rate of IRM-based aquaculture innovations among farmers who have participated in farmer-scientist research partnerships has varied between 65 and 100 percent. More remarkably, farmers involved in the development and testing of the methodology have expanded the fish farming components of their farms continually over the past three years despite continued droughts which have dramatically reduced the productivity of their fish ponds (Figure 3).

Whether the hoped for spirit of evolution has been instilled in these farmers remains to be seen, but preliminary indications are good. Lightfoot and Noble (1993) and Chikafumbwa (1995) noted that farmers with whom researchers had interacted had adopted, modified and spread to at least four other farmers each the technologies which they had helped to develop.

Figure 3. Pond productivity over time in FSRP Vs non-FSRP fish ponds in Southern Malawi.



Note: Entry-level technology under the FSRP is, initially, much simpler and less productive than production-focused technologies but evolves on-farm as farmers who understand the technology are able to more efficiently manipulate it to suit their individual situation.

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THE SMALL FISH FARMERS OF ASIA

Will they have to lift themselves by their own bootstraps?

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THIS ARTICLE IS BASED ON A PAPER PRESENTED BY THE AUTHOR AT THE MEETING OF THE FAO/APFIC AD HOC WORKING GROUP OF EXPERTS ON RURAL AQUACULTURE, 20-22 OCTOBER 1999. BANGKOK, THAILAND

"The central reality of Asian agriculture", the late D.L. Umali, FAO's former Regional Representative for Asia and the Far East once said, "is the small farmer". He said this almost two decades ago at an international workshop in the Philippines on Agricultural Research Management Asia, sponsored by the Southeast Asian Regional Center for Graduate Study and Research in Agriculture based in Los Banos. Much more recently, two meetings held in Thailand involving NACA and FAO, several Asian governments and other organizations working in fisheries, drew the same picture of Asian aquaculture[1]. The practical considerations have since shifted along the knowledge generation-application continuum but the fundamental issues remain.

Dr. Umali was urging researchers to shed their elitism and make the "talents and techniques of science available to the common man and invite the common farmer as a participant". On a somewhat similar line, the two recent meetings, on small aquaculture for rural development, raised, among others, the question as to whether research is addressed to the farmer or to the commodity, and whether it considers the circumstances of the small aquaculturist or simply aims to maximise yield? A plant breeder by training, Dr Umali gave this reply to a research administrator who disagreed to the idea of involving farmers in decision making because he thought it impractical to involve them without the benefit of preliminary testing: "Breeding work should be done by researchers and technicians trained for the job. But breeding work will be more meaningful to the farmers if the breeders take into account the physical limitations of the region and the socio-economic limitations of the farmers. This is where the participation of farmers is useful". The response of researchers eventually came in the form of farming systems research and extension, an approach that the two more recent forums stressed is relevant for small-scale rural aquaculture.

The other side of relevance of research and development efforts is the capability of those to whom these efforts are directed. Dr Umali spoke of using what he termed "alternative economics" to get farmers organized to "stimulate self-reliance and participatory, self-directed community action, and modes of mutual aid to solve problems of peasant insecurity and powerlessness".

Looking at aquaculture on a less lofty level, participants at the two recent meetings identified three major applications of aquaculture for rural development: (1) meeting basic human development needs, particularly food and livelihood; (2) rehabilitating the environment; and (3) maintaining social harmony and promoting social equity.

Tackling these and some major institutional constraints has been the focus of numerous pilot studies and field research. Some of these — reported in seven country reports (from Bangladesh, China, India, Indonesia, Philippines, Thailand and Vietnam) and 13 papers that described and analyzed regional, national and local projects in these same countries, and others in the region — provide useful lessons. What follows is a summary of selected information gained from the meetings.

BASIC CONSIDERATIONS

The various papers suggest five basic attributes of small-scale rural aquaculture with social objectives:

1. It is participatory.
2. It is people-oriented rather than technology-driven.
3. It follows a holistic and systems approach.
4. Participants have access to resources and are assured of security of tenure.
5. It is compatible with the objective of environmental sustainability.

In addition, there are important although non universal considerations that include the following:

1. It is a low-input activity.
2. It is a low-risk investment or risk is spread out.

To enable the fulfillment of the basic attributes, barriers have to be overcome through: Capacity building through manpower training, institutional strengthening or creation, appropriate policy development, and strengthening and coordination of other support systems.

PRIORITIES IN GOVERNMENT PLANS

Both the current importance and future potential of small-scale rural aquaculture, within a wide range of farming systems (in Asia), are not fully reflected in most governmental development programs. However, there are several examples (from Bangladesh, India and Vietnam, as well as in Cambodia) of projects with social objectives addressed to small-holders, or even the landless, being implemented by Government-NGO cooperation, invariably with donor support.

Although there is now a discernible shift in emphasis, previous government policies have tended to be commodity-based and technology-oriented with focus on production maximization. Appreciation of the capacity of small-scale aquaculture to contribute to rural poverty alleviation, improved household food security and the advancement of weaker sections of rural society is a recent development. There has been little co-ordinated attempt within the region to inform policy makers of the potential of small-scale aquaculture in rural livelihood development.

SUPPORT TO SMALL-SCALE AQUACULTURE

In all seven countries reporting, the basic infrastructure to support aquaculture development exists and, in all cases, is well organized and operated. Training and education centres, research and development institutions, extension services seed production and distribution facilities, as well as those for other input supplies, are generally well-developed and have systematic programmes targeted at aquaculture. Post-harvest, market and transport facilities are generally adequate. However, the problems related to availability of and accessibility to credit sources are commonly shared, although there are a few cases that provide examples of appropriate credit schemes targeted at small farmers, the landless and women, such as the Grameen Bank in Bangladesh and NABARD in India. In Bangladesh, NGOs have strong credit programs.

But capability, as well as expressed policy, are not the issues surrounding the support infrastructure and services in relation to small scale fish farming. It is the actual orientation of their programs and activities, which are generally biased – however inadvertently – towards the bigger and more progressive farmers, or at the least, overlook the segment of the farming population to which they are targeted. In some countries, this shortcoming is usually addressed by focused projects assisted by donor agencies or those implemented by NGOs; Bangladesh, Vietnam and the Philippines provide a number of examples. The usually strong and substantial technical input coming from government is complemented (and adapted) effectively for grassroots utilization by the strong suit of NGOs – which is organizing communities and assisting the people to diagnose their own problems, set their priorities, and seek or devise solutions. In other words, the NGOs and, in the Philippines, People's Organizations, catalyze people's participation in development, an element that is not often emphasized in the execution of government programmes. At least, the participation of farmers in research has been made possible through the farming systems research and extension approach. In addition, over the past few decades and especially in recent times, the attention of governments has been steadily swinging from higher production to sustainable production, thanks in part to productivity targets already being or almost attained and to the rising awareness of social and environmental issues.

There are also numerous assistance programs at the national, sectoral, and local government level that focus on the social objectives of food security, poverty alleviation and livelihood improvement. The government plays an important role, not so much in initiating the activity and providing the policy basis and initial funding support as in offering the framework and usually drawing the participation of organizations and corporate bodies such as Banks, NGOs, suppliers of inputs to take part in the programme.

Bangladesh has a strong element of external-assisted and NGO-implemented projects which are very well targeted and focused; that of the **People's Republic of China** is firmly government directed with emphasis on technology and organization; **India** portrays a government guided program that is nevertheless devolved to an organized grassroots-level institution (FFDA)[2] for implementation; **Indonesia** follows a sector program approach with specific technical and institutional support to well-defined programs; the **Philippines** has a complex structure of institutional linkages and several layers of supporting activities; **Thailand** is also strongly government guided, all the way down to the farm level (as its farmer organizations are still developing) with a very efficient R and D and extension support system; and Vietnam is likewise strongly government-planned and supervised with a strong element of participation and ground-level guidance of donor and development assistance organizations.

CONSTRAINTS

The summary of main constraints in promoting aquaculture for rural development as identified by countries, are listed in Box 1. These are broadly classified into institutional, technical, social, and economic, although there are clear overlaps and some are the consequence of others.

Box 1. Constraints, as identified by countries[3]

A. Institutional

- Overlapping functions and responsibilities between various Government Organizations (Bangladesh)
- Lack of co-ordination between GOs and NGOs (Bangladesh)
- Lack of co-ordination between banks, extension, and farmers (Bangladesh)
- Weak linkages between research and development (India)
- Weak extension, both GO and NGO (Bangladesh, India)
- Weak research and extension linkage (Thailand)
- Inefficient institutional capacity (Thailand)
- Inadequate human resources for R&D in aquaculture (India, Thailand)

B. Technical

- Limited supply of high quality fish seed (Philippines, Viet Nam)
- Limited supply of inputs, particularly fish feeds/ fishmeal (Philippines)
- Lack of infrastructure and facilities (Bangladesh) particularly for feed manufacture and distribution (India)
- Lack of diversification of aquaculture practices (India)
- Technical problems related to natural disasters (Bangladesh, Philippines)
- Limited water availability (Thailand)
- Inadequate production technology (Thailand)

C. Socio-economic

- Target group identification: NGOs target group is the landless and the poor farmers (Bangladesh)
- Geographic isolation of target groups and related problems (communication, extension, other support services) (Viet Nam)
- Limited access to water bodies for pen and cage culture (Bangladesh)
- High investment costs (Bangladesh)
- Land use conflicts (Bangladesh)
- Lack of security (Bangladesh)
- Multiple use of ponds and other water bodies (Bangladesh)
- Multiple ownership of ponds and other water bodies (Bangladesh)
- Financing of projects (Philippines,Thailand)
- Lack of economic incentive (Thailand)
- Limited access to credit (Bangladesh, Viet Nam)
- Lack of awareness among financing institutions (India)
- Complex credit norms (Bangladesh)
- Limited knowledge of farmers (Bangladesh)

D. Others

- Need for information on different water resources and aquaculture production from different farming systems (Bangladesh, India)
- Political will to promote food production and aquaculture (Philippines, People's Republic of China)

It is widely considered that there is great scope for improving productivity, but a range of obstacles impede this development. The obstacles are remarkably similar to those which impede productivity growth in smallholder crop and livestock enterprises, and include the following:

- commodity focused research aimed at maximizing yields without much attention to the needs, aspirations and possibilities of small-scale producers;
- extension services with poor coverage and inappropriate messages derived from the flawed research process;
- low capacity of farming communities to diagnose their problems, prioritize improvement options and plan the exploitation of opportunities;
- problems in obtaining purchased inputs – either because they are not readily available or because of cash flow problems and poorly developed rural financial services;
- poor supply of fish seed;
- marketing and post-harvest problems; and
- lack of participatory resource management mechanism and awareness by local communities.

LESSONS LEARNT

Recent studies and development projects indicate small-scale aquaculture can and does help achieve social development and environmental objectives. While aquaculture can close the gap between supply and demand, help meet the needs of the landless poor through such systems as cage culture and enhanced fisheries (provided security of tenure over communal resources is ensured), and from employment in fish farms and related services, there is not enough documented evidence to corroborate the claim that it can have an impact on poverty. Impacts of recent pilot development projects are rare and are just beginning to be reported. Examples of lessons learned, reported at the FAO/NACA Chiang Rai consultation are summarized below.

Lessons learnt from DFID[4] projects in Bangladesh (Anon. 1999 [5])

Technical issues and lack of new knowledge are not the major constraint to aquaculture development in Bangladesh. There is a wealth of indigenous and local knowledge that requires effective widespread dissemination to enhance human capital. People, and not ponds or technology, are the entry point for aquaculture development. Poverty and environment degradation can be eliminated through holistic development interventions that facilitate diversified sustainable livelihoods.

Summary of lessons learnt:

- Aquaculture makes significant contribution to nutrition, food security and sustainable livelihoods in Bangladesh.
- Rural households and communities are complex and therefore require a holistic inter-disciplinary cross-sectoral approach.
- Households are not homogenous so household family members should be treated separately to reach all of them effectively.
- Capacity building, skill development, knowledge and access empower the poor.
- Greater use should be made of indigenous knowledge.
- There are wide opportunities for the poor to integrate fish culture within existing farming systems.
- Diversification of livelihoods reduces risk.
- Low risk, low investment, and low external input strategies should be promoted in targeting the poor.
- Key stakeholders should participate at all stages of the project process including project design and selection of indicators of change.
- Investment should be primarily in human capital and not resources or technologies.
- Projects should facilitate people to assess their own risks, and determine their own levels of investment, use of external inputs; use of aquatic and natural resources.

Lessons learnt from CARE projects in Bangladesh (Nandeesha and Chapman 1999)[6]

- The experiential learning cycle (ELC) proved to be the most effective mechanism to build confidence and enrich knowledge of farmers.
- Research results obtained by farmers on their own farm or in the locality are better adopted.
- Tools like Participatory Monitoring and Evaluation Process (PMEP) are useful to provide ownership of the results to the farmers.
- Simplifying science to a level where both literare and illiterate farmers can understand is necessary to ensure farmers participation in the investigation process.
- In fixing indicators for a project, it is necessary to lay emphasis on increasing decision-making capacity of the farmers, instead of production targets.
- To accomplish the task of empowering farmers with knowledge, project staff must possess excellent facilitation skills coupled with awareness of social and technical issues.
- Results have consistently demonstrated that families involved in rice-fish activity earn more income and eat more fish. Based on on various indicators, techniques developed by farmers are ready for wider testing and adaptation in Bangladesh.

Lessons learnt from the AIT (Asia Institute of Technology) Aqua Outreach Programme

- Farmers should be involved in all stages of the research and development process, including the development of the extension system and extension materials.
- A farming systems approach appears to hold promise for the development of low-cost aquaculture for small-scale farmers.
- Technical recommendations should not be prescriptive; farmers will experiment with the technology and adapt it to their circumstances.
- Too narrow a focus on aquaculture in assessing its relevance to rural livelihood development is dangerous; attention needs to be widened from the micro-level of the farm to include regional level assessment of where aquaculture fits in the wider resource context.
- Focused surveys, designed on the basis of prior 'rapid appraisal', may be more efficient than complex agro-socio-economic surveys, in terms of time and money, since few data collected through the latter are actually used for situation analysis.

Lessons learnt from the Pond Dynamics/ Aquaculture CRSP

The CRSP[7] (Egna *et al.* 1999)[8] strives for institutional sustainability. The CRSP in Southeast Asia had at first concentrated on research for the benefit of small-scale aquaculture, then shifted from production optimization to environment and socio-economics. Some lessons learnt are listed below:

1. There is need for:
   - continuity of funding and commitment by donors and participants;
   - balance in emphasis between capacity building and technology development;
   - the right balance between short and long-term objectives;
   - nurturing collaboration by administrators, donors, and participants and through effective policies;
   - decreasing reliance on expatriate staff in favour of collaboration with local staff ; and
   - early-on investments in social and economic research and its continuation throughout the project.

2. Major challenges revolve around the politics of setting a relevant research agenda by balancing top-down and field-based inputs, fostering a sense of common ownership, encouraging input from the target community, and providing mechanisms for full participation by all researchers.

3. Transparency and participation in the agenda setting process is critical, but the increased costs of administering participatory processes must also be considered.

4. Inadequate resources are devoted to needs assessments, impact assessments, design, broad participation and project planning.

5. The poorest, smallest producers are less likely to take advantage of CRSP's technologies tha farmers with some access to resources.

INSTITUTIONALIZING PROJECTS IN NATIONAL DEVELOPMENT PROGRAMS

The age-old question has been "After project support ceases, what next?" and its kin, "Can this be done elsewhere with the same degree of success?" Much has been said about political will as a major force in any development endeavour, from initiating something to pushing it forward, to making it a permanent entity, or, if something is eventually found wrong, having the courage to have it excised. Political will is not a magic bullet, however, but the term does focus on where the major responsibility rests and what needs to be done to convince government to incorporate the positive aspects of a project into policy and the development programmes of a country. AIT's Outreach (Demaine 1999)[9] provides lessons in institutionalization. The programme approach incorporates the institutional dimension and makes capacity building its core objective. The Outreach has been pointed out as targeting improvement in government systems, rather than rural poverty directly. The strategy is to change understanding, processes and attitudes on the assumption that these changes "can bring about development on a broad front rather than in isolated enclaves". The latter, Demaine says, usually result from area-specific development projects, "which create parallel systems of such a resource intensity as to be non-replicable".

Some key lessons from AIT Outreach are listed below:

- There is no single or simple model for the process of capacity building. The cultural and developmental background of the different countries in which Outreach works varies considerably and so must the approach taken. This implies different roles for the external advisors and the need for flexibility in relation to key issues of project management.
- The process of institutionalization seems hardest where there are long-standing norms and traditions of working, so that individuals and institutions carry an 'intellectual baggage' which makes it difficult for them to innovate. With this in mind, DOF (Thailand) introduced farmer-managed on-farm trials into its research system, which up to then was not part of the research approach followed by the government. A second innovation has been the introduction of provincial level resource assessments as a basis for setting a framework for joint action between provincial fisheries offices and fisheries stations.

- It is not possible to create regional or national 'networks' at the beginning of the process as the pace at which change can take place in different institutions differs considerably. Only as the process matures does the common ground emerge on which collaborative activities can take place. Only in the last two years did such interchanges begin particularly between institutions in Thailand and Vietnam and, in Vietnam, between institutions in-country.

CONCLUDING REMARKS

The lessons learnt from recent projects will help guide future research and development efforts. This type of information is only now becoming available; much remains undocumented. Unfortunately, there has been no review of the considerable experience that has been gained through farmer participatory research projects over the past decade. Nor is there a framework available to make comparisons between projects which have used a variety of often experimental approaches in diverse contexts (Edwards, 1999)[10]. Most projects are being implemented as isolated efforts with little or no communication between one project and another.

Regional networks provide an effective mechanism to handle diverse contexts within and between countries. The proposed NACA-FAO regional programme on Aquaculture for Sustainable Rural Livelihood Development (ASRLD), which emerged from the two meetings discussed here, is intended to provide a vehicle for Asian regional cooperation to promote and catalyze the further development of small-scale rural aquaculture. This will be accomplished through a voluntary network of national institutions and field projects, and by building capacity and mobilizing information and expertise in the region.

[1] The meetings were the FAO/NACA Expert Consultation on Sustainable Aquaculture for Rural Development held in Chiang Rai, Thailand in March 1999, and the Asia Pacific Fisheries Commission working group meeting on rural aquaculture held at the FAO Regional Office in Bangkok in October 1999. Taking part were experts from government agencies, NGOs, regional organizations, international development assistance agencies, academic institutions, donor agencies, and rural development projects and programmes.

[2] Fish Farmers Development Associations

[3] FAO/NACA. 1999. Report of the FAO/NACA Expert Consultation on Sustainable Aquaculture for Rural Development.FAO Fisheries Report. No. 611. Rome, FAO. 1999. 34p.

[4] Department for International Development, UK

[5] Anonymous. 1999. Lessons learned and issues relating to aquaculture and rural livelihood- DFIF Bangladesh. Paper presented at the FA/NACA Consultation on Sustainable Aquaculture for Rural Development. Chiang Rai, Thailand, 29-31 March 1999.

[6] Nandeesha, M.C. and Chapman, G. 1999. Aquaculture development in Bangladesh through capacity building: Experiences of CARE. Paper presented at the FAO/ NACA Consultation on Sustainable Aquaculture for Rural development. Chiang Rai, Thailand, 29-31 March 1999.

[7] Cooperative Research Support Program (USAID)

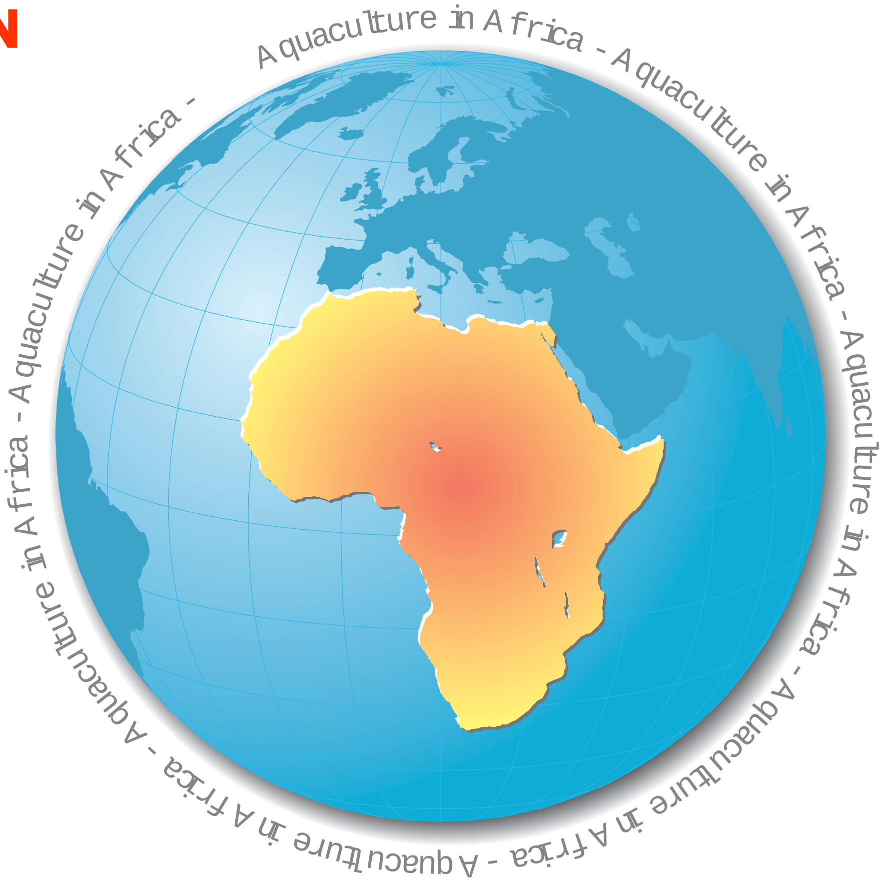
[8] Egna, H.S., Kwei Lin, C. & Clair, D.Z. 1999. The Pond Dynamics/Aquaculture CRSP: Developing technologies and networks for sustainable aquaculture and rural development. Paper presented at the FAO/NACA Consultation on Sustainable Aquaculture for Rural development. Chiang Rai, Thailand, 29-31 March 1999.

[9] Demaine, H. 1999. AIT Aqua Outreach: Experience, lessons learnt and issues. paper presented at the FAO/ NACA Consultation on Sustainable Aquaculture for Rural development. Chiang Rai, Thailand, 29-31 March 1999.

[10] Edwards, P. 1999. Draft guidelines for the assessment of rural aquaculture projects. Paper presented at the meeting of the APFIC Ad Hoc Working Group of Experts on Rural Aquaculture. 29-31 October 1999. Bangkok, Thailand.

AQUACULTURE IN AFRICA

Perspectives from the FAO Regional Office for Africa



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Africa Regional Integrated Irrigation and Aquaculture Workshop

Background

Water is recognised as one of the key limiting resources for the new millennium. Areas with once abundant water reserves are now forced to take a close look at rationing, while water-stressed areas are being forced to get by with less and less water. Diminishing supplies and increased demand mean that water use and re-use is a critical issue. It is now clearly imperative that water use be optimized. One form of optimisation is to *integrate irrigation and aquaculture* (IIA) and develop synergy from this marriage. Aquaculture, generally in the form of fishponds, can stock water for irrigating plant crops or can capture water leaving irrigation schemes. Ponds can also be built in adjacent waterlogged areas not suitable for other crops. By-products from the crops can be used as nutrient inputs for the fish; green manure for composting, spoiled produce and/or by-products such as bran or oil cake as supplemental feeds.

Moreover, at the household level IIA helps establish food security and balanced nutrition by providing a ready source of high protein – fish. There are indications that, in some communities, families depend upon fishing in ponds or reservoirs to provide food during the "hungry period" when few alternatives are available; the ponds serving as food banks, reserving fish for times of need. For these reasons, aquaculture is an important diversification component of the *FAO Special Programme for Food Security* (SPFS), which targets enhanced water management.

Although neither irrigation nor aquaculture is a new innovation, their merger in IIA is new and many of the technical details are still being worked out. There is a need to exchange information on IIA and identify the appropriate technologies for the various agro-ecological zones found across the Region.

An IIA Network

Information exchange is a major factor in many areas of development. All too often, access to information, rather than lack of information, is problematic. In 1993, the Working Party on Aquaculture of the Committee for Inland Fisheries for Africa (CIFA) met to review the aquaculture development and research needs in sub-Saharan Africa (reported in CIFA Technical Paper 23). The CIFA paper states "An improved information flow throughout Africa should be created" and "direct access to past and up-to-date information is stressed". To this end, improved aquaculture information exchange was of the highest priority. In addition to proposing an information network, the Working Party identified a number of research programmes to address the Region's needs; one of these programmes was *Aquaculture in Irrigation Schemes*.

As a result of this proposal, in October 1997 the Inland Water Resources and Aquaculture Service of the FAO Fisheries Department organized an identification mission to Burkina Faso, Ghana, Mali, Zambia and

Zimbabwe to assess the possibilities of establishing an African IIA Network. The mission recommended the organisation of a workshop as a first step for the establishment of this network.

Subsequently, in September 1999, the Agriculture and the Fisheries Department Groups of the FAO Regional Office for Africa, assisted by colleagues from Headquarters, organised an *IIA Workshop* in Accra, Ghana. The Workshop brought together 32 irrigation and aquaculture technicians from seven countries as well as representatives of related international institutions including: the Regional Association for Irrigation and Drainage (ARID), the International Institute of Tropical Agriculture (IITA) with its Ecoregional Programme for Humid and Sub-Humid Tropics of Sub-Saharan Africa (EPHTA), and the West Africa Rice Development Association (WARDA) with its two regional research consortia, the Inland Valley Consortium (IVC) and the Regional Rice Research Network (RRRN) and the International Centre for Living Aquatic Resource Management (ICLARM).

The Workshop assessed the current status of IIA activities, determined information needs, discussed how these could be met through networking and agreed on a proposal for establishing an African IIA Network.

Conclusions

The Workshop reached the following conclusions on the status and relevance of IIA and the establishment of an IIA network:

On Integrated Irrigation-Aquaculture

- IIA is a new name for existing activities practised by farmers around the region. Experience has shown that good water managers tend to have the necessary skills for IIA.
- IIA field activities were noted in Mali and Zambia while IIA-related research was only reported in Ghana, although all countries indicated a high potential for IIA.
- Even if not specified as "IIA", an acknowledgement of these activities' potential is seen in pending IIA projects in Côte d'Ivoire and Zambia.
- The relatively unknown and little used status of IIA is a result of several factors including:
  - modern irrigation and aquaculture are relatively new technologies in the Region;
  - efforts have focused initially on each reaching its individual potential before considering how they could be integrated.

On the Need for an IIA Network

- As more pressure is applied to water resources, especially in water-stressed areas, IIA becomes increasingly important.
- Possible actors involved in IIA activities represent a wide variety of research and development agencies in each country and collaboration between these is often lacking.
- National co-ordination would be facilitated by multidisciplinary national networks.
- Frequently information to facilitate IIA development is lacking and joining national networks into a regional network would expedite access to, and exchange of information.
- Networking could be accomplished by including IIA in existing regional networks or by establishing a specialized information network targeting IIA.
- There is a need to seek external resources to support network activities.
- Overcoming language barriers between members from different countries is a costly prerequisite.
- The quality of communication infrastructure between countries will have a direct impact on the effectiveness of networking.

Recommendations

With reference to the proposed regional IIA Information Network, the Workshop made the followingrecommendations:

Goal of the Network

- To contribute to improved food security

General Objective of the Network

- To promote research and development activities for IIA and to enhance sustainable use of land and water resources

Specific objectives of the Network

- To improve information exchange
- To promote capacity building at all levels
- To promote technology development

Themes of the Network

- To improve the technical sustainability of IIA
- To promote the social sustainability of IIA
- To promote the economic sustainability of IIA
- To promote the environment sustainability of IIA
- To provide extension for IIA development

Africa Regional Aquaculture Review

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Background

Aquaculture was introduced to much of the African Continent five decades ago as an innovation that would improve the economic and nutritional well being of producers. From Kenya to Sierra Leone thousands of ponds were built, many only to be abandoned after a few years of meagre production.

In 1975, to gauge progress toward establishing sustainable aquaculture in the Region, FAO organized the First [Africa] Regional Workshop on Aquaculture (ADCP/REP/75/1). This workshop recognized the importance of aquaculture and the high priority attached to it by many governments. It was further noted that:

> *"failures of some of the ill-conceived programmes during the early part of the century have continued to remain a major constraint in convincing the farmers and investors of the economic viability of aquaculture. Insufficient appreciation of the basic requirements of an effective aquaculture development programme and consequent inadequacy of governmental support activities, have handicapped the orderly and rapid development of the industry."*

Following this Workshop there was increased aquaculture activity, with nearly every African country launching donor-supported fish farming projects. However, thirteen years later in 1988, the FAO Expert Consultation on Planning for Aquaculture Development (ADCP/REP/89/33) concluded aquaculture output from sub-Saharan Africa was still very low, with only Nigeria, Côte d'Ivoire, Kenya and Zambia being important producers. Moreover, most of this production was attributed to small-scale semi-intensive farming of tilapia; few large-scale commercial ventures having been able to demonstrate long-term economic viability. Ineffective or non-existent policies combined with inadequate infrastructure, poor extension support and unavailability of inputs (including seed, feed and credit) were cited as major problem areas. It was recommended that seed production should be privatized and resources devoted to upgrading extension through training and improved information flow to producers.

Five years later in 1993, FAO, assisted by other collaborators, assembled a series of twelve national aquaculture reviews from countries within the Region (CIFA Technical Paper 23, 1994). These reviews identified major constraints on the continental level as:

- no reliable production statistics;
- credit availability limited for small-scale farmers;
- very low technical level of fish farmers;
- unavailability of local feed ingredients;
- lack of well-trained senior personnel;
- prohibitive transport costs; and
- lack of juvenile fish for pond restocking.

Today Africa's fish and shellfish aquaculture production is only slightly over 110 000 tonnes. Although this figure represents over a 60 percent increase during the previous decade (1988-1997, FAO Aquaculture Production Statistics), it is only 0.4 percent of the world total. In spite of the Region's natural endowments, including untapped land, water and human resources, Africa remains in an aquaculture backwater.

The 1999 Africa Regional Aquaculture Review

With this background, FAO organized the 1999 Review[1] to:

- evaluate the past 30 years of aquaculture development efforts in sub-Saharan Africa with specific focus on extension and public sector support for aquaculture;
- review the present status of aquaculture in the Region through an analysis of small-scale integrated production systems and medium- to large-scale systems;
- identify trends in aquaculture development; and
- prepare an outline of key elements of a general aquaculture development strategy.

The Review brought together 31 aquaculture practitioners from 14 countries across the Region, including FAO staff from Headquarters and the Regional Office as well as a representative from the International Centre for Living Aquatic Resource Management (ICLARM). These practitioners, representing decades of field experience in aquaculture development, were asked to assess why aquaculture has not established a solid and economically viable foundation in Africa.

The Review took a two-pronged approach to problem solving; reviewing ten national aquaculture programmes in the Region as well as assessing specific production systems. The Review also established Working Groups on four major themes:

- public sector support to aquaculture development (excluding extension);
- aquaculture extension;
- small-scale integrated aquaculture systems; and
- medium and large-scale aquaculture systems.

Present situation

For the ten countries assessed, the following elements describe the present situation for at least 80 percent of the national aquaculture programmes:

- little government support for aquaculture;
- government stations and hatcheries abandoned;
- private fish ponds abandoned;
- feed and seed shortages;
- reduced aquaculture extension activity;
- shortage of field staff;
- loss of institutional memory;
- lack of access to available aquaculture information; and
- lack of reliable aquaculture statistics.

Most countries are focusing on small-scale integrated systems producing tilapia and/or catfish (*Clarias* or *Heterobranchus*). As effective extension becomes more difficult, there is an orientation to rely increasingly on farmer groups (fish farmer associations). There is also a growing interest in commercial production and greater involvement of the private sector.

The Review concluded that: (a) aquaculture is now known throughout Africa as a result of previous extension efforts and (b) adoption/acceptance, even if on a modest scale, has been noted in most countries.

Lessons learnt

The review elaborated a list of 27 Lessons Learnt. Chief among these are:

1. an aquaculture development plan should help focus development geographically and facilitate control and evaluation (monitoring) of the programme;
2. farmer participation in development programmes, which has been lacking, should be encouraged;
3. centralized and subsidized fingerling production and supply is a disincentive to private sector involvement and creates shortage of seed — fish seed should be produced locally, in rural units involving small-scale farmers;
4. extension efforts should be focused on small-scale model farmers operating under favourable conditions (water and soil, interest and dynamism, experience with other resources, etc.) — from such model farmers, the farmer to farmer extension approach should be developed; and
5. selected culture species should be able to be reproduced by farmers themselves.

The way forward – a strategy for aquaculture development

Within the context of the lessons learnt, the Review prepared a 37-point aquaculture development strategy to be implemented over a period of five years. The strategy included elements that could be initiated immediately with existing resources as well as others that would require changes or revisions of policies and additional funding. The eight points below encompass the principal issues:

1. establish national development policies and an aquaculture development plan in consultation with stakeholders;
2. reduce expensive and unsustainable aquaculture infrastructure, specifically with a reduction of at least 50 percent of government fish stations within five years;
3. promote and facilitate the private sector production of feed and seed;
4. encourage credit for medium and large-scale producers;
5. revise aquaculture extension, establishing a flexible and efficient structure that can meet producers' needs;
6. advocate farmer-friendly existing technologies that use readily available culture species and local materials;
7. promote collaboration, co-ordination and information exchange between national and regional aquaculture institutions and agencies; and
8. facilitate the formation of farmers associations.

The first step in the strategy is the elaboration of national aquaculture policies and development plans. This was a key recommendation of the Workshop twenty four years ago. Yet, of the ten background country reports, eight indicated the lack of aquaculture policy as a recurrent problem while six stated there was also a lack of aquaculture planning. To a great extent, policies and planning are a question of ***political will***. If there is the political will, formulation of appropriate policies and plans is within the capacity of nearly all countries in the Region.

For decades aquaculture in Africa has been vacillating between crests and troughs of various waves of development with the same constraints identified time and again: lack of seed, feed, credit and extension support. All of these constraints relate to the underlying lack of policy. If there is political will to establish workable policies, solutions to these other issues will be forthcoming.

[1] Held in Accra, Ghana, 22-24 September 1999.

News from the

GFCM MEDITERRANEAN AQUACULTURE NETWORKS

S. HADJ-Ali (SIPAM Coordinator)

SIPAM

System of Information for the Promotion of Aquaculture in the Mediterranean

The 4th annual SIPAM meeting was held in the National Aquaculture Center, Marsaxlokk, Malta, November 24-28, 1999. Thirteen National Co-ordinators, including Algeria and Libya as new SIPAM members, and the Regional Co-ordinator attended the meeting. FAO was represented by Mr.Coppola. The main objectives of the meeting were to: (i) Review the status of SIPAM data, particularly those data bases considered to be of high priority by the last SIPAM meeting (Olhao, Portugal, 17-19 September 1998), (ii) to discuss the new software version 2.2 which was distributed to all the National co-ordinators, (iii) to review and comment on the prepared SIPAM home page and (iv) to discuss ways and means to make SIPAM more visible and open to the world.

SIPAM software version 2.2

The Regional Center, jointly with Mr. John Laurijsen, from the Institute of Marine Biology of Crete (IMBC), has modified the SIPAM software in order to take into account the suggestions expressed by the National co-ordinators during the training course organized in Zaragoza, Spain, in January 1999. Eight modifications were introduced, making the SIPAM software more advanced and responsive to users' needs. Thanks to the newly introduced tools, especially for developing internal networks within the member countries, such national networks have been installed in Tunisia and Turkey and will assist the National Centers in data collection and dissemination.

SIPAM data

The National co-ordinators reviewed data quality on the basis of a report prepared by the regional center. They focused on the first core of high priority data bases which they agreed to finalize before the end of the year. They also examined other databases and selected, among them, a second core of five data bases. Three data bases (Export, Import and Pathology) will be re-evaluated later, since they are very close to the two specialized databases on Marketing of Aquaculture Products and on Pathology, respectively. SIPAM is dealing with those two databases, jointly with the TECAM (Technology of Aquaculture in the Mediterranean) and SELAM (Socio-Economic and Legal Aspects of Aquaculture in the Mediterranean). As a follow up to the joint meeting organized by SIPAM, TECAM and FAO last December, 1998 at FAO HQ, Rome, on the SIPAM Pathology Database design, the SIPAM programmer participated in a one week session on AAPQIS (Aquatic Animal Pathogens and Quarantine Information System) software developed by FAO for the Asian Region.

Regional data base

Two issues of the Regional Database were prepared and distributed in March and July 1999. The first issue under SIPAM version 2.2 will be released in January 2000, including a set of complete data of five priority areas (National Reports, Production Statistics, Experts and Institutions Directories, and Research and Development Programmes).

New SIPAM member countries

Algeria and Libya have officially joined SIPAM and designated their national centers as **Centre National de Documentation pour la Pêche et l'Aquaculture** in Bou Smail, and **Center for Marine Wealth Biology**, in Tajaura respectively. Last November the Algerian co-ordinator received training at the Regional Center in Tunis on the set up and use of the SIPAM software as well as the functioning of the SIPAM system including internal networks. Regional Center staff will visit Libya in 2000 to assist in the installation and the use of the software.

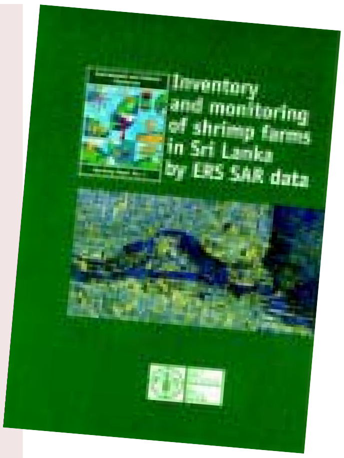
SIPAM as ASFA partner

Agreement was reached at the Malta meeting that the SIPAM Information Network, as represented by the SIPAM Regional Center in Tunis, will become an FAO/ASFA collaborating partner. As such, SIPAM will prepare bibliographic references of aquaculture literature published in the SIPAM participating countries for inclusion in the ASFA database. It will also carry out bibliographic searches of the ASFA database on behalf of the National SIPAM centers. In return, SIPAM will receive , free of charge , all ASFA database issues.

SIPAM brochure

The SIPAM Brochure is available in four languages : English, French, Spanish and Portuguese. It will be disseminated to all potential SIPAM end users within the participating countries and others outside the system. Participants in the last SIPAM meeting in Malta recommended that the brochure should also be prepared in four other languages: Arabic, Greek, Italian and Turkish.

FAO. 1999. Inventory and monitoring of shrimp farms in Sri Lanka by ERS SAR data. *Environmental and Natural Resources Working Paper* No. 1, by C. Travaglia, J. M. Kapetsky and G. Profeti. Rome. 34pp.



The study is based on interpretation of SAR satellite data and a detailed image analysis procedure is described.

Inventory and monitoring of shrimp farms are essential tools for decision making on aquaculture development, including regulatory laws, environmental protection and revenue collection. therefore, the availability of an accurate, fast and mainly objective methodology that also allows the observation of remote areas assumes a great value. The satellite remote sensing approach is also economically viable, as the value of shrimps more than justifies an accurate inventory and monitoring of the development of farms.

SAR data are unique for mapping shrimp farms, not only for their inherent all-weather capabilities, which is important as shrimp farms occur in tropical and subtropical areas, but mainly because the backscatter from surrounding dykes allows for recognition and separation of shrimp ponds from all other water-covered surfaces.

Although hardware and software needed for the extraction of useful information from SAR data are currently available at most remote sensing laboratories, good knowledge in imaging radar theory and practice in handling and processing SAR data are not. The report aims at the necessary technology transfer for an operational use of the approach in other, similar environments.

The methodology reported in this study has been tested under operative conditions in north-western Sri Lanka with the support of FAO project TCP/SRL/6712. the mapping accuracy achieved for shrimp farms, after field verification of preliminary results and refining of interpretation keys, is estimated to be more than 90 percent.

FAO. 1999. Historical consumption and future demand for fish and fishery products: Exploratory calculations for the years 2015/2030, by Y. Ye. *FAO Fisheries Circular* No. 946. Rome. 31pp.

The study provides an estimate of global demand for fish as food in the years 2015 and 2030. Global demand is obtained by adding estimates made for 17 groups of countries. After a review of consumption during the last 35 years, the author projects demand using observed statistical relationships between *per caput* consumption (live weight equivalent) and *per caput* GDP, a choice dictated by the paucity of historical data on price. For regions where a relationship (established through regression analysis) between observed *per caput* consumption and *per caput* GDP does not have statistical significance, or leads to clearly unrealistic results, a time trend regression was used. The author presents his results grouping the 17-country groups into six continents. He ends by discussing the significance of his findings, stressing that they represent potential demand; actual demand will be determined by the supply response to prices.

Rural aquaculture

As a follow up on the publication "Rural aquaculture: Overview and framework for country reviews". *RAP Publication* 1997/36 (see *FAN* No. 19, August 1998, p. 34), efforts have been made to review rural aquaculture in some of the major aquaculture countries in Asia and the Pacific Region, using the outline suggested by the above publication. The publications listed below, on the Philippines, India and the People's Republic of China, are the first three in the series. It is expected that similar publications on other countries in the region will follow.

FAO/RAP. 1999a. Rural aquaculture in the Philippines, by W.G. Yap. *RAP Publication* 1999/20. Bangkok. 101pp.

In 1997, aquaculture accounted for 34 percent of total fishery production and 41 percent of exported fishery products by value. Aquaculture in the Philippines is mostly small scale and house-hold/ community operations. It contributes substantially to food security, employment, household income and foreign exchange earnings. The sector provided employment to about 300 000 labourers and operators. The largest upsurge in the aquaculture labour force occurred in the seaweed culture sub-sector, with employment increasing from about 33 000 to 125 000 between 1980 and 1997. Small scale aquaculture assumes even greater importance when viewed against the micro-economies of specific localities (e.g. municipality of Lake Sebu where tilapia culture accounts for 50 percent of municipal income and 10 percent of the total labour force). In concluding his review, the author recommends projects for the further development of rural aquaculture.

FAO/RAP. 1999b. Rural aquaculture in India, by V.R.P. Sinha. *RAP Publication* 1999/21. Bangkok. 84pp.

Aquaculture production has increased threefold during the past decade, but aquaculture remains a small sub-sector of agriculture. Most aquaculture activities in India can be considered rural aquaculture. Freshwater aquaculture in village tanks and ponds follow the improved traditional semi-intensive composite culture/polyculture system. The practice meets household needs for fish and generates some additional income for the family. Successful commercial pond culture is a recent development in the States of Andhra Pradesh, West Bengal, Punjab, etc. In brackishwater aquaculture, more than half the total area (100 000 ha) under shrimp culture is made up of small farms following the traditional/improved or the traditional/extensive system of culture and as such they are considered a form of rural aquaculture. Freshwater aquaculture provides full time employment for about 1.2 million labourers and part time employment for 0.25 million, while brackishwater aquaculture employs about 67 000 and 15 000 respectively. The author presents case studies on income from integrated rural aquaculture activities (rice-fish, dairy-fish, vegetable-fish, etc.) and summarizes the results of recent rural aquaculture projects.

FAO/RAP. 1999c. Rural aquaculture in China, by S. Zhiwen. *RAP Publication* 1999/22. Bangkok. 71pp.

The dramatic growth in aquaculture production was given impetus by the introduction of the free market policy by the Government in 1978, particularly the policy stress on implementation of the household contract responsibility system with remuneration linked to output. In 1997, aquaculture production value was about 5 percent of total agricultural production value of 2 459 billion yuan; per capita fish availability from aquaculture reached 17.5 kg and aquaculture products accounted for most of fisheries exports, worth US$ 3.1 billion.

In 1997, 3.29 million labourers were employed in freshwater aquaculture and 0.46 million in marine aquaculture. In addition, the sector provided part time employment to a large number of labourers in pond coinstruction, maintenance, harvesting, etc. Surveys in 1997 showed that *per capita* net income of aquaculture households (5 325 yuan) was more than twice the *per capita* income of agricultural households (2 090 yuan). Rural aquaculture in the country involves the entire family irrespective of gender.

FAO. 1999. Global characterization of inland fishery enhancements and associated environmental impacts. *FAO Fisheries Circular.* No. 945. Rome, FAO. 89pp.

This circular summarizes the results of an effort to characterize inland fishery enhancements on a global scale. The basis was an automated literature search in the aquatic Sciences and Fisheries Abstracts (ASFA) for the years 1978-1997 with focus on introductions, stocking, environmental engineering and fertilization. The results were combined with information from the FAO Database on Introductions of Aquatic Species (DIAS) and the FAO Hatchery Production Database. The results were linked to maps for a geographical presentation. An additional overview of the possible environmental impacts of inland fishery enhancements and associated prevention, mitigation and rehabilitation measures is also given.

FAO/RAP. 1999. Trickle down system (TDS) of aquaculture extension for rural development, by D. Kumar. *RAP Publication* 1999/23.

Extension services have made tremendous contributions to the development and establishment of aquaculture as an important contributor to household food security, employment and income. As in the case of agriculture, each country has developed its own aquaculture extension delivery system with its own methods and approaches. In this publication reviews an extension method called Trickle-Down-System (TDS) of extension, which was successfully applied through FAO aquaculture projects in Bangladesh and Vietnam. The document details methods for planning, design and operation of TDS and presents case studies of application in Bangladesh and Vietnam.

Top: Extension agent visiting home of RDF (Result Demonstration Farmers)
Below: RDF taking lead role in method demonstration

FAO. 1999. Fish and fisheries at higher altitudes: Asia, by T. Petr ed. *FAO Fisheries Technical Paper* No. 385. Rome, FAO. 304pp.

The 13 papers presented in this publication review fish stocks and fisheries of mountainous areas of Asia. Cool and coldwater streams and rivers support subsistence and/or recreational/sport fisheries, with commercial fisheries practised only in some lakes and reservoirs. While fishing of streams and rivers is largely unmanaged, considerable management effort has gone into some lakes and reservoirs, especially in Kazakhstan, Kyrgyzstan and India in order to maintain reasonably high fish catches. A number of countries are pursuing the development of hatchery technologies for indigenous fish, with success achieved with mahseer (*Tor* spp.) in India and Nepal. Much still needs to be done to develop efficient technologies for production of viable fingerlings of other indigenous species. This is a matter of priority, especially as some species, like river sturgeon and the salmonid (*Hucho taimen*), are in danger of extinction. Deterioration of catchment soils by inappropriate agricultural practices and deforestation and pollution inputs are reducing water quality in streams and rivers, making them unsuitable for many coldwater fish species.

CIHEM/FAO/INRH. 1999. Aquaculture planning in Mediterranean countries. *Cahiers Options Méditerranéennes* Volume 43. Zaragoza, Spain. 187pp.

This publication comprises the Proceedings of the Workshop on Aquaculture Planning in Mediterranean Countries, of the CIHEM Network on Socio-economic and Legal Aspects of Aquaculture in the Mediterranean (SELAM). The Workshop was organized by the International Centre for Advanced Mediterranean Agronomic Studies (CIHEM), the FAO Fisheries Department and the Institut Nationale de la Recherche Halieutique (INRH), Morocco, and convened in Tangiers from 12 to 14 March 1998.

The objectives of the Workshop were to: (a) Analyze the evolution of aquaculture planning and development in the countries of the Mediterranean basin; (b) identify the most pressing needs in strategic planning, with a view to sustainable and responsible development of the sector; and (c) identify the role of regional cooperation in the aquaculture development planning in the region. The sessions addressed the general framework of aquaculture planning in Mediterranean countries, several national case studies, the planning process, supranational and international guidelines for planning, and regional cooperation. The publication compiles the manuscripts presented at the Workshop, and a summary of Workshop conclusions and recommendations.

FAO. 1999. Report of the Consultation on the Application of Article 9 of the Code of Conduct for Responsible Fisheries in the Mediterranean Region. Rome, Italy, 19-23 July 1999. *FAO Fisheries Report* No. 606. Rome, FAO. 208pp.

The Consultation was the final activity of a special project (TEMP/RER/908/MUL) requested and financed by the Italian Government. It was held at FAO, Rome and attended by delegations from 20 members of the General Fisheries Commission for the Mediterranean (GFCM) and by observers. The Consultation discussed two working documents presented by the secretariat: a synthesis of the national reports submitted by the countries, and a proposal for elements to be considered for the preparation of action plans at national and regional levels.
Three working groups discussed elements dealing with: (i) Dissemination of the Code and improvement of the planning process, (ii) enhancement of the harmonization between aquaculture development and environmental conservation and (iii) the use of the Code to upgrade the economic value of aquaculture and to improve and stabilize trade in aquaculture products in the Mediterranean. The working groups evaluated the document provided by the Secretariat and amended the list of proposed activities. These were also ranked in order of priority at the national and regional level and general mechanisms for their implementation proposed. The Consultation recommended that the GFCM be the umbrella institution for implementation of the programme of activities identified by the Working Groups.

Reddy, P.V.G.K. 1999. Genetic resources of Indian major carps. *FAO Fisheries Technical Paper.* No. 387. Rome, FAO. 76pp.

This publication, written for resource managers, aquaculturists and scientists, reviews the genetic resources of Indian major carps: the catla (*Catla catla*), the rohu (*Labeo rohita*), the mrigal (*Cirrhinus mrigala*), and the kalbasu *(Labeo calbasu)*. The review includes information on spawning behaviour and breeding under natural and culture conditions, distribution, genetic characterization, status of genetic resources, conservation efforts, and hybridization among Indian major carps and with other cyprinids. Research on genetic improvement through selective breeding, chromosome-set manipulation and genetic engineering in India is reviewed. The status of Indian major carps in Bangladesh, Thailand, Vietnam and India work on cryopreservation and genebanking is also discussed.

FAN

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