

## TECHNOLOGY TRANSFER OF AQUACULTURE TECHNOLOGIES: FRAMEWORK AND STRATEGIES

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### INTRODUCTION

#### **Aquaculture: fastest growing food production system**

All over the world, aquaculture has been the fastest growing food production system for almost two decades now. Aquaculture provides 43% of the fish consumed worldwide (FAO 2006). The growing dependence on aquaculture to fill the increasing demand for fish is due to dwindling catch from the wild. Many developing countries, especially in Southeast Asia, look upon aquaculture to help address food and livelihood problems. To promote the development of aquaculture, governments have invested on aquaculture research and development (R&D), provided tax incentives to companies that are engaged in aquaculture and related enterprises, and formulated policies in support of aquaculture and aquaculture-related industries.

#### **Aquaculture: boon or bane?**

Aquaculture boom has become both a boon and a bane to fish-producing countries. Fish export, mainly from aquaculture produce, is a major source of foreign currency for developing countries in Southeast Asia. Aquaculture produce, e.g. tilapia and milkfish, has stabilized fish prices by providing abundant alternative to the preferred-but-increasingly-costly wild-caught fish. Aquaculture enterprises and aquaculture products processing have provided employment for people in both rural and urban areas, and have significantly contributed to government revenues.

On the other hand, aquaculture has been blamed for the destruction of natural resources such as mangroves, seagrasses, and coral reefs. Over-pumping of fresh water to support aquaculture operations has caused ground subsidence and the intrusion of saltwater into freshwater tables. There are also claims that only the rich investors have benefited from the aquaculture production and export. Small-scale fishers have been further marginalized by the destruction of aquatic resources that are the main source of their food and livelihood.

#### **SEAFDEC /AQD: R&D for sustainable aquaculture**

Since the 1990s, research efforts throughout the world have focused on developing environment-friendly culture systems, or techniques for sustainable aquaculture. FAO defines sustainable aquaculture as the management and conservation of the natural resource base and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Sustainable aquaculture conserves land, water, plant and animal genetic resources; it is environmentally non-degrading, technically appropriate, economically viable, and socially acceptable.

The Southeast Asian Fisheries Development Center Aquaculture Department (SEAFDEC/AQD) is mandated to promote and undertake aquaculture research and development relevant to Southeast Asia, develop researchers, train technicians and resource managers, and collect, disseminate and exchange information. To accomplish these goals, SEAFDEC/AQD drew up a conceptual framework for its R&D that provides a continuum of activities from research and technology generation to training and information dissemination and impact assessment.

## SEAFDEC/AQD RESEARCH & DEVELOPMENT FRAMEWORK

Aquaculture research and development is a cycle of activities (Fig. 1). It is founded on strong collaboration among the various stakeholders - policy makers, scientists and technologists, private businessmen and fishers/fishfarmers, teachers and students, and the general public.

Scientific research is the foundation of technology generation. Sound research provides accurate and consistent bases for determining problems areas, methods of problem analysis, and generation of verifiable data and information for problem solving. SEAFDEC/AQD researchers adhere to the “publish or perish” tenet. They write the results of their research projects, submit their manuscripts to Institute for Scientific Information journals that will subject them to review by respected experts from all over the world before they are accepted for publication. Peer review of manuscripts - the evaluation of the soundness of the research methods, analysis and presentation of results - motivate researchers to conduct relevant research and write manuscripts that meet standards of international experts.

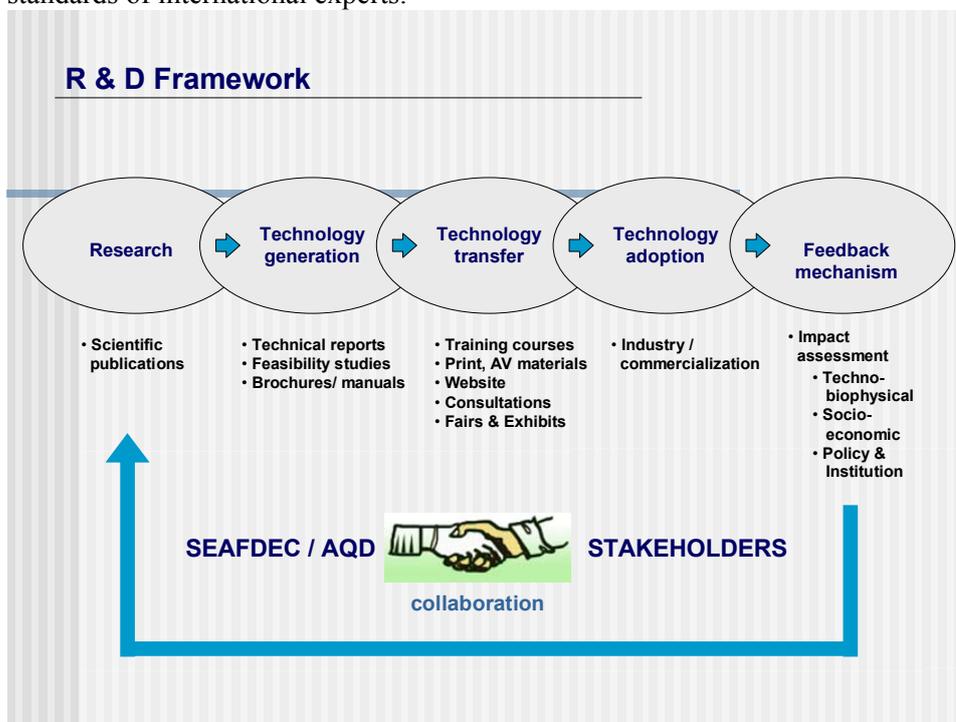


Figure 1. SEAFDEC R&D Conceptual Framework

At SEAFDEC AQD, the scientific publication is not the end of the researchers’ work. It is, in fact, the start of the process of informing the general public about the significance of the knowledge generated from research as an important input to technology generation.

The primary information contained in a scientific publication has to be tested and verified in an economic scale to evaluate the financial viability and technical feasibility. Trial runs using statistically accepted methods (time and space) are done in different aquatic environments (freshwater, brackish water and marine waters) using different culture systems (breeding and hatchery, pond, cage and pen, sea farming and sea ranching systems). Depending on the results of the run - in terms of production and farm economic indicators - trial runs in commercial scale are done in demonstration farms in collaboration with private operators, schools and organized fisherfolk organizations. Popular publications, e.g. operating manuals, brochures, flyers, audio-visual materials, are produced for wider circulation to the private sector, fisherfolk organizations and other stakeholders.

The impacts of the aquaculture technologies are assessed in terms of the techno-bio-physical sustainability, social and economic acceptability, and policy and institutional arrangements in the transfer and adoption by the stakeholders. The impacts of the aquaculture technologies will be subjected to further studies to ensure that they conform to standards set for aquaculture sustainability.

## **STAKEHOLDERS, TECHNOLOGY TRANSFER PATHWAYS AND STRATEGIES**

### **Four Levels of Stakeholders/Cientele**

There are four levels of stakeholders that are the target recipients of SEAFDEC/AQD's "research products" or technologies and knowledge generated from research.

The first level of clientele/stakeholders consists of officials in the policy-making and planning bodies of the government, national and international fisheries research organizations, and funding agencies. These are the people who make policies, or who influence policy-making, related to fisheries resources management. Researchers provide them with policy papers or briefs to guide them in their preparation of policies and enactment of laws. Recipient government agencies are the Bureau of Fisheries, Department of Agriculture, Department of Environment and Natural Resources and local government units. Recipient international organizations include SEAFDEC's Secretariat, the fisheries agencies of the 11 member-countries of SEAFDEC, the WorldFish Center, and the UN Food and Agriculture Organization (FAO).

The second level of stakeholders is composed of researchers of R&D institutions and academe, and development workers of non-government organizations. Their primary interests are the scientific methodologies and analytical tools used in the conduct of research, whether bio-physical, socioeconomic or policy-related. In the Philippines, some of these institutions are the University of the Philippines, Mindanao State University, Central Luzon State University, Palawan State University, Bicol State University, National Fisheries Research and Development Institute, and schools of fisheries. The main research products given them are publications in primary journals and proceedings in scientific conferences.

From 1976 to December 2006, SEAFDEC/AQD has produced 1,223 publications, broken down into: international journals (50%), conference proceedings (33%), and other journals (17%). SEAFDEC AQD is strongest in this level in view of the many scientific publications that have been cited by other scientists doing research in the fields of fisheries and aquaculture, marine biology, socioeconomics and policy related to fisheries and aquaculture.

The third level of stakeholders consists of officers and staff of "on-the-ground" institutions, such as local government units (LGUs) and regional government agencies, community-based organizations, local non-government organizations (NGOs) and fishery schools. They are the front liners in the management and regulation of fisheries and aquaculture resources and environment and, therefore, need relevant and updated scientific information pertaining to aquaculture technologies and coastal resources management. Unfortunately, the reality is that they are the weakest link in the management and conservation of aquaculture resources and environment due to lack of support in terms of technology, logistics, financing, and capacity-building.

The fourth level of stakeholders is the internal staff of AQD and other SEAFDEC departments in Thailand, Singapore and Malaysia. Information exchange among the departments, divisions, and section in the organization is vital since the internal staff are the agents of information who cater to the general public.

### Technology Transfer Pathways

Figure 2 shows the technology transfer pathways, or the distribution and dissemination channels of the communication products leading to the various clientele/stakeholders of SEAFDEC/AQD. The various research products (policy briefs, technical reports, journal publications, posters, audio/video clips, etc) are delivered through one or a combination of various delivery systems. The delivery systems will depend on the information materials and the target audience. The multi-media mix, such as print, radio, television and Internet, has been used in disseminating research information. The Internet has been an effective tool for information dissemination because most of the information materials are downloadable. Interpersonal communications, such as policy briefings and consultations, scientific forums, training courses, and extension activities have been effective in transferring information and technologies for aquaculture and fishery resources management. Researchers and research products end-users are able to discuss various issues pertaining to technologies, technology transfer and adoption, economics and marketing, and policy matters.

At the end of the technology transfer pathway, impact assessments are conducted covering the technological-bio-physical factors, socioeconomic conditions, and environmental changes that occurred as a result of technology transfer and adoption. Impacts may come in the form of improved and more effective ordinances and regulation in resource management in the municipal levels; improved productivity of aquaculture farms, and the resulting increase in the income of the fish farmers; and improved general well-being of aquatic resources like mangrove forests, seagrasses, and coral reefs. Overall, impact assessment aims to produce a better informed and enlightened citizenry who are empowered to manage and conserve their resources for sustainable development.

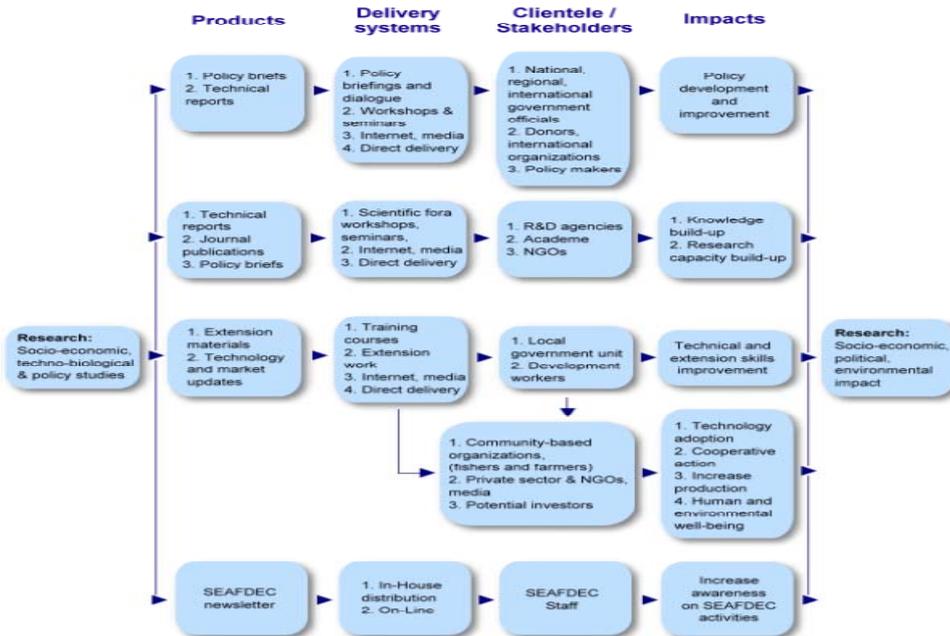


Figure 2. Technology Transfer Pathways

## Research Products

There has been a great waste of research funds, dwindling as they are, because of the lack of policies and mechanisms for the dissemination of valuable information generated by research. The results of a research project undergo some “processing and packaging” in order to convert them into appropriate forms or products (journal publications, policy papers, brochures, audio/video clips, etc) and languages (scientific, technical, layman) that will be easily understood by the intended users. For the research product to be acceptable and useful, it is important to tailor them according to the characteristics, idiosyncrasies and location of the users.

The following are the main research products of SEAFDEC/AQD:

### 1. Scientific publications

Journal publications are the standard media for disseminating primary information from research. Internationally recognized experts evaluate the manuscripts that are submitted for publication to ensure high quality and integrity of the science of the paper. SEAFDEC AQD researchers have published 611 papers in international journals, 208 papers in local journals, and 404 papers in international conference proceedings.

### 2. Policy papers

SEAFDEC/AQD’s scientific publications are cited in the two most important policy papers governing fisheries in Southeast Asia: Code of Conduct of Responsible Fisheries, Regional Guidelines in Responsible Aquaculture (Department of Agriculture, 1998) and Code of Practice for Sustainable Use of Mangrove Ecosystems for Aquaculture in Southeast Asia. Policy papers are necessarily prepared by interdisciplinary team of researchers because of the cross-sectional implications of policies. Policy briefs are prepared for extremely busy target readers of policy papers, such as lawmakers, and government program planners and technocrats. Policy briefs are written in concise and direct-to-the-point language.

### 3. Manuals, handbooks, brochures and flyers

The information contained in manuals, brochures and flyers are generally extracted from scientific publications and technical reports. The contents of these information materials are technology tips and "how-to's," market updates, and general information on aquaculture technology, aquatic resources, and government policies. SEAFDEC/AQD has produced 79 aquaculture extension manuals, monographs, brochures and flyers that have been sold or distributed for free.

### 4. Magazines and newspapers, and industry newsletters

Research results that are deemed of interest to the general public are written “feature style” for publication in newspapers, magazines and industry newsletters. Feature articles are written either by SEAFDEC/AQD staff or by newspaper/magazine correspondents who are given information to flesh out.

Since 1979, SEAFDEC/AQD has produced 660 newsletters, 131 magazines (SEAFDEC Asian Aquaculture) for international distribution, and 52 aquaculture farming news on technology updates.

### 5. Audio-visual aids: video/audio clips, tapes and CDs

Audio/video clips, tapes and CDs contain documentaries and instructions and demonstrations that are shown for the benefit of SEAFDEC/AQD visitors and trainees. Fishery schools usually buy these products for classroom use. SEAFDEC/AQD has produced and distributed 62 audio-visual products on culture systems of various species like milkfish and grouper and on community fisheries resources management.

## Delivery Systems

Effective information dissemination and technology transfer do not depend solely on the quality and relevance of the research products. Good information and knowledge are wasted unless they reach the users in the right place, at the right time, and at the right price. It is important to have in place effective and cost-efficient delivery systems to reach out to various users of information and technology.

### 1. Multi-media mix strategy

SEAFDEC/AQD uses a variety of delivery systems to reach different stakeholders, namely: a) multi-media, e.g. print, radio and television; b) website; and c) interpersonal communication. Print media includes national and local dailies and magazines that feature stories about SEAFDEC activities (training courses, technology updates, field projects.) Local radio is used to reach out to fisherfolk and community organizations. Radio is an effective medium for the exchange of ideas about fishery resources management strategies as it encourages debate among resource users (fishers, aquaculturists, policy makers, and law enforcers). Television is effective in showing visually the “how-to’s” of aquaculture and the adverse effects of illegal fishing and certain aquaculture practices.

### 2. Website

The webpage of SEAFDEC [www.seafdec.org.ph](http://www.seafdec.org.ph) is optimally used in disseminating research information. Most of SEAFDEC/AQD’s publics – researchers, students and academicians, government policymakers and decision-makers, fund donors, and collaborators - have access to the Internet. The SEAFDEC/AQD website is updated regularly and contains materials that are downloadable by clients from all over the world.

### 3. Interpersonal communication

Interpersonal communication, such as policy dialogues, village general assemblies, training and field extension, is a very effective way of reaching out to various publics because it is interactive and it gives the audience the opportunity to verify information personally. This approach was extensively used by SEAFDEC/AQD in the implementation of its Community-based Fishery Resource Management project on Malalison Island, Culasi, Antique province (Agbayani et al, 2000) in 1991-98. In this project, researchers and development workers effectively made use of general assemblies to dialogue with the Malalison fisherfolk, their leaders and local government officials. The general assemblies gave researchers and development workers opportunities to explain information, and clarify issues and concerns in layman and easy-to-understand language that could be understood by the villagers who generally had low educational attainment. Feedback about the project was obtained firsthand, and responded to immediately.

## Training

On-site and hands-on training courses have been conducted by SEAFDEC/AQD since 1977. They were attended by government fisheries personnel, academics, entrepreneurs and fish farmers from SEAFDEC member-countries, as well as from countries in South Asia, Asia-Pacific, South America and the Middle East. Special courses have been designed to suit the needs of requesting agencies. Most of the lecturers and practicum instructors in these training courses are AQD’s own researchers and technicians.

SEAFDEC/AQD continues to widen and add to its information delivery systems. In 2002, it opened its first Internet-based distance learning course on the Principles of Health Management in Aquaculture. In 2001, it embarked on textbook writing upon the request of fisheries schools. It has produced two books: one on fish health management, and the other on tropical fish nutrition.

A recent innovation in the training methodology of SEAFDEC/AQD is the season-long training course. This is done in collaboration with long-term projects of local government units and fishery



schools. This course is a combination of lecture (2-3 days) and monthly hands-on monitoring, including on-farm discussion and analysis of problems and concerns, such as disease detection and feed formulation. The last session of the season-long training course is the actual harvest of fish in the fish farm. The training course lasts 4-5 months. The lecture topics include principles, concepts, technical and socioeconomic aspects of sustainable aquaculture. The language used is a combination of English, Filipino and the local dialects.

All training courses include lectures on the principles and concepts of sustainable aquaculture and aquatic resources management. Training courses on community-based coastal resources management give emphasis on sustainability issues like environment conservation, socioeconomic acceptability and policy implications of the resource management strategies.

### **Library and FishWorld Museum**

Established in 1975, the SEAFDEC/AQD Library has accumulated the biggest collection of aquaculture literature in Southeast Asia. Besides the SEAFDEC/AQD researchers and staff, Library users include students and faculty members of fishery schools and the general public. The Library also serves requests (by phone, letter, fax or email) for information and materials from clients outside the country.

The prized collections of the AQD Library are literature on brackishwater species, abalone, grouper, milkfish, mudcrab, rabbitfish, seabass, seaweeds, tiger shrimp, freshwater prawn and tilapia. It also has an impressive collection of Filipiniana materials.

The library collection - 34,734 titles and 53,911 volumes/copies as of December 2006 - is in electronic databases that can be searched through the AQD website under the online-public-access-catalogue.

FishWorld is AQD's museum-aquarium and visitor center. Established in July 2000, it is dedicated to science and environment education of the general public, especially about aquatic ecosystems and biodiversity, fisheries, and aquaculture. It has become a must-see for school field trips and tourists. The Aquaculture Week hosted by FishWorld is annual event of SEAFDEC/AQD's environment education program. It is participated by students and teachers from elementary and secondary schools and learn about aquaculture and the environment through competitions in science, art, writing and livelihood projects. The FishWorld museum has a collection of about 3,000 species of fishes, mollusks, crustaceans, echinoderms, corals, seaweeds, and others. FishWorld is now recognized as a rescue and rehabilitation center for endangered marine animals. Recently, five marine turtles that have been in SEAFDEC/AQD's tanks for a month to a year were loaded onto a large outrigger boat and released in the Sulu Sea.

### **INSTITUTIONAL CAPACITY DEVELOPMENT FOR SUSTAINABLE AQUACULTURE**

Fishery resources provide food and livelihood to coastal communities and investment opportunities for the private sector. There is, thus, an urgent need for balanced development strategies that will ensure protection and sustainable utilization of the fishery resources. The Local Government Code of 1991 and Philippine Fisheries Code of 1998 provide that "The municipal/city government shall have jurisdiction over municipal waters which include streams, lakes and other inland bodies of water and tidal waters, fishery reserves and marine waters up to 15 km from the coastline." Effective and efficient governance of the fishery and aquaculture resources will depend on the capabilities and political will of the LGUs, the Fisheries and Aquatic Resources Management Councils (FARMCs), fisherfolk organizations, and other "on-the-ground" institutions.

In support of the government thrust to strengthen the capacities of local governments to manage and utilize their fishery resources for food and livelihood, SEAFDEC/AQD launched in September 2006 a project concept called "Institutional Capacity Development for Sustainable Aquaculture"

(ICDSA). The goal is to enable aquatic resource users to become efficient managers and prudent users of their resources by providing them with necessary knowledge and skills. The overall strategy is to transfer and disseminate science-based information and appropriate aquaculture and coastal resources management techniques. The approach is community-based, interdisciplinary and participatory: scientists and technologists, trainers and extension workers, LGU planners and development workers, members of people's organizations (fishers and farmers), NGO workers, and academe (faculty and students) consult and work with each other in the planning and implementation of projects and initiatives.

SEAFDEC/AQD's ICDSA team is interdisciplinary; it is composed of biologists, environmentalists, aquaculturists and socio-economists.

Two LGUs are now collaborating with SEAFDEC/AQD in the implementation of ICDSA projects. These are the provinces of Antique and Capiz on Panay Island in central Philippines. Local officials of the provinces of Ilocos Norte and Bulacan have also requested assistance from SEAFDEC/AQD to set up similar projects in their areas.

For the Antique project, the first activity of the SEAFDEC/AQD Team was to conduct a rapid appraisal of proposed aquaculture sites, then discussed with LGU officers the problems and issues affecting the fishery resources of the province. The team also conducted interviews with key informants, focus discussions, and general assembly consultations. As a result of the rapid appraisal exercises, a problem tree analysis (Figure 3) was built jointly by the team members in order to see the problems from the perspectives of the different disciplines (Callens and Seiffert, 2003). The Problem Tree was the team's initial output which became an input to the preparation of a working plan for the project (SEAFDEC, 2007). This Problem Tree will be revisited from time to time as changes occur due to interventions - such as training and information dissemination and aquaculture technology adoption - that are introduced by the project.

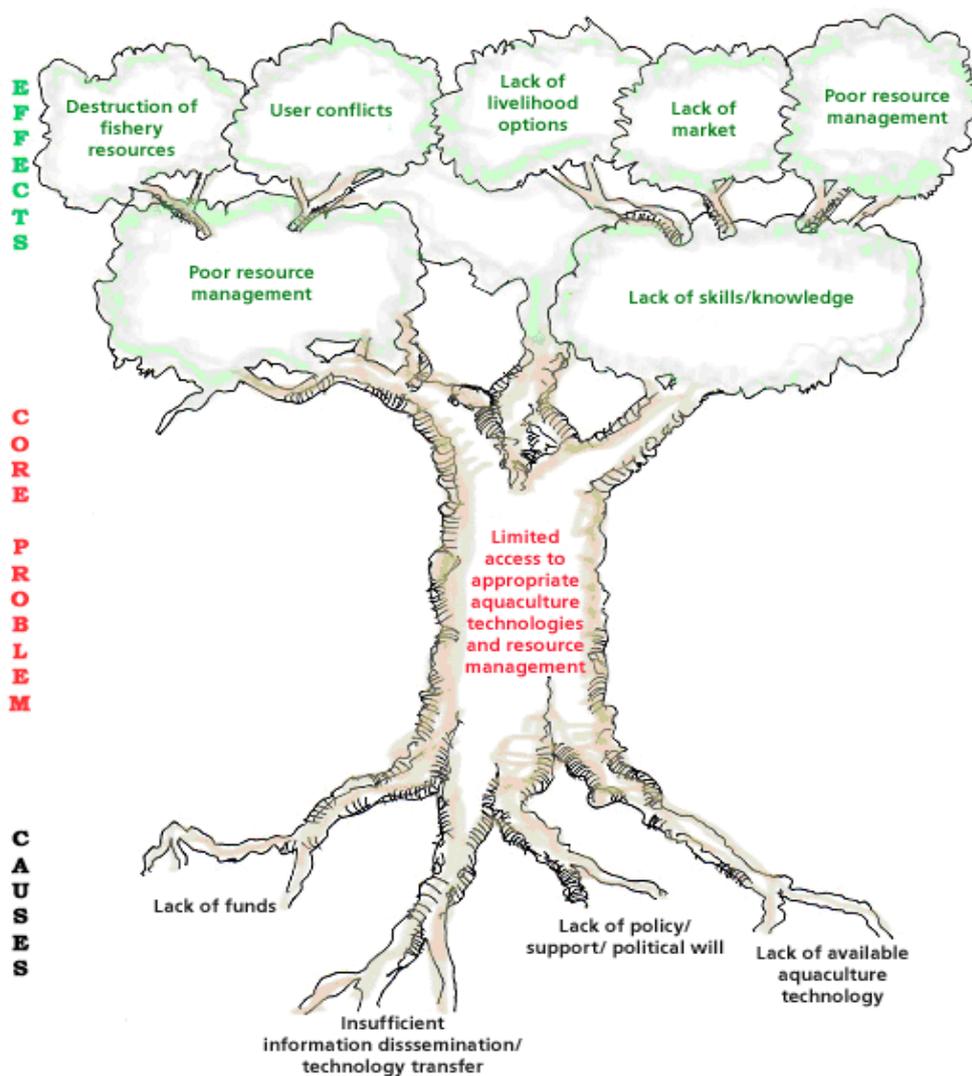


Figure 3. Problem Tree Analysis: Antique Province

The selection of aquaculture technology to be transferred to an ICDSA project site is demand-driven. The aquaculture sites should be suitable, and the technology appropriate for the intended users. Below is a list of aquaculture technologies that SEAFDEC/AQD has generated for hatchery and grow-out culture systems.

Brackishwater Aquaculture

1. Milkfish
2. High-value fish– Grouper, Seabass, Snapper, Siganids
3. Crustaceans – Shrimps, mudcrabs

Freshwater Aquaculture

1. Tilapia
2. Native catfish
3. Freshwater shrimps (Ulang)
4. Carp

Marine Aquaculture (seafarming, sea ranching, stock enhancement)

1. Seaweeds
2. Molluscs (Abalone)
3. Endangered species - angel wings, sea cucumber, sea urchin

Community-based Fishery Resources Management

1. Community organizing and empowering
2. Aquaculture livelihood
3. Aquatic Resource regeneration

The transfer of technologies for sustainable aquaculture (freshwater, brackishwater, and marine) in the project sites is anchored on the principles of sound fishery resources management, i.e. people-centered, environment-friendly and economically viable.

To complete the cycle of the R&D framework, there will be an assessment of the: 1) impacts of the adopted aquaculture technologies on the aquatic environment and on the socioeconomic condition of the technology users; and, 2) policy and institutional implications the adopted technologies on the overall management of the aquaculture environment. The information generated from the impact assessment will be used in the R&D planning of SEAFDEC/AQD.

It must be noted that SEAFDEC/AQD has had experiences in drawing up and implementing community fisheries resources management projects. Foremost of these is the community-based coastal resources management project on Malalison Island, Culasi, Antique (Agbayani, et al 2000; Baticados and Agbayani 2000). Implemented over an eight-year period (1991-98), the project was able to empower the Malalison fisherfolk to become active co-managers of their fishery resources. The project's capacity-building and social preparation activities included community organizing, leadership training, values inculcation; livelihood skills training (seaweeds and grouper farming), and environmental rehabilitation (construction and deployment of concrete artificial reefs). The data on marine resources generated by the SEAFDEC/AQD studies were used in the formulation of regulations that now govern the utilization and management of the coastal waters surrounding the Malalison Island. The Municipal Council of Culasi enacted ordinances that granted territorial use rights in fisheries (Siar et al 1991) to the Malalison fisher folk, and established a fish sanctuary that is now managed by the Fishermen's Association of Malalison Island.