FISH for the PEOPLE

A Special Publication for the Promotion of Sustainable Fisheries for Food Security in the ASEAN Region

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Southeast Asian Fisheries Development Center

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Cover: *Healthy and whole-some aquaculture -- from farm to table*

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Editorial

Since its inception, the Special Publication *Fish for the People* had Olivier Delahaye Gamucci as one of the members of the Editorial Team, as its Managing Editor. He was instrumental in inviting authors from SEAFDEC Departments and Member Countries as well as from other agencies and institutions to contribute articles for the publication. Olivier performed his duties excellently and exceedingly well until he decided to part ways with SEAFDEC and his brainchild *Fish for the People* in December 2006 for a greener pastures. During his term as Associate Professional Officer of SEAFDEC and as the staff responsible for the publication, he saw the production of 10 issues of *Fish for the People* from Volume 1 in 2003 to Volume 4 in 2006, a feat that is quite difficult to surpass. The interest of Olivier was with coastal fisheries and rural development, as reflected in the articles that he also wrote and published for *Fish for the People*.

Following Confucius who said "*At 15 I set my heart on learning; at 30 I took my stand; at 40 I came to be free from doubts*," SEAFDEC is now proud to say that the technologies it has developed in the past 40 years have been refined and without doubts, are ripe for dissemination to the region.

SEAFDEC, which was established in December 1967, will be on its 40th year of service to the region by December 2007. This is therefore an opportune time for SEAFDEC to recall its past and focus sight on the future after having amassed a wealth of expertise and technologies in all aspects of fisheries. There is no better time for SEAFDEC to drum beat its achievements during the past 40 years, than now and through the Special Publication *Fish for the People*.

Consistent with the publishing policy on *Fish for the People* named after the Millennium Conference that SEAFDEC organized in collaboration with the ASEAN in 2001, we give more focus on aquaculture and post-harvest and trade in this volume. We are starting off with sustainable aquaculture for the first issue of Volume 5.

After Olivier, the task of the publication's Managing Editor was inherited by Ms. Virgilia T. Sulit. She who used to work with the SEAFDEC Aquaculture Department (AQD) for more than 30 years conducting various important works in professional manner. SEAFDEC is very confident that her competence and new challenge will certainly meet your satisfaction.

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CONTENTS

FISH for the PEOPLE is a special publication produced by the Southeast Asian Fisheries Development Center (SEAFDEC) as part of the ASEAN-SEAFDEC Special 5-year Program to promote sustainable fisheries for food security in the ASEAN region.

Better Management Practice, Public Health and Sustainable Farming

Pedro B. Bueno, C.V. Mohan, Michael J. Phillips, Koji Yamamoto, Flavio Corsin and Jesper Clausen

Global aquaculture output is shooting towards the 60 M mt level. Since the 1980s, aquaculture production has sustained an average yearly growth of 10%. This rapid growth, attained by increasing farm area, intensification in farming practices and often high density of stocking and structures has contributed much to the supply of seafood. It has also spawned concerns over food safety and aquaculture's own sustainability. This article draws examples from and focuses on coastal aquaculture.

Editors' Note: This is an invited article and we thank NACA for the contribution. The reader gets a feel of how addressing food safety and environmental concerns to meet the requirements of the consumers and society can be a daunting task for small-scale farmers. Probing and trying to establish the links between environmental deterioration, aquatic animal diseases, food-borne illnesses, health hazards from poor aquaculture management and food safety, the article bares the complexity of the effort to encourage and enable farmers, especially the small-scale, to adopt responsible practices. A number of proven and potential technological fixes and management approaches, which the authors review, gives hope. Although some of these might not be easy nor cheap to adopt, there is reason for optimism. Summarizing the experiences from various initiatives of national, regional and international organizations including Thailand's Department of Fisheries, MPEDA and ICAR in India, NACA, SEAFDEC, FAO, WWF, WB, UNEP and others, implemented separately or in collaboration with each other, the authors highlight a fundamental finding: *that adoption of better management by organized farmers leads to more environmentally responsible and economically efficient farming, as well as better quality product — requisites to sustained fish farming, market access and competitiveness*. The authors draw attention to the International Principles for Responsible Shrimp Farming and the efforts going on to translate the principles to practice, and recommend similar collaborative efforts for other species and systems.

Food Safety and Environmental Issues

Health Benefits and Risks

"You are what you eat," goes an old saying. Medical research however, has come up with plenty of reasons to be very careful with what and how much you eat. With seafood, the advice is not to consume frequently the species that may have high mercury content. That said, findings show that consuming fish and shellfish improves one's general health, mental ability and other faculties as well. A study on the risks and benefits of fish and shellfish intake shows that *among adults the benefits of fish intake exceed the potential risks* (D. Mozaffarian and E.B. Rimm, 2006). Eating a variety of seafood is good but frequent consumption (five or more servings a week) is risky especially the species that might have high mercury levels.

(Farmed fish in general are likely to have much lower levels of mercury than their wild counterpart as the feed rations are monitored and they are harvested younger. Mercury accumulates during the life of the fish). Other studies in Britain, suggest the omega-3 fatty acids from fish are even more important than had previously been recognized. For instance, the amount of omega-3 in a pregnant woman's diet helps to determine her child's intelligence, fine-motor skills and propensity for anti-social behavior. Children of women who had consumed the smallest amounts of omega-3 fatty acids during their pregnancies had verbal IQs six points lower than average which could have a serious effect on a country's brainpower if it were widespread.

Much of the concern associated with seafood is food-borne illnesses. Some 200 different types of illness had been identified as being transmitted by food. The Center for Disease Control and Prevention (CDC) of the US estimated in 1999 that there were 76 million cases of gastro intestinal illnesses in the US of which 325 000 required hospitalization and 5000 resulted in death (N.S. Yang, 2003). A 1995 World Health Organization survey estimated that 39 million people worldwide were infested with parasites from eating raw or improperly cooked freshwater fish and crustaceans; of these 38 million lived in Asia. WHO gave the possible reasons as increasing urbanization, human and industrial pollution, improper use of antibiotics, new emerging pathogens, uncontrolled recycling of organic material, increased susceptibility to contaminants, increased consumption of mass-produced foods, introduction of "minimally processed foods", and prolonged rains, droughts or increases in average temperatures which favour the ecologies of pathogens. (This last one gives a preview of the likely impacts of climate change on aquaculture).

Human health risks associated with aquaculture also arise from pathogens and spread of disease vectors, chemicals and toxins and, as WHO listed, abuse of antibiotics. These, however, are largely manageable. Water and insect borne diseases and a range of parasitic worms, pathogenic bacteria and viruses are common to both natural and farm environments. While poorly managed intensive aquaculture may render aquatic animals more susceptible to disease, most health problems of aquatic animals do not have zoonotic potential (they are not transferable from animals to humans) and so far there is no equivalent to a BSE. Human infection comes mainly from consuming raw or inadequately cooked aquatic animals. Most parasitic worms and bacteria are destroyed through cooking and in some cases by storing fish at low temperatures. In addition, epidemiological evidence suggests that the risk to human health is low. Risk also needs to be seen in perspective with better availability of low-cost aquatic animals and better sanitation and food safety protocols, particularly in commercial aquaculture.

Agricultural chemicals, pesticides, veterinary drug residues, and accumulation of other pollutants pose hazards to farm workers and consumers alike. High levels of polychlorinated triphenyls (PCBs), dioxins and other contaminants have been reported in farmed salmon, attributed to the bio-accumulation of contaminated fish meal in feed. The levels of mercury and organochlorides in wild fish as well as farmed, are a public health concern: the latter because of possible feed contamination and, for animals raised in coastal cages, because of land-based discharges.

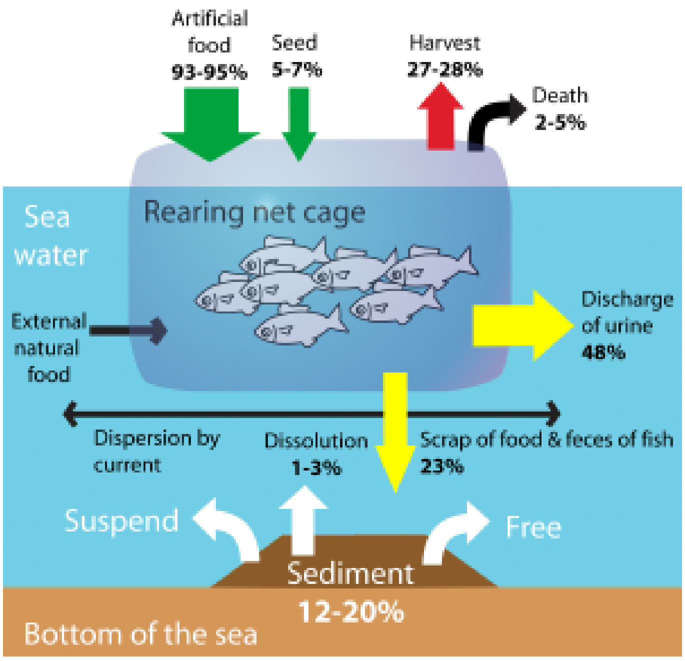
In case of bivalves (oysters, mussels, clams), the risk of human health is not only caused by industrial, agricultural and domestic sewage containing heavy metals, chemicals, pathogenic bacteria and viruses. There are also biotoxins in the water, which are produced by naturally occurring phytoplankton, typically in form of algal blooms, occurring with increasing frequency because of eutrophication of the coastal waters (Australia-New Zealand Food Authority, 2001). The most common shellfish poisonings are paralytic (PSP), diarrhetic (DSP), neurotoxic (NSP), and amnesic shellfish poisoning (ASP). Early warning systems for red tides and responses to harmful algal blooms have been successfully installed in Hong Kong, South Korea, Singapore and Japan in the Asia-Pacific region. Still, shellfish and finfish farming areas infested by toxic algal species may need to run monitoring programs to check for toxic algae in the water and, whenever these are present, carry out regular tests for toxins in seafood products. This can be costly to governments or farmers. Depuration, as well, can be a significant cost item to small-scale growers, which in any case, cannot be readily passed on to consumers.

Drug resistance from the use of veterinary drugs presents another risk — to consumers from ingestion of the drugs or residues leading to development of antibiotic resistance in human pathogens, and to workers from exposure to drugs and drug-resistant pathogens generated from release of drugs in the environment. Guidelines for the proper use of chemicals are now important components of good management practices. In Norway the decreased use of antibiotics is a result of good site selection, one generation per site (site rotation); improved culture management; effective vaccines; strict veterinary control of all farms; and strict rules for movement of live fish.

Pollution

Pollution from land-based sources and coastal fish farms invariably leads to disease outbreak requiring chemical and drug applications. Poor information or lack of good advice leads to farmers' misusing or abusing antibiotics, disinfectants and water quality improving chemicals, which jeopardize the quality and safety of fish products. Poorly sited and densely located fish cages, pens or ponds have caused water pollution that exacerbate disease and parasite outbreaks and, as some suggest, may lead to blooms of harmful algae. Environmental impacts associated with marine finfish cage culture come from nutrient inputs from uneaten fish feed and fish wastes. Although small in comparison with other coastal discharges, these nutrient inputs cause localized water quality degradation and sediment accumulation. In severe cases, this ‘self pollution’ can lead to cage farms exceeding the capacity of the local environment to provide dissolved oxygen and assimilate wastes, contributing to fish disease outbreaks.

Y. Chang and J. Chen (2006) pointed out that the impacts of sea cage aquaculture on coastal waters may be relatively insignificant compared to the impact of discharge from land-based sources (or the occasional oil spill). A study in Japan however presents a picture of serious organic pollution from highly intensified fish culture in coastal areas. Coastal water pollution from organic matter discharged by mariculture is aptly illustrated below. Calculations placed the level of pollution by mariculture in Japan as equal to the nitrogen discharge from 5-7 million people and the phosphorus discharge from 9-10 million people (T. Maruyama, 1999 cited by Y. Yamamoto and S. Hayase, 2006). Apart from the environmental impacts, a poor image of aquaculture products is feared because of residual medicine and the deterioration of the mariculture grounds and surrounding waters.



Nitrogen balance of mariculture by net cage rearing. (Case study in rainbow trout) (Hal et al 1992, modified)

Environmental Impacts and Benefits of Aquaculture

There is no doubting the links between environmental pollution, aquaculture and public health. Responsible farming practices therefore can prevent or mitigate the adverse impacts on public health as well as provide other benefits, as outlined below:

Negative environmental impacts of irresponsible aquaculture

- loss or degradation of habitats such as mangrove systems
- salination of soil and water
- coastal and freshwater pollution, e.g. contamination of water and fauna through misuse of chemicals and drugs
- alteration of local food webs and ecology
- depletion of wild resources and biodiversity for seed or broodstock
- spread of pathogens to wild stocks
- depletion of wild genetic resources through interactions between wild and cultured populations
- impacts of introduction of exotics

Modified from: “Aquaculture: Changing the Face of the Waters Agriculture and Rural Development Department,” World Bank

Technological and Management Options

Reviews presented at the “Future of Mariculture” workshop held in Guangzhou by FAO and NACA and hosted by the Guangzhou Government in June 2006 describe a number of technological solutions and management arrangements to deal with the issues of environmental impacts of, and on, coastal aquaculture. Some considerations for developing BMP in Mariculture and some of the issues and suggested solutions have been or could be incorporated into better management practices, codes of practices, market based incentives and regulations, are presented below:

Environmentally friendly feeds and feeding regimes

Although pellet diets are available for a range of marine finfish as well as some crustaceans, there remain important constraints to the widespread use of compounded diets: Farmer acceptance of pellet diets is low because they see these diets as much more expensive than trash fish. Farmers often do not appreciate that the food conversion ratios of pellet diets (usually 1.2–1.8:1) is dramatically better than that of ‘trash’ fish (usually 5–10:1, but sometimes higher).

Lack of farmer experience in feeding pellets may result in a lot of wastage. Distribution channels for pellet feed are not widely available in rural areas, which limit accessibility to and increase the cost of feed. Small-scale farmers operating fish cages may not have access to the financial resources necessary to invest in purchase of pellet diets or infrastructure such as refrigeration, finding it easier to collect 'trash' fish themselves, or in small amounts as and when financial or 'trash' fish resources are available. Trash fish collection can be an opportunity cost, which in family-operated farms may be easily absorbed, whereas the purchase of pellets is a cash cost. Use of dry pellets rather than wet feeds reduces nutrient inputs through better feed utilization (M.J. Phillips, 1998 and Y.Y. Feng et.al, 2004).

Environmental benefits from responsible aquaculture

- agricultural and human waste treatment
- improved habitat diversity and productivity
- water treatment and recycling
- freshwater water storage
- nutrient and heavy metal sink
- reduced water pollution loads
- pest control
- weed control
- disease vector control
- desalinization of saline lands
- restoration of populations of endangered species
- recovery of depleted wild stocks
- preservation of wetlands

: Meeting the Promise and Challenge of Sustainable Aquaculture"
, July 2006. in press.

Farmer carrying trash fish (photo by Chen Jiaxin)

Suggested solutions to self-pollution of sea cage sites include: (i) adoption of Better Management Practices (BMPs), including efficient feed formulation and feeding practices; (ii) keeping stocking densities and cage numbers within the carrying capacity of the local environment; (iii) minimal and responsible use of chemicals; (iv) locating cages so that there is adequate water depth below and sufficient water movement to disperse wastes; and (v) moving cages regularly to allow recovery of the sediments of affected sites.

Zoning, co-management and legislation

While there is increasing appreciation of the environmental impacts of mariculture in East and Southeast Asia, many countries lack the legislative framework or effective enforcement. Problems can be addressed by more emphasis on local planning initiatives and co-management frameworks, and zoning of coastal areas. Hong Kong SAR provides an example where the government has designated mariculture zones although critics argue that zoning has allowed too much crowding and localized water pollution (L.W.C. Lai, 2002 and Y.J. Sadovy and P.P.F. Lau, 2002). Zoning of marine fish farming areas has to be accompanied by control measures that limit farm numbers (or fish output, or feed inputs) to ensure effluent loads remain within the capacity of the environment to assimilate wastes. Aquaculture development plans need to consider competing objectives on the use of the coastal lands and water, include regulations that limit aquaculture development within appropriate levels, and devise a robust, cost-effective environmental monitoring system appropriate to tropical mariculture.

Use of low-trophic species

Cultivation of low-trophic-level marine species could alleviate some of the impacts of farming animal species that require high levels of organic inputs, such as marine finfish. There are two ways to achieve this: (i) direct replacement of high-input species with low-input species, *e.g.*, replacing production of carnivorous finfish (such as groupers) with omnivorous species (such as milkfish and rabbitfish); and (ii) promotion of low-trophic-level species that act as 'sinks' for the waste products from high-input aquaculture. Such species include mollusks, sea cucumbers and seaweeds. A constraint to adopting low-trophic-level species is price; most species are relatively low-priced, the exception being sea cucumbers, scallops and abalone.

Phytoremediation

Studies on freshwater decontamination with plants have shown the efficacy of some species, especially water hyacinth, in accumulating heavy metals. But few studies have been conducted on marine macroalgae. Although a number of species such as *Ascophyllum nodosum* and *Sargassum aquifolium* are known to accumulate metals to as much as 30% of the biomass dry weight. Some unicelled marine algae, *Tetraselmis suecica* and *Chlorella* spp. NKG16014 are being used in heavy metal bioremediation. The gametophytes of *Lemna japonica* have demonstrated in experiments their efficiency as heavy metal decontaminator, especially cadmium (Naihao Ye, 2005 cited by Y. Liu, 2006).

Integrated coastal aquaculture

Integrated aquaculture is broadly defined as the culture of a range of trophic-level organisms whereby outputs from one species can be utilized as inputs by another species. China has the best examples of large commercial-scale integrated mariculture where suspended multi-species aquaculture operates at scales of whole bays. For example in Sungo Bay, East of the Shandong Peninsula, scallops are cultivated together with kelp, abalone and fish in cultures extending 8 km offshore (M. Troell, 2006). Integrated practices provide additional income from co-cultured crops and reduce nutrient release to the water. Other benefits are the facilitation for re-circulation of waters (through ammonium removal and oxygenation by seaweeds), which could reduce pumping costs. The additional crop, which is the extractive organism generates an economic value or be used as input to co-cultured species. Additional arguments for integrated mariculture include possible social benefits and diversified production to reduce risk and increase income. But it also entails additional costs such as additional investments, maintenance and need for higher skills.

Rope cage (top) and a submersible cage manufactured by FMIRI,Shanghai (above) (Photos by Chen Jiaxin)

Offshore cage farming

While a host of technical and economic issues remains to be resolved, offshore cage farming presents an attractive option for governments to promote. Its advantages include expansion of space for mariculture without occupying precious land, abating the eutrophication of seawater, increasing opportunity for employment of displaced fishers and generating new enterprises such as the manufacture of cages and accessory instruments and equipments for monitoring, grading, and feeding. With improved design and better materials, sea cages are better able to withstand typhoon and swift current. It can also be more technically efficient than traditional near-shore cages (J. Chu, 2006)

Artificial reef

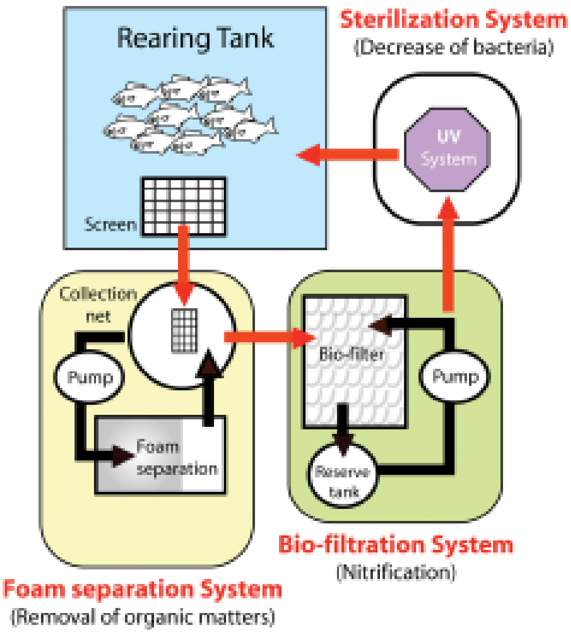
Another promising technique is the use of artificial reef (AR) as biofilter in a fish culture zone. A study in Hongkong showed that it can be an efficient device to remove nutrients from fish farms: i.e., 16 pieces of 3m x 3m x 4m specially-designed AR removed 2352 kg of carbon, 624 kg of nitrogen and 103 kg of phosphate a year (J. Chu, 2006).

Items	Traditional cage	Offshore cage
Survival rate of fish (%)	70%	> 90%
Cage volume (m3)	< 100	> 1000
Capacity against wind (km/hr)	< 100	> 110
Capacity against current (m/s)	< 1	< 1.5
Capacity against wave-height (m)	2	> 6
Life span of cage (year)	< 3	> 10
Sea site suitable the cage	Inshore and sheltered only	Offshore, exposed
Yield (Kg/m^2)	about 5	> 20
Input-output ratio	1 : 1.3 - 1.5	1 : 1.5 - 2.0

Artificial reef with mussel ropes around the structure (photo by Agriculture, Forestry and Conservation Department, Hong Kong)

Land-based closed recirculation system

Closed recirculation systems are designed for "zero emission". This Figure illustrates an almost complete system control, which gives the following benefits: less pollution, less external risk (*e.g.*, disease and bad water quality, *etc*.), stable productivity and lower energy use. Development of the closed recirculation system for seed production of red sea bream started in the Yashima Station in Japan, in 2000.The system consists of: (i) foam separation unit; (ii) bio-filtration system; and (iii) UV system. The foam removes organic matter in the rearing water, the biofilter converts nitrogen waste into less harmful form, and the UV system kills bacteria. The technical efficiency of seed production (of red sea bream) by this system is higher than that of flow-through rearing. Japan plans to use this system for other species that are difficult to produce (Y. Yamamoto and S. Hayase, 2006).



Seed production by closed recirculation system in Yashima station, NCSE, FRA

Closed systems are well developed in some EU countries and Australia. Some Australian farms raising barramundi (*Lates calcalifer*) grow vegetables in hydroponics (also called aquaponics); the vegetables strip the nitrate from the water and are an additional farm product.

Better Management Practices in Aquaculture

An approach to improving the sustainability of aquaculture has been the development of Better Management Practices. BMPs have been widely tried in shrimp culture. The

- The profitability of small cage culturists has gone down,
- Coastal waters are becoming more polluted from land based sources, exacerbated by poor sewage treatment facilities,
- They have suffered from disease outbreaks,
- Cost of production has gone up although prices for certain species (the seed supply of which is not enough) remain good in the Hong Kong and local markets,
- Some have gone back to fishing and, while scallop farming could be more profitable, it is labor intensive for a small family,
- They know of but have no capital to invest in offshore cages, and
- The younger generation has not shown much interest in fishfarming

development of BMPs for mariculture particularly on tropical marine finfish started recently. To place BMPs for mariculture in a socio-economic context, a glimpse at the circumstances and prospects of a coastal farming village called Nan Hu in Guangdong Province which provides some insight into the problems faced by coastal fishfarming communities in Southern China, and likely in many other areas in the region, is briefly summarized below.

In contrast, mechanized large scale companies are being established in the area, which are likely to be more cost-efficient and could employ people from the villages.

This social and economic backdrop suggests a difficult pathway to the promotion and adoption of technological and management approaches. In technical advisory-speak the approach would require "a governance framework consisting of an appropriate mix of regulatory, market incentive, and voluntary instruments". Technologies as those described earlier, and regulatory measures as those suggested would enable the farmers to raise aquatic products that are safe and wholesome and reduce the impacts of pollution on and from fishfarming. The benefit to society would be mitigation of pollution and other adverse environmental impacts. The benefit to consumers is safe and quality product. The bottom line for the farmers would be whether or not it makes economic sense to adopt these measures.

Some Lessons from Shrimp Aquaculture

Projects that have promoted the voluntary adoption of BMPs among small shrimp farmers in India and Vietnam and a program on Code of Conduct in shrimp aquaculture in Thailand give evidence of the benefits of being organized into self-help groups or formal associations and adopting better management practices. These range from individual private benefits such as higher production, better chances of increasing profitability, less losses from disease, etc., to social and environmental benefits such as less or non-use of antibiotics and therefore no discharge of these into receiving waters, less pollution, and a better cooperation among players along the value chain.

Thailand's "Farm to Plate" program was launched in 2003 to promote an international image of safe and responsibly produced aquatic food products. This encompassed good aquaculture practices, a code of conduct program in shrimp, traceability schemes, detection of banned chemicals and drugs, HACCP and other standards and quality certification schemes in food handling and processing. For shrimp farming, a Good Aquaculture Practice (GAP) which is food safety-targeted and a Code of Conduct (CoC) program, which is environmentally oriented and designed to reduce disease risks and pollution, were devised. An analysis of the CoC program of Thailand suggests that a voluntary management scheme would need supportive measures largely to improve farmers' perceptions of long-term benefits and reduce perceived risks. A green insurance for instance would reduce perceived risks associated with adoption of the CoC standards (T. Pongthanapanich and E. Roth, 2006).

The analysis also recognizes that farmers organizations would facilitate the provision of assistance and points out that being organized induces self-monitoring and -inspection within the group. As such, implementation of a voluntary scheme is likely to be more effective than using legal sanctions, or more acceptable than using market- based tools to protect the environment.

To sum up, better management practices are adopted voluntarily. For best effect they should be developed with the farmers who are going to use them, and should be adopted by farmer groups. BMPs could be devised to provide an economic incentive for farmers to exceed market-based standards rather than comply, largely to avoid penalty, with a bureaucratically-set standard or piece of regulation. Success in implementing regulations depends on the effectiveness of enforcement, which relies on supportive institutional structure. Enforcing compliance is often difficult and expensive. And, if done with excessive enthusiasm, it could stifle growth, lead to inefficiencies or present an opportunity for corruption.

Conclusion and Way Forward

Regional cooperative activities

The workshop, "Future of Mariculture" had recommended a number of regional activities. Three are relevant to this article:

Review of the COC/GAP/BMP systems for the region

This means working on a basic set of harmonized principles of better management from which commodity- or system-specific principles or standards could be developed. Much work has been done on shrimp but limited attention is being given to mariculture species[1].

Pilot activity on labeling according to emerging BMP for some specific pilot sites and commodities

This will initiate dialogue on the emergence of specific commodity or systems-based BMPs such as *BMP cage mariculture; BMP mollusk mariculture*. As with the shrimp consortium, a consortium model would be developed among institutions to start developing issues-based awareness and information on principal mariculture areas. An expert consultation on one or two key species for setting out some baseline standards for production and quality would be organized.

Special attention on food safety issues

This would include veterinary guides of diseases and allowed therapeutants, contaminants and residues, an agreed list and awareness brochure, and a watch list. Work should also be done towards harmonizing traceability and food safety systems with the needs of importing countries.

Moreover, training on detection and analysis of chemical and drug residues, which requires standardization and harmonization of laboratory facilities and procedures, would be conducted.

To conclude this article, we quote from a World Bank review on aquaculture conducted in 2006, thus, "There is a need for the governance framework for a rapidly expanding aquaculture sector to adapt so that the sector becomes or remains responsible; good environmental practices improve fish health and economic returns; as food safety requirements are harmonized at international levels, quantitative risk

1 International Principles for Responsible Shrimp Farming. 2006. *www.enaca.org/shrimp*. This comprises eight principles that had been synthesized from the outcome of several studies and a series of consultations conducted by the Consortium on Shrimp and the Environment which members are FAO, NACA, WWF, WB and UNEP. The principles and implementation guidelines may be used to develop locally specific codes of practice, better management practices or other management approaches.

assessment and traceability are becoming integral components of aquaculture management; and improved dialogue and coordination among engineers, public health officials, veterinarians and regulators will improve the environmental services from aquaculture, reduce health risks, avoid trade restrictions and improve profitability."

Acknowledgement

This article is based on a paper presented by Pedro Bueno at the International Conference on Environment and Public Health Management, convened by the Croucher Institute for Environmental Science, Hong Kong Baptist University, 7-9 December 2006. Hong Kong China. The paper, which is referenced, may be obtained on request from *pedro.bueno@enaca.org*. *Eds*

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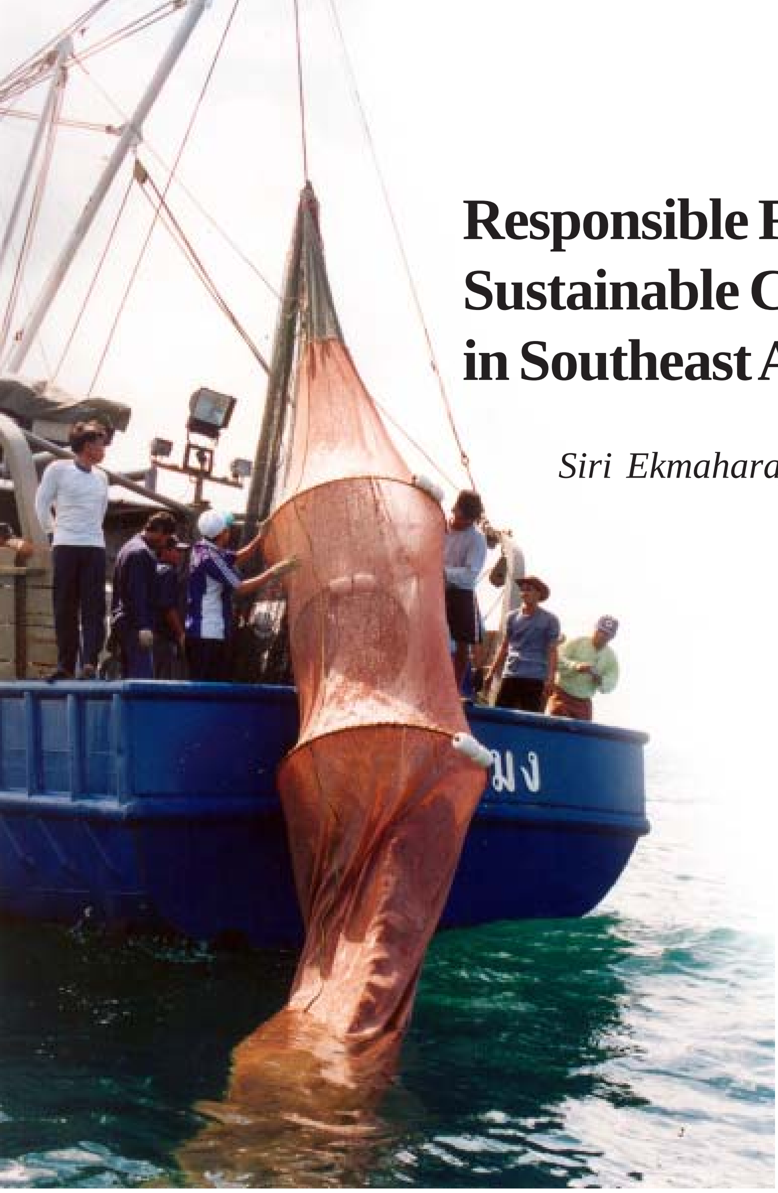


Responsible Fishing Technologies and Sustainable Coastal Fisheries Management in Southeast Asia

Siri Ekmaharaj

Established in December 1967 for the purpose of promoting sustainable fisheries development in Southeast Asia, the Southeast Asian Fisheries Development Center (SEAFDEC) has been working in partnership with countries in the region and other institutions worldwide to assist the region on sustainable fisheries development for food security and improvement of the livelihoods and well-being of the Southeast Asian people.

In Southeast Asia, fisheries provide significant means of livelihood and food security particularly to people living in the coastal areas. Relentless population growth and accelerated economic development in the region have brought about a rapid expansion in fisheries, causing an enormous pressure on the fish and other aquatic resources, leading to rapid depletion of fish stocks, and severe disruption and degradation of ecosystems and fish habitats.

In response, SEAFDEC and its member countries are working on establishing better management of the region's coastal fisheries. The strategic approaches focus on capacity building and participation of stakeholders in coastal resource management and community development; rights-based fisheries; and co-management system for coastal fishing communities. Responsible fishing technologies, particularly the use of Turtle Excluder Devices (TEDs) and Juvenile and Trash Excluder Devices (JTEDs), have been promoted to reduce and minimize undesired fishing impacts on the fish resources.

Overview of Fisheries in Southeast Asia

The Southeast Asian region covers a large expanse of maritime and inland waters in the tropics. The region is rich in productive aquatic resources from its surrounding seas and inland waters including the Mekong River and other big rivers, lakes and reservoirs. In Southeast Asia, fisheries production is important not only as a source of protein but also as means of employment, and income generation through domestic and international trade.

According to the FAO 2004 statistics on fisheries and aquaculture, the production of fish from both marine and inland waters in Southeast Asia contributed significantly to the world fisheries production. Furthermore, FAO reported that the increase in capture fisheries production in Southeast Asia has been very strong for the past four decades during which the production of marine capture fisheries increased to about 14 million mt in 2002. Together with rice, eating fish and fish products constitutes as almost a "way of life" for the majority of ethnic and religious groups in Southeast Asia.

Many countries in the region are ranked among the world's top 20 producers in capture fisheries, with some countries experiencing an annual increase of up to 5%. Pelagic fishes dominate the landings by volume and value, as demersal fisheries are largely over-exploited. Fisheries in Southeast Asia are small-scale and operated in coastal areas. Most fish catch is landed in small and decentralized landing places for distribution to domestic markets through a very complex marketing network. With abundant tropical fishery resources, the fish catch in Southeast Asia predominantly comprised many species. Most fishers rely on harvesting different species for their livelihood and rarely on one particular target species. Consequently, the fishers usually find it difficult to clearly define and understand the by-catch issue. The ecological features of tropical organisms, e.g., fecundity, migration or productivity, are very different from those in temperate waters. The monsoonal climate and ecosystems such as coral reefs, mangrove areas, sea grass base and other critical habitats are also unique to the tropics. This complexity requires new and innovative fisheries management approaches, which are based on specific local fisheries conditions. The most promising underlying principle for managing such complexity empowers the coastal fishing communities to deal with the present pressures and solve problems through co-management approaches, i.e. in partnership with local and national fisheries institutions.

SEAFDEC's Role in Sustainable Fisheries Management

With its 11 member countries: Brunei Darussalam, Cambodia, Indonesia, Japan, Lao PDR, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam, SEAFDEC aims to develop the fisheries potential in the region through research, training and information services to improve the food supply through rational utilization and management of the fishery resources. With adoption of the Strategic Plan in 1998, SEAFDEC placed its emphasis on activities related to the development of regional fisheries policy and on the establishment of ASEAN's common position on fisheries issues. In 2001, with the adoption of the Resolution and Plan of Action on Sustainable Fisheries for Food Security in the ASEAN Region, the efforts of SEAFDEC have been focused on the promotion of sustainable fisheries ensuring food security for the people.

In order to fulfill its mandate, SEAFDEC initiates fisheries programs to provide a regional platform for priority fisheries issues, exchange of expertise and experience, policy development and technical advice to support national fishery initiatives towards sustainable development of fisheries. Thus, for the effective implementation of regional fishery programs and enhancement of the impact on sustainable

fisheries development in the region, SEAFDEC collaborates closely with the Association of Southeast Asian Nations (ASEAN). With SEAFDEC's technical fisheries capability, the ASEAN member countries recognize that mutual benefits related to regional fisheries activities could be gained from the collaboration. In 1999, the ASEAN-SEAFDEC Fisheries Consultative Group (FCG) was established as a strategic alliance to pool resources and to avoid duplication of efforts. The FCG is mandated to identify important regional/international fisheries issues, provide technical assistance to ASEAN in the formulation and implementation of common policies, and to assist its member countries in formulating common positions on regional/international fisheries issues.

Responsible Fishing Technologies and Practices

One area of concern is the widespread use of damaging fishing techniques. The case in point is the shrimp trawl, which can cause serious damage on the marine environment especially on non-target organisms, such as the indiscriminate catch of sea turtles and juvenile fishes. The by-catch of juveniles and trash fish, once seen as unwanted and a waste of valuable resources, has caused negative effect on the fishery resources. Although such catch may present low economic value to fishers, it can comprise high value species in the future, if these are allowed to survive and grow to commercial size. To ensure the sustainability of the resource, avoiding such kind of catch should be a priority. Over the last years SEAFDEC has been actively engaged in the development and promotion of responsible fishing technologies and practices, that have the potential to significantly reduce such "by-catch".

The Turtle Excluder Devices (TEDs) and Juvenile and Trash Excluder Devices (JTEDs) were promoted in the region to avoid catching of sea turtles, other endangered species, and juvenile fishes by trawlers. These devices were introduced to fishers and managers in the Southeast Asian region, through training and pilot demonstrations.

TEDs

Turtle Excluder Devices (TEDs) and various types of Juvenile and Trash Excluder Devices (JTEDs) were tried, modified and improved to reduce the by-catch at different sites in SEAFDEC member countries.

The SEAFDEC Training Department (TD) in cooperation with the Department of Fisheries of Thailand, designed a TED known as the Thai Turtle Free Device (TTFD). This device was developed in consultation with scientists and after discussions with the fishers and stakeholders, and was modified after a series of repeated field tests. Thus, various types of TEDs have been designed, constructed and tested in order to develop the most effective and practical TED suitable for the Southeast Asian waters. Recently, the TTFD has been certified by NOAA (USA) and is now widely promoted to prevent the catch of marine turtles especially in the waters of Thailand and those of the SEAFDEC member countries.

Moreover, SEAFDEC in collaboration with ASEAN started on a comprehensive program to investigate the impact of fisheries on the marine turtle populations. The collection of information from this program will provide a valid base for the appropriate management and conservation of marine turtles. In particular, the program covers incidental catch, distribution, and migration routes, together with some research work on turtle hatchery operations. It also emphasizes the importance of continuously promoting the adoption of TEDs to prevent the incidental catch of the marine turtles.

JTEDs

The other important device developed to prevent the catching of unwanted juveniles and trash fish is the JTED. The research on JTEDs was initiated by SEAFDEC/TD in

JTEDs (below) and TEDs (right) as selective fishing devices to promote responsible fishing technologies and practices in Southeast Asia

1998. Originally, two types of JTEDs were developed to be attached to the upper part of the cod end of a trawl fishing gear. The device comprises a rectangular-shaped window and semi-curved window, both made of a stainless steel frame 80 cm x 100 cm. The frame is covered with 'soft' separator gratings made of 8 mm polyethylene rope to separate the small catch from the larger catch. Different spacing between the soft separator gratings were set to investigate the level of escape from the net. After a series of field tests and demonstrations on the effectiveness of these devices, two types of JTEDs were finally developed and promoted: the Rigid Sorting Grid and the Semi-curved Rigid Sorting Grid.

Another study was conducted by SEAFDEC/TD to assess the performance of JTEDs in fishing operations, catch loading and water 'drag' as well as the effects of various towing speed on the net's deformation. All these factors can influence the escape potential of the JTEDs. Thus, many sea trials and experiments on the release of juveniles and immature commercial fish species using various kinds of JTEDs have been carried out in the region. The trials and experiments were conducted off the coasts of Prachuab Kiri Khan and Chumporn Provinces in the Gulf of Thailand, Muara Town of Brunei Darussalam, and Cat Ba Island in Hai Phong Province of Vietnam. More recently, tests were also conducted in the coasts of Alor Star, Kedah State of Malaysia, Manila Bay of the Philippines, Sorong, Bintuni, Arafura seas and Papua of Indonesia, Myeik and Tanwe of Myanmar and in Sihanoukville of Cambodia.

The JTEDs have since been improved and adopted by more resource users and stakeholders after understanding the device's performance, and have been refined to suit their fishing practices for the benefit of the fishery resources.

Sustainable Coastal Fisheries Management

The overexploitation and conflict on the uses of natural resources in coastal zones by fishing communities often lead to loss of access to and control over the fisheries resources, further reducing fishery production and resource values. Considering that this problem needs to be addressed as a priority, SEAFDEC initiated a number of pilot projects aimed at achieving the sustainable use of coastal resources to support the livelihood of the communities.

Locally-Based Coastal Resource Management

This project aims to alleviate poverty in coastal communities, as poverty and insecure livelihoods are one of the driving factors of unsustainable use of fishery and other coastal resources. The project has been implemented to stimulate and encourage people's participation in coastal resource management and community development, which would contribute to the establishment of local community groups for the development and management of their own resources. The local management body could also promote the establishment of local businesses creating job opportunities inside and outside the fishery sectors of the community. In addition, the local management body could also encourage the people to participate and develop activities that would strengthen the people's awareness on managing their resources.

A Locally-Based Coastal Resource Management Project (LBCRM) was therefore established as a pilot project in Chumporn Province in Thailand. SEAFDEC/TD and the Department of Fisheries of Thailand collaborated in the conduct of the project under the ASEAN-SEAFDEC Fisheries Consulting Group (FCG) mechanism. The most pressing problems identified at the project site were coastal resource degradation, underemployment of local people and community poverty. Community based co-management was identified as the most appropriate approach to implement

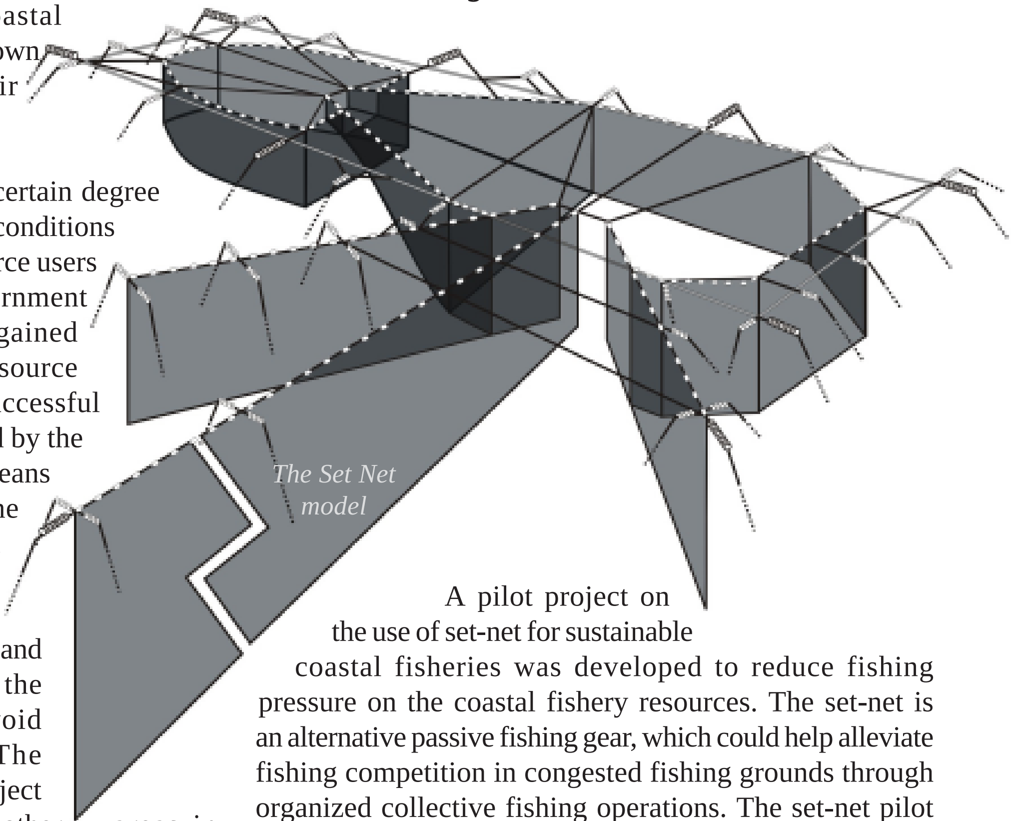
Consultation with local fishermen for fisheries co-management (top); and fishers planting mangroves to rehabilitate the natural resource (above) the LBCRM project. Local government agencies, the fishers and other stakeholders were encouraged to participate in the decision-making process on coastal resource management, employing their own sustainable fishing methods in their immediate coastal areas.

The project succeeded in achieving a certain degree of improvement in the people's living conditions and reduction of conflicts among resource users by sharing the fishing ground. Government officers, stakeholders, fishers, etc. gained understanding on community and resource management. Furthermore, a very successful crab bank program (in Box) established by the fishers, was promoted. It serves as a means of responsible use of resources by the communities themselves. Additionally, fishers participating in the project and using collapsible crab traps agreed to modify their gear to be more responsible and environment-friendly by expanding the bottom mesh size of the trap to avoid catching the small-sized crabs. The successful outcomes from this pilot project proved that this model was applicable to other areas in the region.

The experience and knowledge gained from the pilot project has been disseminated to other member countries through the SEAFDEC information transfer mechanism. As a result, Brunei Darussalam, Indonesia, and Myanmar have expressed their intensions to initiate similar projects in their countries, while comparable projects are already implemented in Malaysia and Cambodia.

> **Crab Bank Program**
>
> Crab Bank Program, which was first implemented in Banpred Village of Trad Province in Thailand, is a scheme used to conserve the crab resource. It is usually established by the community as part of their effort in coastal resource management. The fishers deposit their caught berried female crabs in cages maintained by the program until they spawn. After spawning, the crabs are sold by their weights in local markets with the proceeds proportionately shared: 50% of the sales is returned to the fishers who turned over the berried crab, 40% is retained by the Program for maintenance of the cage facilities and equipment, and 10% is allotted for the feeds. Under this Program, the fishers' motivation and morale have been very high.

Use of Set-net to Develop Sustainable Coastal Fisheries Management


The Set Net model

A pilot project on the use of set-net for sustainable coastal fisheries was developed to reduce fishing pressure on the coastal fishery resources. The set-net is an alternative passive fishing gear, which could help alleviate fishing competition in congested fishing grounds through organized collective fishing operations. The set-net pilot project aimed to develop a common policy concept of fishery management for fishing areas occupying wide fishing grounds. The project also aimed to assess the feasibility and environmental impact of installing large stationary fishing gear. During the implementation of the project, various types of set-nets appropriate for specific fishing grounds were designed and modified. Monitoring was conducted to determine the efficiency of the gear especially with regards to the design, installation position, harvest operation and maintenance.

Another activity conducted was the transfer of information, which would lead to understanding of the advantages of


Set Net operation

the set-net. This involved organizing local fishermen and their leaders, and encourage them to participate in set-net preparation, installation and operation. A project evaluation was conducted through technical seminars attended by scientists, fishing gear specialists, fishers in the set-net group, and other resource users. The result of the project showed that the set-net is an appropriate fishing gear for coastal fishing grounds considering their environmental conditions and the community's participation.

As the fish caught in the set-nets are of good quality, the fishers using the set-net can increase their catch value. The fishermen who were involved in the project, had the chance to work under a group cooperation and management, facilitating future cooperative development. The fishermen also gained more knowledge on the fishery resources of coastal fishing grounds and the utilization of the resources as a group, in a responsible manner.

Capacity Building on Coastal Resource Management

One of the main reasons for the lack of success in modern fisheries management is the top-down approach which leaves the fishing communities completely out from the decision-making process. This leads to the building up of barriers between the fisheries administrations and the fishing communities. In view of this, SEAFDEC/TD offers training courses on Coastal Fisheries Management for Fishery Managers. The participants are the fishery managers who provide information to the decision makers in formulating and transforming policy into management plans.

The training course is aimed at extending the knowledge and experience of fishery managers on sustainable coastal resource utilization and management with practical methods and approaches in coastal resources management under different conditions. It also intends to strengthen the participants' practical competence in planning and implementing applicable coastal fishery management plans. Participants undertake simple research studies on several management issues and discuss these with project officers, local institutions and the fishermen. SEAFDEC hopes that through this training course, the gap between what is implemented in the field and what is happening in central government offices can be reduced.

Another important training course is on Coastal Fisheries Management and Extension Methodology, which targets the extension officers dealing with the communities, as participants. The course aims to familiarize the participants with the principles, concepts and needs for basic changes in coastal fisheries management and the roles of fishing communities in the sustainable development and management of the coastal resources. The course capitalizes on the fact that extension techniques and methodologies are tools for communication between the fishers and fishery organizations. During the course, the participants make use of active extension tools and methods in gathering information on the ground situation and present the problems to the communities thus, leading directly to problem solving. Capacity building on extension services with knowledge and experience through the extension officers is instrumental for the success in fisheries resources management.

Sustainable Utilization of Potential Fishery Resources and Reduction of Post-harvest Losses

Short supply and ever-increasing demand for fishery products require greater efficiency in utilizing the fish catch. This means that there is the need to reduce wastage and losses during harvest operations and post-harvest processing. One way to achieve this is to improve fisheries technologies in harvesting (onboard and onshore), processing and distribution of the fishery products from the fishers to the consumers. SEAFDEC considers improved technologies for food safety in fish handling and preservation as among the most important issues that need to be developed and implemented in the region. As an example, many countries in the region are still using low-level technologies in fish handling due to lack of chilling and preservation facilities, causing high wastage due to poor hygiene and spoilage.

Thus, SEAFDEC initiated a study on appropriate on-board fish handling and preservation technology in the Southeast Asian countries with the objective of developing an appropriate technology on handling and preservation of fish at sea. The study had two components: (1) research on the improvement of fish handling technology for medium-scale fishing boats; and (2) training on fish handling and preservation techniques.

For the research on the improvement of fish handling technology for medium-scale fishing boats, refrigerated containers with chilled seawater system (Super Chill) was developed. This involves maintaining/keeping the temperature of chilled seawater as long as possible without adding large amounts of ice. This technology was transferred to fishermen and fishing boat owners, many of whom did not have even a basic knowledge on fish handling and preservation, and thinking that having only ice is enough to preserve the fish.

For the second component of the project, training on fish handling and preservation techniques has been conducted on-site in different countries in the region. Specifically, the training was conducted at the Permankat Fishing Port and

Semarang Fishing Technology Training Center in Indonesia; in some fishing villages and fisheries colleges in Thailand; at the Myanmar Fisheries Federation; with many groups of fishermen in Nha Trang, Vietnam; and with the trawl fisher groups in Singapore. At present, many fisheries groups are already familiar with the Super Chill technology and many fishing boats apply it in their fishing and carrier boats. Furthermore, the knowledge and techniques on the use of the Super Chill have also been transferred to government officers, stakeholders, college instructors, and students who are expected to promote the technology to other interested parties. SEAFDEC hopes that this technology will help the fishermen improve the quality of their catch.

CONCLUSION

There are many internal and external factors affecting the state of the coastal resources that include environmental deterioration as well as socio-economic pressure, which eventually impact the livelihood of coastal people. Given the fact that majority of the fishers in the region still predominantly practice semi-subsistence fishing, better management of the coastal resources and community fisheries is fundamental to ensure long-term food and financial security for coastal communities now and in the future. The coastal communities can actually play a greater role in coastal resources management than previously practiced. Lessons learnt from many projects implemented by SEAFDEC show that the success of the projects is based on factors like (1) adequate financial support, clear work plan and effective organization; (2) appropriate policy and regulation with back up from the central and local governments; (3) support of local institutions and cooperation among the project stakeholders; and (4) responsible project staff. The future of resources management lies in the ability of the fishers and the coastal communities to implement management regulations and technologies through co-management systems that ensure cooperation and partnership among all stakeholders.

SEAFDEC has greatly contributed to the fishers' growing awareness on the need to secure the marine fishery resources for their livelihood by adopting sustainable utilization of the coastal resources, and the need to protect the coastal habitats and biodiversity.

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Capacity Building for Innovative Coastal Fisheries Management:

Addressing the Changing Role of Fisheries Extension and Development

Theo Ebbers, Panitnard Weerawat and Arpaporn Eiamsa-ard

The changing nature of fisheries in Southeast Asia poses tremendous challenges for all those who are involved in the management of the sector. Faced with severe resource degradation and widespread poverty among fishing communities, both governments as well as the private sector are struggling to cope with the social, economic and environmental transformation the fisheries sector in Southeast Asia is undergoing. Increasing numbers of fishers are fiercely competing for decreasing resources, thereby escalating tensions and conflicts over aquatic resources. New stakeholders such as tourism and environmental conservationism claim responsibilities and competence for aquatic resources management from traditional fisheries management agencies.

Having no room left for a further expansion of the sector, these fisheries agencies are increasingly shifting their focus from fisheries development to management and conservation of fisheries resources. This change in direction poses new for fishers, fisheries officials and managers and other stakeholders in the sector, who have to rethink the ways they approach and view the sector and use fisheries resources. To cope with these challenges, stakeholders need new skills that will enable them to take up new roles and responsibilities arising from these changes. Considerable capacity building and human resources development for fisheries stakeholders, particularly for fisheries officials and extension workers are needed to prepare traditional fisheries agencies for their new roles and responsibilities.

Flashback: development and fisheries as engine for growth

With the "invention" of development and during the post-war growth optimism of the 1950s and 1960s, ocean and fisheries scientists enthusiastically proclaimed the oceans and their fisheries resources as the basis for satisfying the world's ever increasing hunger for protein; optimistically they predicted global fish production to reach 500 million mt annually. Facing seemingly limitless resources, the world welcomed and promoted the arrival of new technologies, which promised to increase and improve the harvest from the riches of the oceans. Echo-sounders, synthetic fibers, powered winches, on-board refrigeration and other technological advances were eagerly taken up by the fisheries sector to increase production. Encouraged by developments in other countries, newly independent and so-called developing countries discovered fisheries as an important source for rural growth, income generation, food supply and foreign exchange earner. Aid and development programs for these countries included extensive measures to build up modern motorized and mechanized fishing fleets.

One well-known and studied example of such modernization and expansion of the fisheries sector is the tremendous growth of fisheries in Thailand during the early 1960s, which started with the introduction and promotion of otter-board trawlers in the Gulf of Thailand. The following explosion-like expansion of the Thai trawler industry saw an increase in the number of trawlers operating in the Gulf from 99 in 1960 to 2700 in 1966; landings rose from 59,000 to 360,000 mt during the same period (J.G. Butcher, 1999 and D. Pauly and R. Chuenpagdee, 2003). This development of the Thai fishing industry reflects and typifies the optimistic atmosphere of ostensibly unlimited growth and development.

Impressed by such tremendous growth rates as were witnessed by the Thai fishing industry, governments in Asia and elsewhere were encouraged to further promote fisheries as a tool for the emerging development objectives of poverty reduction and food security. Not only large-scale commercial fishing operations, but coastal small-scale fisheries and aquaculture were seen as crucial in creating employment and increasing rural incomes. Providing small-scale, artisanal fishers, with outboard engines for their traditional crafts was the least one could do to improve their livelihoods. If and where traditional boat designs were deemed unsuitable for these new technologies, new boat types were introduced and provided by benevolent donor and aid agencies. Just one of the many examples of this view on fisheries and fishery development is reflected in the "Report of 1st Advisory Committee Meeting, October 28 and 28, 1976, Colombo, Sri Lanka" of what was to become the Bay of Bengal Programme. The countries represented during this meeting identified, among others, the "inadequate gear and equipment", "inadequate technological know-how" and "low level mechanization" as the main constraints and issues affecting the development and functioning of the fisheries sector. Consequently, the mechanization of craft and suitable engines, supply of boats, the introduction of synthetic nets and mechanical as well as electronic aids for better fishing were identified as priority issues to be supported by technical inputs and training.

"Teach a man to fish...

…and you will feed him for a lifetime" as a synonym for helping people to help themselves became something like a basic paradigm for fostering development in general. Taking this literally, national fisheries agencies established extension systems for the promotion of a further expansion of the sector and for improving the fishers' capacity to catch more fish. Taking the lead from countries like Japan and the Soviet Union, fisheries schools and colleges emerged in many developing countries, to provide the knowledge and skills deemed necessary to support this drive for maximizing fisheries production.

Graduate and post-graduate courses in fisheries sciences were established during which the students were taught fishery biology, fishery technology and fishery economics. Fishery biology and its various models for stock assessments served to predict potential yields, while fishing technology provided increasingly efficient means for realizing these. In other words, technological advances in increasing the efficiency of fishing operations were promoted enthusiastically.

Thus equipped with the latest knowledge on how to make optimal use of fisheries resources, graduates of these courses joined fisheries institutions like national Departments or Ministries of Fisheries and started to implement extension programs aimed at modernizing the sector. Research and technical advancements in fishing and related technologies determined the content of the extension programs; transfer of new knowledge on fishing gear, efficient fishing methods, fish handling, processing was seen as the driving force for fisheries development. Guided by a vision of progress, fisheries institutions and their extension agents were convinced that the knowledge and skills they had to offer to fishers would enable them to create growth and both contribute to and benefit from the increases in wealth thus generated.

When it became apparent, that the benefits of this growth were not always distributed equally, with some communities and sections of the population being left out, extension services became "target-group oriented", with the objective of extension shifting from promoting the growth of the sector to meeting the needs of the fishers and resource users. Extension programs were now ideally built around the real (and not the perceived) needs of the resource users, with expert agencies providing the solutions people and communities were asking for.

The following excerpt from "Fisheries Extension Services for Coastal Provinces - Learnings from a Project in Ranong, Thailand" nicely describes and typifies this kind of extension services approach nicely. According to this, extension activities could be classified as:

"- Adapting, demonstrating and extending capture fisheries and aquaculture technologies;
- Facilitating credit to fisherfolk;
- Promoting income-generation activities for women in the fishing communities;
- Enabling fisherfolk access to social services provided by other cooperating agencies; and
- Providing support to fisherfolk in the creation of infrastructure.
....Broadly speaking, a pattern emerged:

When an activity was identified, either due to fisherfolk requests or due to suggestions from the DOF and/or BOBP, discussions were held with the community and, in some cases, further studies were undertaken to better understand the problem and its context. There followed a technology development stage, particularly where a technology had to be adapted to the local ecosystems, and this was more pronounced in the case of aquaculture; where a technology already existed in some other part of the country, video films were used to explain to the fisherfolk the technology and its implications. This was also found to be an excellent way to identify potential fisherfolk and farmers for participation in trials and as beneficiaries. The group was then taken on a study tour to give them a hands-on view of the technology functioning and also to enable them to discuss the technology and its pros and cons with fisherfolk more experienced in the practice. Extension through demonstration followed, often with some credit support. Parallel activities were conducted to mobilise the fisherfolk into groups for credit. A variety of training programmes were held to build up capacity. Finally, the activity was continued over a period of time, under supervision, until the capacity was built up by the fisherfolk to sustain it on their own" (R. Roy, 1994).

The extension processes described here, reflect the changes that occurred in the sector during the 1980s and a further orientation towards what was then called "integrated development". The process described here reflects some basic changes in extension services away from a purely technical fisheries focused orientation to a wider approach of livelihood development and poverty alleviation. Pilot projects and activities were initiated and supported to improve the living conditions of coastal communities and fishers.

This new target group orientation and focus on the real or perceived needs of fishers and their communities, however did not change the general mode by which extension services were carried out. Very much in line with the existing conventional ways of administering fisheries management, extension services were built on a top-down approach through which experts provided what they thought were solutions to local issues and problems. Just as fishers and fishing communities were expected to follow fishing regulations formulated by management experts working with national fisheries agencies, they were supposed to receive and follow advice provided to them through the extension services. The poverty of farmers and fishers made them appear resource poor and the average lack of formal educational achievements among these disadvantaged sections of the population supported the view that extension services have to provide the answers to the problems these communities are facing.

The winds of change

Continuous poverty among fishing communities, mounting evidence of resource degradation and deterioration of critical coastal habitats are generally seen as evidence for these conventional approaches to fisheries management and extension services having failed, or, if not failed, being inappropriate to provide the solutions people need for improving their livelihoods. With the growing consensus that tropical multi-gear, multi-species and multi stakeholder fisheries cannot be adequately managed through centralized conventional fisheries management mechanisms which are based on single species models of "Maximum Sustainable Yield", decentralization, localization and co-management emerged as promising alternative approaches to fisheries management.

Not only are these conventional approaches to fisheries management unable to effectively address these basic features of tropical coastal fisheries, their centralized, top-down approach also leaves fishing communities completely out of the decision-making process and builds up barriers between the fisheries administrations and the fishing communities. As a result, government institutions are unable to solve the problems facing the fishing communities, and the fishing communities are not empowered to seek their own solutions to these issues.

The Millennium Conference "Fish for the People" organized by SEAFDEC in 2001, addressed this issue and confirmed the emerging co-management concept for fisheries as the new policy thrust for the region. These innovative approaches to fisheries management, which are founded on the principles of decentralization and devolution of fisheries management functions to local level institutions, as well as on the establishment of rights-based fisheries are now widely accepted as the guiding principle for establishing fisheries management systems that promise to effectively address both bio-physical and socioeconomic concerns of fisheries.

Establishing such co-management systems and making them functional requires capacity building efforts for all key players, i.e., government agencies and fishing communities to take up their respective responsibilities under such systems. This includes fundamental changes in the orientation and functions of extension services. While technical expertise and advice is still needed, the role of extension workers changes from outside experts and advisors to fishing communities becoming partners of resource users in mobilizing local expertise and capacity for identifying solutions to coastal fisheries and resource use problems.

This new approach of extension respects traditional local knowledge and encourages resource user communities to become their own active agents of change. The skills needed by extension officers go far beyond the traditional extension skills of providing technical advice; instead, extension officers need to be able to facilitate dialogue and community processes. Community organization skills and participatory approaches to solving local resource use and livelihood problems, mediation and conflict resolution skills are needed to strengthen local resource management systems and empowering local communities to find and test solutions for their immediate needs and concerns.

SEAFDEC's Training Courses on Coastal Fisheries Management and Extension Methodologies

Recognizing the needs for such new and innovative skills among fisheries managers and extension workers, the SEAFDEC Training Department over the last years has developed and conducted international training courses for fisheries managers and extension workers from South and Southeast Asia.

Study tour to the project site in Bang Saphan during the International Training Course on Coastal Fisheries Management for Fishery Managers

The International Training Course on Coastal Fisheries Management for Fishery Managers focuses on sharing experiences and lessons from various pilot projects in co-management for policy formulation and designing fishery management plans addressing locally specific management needs.

The lecture session of the training provide the participants with an opportunity to refresh their knowledge on topics related to the management of small-scale tropical coastal fisheries. During the field trips to the pilot projects, the participants engage in active research on each project to generate the information base for management plans for local fisheries management. From 2005 to 2006, two sessions were conducted with a total of 51 participants.

The International Training Course in Coastal Fisheries Management and Extension Methodology is designed to familiarize the participants with co-management principles for small-scale fisheries and the necessary extension skills for establishing and supporting participatory fisheries management approaches on the local level. Through a mixture of lectures, innovative classroom activities, and extensive field practices that promote active learning, the participants learn to first understand the need for local level participatory fisheries management approaches. Then they are familiarized with approaches and tools that can help them facilitate community and stakeholder dialogues for analyzing local resource use patterns and livelihood issues and for formulating solutions for these issues.

Practices of facilitation, communication and presentation skills during the course, effectively prepares the participants for their role as mediators between resource user communities, higher-level government authorities and other stakeholders. During the four weeks training, the participants have ample opportunities to verify the course messages through field visits to pilot projects; field practice of participatory tools for analyzing local issues and problems allowing them to get some deeper insights into the functioning of local communities and their way of thinking. With many of the participants having been formed by conventional top-down approaches to extension, the course successfully initiates a rethinking of their role as extension agents.

Since 2000, 175 trainees have successfully concluded this training. This number may seem to be relatively small when compared to the vast coastal areas where co-management mechanisms need to be promoted and established. Nevertheless, given the right circumstances and a general openness to greater community involvement, each of the course's graduates can play an important role in strengthening local fisheries co-management by applying the newly acquired skills and knowledge in their daily work with fishing and resource user communities.

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Towards Sustainable Aquaculture in the ASEAN Region

Rolando R. Platon, Wilfredo G. Yap and Virgilia T. Sulit

In 2004, aquaculture production from the ASEAN region comprising 10 countries, namely, Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam, was 6,298,399 mt valued at 8,746,084 thousand USD. The region's total aquaculture production contributed about 11% by volume and 12.4% by value to the world's total aquaculture production volume and value, respectively (Table 1 and Table 2). The average growth of the region's aquaculture production over the five-year period from 2000 to 2004 was 14.5% (Table 1) while the average growth rate of the world's total aquaculture production over the same period was 6.8% (FAO SOWA 2006).

The region's aquaculture production systems are located in freshwater, brackishwater or marine environments. Of the three production systems, mariculture contributed most to the volume of production followed closely by freshwater aquaculture (Figure 1). In 2004, the major mariculture and brackishwater culture species were seaweeds, penaeid shrimps (*Penaeus monodon*, and *P. vannamei*, kuruma prawn, banana prawn, etc.), milkfish, oysters, mussels and other bivalves, groupers, sea bass, snappers, etc. Freshwater aquaculture was dominated by tilapia, carps, catfishes, gourami, snakehead, freshwater prawn, etc. (Figure 2).

Table 1. Aquaculture production in the ASEAN region, by volume (mt)

Country	2000	2001	2002	2003	2004
Brunei Darussalam	113	99	157	160	708
Cambodia	14,430	17,500	18,250	26,300	37,675
Indonesia	993,727	1,076,749	1,137,151	1,228,559	1,468,612
Lao PDR	42,066	50,000	59,716	64,900	64,900
Malaysia	167,898	177,021	183,990	192,160	202,227
Myanmar	98,912	121,266	190,120	252,010	400,360
Philippines	1,100,902	1,220,456	1,338,394	1,448,504	1,717,028
Singapore	5,112	4,443	5,027	5,024	5,406
Thailand	738,155	814,121	954,567	106,4378	1,172,866
Vietnam	513,517	608,098	728,041	967,502	1,228,617
Total	**3,674,832**	**4,089,753**	**4,615,413**	**5,249,497**	**6,298,399**
World's Total	45,657,773	48,555,041	51,971,882	55,183,013	59,408,444

Source: FAO FISHSTAT PLUS 2006

Table 2. Aquaculture production in the ASEAN region, by value (‘000 USD)

Country	2000	2001	2002	2003	2004
Brunei Darussalam	502.0	473.3	715.1	747.3	3,159.1
Cambodia	28,274.8	28,835.7	27,510.3	35,726.0	42,165.0
Indonesia	2,268,269.8	2,418,615.2	1,494,529.9	1,715,901.1	2,162,849.6
Lao PDR	88,128.3	100,000.0	119,432.0	129,800.0	129,800.0
Malaysia	255,974.3	320,042.7	283,019.5	302,652.5	328,357.9
Myanmar	781,368.0	380,217.0	576,970.0	775,331.0	1,231,230.0
Philippines	734,018.0	719,179.5	695,412.0	668,514.0	794,711.5
Singapore	9,913.4	8,533.7	6,882.5	9,150.9	8,596.3
Thailand	2,513,845.9	1,752,064.1	1,574,990.9	1,462,966.0	1,586,626.0
Vietnam	998,817.9	1,355,712.7	1,611,949.0	1,983,331.0	2,458,589.0
Total	**7,679,112.0**	**7,083,673.9**	**6,391,411.2**	**7,084,120.6**	**8,746,084.4**
World’s Total	56,687,908.8	58,689,246.4	61,103,566.6	65,298,295.3	70,302,473.3

Source: FAO FISHSTAT PLUS 2006

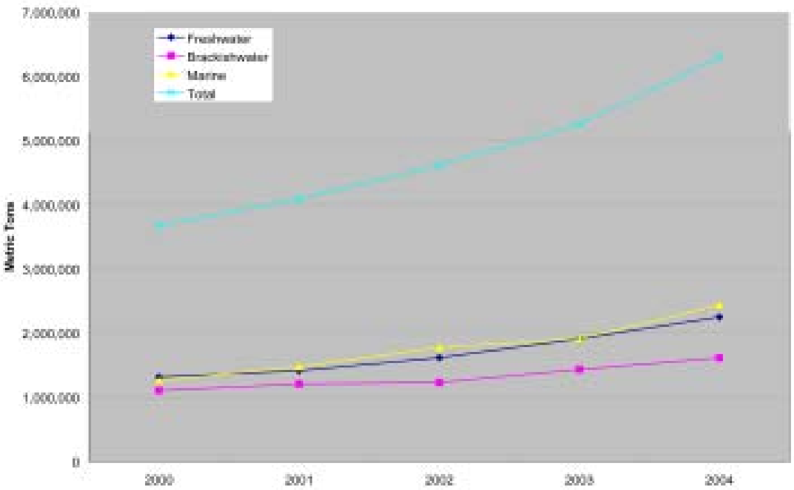


Figure 1. Aquaculture production volume (mt) in the ASEAN region by culture environments (Based on FAO FISHSTAT PLUS 2006)

Fish has always been an integral part of the traditional diet in the ASEAN countries. Assuming that in 2005 the total population in the region was 555.5 million (UN 2005 estimate), and assuming further that the apparent total per capita fish consumption remains constant at 23.4 kg (SEAFDEC Technical Document, ASEAN-SEAFDEC Conference, 2001), this means that the people from the ASEAN region need about 13 million mt of fish by 2005. Considering that the annual average growth rate of fish production from aquaculture is 14.5%, about 7.2 million mt of fish could be contributed from aquaculture in 2005 or about 55% of the fish requirement of the people in the region could be provided through aquaculture.

The impact of aquaculture on livelihood/employment cannot be easily quantified as there is no current uniform statistics in the region on the number of people directly employed or dependent on the aquaculture industry. Women also make significant but often undervalued contribution to the aquaculture labor force, but there has been no recent information on this from the region. Nevertheless, it is clear that the aquaculture industry in the region contributes to food security, employment and foreign exchange generation.

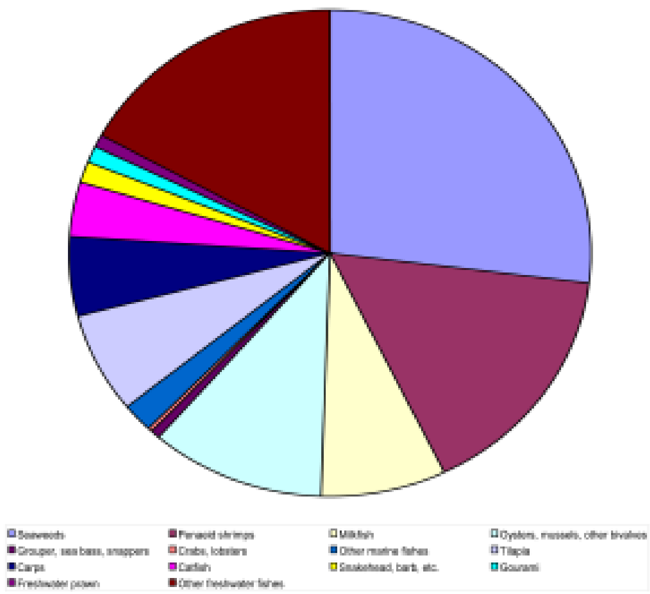


Figure 2. Aquaculture production in the ASEAN region by important commodities in 2004 (Based on FAO FISHSTAT PLUS 2006)

Sustainable Aquaculture: Issues and Concerns

Aquaculture has the greatest potential to fill the gap between supply and demand for fish products. In order to make aquaculture a long-term strategy to contribute to the region's further growth and development, aquaculture should be sustainable, which means that it should not only be technically feasible and economically viable but should also be environment-friendly and socially equitable. There are key issues and concerns, however that should be addressed to make this possible.

In 2001, ASEAN and SEAFDEC organized the "Conference on Sustainable Fisheries for Food Security in the New Millennium". It was a consensus and awareness-building exercise on the issues arising from a series of consultations conducted in each ASEAN country prior to the Conference. It was designed to help develop regional fisheries policies and plan activities for achieving sustainable fisheries and increased supplies of fish and fishery products in the region. It covered the sectors on fisheries management, aquaculture and utilization of fish and fishery products. The Conference "Resolution on Sustainable Fisheries for Food Security for the ASEAN Region" was adopted by the ASEAN Ministers responsible for fisheries and the subsequent Plan of Action was adopted by their respective Senior Officials. The key technical issues and concerns as well as opportunities for sustainable aquaculture, based on the Conference proceedings, are discussed in this paper within context of aquaculture in the ASEAN.

Low quality and inconsistent supply of seeds

Seasonality and inconsistency of seed supply

The foundation of the aquaculture industry is the supply of seeds. The traditional source has been the wild fry or fingerlings that depend on the productivity of natural habitats. However, many of these habitats have become degraded resulting in scarcity of seed supply. This constrains aquaculture operations. To overcome these difficulties captive broodstocks have to be established. Such is the case for the broodstock of tiger shrimp, which are still mainly obtained from the wild and spawned in captivity.

Lack of technology for producing pathogen-free tiger shrimp broodstock drives some people in the shrimp industry to import exotic species that are advertised as pathogen-free. There is evidence in certain countries where introduction of so-called pathogen-free exotic shrimp species resulted in outbreak of a disease that was non-existent before the introduction. For captive broodstock of marine and freshwater species maturation and spawning is still mainly seasonal. Standardized and reliable techniques still have to be developed for year-round seed supply.

Captive broodstock have to be fed the right type and amount of diet to produce quality seeds. While nutrient requirements for many species have already been determined, basic knowledge gaps still remain. A variety of feeds are given to shrimp and fish larvae in hatchery rearing. These larval diets consist of combinations of formulated feed and live food organisms. In order to enhance the quality of hatchery-reared fry, there is a need to optimize diets, ensure their consistent quality, and should be cost effective. In anticipation

Captive P. monodon *as broodstock for larval production (top); and grouper fingerlings in the hatchery (right)*

Recommendations on supply of good quality seeds

1. Promote development of domesticated broodstock of economically important species
   a) Identify and prioritize species to be developed
   b) Encourage private sector production of good quality seeds through incentives like R & D support, marketing assistance and facilitating access to domesticated broodstock
2. Support and encourage R & D institutions to undertake programs in production of high quality seed on consistent and sustainable basis
   a) Develop domesticated broodstock with high levels of heritability of desirable traits
   b) Promote collaboration among government agencies, R & D institutions and industry
   c) Increase awareness on the genetic fitness of seed for stock enhancement and interactions and impacts on wild populations
3. Strengthen technology transfer mechanisms
   a) Simplify application of technology appropriate for small-scale hatcheries.
   b) Increase awareness of negative impacts of uncontrolled introduction of seed to open water bodies

of the availability of low-cost high quality and consistent supply of seed produced from captive broodstock, social implications on the wild seed industry need to be considered. Marginal fishers who depend on collection of wild seeds as livelihood will be most affected. Alternative livelihood opportunities needed to be instituted.

Impacts of releases of cultured seed stocks

Aquaculture stocks are increasingly used to enhance production in natural waters as degradation of habitats and excessive extraction of fishery stocks continue. There are concerns however, which must be addressed when releasing domesticated stocks to natural waters. These relate to genetic and ecological impacts of hatchery-bred stocks on wild stock populations. Seeds for aquaculture purposes requires characteristics of high survival and optimal performance under culture conditions. These characteristics are products of breeding protocols appropriate for domestication and not for release to the wild. The genetic requirements of stock for release differ from those for domestication.

The fitness to survive in the wild is the more important characteristic of seeds for release. Uncontrolled releases of hatchery stocks into the wild may result in introgressive hybridization in wild stocks. There are evidences that support the threat of these impacts on natural genetic resources. However, considering the need to enhance declining stocks, there are approaches that can be taken to minimize potential ecological impacts of the introduction of seeds. An example is the release of species native to the water body from where their broodstock originated. A policy and regulatory framework should be developed to ensure more responsible stock enhancement programs.

In order to enhance the supply of good quality seeds, R&D on captive broodstock of economically important species should be intensified. Governments should develop policy and regulatory frameworks that recognize basic differences in reproductive protocol for producing seed for aquaculture and seed for stock enhancement. These frameworks should also provide for measures to mitigate loss of economic opportunity to marginal fishers who derive income from collection of wild seeds. The technology transfer mechanisms should be strengthened and this requires a more proactive role for government agencies, and research institutions in collaboration with the private sector.

The AQD technology verification laboratory, where R&D activities on aquaculture development are undertaken

Environmental Degradation

The ASEAN region has registered the rapid growth of aquaculture over the past two decades. This could be attributed to expansion in area and intensification of aquaculture systems. Expansion of aquaculture areas included conversion of large tracts of mangrove forests and swamps, and even coconut plantations, into fish and/or shrimp farms. For example, the total mangrove area in the Philippines decreased from 450,000 hectares in 1920 to only about 141,700 hectares in 1988 (Aypa and Bacongis, 2000). The resultant impacts are social and ecological. Loss of forestry and fish and fishery products, including wild seeds have implications on income of coastal dwellers derived from these resources. Ecological impacts include alterations to patterns of silt retention, land formation, erosion and loss of protection from storm surges. After damages have been done, it is now generally agreed that mangrove areas are poor sites for aquaculture because of acid sulfate soil problems.

Intensification involves high stocking of the cultured species per unit of production area. This requires feed inputs since the natural food organisms within the culture system cannot support the food requirements of the cultured fish. Feeding increases nutrient loads from fecal and non-fecal excretion and unconsumed feeds. Chemicals such as therapeutants, pesticides, herbicides, and inorganic nutrients are also commonly used to enhance productivity. When released directly into natural bodies of water these wastes and chemicals have polluting effects when the volumes exceed the carrying capacity of these waters.

Conversion of mangroves for shrimp farming in Thailand

It has also been a common practice for aquaculture farms to develop in clusters concentrated within a small geographic area like enclosed coastal waters with poor water exchange. This often leads to self-pollution where one farm's effluent becomes another farm's or even the same farm's intake. These problems may be attributed to lack of properly planned and regulated aquaculture development that should have a balance between economic development and environmental considerations. Since aquaculture development makes use of many resources like mangroves, water or sea areas that are common property, mechanisms should be in place to ensure that aquaculture development is planned in close consultation with other resource users. Approaches can include integrated coastal zone management with specific conditions on location and intensity of aquaculture, establishment of buffer zones and other considerations.

There are now available technologies and practices that would make aquaculture operations environment-friendly. The most effective approach is to prevent or reduce the discharge of pollutants. These technologies include integrated recirculating systems and treatment of wastes before discharge. Development of environment-friendly feeds with optimum nutritional characteristics and improvements in feed management can also minimize environmental impacts. The best approach to a successful aquaculture venture is to culture at the highest stocking density possible without degrading the environment. The trend toward environment-friendly aquaculture is also evident in the activities of the various aquaculture agencies and institutions in recent years.

However, these apparently still have no impact as serious environmental problems in the sector still remain. Limited budgets and the overriding desire to produce more impede

Recommendations on environment-friendly aquaculture

1. Promote development of environment-friendly aquaculture by encouraging the integrated system approach within the farm and in harmony with the environment
2. Support and encourage R&D institutions to undertake programs on advancement of environment-friendly technologies, to include formulation of non-polluting feeds and innovations in culture practices
3. Promote these technologies among the private sector through effective training, extension and demonstration
4. Encourage the private sector to adopt the Codes of Conduct for responsible aquaculture by developing economic incentives
5. Review and effectively implement regulations pertaining to penalizing environmental offenders
6. Develop zoning and resource-use plan based on the environmental carrying capacities of zones

the development of a totally environmentally responsible aquaculture sector. The profit motive orientation, voluntary nature of the code of practice for aquaculture, and weak monitoring and enforcement capabilities constrain the adoption of environment-friendly practices. Another is the people's attitude of careless disregard toward the environment and the ineffective enforcement of regulations to penalize the violators. In addition, some people, who are prepared to adopt environment-friendly practices, could not do so because of lack of financing in the re-construction of their farms to suit the innovations.

Research on environment-friendly technologies should be intensified, to include formulation of superior diets and innovations in culture practices that minimize polluted effluents. These innovations should be promoted among the private sector through effective training, extension and demonstration. The adoption by the private sector of the codes of conduct for fisheries and aquaculture should be hastened by developing economic incentives.

Importantly, there should be zoning and resource-use plan based on environmental carrying capacities of zones. Incentives should also be provided to encourage farmers to locate their farms within designated zones through the provision of infrastructure, training on best management practices, access to credit and marketing support and other related assistance.

"Fish Meal Trap"

Many cultured fish are carnivorous and require fish protein in their diets. Other types of fish, although less reliant on fish protein, also require fish products in their diets to satisfy certain nutritional requirements. This requirement is provided by feeding lower-value fish or fish meal-based feeds. The aquaculture industry is now at the stage where its further growth depends on the availability and supply of fishmeal and other fish-based products. This raises the issue of whether this is an effective way of using fishery products compared with using the same resources for direct human consumption. It is to be noted that a large proportion of total fishmeal supplies also goes to the formulated feed for terrestrial animals. This demand for fishery products is forecast to increase further to feed the cultured fish and other animals as well as humans.

For the sustained growth of the aquaculture industry it is imperative to look for suitable and cost-effective substitutes for fish meal and fishery products in fish diets. Research studies have shown the potential of alternative protein sources as fishmeal substitutes. Agricultural proteins, like vegetable and animal meals, have been incorporated in diets of several species and found to be cost-effective. Through biotechnology the potential of producing single-cell proteins with desired nutritional characteristics has been demonstrated. Enzyme treatments have also been shown to improve nutritive value of plant ingredients.

Recommendations on getting out of the "fish meal trap"

1. Review and implement policy and regulatory framework that addresses the issue of quality criteria and standards of manufactured aquaculture feeds
2. Encourage and support R & D initiatives to reduce dependence on fishmeal or other fishery products
   a) Encourage collaboration among R & D institutions and among different expertise in fish physiology and nutrition, crop science, biochemistry and chemical engineering
   b) Intensify research on suitable and cost effective substitutes for fish meal by using low-cost agricultural products
   c) Enhance nutrient characteristics of low-grade materials through biotechnology
   d) Improve feed formulations and feeding practices to reduce pollution in the farm and in effluents
   e) Integrate R & D efforts of private sector with those of national agencies and determine the optimal level of investment
3. Strengthen extension and technology transfer mechanisms that would include education on environmental impact of using inappropriate feeds and feeding practices and overfeeding

There are still other concerns in fish nutrition research that need further attention. One is how to raise the involvement of the feed producing private sector that is a direct beneficiary of the fish nutrition R&D. Another issue is at what optimal levels of funding and effort and in what particular areas of work should public agencies commit and concentrate on in terms of fish nutrition R&D given that the private sector, particularly the large scale feed producers and aquaculture operators, are also into it on their own.

There should be mechanisms to involve and integrate the R&D efforts of the private sector with those of the governments and determine the optimal level of investment into the program. There should also be a policy and regulatory framework that addresses the issue of quality criteria and standards for manufactured feeds. Furthermore, there should be proactive extension and technology transfer mechanisms that include education on environmental impact of using inappropriate feeds, feeding practices and overfeeding.

Diseases

One of the major concerns resulting from the rapid but poorly regulated development of aquaculture is the frequent occurrence of infectious diseases that have been bringing damage to crops amounting to hundreds of million USD. This concern includes disease control, food safety and environmental integrity.

Disease diagnosis and control

Identification and control of diseases requires reliable diagnostic methods. Diagnosis may be done with simple visual and microscopic examination for parasites or with more sophisticated tools and techniques such as cell lines of host animals and molecular-based techniques for viral diseases. Rapid assay field kits have been developed for a number of bacterial diseases. Improved diagnostic techniques should be pursued particularly for pathogens that are of high significance in the country. Operationalizing on-site fish health management industry-wide requires transfer of knowledge and awareness to farmers. This involves extension and delivery of health management concepts to the various sectors of the industry through formal and informal education. It is also necessary to build the capabilities for disease diagnosis at farm level in order to apply prevention and control measures.

For disease control, chemicals and therapeutants like pesticides, anti-fungal agents, antibiotics and disinfectants are commonly used. Very often these substances are administered by farmers not knowing that some are very toxic to humans. Improper use induces development of resistant pathogens in the cultured species, the human consumers and the environment. To minimize risks techniques for the proper use of these substances should be taught to farmers. Or better still disease control methods that are safe, like vaccination should be developed. This will reduce the use of anti-microbials.

In most instances, the occurrence of diseases in aquaculture systems is attributed to bad management practices that bring about deteriorated culture conditions. In order to prevent disease outbreak, innovations should be done. For example, the installation of influent reservoirs was found effective in controlling viral diseases. The use of “green water” and of beneficial bacteria as probiotics or bioaugmentation agent has been found effective in controlling luminous bacteria in shrimp ponds. The mechanism however, on why these innovations are effective are not clearly understood. These knowledge gaps need to be filled. These preventive measures have clearly high potentials to obviate the need for chemical inputs but there should still be considerable efforts toward further development and refinement.

Reporting System

An important component of a well-coordinated fish-health management program is a timely and efficient reporting system that would alert the various sectors of the industry on outbreak of any disease. This surveillance program should include human capability and laboratory resources to conduct diagnosis; standardized laboratory methods; reliable recording; proper management and reporting of data; and efficient flow of information from point of collection to the decision or policy-making level.

Recommendations on controlling fish diseases and safeguarding quality of aquaculture products and environmental integrity

1. Develop improved diagnostic techniques for disease agents that are of high significance
   a) Harmonize diagnostic techniques to ensure standardized reporting.
   b) Implement mechanism for referral systems and designation of service reference laboratories
2. Develop human capabilities for disease diagnostics and control
   a) Identify qualified experts as members of coordinating team to provide essential services during disease outbreaks
   b) Provide mechanism for linkages between researchers, extension workers and farmers to build capabilities at farm level
3. Increase awareness of negative impacts of use of chemicals in aquaculture
   a) Establish policy and effectively implement regulation on the use of chemicals in aquaculture to include quality standards, labeling requirements and designated applications
   b) Teach farmers on proper use of chemicals
4. Support and encourage innovations in culture practices to prevent disease outbreak
   a) Promote physical and biological approaches to prevent disease outbreak in culture systems, integrating the culture of other economically important species
   b) Strengthen technology transfer mechanism to disseminate environment-friendly practices to farmers
5. Support research efforts on
   a) genetic improvement with disease resistance
   b) alternative disease prevention methods like vaccination, use of probiotics and bio-augmentation agents
6. A quality assurance and monitoring system should be developed and effectively implemented to ensure that aquaculture products are safe for human consumption and satisfy standard quality criteria
7. Effective implementation and enforcement of regulations regarding introduction and transfer of aquatic organisms that pose potential threat to (a) health of cultured and wild stocks, and (b) biodiversity. Accepted procedures are provided in the FAO “Asian regional technical guidelines on health management for the responsible movement of live aquatic animals” and the “Beijing consensus and implementing strategy.”

Public Health and Environment

Prevention of disease outbreaks should be the standard industry practice. However, in certain instances, it may be necessary to treat the cultured fish with antibiotics or other chemicals as a last resort. The presence of chemical residues and harmful microorganisms in the final fish products should be examined to ensure that these are safe for human consumption. A quality assurance and monitoring system should be developed and effectively implemented. The use of chemicals in aquaculture should be regulated and controlled.

Many of the chemicals now being used have not been evaluated with respect to their effects on non-target species and the aquatic environment, such as stability and persistence, formation of residues, accumulation in cultured fish, native biota and toxicity to non-target species and farm workers. This evaluation requires extensive research efforts. The presence of chemical residues and pathogens in the region's exported fish products can have negative implications on international trade and on the region's capability to meet international standards for food safety and quality. This should be given utmost attention since non-tariff barriers are now increasingly imposed by importing countries.

Ensuring continued growth and sustainability of aquaculture requires that culture management practices be adopted to produce healthy fish, to maintain environmental integrity and to ensure that aquaculture products are safe for human consumption. There should be effective implementation and enforcement of regulations regarding introduction and transfer of aquatic organisms that pose potential threat to (a) the health of cultured and wild stocks, and (b) biodiversity. There should be proper risk analysis prior to granting permission. The FAO "Asian regional technical guidelines on health management for the responsible movement of live aquatic animals" and the "Beijing consensus and implementation strategy" provide the accepted procedures for the risk analysis.

Samples of diseased marine fishes cultured in cages

There should be appropriate support for human and facility capacities to undertake fish disease diagnosis and control. Research efforts should be intensified in the following areas: (a) genetic improvement of stocks with disease resistance; (b) alternative disease prevention methods through probiotics, and bio-augmentation agents; and (c) more innovative culture practices that do not rely on chemicals. There should also be regulatory measures on the registration and classification of all chemicals used in aquaculture including quality standards, labeling requirements and designated applications. Most importantly, measures should be taken to ensure that aquaculture products meet food safety requirements.

Biotechnology

Biotechnology has been recognized as a promising strategy for attaining increased productivity in aquaculture. The benefits, however, should be carefully balanced against any risks to humans and the environment.

Biotechnology use in aquaculture

Hormones are commonly used in aquaculture to induce spawning of broodstocks, to enhance growth or for sex inversion. These hormones are mass-produced through recombinant DNA technology and industrial microbial fermentation. One area where biotechnology can also contribute to improvement of fish growth is through the use of probiotics. When incorporated into fish diets these enhances digestibility and nutrient availability. Beneficial microorganisms can also be used to hasten the breakdown of organic polluting substances in culture systems and metabolize them into benign compounds. The development

Recommendations on biotechnology

1. Develop critical mass of highly qualified experts, provided with necessary research infrastructure and adequate funding support
2. Encourage and support R & D programs that are targeted at improving productivity and sustainability of aquaculture to include:
   a) use of hormones
   b) probiotics and bio-augmentation
   c) immuno stimulants
   d) disease resistance
   e) disease diagnosis
3. Undertake awareness-raising initiatives including consultation with the various aquaculture stakeholders on the benefits and risks associated with the use and application of biotechnology products. The "ASEAN Guidelines on Risk Assessment of Agriculture-Related Genetically Modified Organism (GMOs)" address the issues on effects of GMOs on the environment.

of these improved strains of microorganisms can be hastened by the use of biotechnology, like selection through gene identification and genetics engineering. Biotechnology is also potentially useful in the search for alternative raw materials as replacement for fishmeal in fish diets. Research advances have demonstrated that the nutritional quality of some low-grade agricultural by-products can be enhanced through application of biotechnology.

Genetically Modified Organisms (GMOs)

While at the moment, aquaculture-based GMO research is not an urgent concern, it will expectedly become one in the future. Preemptive actions should therefore be considered with respect to food safety and human health, the environment and social impact from the use of GMOs in aquaculture. There should be open disclosure of information addressing the genuine concerns of the public with respect to benefits and risks of biotechnology. Ownership rights, particularly patenting of products and processes resulting from biotechnology research is an important issue confronting both developed and developing countries. The concerns related to this issue include monopolization of knowledge, restricted access to germplasm and increasing marginalization of majority of the population.

Despite ongoing concerns related to human and environmental safety of biotechnology products it appears that biotechnology can help in increasing productivity in aquaculture. But in order to realize the benefits from the various applications of biotechnology, it is required to develop the human and physical capacity to support the R&D programs and undertake awareness-raising initiatives related to the application of biotechnology. A well-coordinated national aquaculture biotechnology network is necessary to enable collaboration among various institutions concerned with biotechnology research and avoid duplication of efforts, thus optimizing use of limited research funds. It is also necessary to undertake awareness-raising activities including consultation with the various aquaculture stakeholders on the benefits and risks associated with the use and application of biotechnology products.

Strengthening institutional support

Institutional and regulatory frameworks have a very important role to play in enabling and supporting sustainable development and management of aquaculture. These provide the structure by which aquaculture related activities are governed. In order to effectively promote, support and regulate sustainable aquaculture, an institutional framework should be directed towards the objectives of an aquaculture policy.

Recommendations on strengthening institutional support

1. Improve the capabilities of some R & D institutions to conduct quality research and contribute to aquaculture development
2. Encourage fisherfolks to take on greater responsibility in developing and conserving fishery resources
3. Develop a clear and implementable aquaculture industry plan in consultation with all stakeholders to include:
    a) Land and water areas allotted to aquaculture
    b) Appropriate species for specific areas
    c) Carrying capacities of specific areas
    d) Infrastructure requirements
    e) Financial requirements
    f) Training and extension requirements
    g) R & D requirements
    h) Others

It should provide mechanisms for the involvement of non-governmental entities, i.e. the private sector, farmers, etc., in the management of aquaculture and in the enforcement of laws and regulations applicable to aquaculture. It should provide appropriate incentives aimed at developing and implementing best management practices, supporting implementation of effective environmental requirements and supporting maintenance and restoration of the environment. It should provide for regular monitoring and assessment of the aquaculture sector management using criteria provided for under the framework.

Sustainable Aquaculture: Opportunities for Development

Having been confronted with the foregoing and persistent issues and concerns SEAFDEC and the ASEAN through the ASEAN-SEAFDEC Fisheries Consultative Group (FCG) collaborative mechanism, approved the implementation by SEAFDEC Aquaculture Department (AQD) of important aquaculture projects intended to initially address the major issues and concerns. The projects offered opportunities for the development of sustainable aquaculture in the ASEAN region.

Mangrove-Friendly Shrimp Culture Project

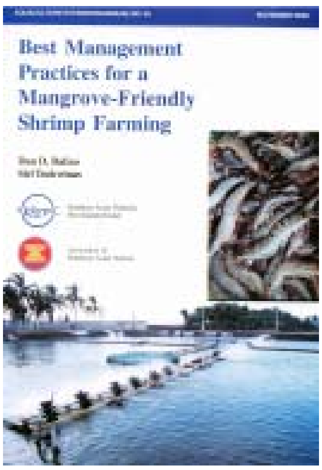
The five-year project, which started in May 2000, was aimed at developing sustainable shrimp culture technologies that are friendly to mangroves and the environment. During the span of five years, pilot demonstration activities were successfully implemented in Thailand, the Philippines, Vietnam, Myanmar, Cambodia, and Malaysia, where the viability of the culture techniques was determined and when necessary, the techniques were refined to adjust to the country's specific requirements. It was the project's desire

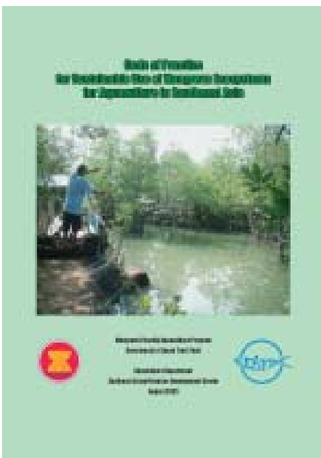
Mangrove-friendly crab culture project

for the countries to carry out on their own the shrimp culture innovations following the environment-friendly technology as suggested in the boxed Summary of Recommendations.

Parallel research activities were conducted at AQD to further refine the culture technology based on feedback and experience from the project's pilot demonstration sites. The techniques developed, verified and refined were disseminated through training at AQD and on-site in the member countries attended by a total of more than 100 participants. This number may be minimal with respect to the wide coverage of the project, but the knowledge gained by the trainees was also supplemented with extension manuals that were translated in major languages in the region for wider national usage. The training participants were expected to echo in their respective countries the knowledge they have derived from the project.

Another output of the project after a review of the policy issues relating to the use of mangroves for aquaculture in the region, was the publication and dissemination of the Code of Conduct for Sustainable Use of Mangrove Ecosystems for Aquaculture in Southeast Asia. The CoC took into consideration the principles prescribing the preferred ways of using mangrove ecosystems for aquaculture complementing certain articles in the Regional





Guidelines for Responsible Fisheries in Southeast Asia: Responsible Aquaculture. The Code includes recommendations for key legislation and enforcement mechanisms to ensure both responsible aquaculture and sustainable use of mangroves, considering that in the region, mangrove losses stemmed from the failures of policy as well as management and enforcement of protection measures.

Development of Fish Disease Inspection Methodologies for Artificially-bred Seeds

Implemented by AQD from 2000 to 2005, the project aimed to enhance disease diagnosis and health management of aquatic animals in aquaculture in order to promote healthy and wholesome trading of aquaculture products and the development of fish disease surveillance network for the region. As the main component of the project, research activities were conducted at AQD with some activities carried out in collaboration with the Department of Fisheries in Thailand and the SEAFDEC Marine Fisheries Research Department in Singapore.

The major achievements during the implementation of the project included establishment and standardization of diagnostic method for the White Spot Syndrome Virus (WSSV), which was responsible for the major collapse of the shrimp industry in the region during the mid-90s. The disease viruses found in cultured marine fishes, e.g., grouper, rabbitfish, were detected through the establishment of cell lines. These viruses have caused mass mortalities in marine fish culture. Husbandry techniques using live bacteria (probiotics) and "green water" culture technique were developed as alternative to chemotherapy to control luminous vibrosis in shrimp culture.

In order to secure safe supply of fish from aquaculture, the project developed and standardized the detection method for residual chemicals especially pesticides and antibiotics in aquaculture products. Specifically, the use of antibiotics in the region's shrimp aquaculture industry was closely monitored. In addition, the epizootiology of Koi Herpes Virus (KHV) was determined and the control of KHV was developed. KHV caused mass mortality of common carps cultured in the region posing threat to the region's freshwater aquaculture industry.

The established diagnostic methods have been disseminated to the region through manuals that reflect the findings from the research activities and the methods that have been established. Training, comprising a major component of the dissemination process, were conducted either formally at AQD or through AQD's On-line Training Program where the participants do not need to leave their work places as they can participate in the training through specialized modules developed by AQD using the internet.

What remains to be done now is the establishment of a well-coordinated surveillance program for timely and efficient reporting system on outbreak of any disease. The program, which includes development of human capability and laboratory resources to conduct diagnosis, is being facilitated through the second phase of the project which started in 2006, and is still ongoing. Meanwhile, the countries in the region that have gained knowledge through the project should continue their efforts in controlling aquatic diseases and safeguard the quality of their aquaculture products. Some suggestions on how to go about this are offered in the Summary of Recommendations.

Integrated Regional Aquaculture Program (IRAP)

Another opportunity offered to the ASEAN countries for their sustainable aquaculture development was the implementation of IRAP by AQD. The Aquaculture Component of the ASEAN-SEAFDEC Special Five-Year Program on Sustainable Fisheries in the ASEAN Region, IRAP was implemented from 2003 to 2005 with two components: (1) Aquaculture for Rural Development; and (2) Supply of Good Quality Seeds. IRAP was aimed at assuring a supply of quality seed stocks of various aquatic commodities; promoting environment-friendly aquaculture; and assuring that the development of aquaculture will benefit the rural populace through consultation, demonstration and dissemination of specific aquaculture technologies.

Since a number of species are being developed in the region for aquaculture in freshwater, brackishwater and marine environments, it was deemed necessary to prioritize the activities and species proposed by the ASEAN member countries (Table 3). In addition, common species with required technology identified by a number of countries were pooled in order to optimize resources, as in the case of the collaborative project on the genetic improvement and seed production of *Macrobrachium rosenbergii* implemented by Indonesia, Thailand, and the Philippines and coordinated by AQD as part of IRAP.

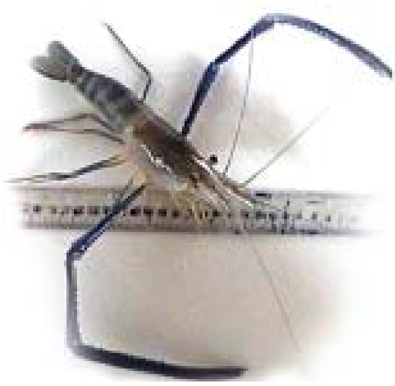


Table 3. Priority activities identified by ASEAN Member Countries for IRAP

Countries	Aquaculture for Rural Development	Supply of Good quality Seeds
Brunei Darussalam	Grow-out culture of *Macrobrachium rosenbergii*	Hatchery verification of *Macrobrachium rosenbergii*
Cambodia	Polyculture of indigenous freshwater fishes in ponds(e.g., *Pangasius* sp.)	Seed production of freshwater fishes (e.g., *Pangasius* sp.) as well important marine aquatic species
Indonesia	Catfish (*Pangasius* sp.) culture in rural areas	Genetic improvement of giant prawn (*Macrobrachium rosenbergii)* and seed production of abalone
Lao PDR	Aquaculture in rural areas (focusing on rice-fish culture)	Seed production of common carp, tilapia, etc.
Malaysia	Pen culture of tilapia, etc. (using improved technologies)	Production of disease-free grouper
Myanmar	Coastal aquaculture (grouper, sea bass and mud crab)	Seed production of marine fishes (e.g., grouper, sea bass and mud crab)
Philippines	Grow-out culture of *M. rosenbergii* in ponds	Genetic improvement and seed production of *M. rosenbergii*
Thailand	Cage culture of abalone and Babylonia shell	Genetic improvement and seed production of *M. rosenbergii*
Vietnam	Pond culture of milkfish and siganids	Seed production of milkfish and siganids

IRAP provided technical assistance in the pilot demonstration activities of the respective countries, where the services of appropriate ASEAN experts external to the participating country, were tapped to serve as technical resource persons. This ensured certain more advanced technologies developed by other ASEAN countries being easily adopted by another ASEAN country, making the transfer of technology faster. Through IRAP, the efficient mobilization of expertise in the region was successfully demonstrated.

Training, which was offered to assist the ASEAN countries in their respective pilot demonstration activities were of three types. The on-site training for technicians and farmers in beneficiary country utilizing expertise from other ASEAN countries with the requesting ASEAN country as host, maximizes the participation of more participants including the involvement of the host country's private sector, for a lesser cost. Training was also conducted at AQD for technologies that have been developed by AQD and conducted upon request from any ASEAN country. Attachment training was also arranged in other countries where specific technologies required by another country have already been developed, with the other ASEAN country as host and providing the necessary resource persons. This facilitated fast transfer of technologies from one country to the other countries in the region. During the on-site training, SEAFDEC's cost-sharing scheme was successfully promoted with the host country providing funds for the expenses of the trainees while IRAP provided the technical resource persons. The training sessions conducted through IRAP dealt with the various aspects of aquaculture involving a variety of aquatic species.

In the evaluation of IRAP in 2005, the ASEAN member countries expressed the need for some aspects of aquaculture to be developed further including the development of human capacity. The countries also recommended that in order to optimize resources, aquaculture technology packages known to be economically viable and well developed in one country should be considered for verification in another country. This was made as one of the basis for the development of the activities during the second phase of IRAP starting in 2006. Moreover, more activities related to human capacity building were also included in the plans for the second phase, which is ongoing.

Conclusion

Now that the countries have been equipped with the aquaculture technologies available through the initiatives of SEAFDEC, it is now the turn of the countries in the region to mobilize their resources to verify and adopt such technologies considering the suggested items in the Summary of Recommendations in their planning exercise. It is hoped that the projects implemented by SEAFDEC in the ASEAN countries after the Millennium Conference, paved the way for the sustainable development of aquaculture in the region.

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COSTS AND EARNINGS FROM OFFSHORE TUNA LONG-LINE FISHERY IN NHA TRANG, VIETNAM

Kim Anh Thi Nguyen, Tam Ngoc Dang Thi, Prof. Ola Flaaten, Dung Thi Phan, and Tram Anh Thi Nguyen

Khanh Hoa Province is located along the coastal zone in south central Vietnam, covering a sizeable area of approximately 5258 km^2 with a coastline of 520 km. Its borders are Phu Yen Province on the north, Dak Lak and Lam Dong Provinces on the west, and Ninh Thuan Province on the south. Its capital city is Nha Trang and comprises six districts: Van Ninh, Ninh Hoa, Dien Khanh, Khanh Vinh, Khanh Son, and Troung Sa. The province also includes more than 200 islands offshore of which more than one hundred islands of various sizes are in Truong Sa District. With adjoining open oceans and international marine routes, Khanh Hoa's offshore area is one of the deepest in Vietnam. The province also includes well-known bays, such as, Cam Ranh, Van Phong and Nha Trang.

Khanh Hoa has therefore, the natural advantages for marine fisheries development, especially that it has been authorized to manage and exploit a very important fishing area in Truong Sa District, supplementing efforts for the intensification of the province's offshore fishing operations. An equally important factor that contributes to the successful fishing operations of Khanh Hoa is the attitude of its fishers. They are hard working and are attached culturally to their fishing activities. They have good learning spirits with their minds open to improving their skills especially in applying advanced technologies for sustainable production.

Due to these favorable conditions, Khanh Hoa fisheries have gained considerable and continued to generate achievements, so that by the end of 2005, about 5424 vessels were registered with the total capacity of 216,775 HP, 369 of which have capacities of over 90 HP and are qualified for offshore fishing operations. In 2005, the total fisheries production of the province was about 88,740 mt, comprising marine harvest of 66,190 mt and from inland aquaculture and fishing about 22,550 mt. The fisheries export during the same year reached USD230 million.

In Khanh Hoa, long-line is now the most important gear used in offshore fisheries, while in the past, long-line was employed for both inshore and offshore operations. In 1995, offshore tuna long-lining was introduced by a private company, Truc An Co., Ltd. Since positive results were reported in 1996 by the hired experimental fishing vessels of Truc An, the fishers from those vessels shared their experiences with the other fishers from the province.

Coupled with some experiences provided by fishers from nearby Phu Yen Province, Khanh Hoa fishers upgraded their vessels and purchased fishing gears in order to take part in tuna long-lining operations. Since then, long-line has been playing an increasingly important role in Khanh Hoa's offshore fisheries. Hence, in the past few years, the operations of offshore tuna long-liners have brought about initial improvements in the living standards of fishing households and contributing to increased fishery exports. Obviously, tuna long-lining operations have contributed to the sustainable development of offshore fisheries in Khanh Hoa Province.

This study was therefore, conducted in order to establish an economic database that would support fisheries development policies for Nha Trang, the capital city of Khanh Hoa Province. The study described the important economic performance indicators for tuna long-line fishing operations that include investments, revenues, costs, earnings and returns on equity ratio (ROE). Further analysis on the factors affecting their performance must be a good topic for another study in the future. The study considered only 31 offshore tuna long-liners in three wards/communes in Nha Trang, such as, Vinh Phuoc, Xuong Huan and Phuoc Dong. The economic indicators used in the study are defined in the Box below.

Revenues: Considered as gross annual vessel revenue, this is the total year's vessel revenue at landed price, comprising all profits during the main and sub-seasons but excludes extra income that the vessel crew collect individually during the fishing trips

Costs or Total Costs: Consist of fixed costs (depreciation, payments for major repairs, loan interests, insurance, taxes) and variable costs (payments for fuel, preservation and storage (ice), provisions (food, soft drink, etc.), labor, minor repairs, and others that are included in each fishing trip)

Earnings: The difference between revenues and costs

Return on equity ratio (ROE): Measure of return on the owner's equity calculated by expressing the net earnings as a percentage of the owner's equity

The Offshore Tuna Long-line Fishery in Nha Trang

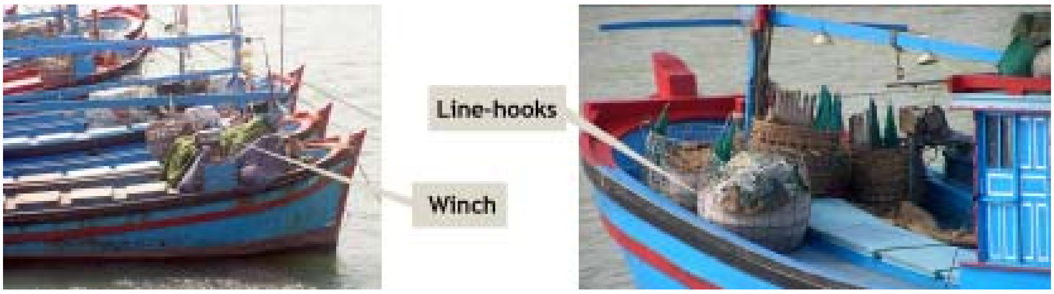
There are more than 300 vessels in the offshore tuna long-line fishery in Khanh Hoa, mostly concentrating in several wards/communes in Nha Trang such as in Vinh Tho, Vinh Phuoc, Xuong Huan, Hon Ro, and Phuoc Dong. Many vessel owners have organized themselves into groups that operate in the same fishing grounds, mutually cooperating in the harvesting activities, and sharing information about market prices as well as other information for the benefit of the members of the groups necessary in case of unexpected incidents.

The fishing season in Nha Trang Bay area falls during the lunar period between January and August and the fishing grounds geographically vary depending on the season and time of the year. During the early part of the year, the long-liners operate mainly in the fishing areas close to Hoang Sa Island (12ñ 00 - 17ñ 00'N and 111ñ 00 - 117ñ 00'E), but they gradually move to the South in the following months. In July and August, long-liners operate at Tu Chinh fishing grounds and in the South-West of Truong Sa (6ñ 00 - 11ñ 00'N and 110ñ 00 - 115ñ 00'E). During the last three years, the fishers generally got hefty harvests in the so-called "North" season (from January to May in the lunar cycle), while in the "South" season (from June to August in the lunar cycle), their production has been relatively low.

Basically, the fishing vessels have wooden hull with traditional designs native to central Vietnam. The engine capacities vary from 45 to 400 HP. Since the target fishing grounds are offshore and long fishing trips-at-sea are required, most if not all of the long-liners are equipped with sonar, and short-range radio for easy contact among the vessels. Furthermore, long-distance communication systems have also been acquired for contact from the vessels in the fishing grounds to their home bases so that information regarding prices, weather, and unexpected incidents can be timely transmitted.

As for the technical aspects, the offshore tuna long-line vessels from Nha Trang are equipped with winch, light, compass, navigator, short distant communication equipment, etc. The fishing gear consists of the main line, branch line, hook and net. The number of hooks per vessel varies with the vessel size, from 800 to 1600 hooks, equivalent to the length of the main line which is from 40 to 60 km. Long-liners often use as baits flying fish, scad and squid that they caught by themselves or sometimes purchased from other fishers. Each fishing trip of long-liners often lasts from 8 to 12 days, with the maximum of 2 hauls per day, and 3-5 hours for each haul.

Yellowfin tuna is the main species caught followed by the big-eyed tuna. As observed, the offshore tuna is relatively abundant during the period from February to June. On the average, one vessel can harvest 700 kg per fishing trip during this period. The annual overall tuna production of Khanh Hoa ranges from 1500 to 2000 mt.



Tuna long-liners in Nha Trang equipped with necessary navigational and communications equipment, preparing for their fishing operations. At right, the design of the wooden hull, which is typical to vessels from the central part of Vietnam

With respect to semi-processing and storage, the fish is roughly handled upon its loading on board. Fishers use heavy tools (short sticks, pestles, etc.), hitting hard on the fish's head or drive pointed nails through its brain to kill the fish. Then, they use sharp knives to make a slit in the abdomen for gutting and cleaning the blood, removing the gills, and in taking out the mucous membrane and other internal organs. They also take advantage of the marine water to clean the fish, putting ground ice in place of the removed organs. Some fishers put the fish into barrels filled with marine water to lower the fish's temperature rapidly before putting ground ice in its abdomen. The fishes are then loaded in the cold storage hold on their boats maintaining a distance of 10-20 cm for every two fishes.

Data Collection and Analysis

This study was conducted through a survey of three fishing wards representing the offshore tuna long-line fishery in Nha Trang, namely, Vinh Phuoc, Phuoc Dong and Xuong Huan. During the survey, face-to-face interview was conducted on 31 vessel owners, either at their homes or on board their vessels, accounting for only 10% of the total number of tuna long-line vessels in Nha Trang. For the analysis of the data gathered, the vessels were grouped into four (4) capacity groups, namely: (1) less than 60 HP; (2) 60 – 90 HP; (3) 90 – 140 HP; and (4) greater than 140 HP. There have been no apparent differences in the investment pattern among these four categories, and the values tend to distribute around their means.

Semi-processed tuna stored on board the long-line vessels

Total investments

The investment for the hull takes up 39.1-47.0%, for the engine 17.4-25.7%, mechanical equipment 5.6-8.7%, electronic equipment 4.6-6.6%, fishing gear 16.5-24.2%, and storage equipment 0.10-0.60%. The total investment for the tuna long-line operation in Nha Trang, is summarized in Table 1.

The average total investment for a tuna long-line vessel with sufficient equipment onboard, engine and fishing gear is 444.14 million Vietnamese Dong (VND) based on market value at the end of 2004. The average investment for the hull is 195.65 million VND, which is 44.1% of the total investments. Since the hull is made of wood, its price has increased dramatically starting in 2000 as a result of a government policy on forest conservation.

After the hull, the engine comes second in terms of investment priority, taking up an average of 103.71 million VND, which is equivalent to 23% of the total investment even considering that the vessel engines are usually second-hand but imported from other industrialized countries. This is followed by the fishing gear, which costs 90.53 million VND on the average, equivalent to 20.4% of the total investment. Compared with other offshore fisheries such as the tuna-mackerel gillnet operation, this figure is comparatively low.

In contrast, other items such as mechanical equipment, electronic devices, storage facilities and others comprise only a modest proportion of the total investment because the fishers think that such facilities do not have obvious relationship with productivity. However, this oftentimes led to negative consequences because the poor state of technological applications could result in accidents especially during big storms. There is always the risk of their vessels being damaged during typhoons because of the fishers' inaccessibility to meteorological information. Moreover, their high catch does not often mean high economic value because the fishers still use simple and even outdated storage means and facilities.

The way the fishers raise capital is often "relations-based," obviously exhibiting the characteristic of Vietnam's small-scale fisheries. "Joint investment" is based on kinship or in the case of "sole ownership," one can ask loans from their neighbors. Bank is not a promising source of loans for many fishers because usually only a limited amount is offered by banks, averaging 91.94 million VND, which is only 20.70% of the total investment required per vessel. This confirms an almost no easy access to loans from financial institutions because fishing is always considered a risky business.

Nevertheless, a group of over 140 HP recently received a more generous loan of 328.33 million VND from banks, which is equivalent to 52.83% of a vessel's total investment in 2005. This generous loan was facilitated through the country's offshore fishery program, which makes it easier for fishers to acquire loans from banks for the purchase of vessels which are longer and with stronger engine capacities. This facilitates the adoption of more offshore fishing operations, and therefore, removing part of the pressure on the coastal resources due to overexploitation of the coastal areas.

Cost of depreciation

The depreciation cost for one year, which is 27.18 million VND on the average, is determined by the initial investment value and estimated usage duration of the vessel, as shown in Table 2. Of all the items considered, the depreciation cost of the hull accounts for the largest part, averaging 9.32 million VND equivalent to 34.3% of the total cost of depreciation. This is consistent with the initial investment for the hull of the vessel. While the depreciation of the fishing gear is 31.8% of the total depreciation cost, this is higher than that of the engine, which is 18.6% on the average.

Although this seems to be inconsistent with the investment structure of the fishing gear and engine, the reason could be based on the fact that traditionally, the engine can be put in longer operation from 15 to 25 years inclusive of annual minor and major repairs. The mechanical and electronic facilities and storage equipment show compatibility between the total investment and depreciation costs at 12.2% and 15.2% on the average, respectively. Moreover, comparing the depreciation costs for the hull, there is no remarkable

Table 1. Total investments for tuna long-line vessels

Investment (Unit: Million VND)								
Capacity group	**Vessel Number**	**Hull**	**Engine**	**Mechanical equipment**	**Electronic equipment**	**Fishing gear**	**Storage equipment**	**Total investment**
HP<60 (%)	5	123.00 (43.6%)	49.00 (17.4%)	24.70 (8.7%)	18.32 (6.5%)	67.21 (23.8%)	0.16 (0.10%)	**282.39 (100.0%)**
60<HP<90 (%)	11	176.36 (47.0%)	80.00 (21.3%)	24.64 (6.6%)	24.75 (6.6%)	69.48 (18.5%)	0.27 (0.10%)	**375.51 (100.0%)**
90<HP<140 (%)	9	195.56 (39.1%)	125.56 (25.1%)	29.61 (5.9%)	27.10 (5.4%)	121.11 (24.2%)	0.71 (0.10%)	**499.64 (100.0%)**
140<HP (%)	6	291.67 (46.9%)	160.00 (25.7%)	34.92 (5.6%)	28.68 (4.6%)	102.68 (16.5%)	3.55 (0.60%)	**621.50 (100.0%)**
Average (%)	31	195.65 (44.1%)	103.71 (23.4%)	28.08 (6.3%)	25.16 (5.7%)	90.53 (20.4%)	1.02 (0.20%)	**444.14 (100.0%)**

Table 2. Depreciation costs of long-line vessels

Depreciation costs (Unit: Million VND)								
Capacity group	**Vessel Number**	**Hull**	**Engine**	**Mechanical equipment**	**Electronic equipment**	**Fishing gear**	**Storage equipment**	**Total investment**
HP<60 (%)	5	6.15 32.9%	2.45 13.1%	2.08 11.1%	1.19 6.3%	6.84 36.5%	0.02 0.1%	**18.71 100.0%**
60<HP<90 (%)	11	8.48 37.6%	3.94 17.5%	2.19 9.7%	1.58 7.0%	6.33 28.1%	0.03 0.1%	**22.55 100.0%**
90<HP<140 (%)	9	9.56 30.1%	6.11 19.2%	2.54 8.0%	1.82 5.7%	11.65 36.7%	0.07 0.2%	**31.75 100.0%**
140<HP (%)	6	13.17 36.7%	7.75 21.6%	2.74 7.6%	2.14 6.0%	9.83 27.4%	0.25 0.7%	**35.87 100.0%**
Average (%)	31	9.32 34.3%	5.07 18.6%	2.38 8.7%	1.70 6.2%	8.63 31.8%	0.08 0.3%	**27.18 100.0%**

difference among the vessels in the different categories. The depreciation costs of the hull vary from 30.1 to 37.6%. For the engine, the depreciation costs range from 13.1 to 21.6%, mechanical devices 7.6-11.1%, electronic devices 5.7-7.0%, fishing gear 27.4-36.7%, and storage facilities 0.1-0.7%.

Cost of major repairs

For the cost of major repairs of the vessels, a comparison was made of the costs in 2004 with those in 2005. Thus, the cost of major repairs of the vessels was 17.43 million VND on the average in 2004 and 19.87 million VND in 2005, an increase of about 14% (Table 3).

The annual increase in repair costs may have been due to many factors that include:

- The cost for repair and maintenance of the hull averaged at 10.50 million VND in 2004, which increased to 12.31 million VND (by 17.2%) in 2005. This was due to increased fees for some cost-driven activities such as landing of vessels in shipyard, cleaning the hull surface, applying protective paints and other repair works. The increase in labor costs associated with the repair and maintenance services ranging from 10 to 15% of the total repair costs, also contributed to the high costs of major repair of the hull.
- With respect to the engine, its repair costs were mostly determined by the cost of replacing the piston rings and fixing some component parts that were not working properly, and also the practice of repairing the vessels' engine once every one or two years. Other engine repair work also contributed to the variable operating costs per fishing trip. Thus, the repair costs of the engine as a whole accounted for 5.28 million VND in 2005, about 7.5% increase than its cost in 2004 (4.91 million VND).
- Other devices, especially storage equipment, did not take much of the budget for major repairs, contributing only 1.69 million VND in 2004 and 1.95 million VND in 2005. This is because the storage equipment was mostly free from repair costs since the fishers only replace the insulating materials and plastic boxes, "accounting for a very minimal cost", said to the fishers.
- No marked change in terms of value was observed in the costs for fixing the fishing gears within the two-year period, because they contributed only a small proportion (less than 2%) to the total costs for major repairs. This could be due to the fact that that most fishers repair their fishing gears during the fishing operations, so the costs must have been added in the variable costs per fishing trip. Also as a practice, not many vessels have their fishing gears fixed at the same time as the hull and the engine.

Table 3. Major repair costs of long-line vessels

Major repair costs (Unit: Million VND)						
Capacity group	**Vessel Number**	**Hull**	**Engine**	**Fishing gear**	**Others**	**Total**
2004						
HP<60	5	9.00	5.20	2.00	0.00	**16.20**
(%)		55.6%	32.1%	12.3%	0.0%	**100.0%**
60<HP<90	11	10.33	4.70	0.00	3.09	**18.13**
(%)		57.0%	26.0%	0.0%	17.1%	**100.0%**
90<HP<140	9	11.22	5.11	0.00	0.44	**16.78**
(%)		66.9%	30.5%	0.0%	2.6%	**100.0%**
140<HP	6	11.00	4.75	0.00	2.42	**18.17**
(%)		60.6%	26.1%	0.0%	13.3%	**100.0%**
Average	31	10.50	4.91	0.32	1.69	**17.43**
(%)		60.3%	28.2%	1.9%	9.7%	**100.0%**
2005						
HP<60	5	10.40	5.30	2.00	0.00	**17.70**
(%)		58.8%	29.9%	11.3%	0.0%	**100.0%**
60<HP<90	11	11.34	4.98	0.00	3.18	**19.50**
(%)		58.2%	25.5%	0.0%	16.3%	**100.0%**
90<HP<140	9	12.33	5.00	0.00	0.44	**17.78**
(%)		69.4%	28.1%	0.0%	2.5%	**100.0%**
140<HP	6	15.67	6.25	0.00	3.58	**25.50**
(%)		61.4%	24.5%	0.0%	14.1%	**100.0%**
Average	31	12.31	5.28	0.32	1.95	**19.87**
(%)		62.0%	26.6%	1.6%	9.8%	**100.0%**

The fixed costs

The fixed costs increased narrowly from 57.55 million VND in 2004 to 60.56 million VND in 2005 (Table 4), which was primarily driven by the rising costs of major repairs and loan interest payments. Meanwhile, the cost of depreciation, taxes and insurance exhibited no significant difference at all. The increase in loan interest payments convey a positive signal in the development of the offshore fishing industry. When a number of vessels (mainly those of the 90-140 HP capacity group) operated efficiently in 2005, the operators were granted additional loans from the banks. Thus, from the data collected in 2005, of the total fixed costs of 60.56 million VND, the cost of depreciation constituted the highest share of over 44.9%, followed by costs of major repairs (32.8%) and payment for loan interests (11.6%). Insurance accounted for only 5.5% of the total fixed costs because very few fishers insure their vessels. However, some banks have pressured the fishers to get themselves and their vessels insured in order to lower the risk factor on their loans. As a result, many fishers insured their vessels only for the purpose of getting their bank loans approved.

Tax payments contributed the smallest share in the total fixed costs (3.14 million VND per year) from 2004 to 2005. Classified as bussiness tax, income tax and resource tax, the fishers' taxes are generally lower than the taxes from other forms of business enterprises. The fishers' business tax enjoys a 50% cut, their income tax is 3-7% of their profits, and their resource tax is equivalent to 0.5-1% of the total revenue. Since the taxes are paid at fixed rate, not on a case-by-case basis, vessels with poor production still have to fulfil their tax duty as the good producers.

This exposes the inadequacy in the fishing tax policy but starting in 2006, as incentive to the fishers, they were exempted from payment of all kinds of fishing taxes and this policy is valid for five (5) years. Moreover, the total fixed costs increased with the vessel capacity groups, notably vessels of over 140 HP paid fixed costs of around 1.5 times higher as those of the 90-140 HP capacity group. This can be explained by their larger loans giving rise to high loan interests and bigger insurance policies.

The variable costs

On the average, variable costs totaled 527.2 million VND in 2004 and 579.1 million VND in 2005, an increase of 9.84% (Table 5). Fuel cost was 274.21 million VND in 2005, an increase of nearly 32% from the fuel cost in 2004 (207.85 million VND), which was governed by the reality that diesel prices increased by 1.42 times during the period. Diesel was the main fuel used for the vessels during their fishing trips.

Table 4. Fixed costs for long-line vessels

Fixed costs (Unit: Million VND)							
Capacity group	**Vessel Number**	**Major repairs**	**Loan interests**	**Tax**	**Insurance**	**Depreciation**	**Total**
			2004				
HP<60 (%)	5	16.20 39.0%	3.08 7.4%	2.10 5.0%	1.50 3.6%	18.71 45.0%	**41.59 100.0%**
60<HP<90 (%)	11	18.13 36.0%	4.36 8.7%	3.22 6.4%	2.11 4.2%	22.55 44.8%	**50.37 100.0%**
90<HP<140 (%)	9	16.78 29.9%	3.85 6.9%	2.75 4.9%	0.96 1.7%	31.75 56.6%	**56.09 100.0%**
140<HP (%)	6	18.17 21.1%	17.16 19.9%	4.43 5.1%	10.60 12.3%	35.87 41.6%	**86.23 100.0%**
Average (%)	31	17.43 30.3%	6.48 11.3%	3.14 5.5%	3.32 5.8%	27.18 47.2%	**57.55 100.0%**
			2005				
HP<60 (%)	5	17.70 41.1%	3.08 7.1%	2.10 4.9%	1.50 3.5%	18.71 43.4%	**43.09 100.0%**
60<HP<90 (%)	11	19.50 37.5%	4.68 9.0%	3.22 6.2%	2.11 4.1%	22.55 43.3%	**52.06 100.0%**
90<HP<140 (%)	9	17.78 30.3%	5.41 9.2%	2.75 4.7%	0.96 1.6%	31.75 54.1%	**58.65 100.0%**
140<HP (%)	6	25.50 27.3%	17.16 18.3%	4.43 4.7%	10.60 11.3%	35.87 38.3%	**93.56 100.0%**
Average (%)	31	19.87 32.8%	7.05 11.6%	3.14 5.2%	3.32 5.5%	27.18 44.9%	**60.56 100.0%**

Fish bait consumed 38.85 million VND in 2004 and this increased to 42.52 million VND in 2005 by 9.45%. Since the long-liners use squid or fish as baits, and the price of squid fluctuated in 2005, the cost of the bait also exhibited certain increases. In 2005, provisions (e.g., food) and storage costs escalated by 10% and 4.4% from 2004, respectively. These increases coincided with the gereral increase of the CPI (consumer price index) in 2005, and the tendency of the fishers to stock more provisions and ice in order to decrease the number of restocking trips, shielding them against the soaring prices of fuel. Minor repair cost also exhibited an increase, which were shared among such items as frequent repairs of the electronic devices, mechanical devices, engine, hull and fishing gears.

Notwithstanding the upward tendency of the other variable costs, labor costs dropped from 178.6 million VND to 153.95 million VND from 2004 to 2005 at a rate of 18.3%. This could be due to the fact that wages were measured by certain percentage of the revenue less the variable costs (exclusive of wage). Both revenues and variable costs increased in 2005 but the increase rate of the variable costs (22%) was much higher than that of revenues (4%). As can be observed from the structure of the variable costs, fuel ranked first followed by labor costs. The costs of provisions and baits did not register a considerable difference in proportion. The least costs were for storage and minor repairs. In summary, the total variable costs of the vessel group of 90-140 HP were highest in 2004 and 2005 because as has been well-documented, these capacity groups operated efficiently with more frequency of fishing trips.

The total earnings

The results of the survey indicated that the average earnings decreased from 113.40 million VND in 2004 to 87.34 million VND in 2005, a reduction of about 23% (Table 6). In this case, the increases of the revenues and the variable and fixed costs were indirectly proportional to the earnings, which decreased from 113.40 million VND in 2004 to 87.34 million VND in 2005. Specifically, the total revenue was 726.97 million VND in 2005 up by 4.13% relative to that of 2004 (698.16 million VND). The total cost (variable and fixed costs) was 639.63 million VND in 2005 an increase of only 9.38% from 2004 (584.76 million VND)

Although the earnings of the vessels in the less than 60 HP capacity group, dropped dramatically by 35.27% their revenues were almost constant during the period from 2004 to 2005: 475 million VND and 470 million VND, respectively. While the variable costs increased sharply due to fuel hike, the respondent-fishers from this vessel capacity group were

Table 5. Variable costs for long-line vessels

Variable costs (Unit: Million VND)								
Capacity group	**Vessel Number**	**Fuel**	**Storage**	**Bait**	**Food**	**Minor Repairs**	**Wage**	**Total**
2004								
HP<60	5	134.88	18.31	21.50	33.40	20.06	130.09	**358.24**
(%)		37.6%	5.1%	6.0%	9.3%	5.6%	36.3%	**100.0%**
60<HP<90	11	155.85	22.37	28.91	42.95	25.55	147.62	**423.25**
(%)		36.8%	5.3%	6.8%	10.1%	6.0%	34.9%	**100.0%**
90<HP<140	9	300.80	36.83	63.22	50.78	40.99	252.87	**745.49**
(%)		40.3%	4.9%	8.5%	6.8%	5.5%	33.9%	**100.0%**
140<HP	6	224.59	26.25	35.00	41.33	39.58	164.45	**531.21**
(%)		42.3%	4.9%	6.6%	7.8%	7.5%	31.0%	**100.0%**
Average	31	207.85	26.67	38.85	43.37	31.86	178.61	**527.21**
(%)		39.4%	5.1%	7.4%	8.2%	6.0%	33.9%	**100.0%**
2005								
HP<60	5	181.74	20.54	17.70	38.20	20.16	103.93	**382.27**
(%)		47.5%	5.4%	4.6%	10.0%	5.3%	27.2%	**100.0%**
60<HP<90	11	206.72	22.91	29.23	44.27	23.82	93.94	**420.88**
(%)		49.1%	5.4%	6.9%	10.5%	5.7%	22.3%	**100.0%**
90<HP<140	9	399.21	38.51	77.56	61.33	46.11	238.37	**861.09**
(%)		46.4%	4.5%	9.0%	7.1%	5.4%	27.7%	**100.0%**
140<HP	6	287.52	27.00	35.00	41.92	39.58	179.03	**610.05**
(%)		47.1%	4.4%	5.7%	6.9%	6.5%	29.3%	**100.0%**
Average	31	274.21	27.85	42.52	47.79	32.75	153.95	**579.07**
(%)		47.4%	4.8%	7.3%	8.3%	5.7%	26.6%	**100.0%**

engaged in other forms of employment when production was low, so their revenues were still stable.

The 60-90 HP capacity group recorded the biggest plunge in earnings from 85.29 million VND in 2004 to 32.15 million VND in 2005, at a decreasing rate of 62.3%. Comparing the 60-90 HP capacity group with the less than 60 capacity group, the total costs of the former remained almost unchanged in two years while the total costs of the latter increased only at a minimum rate (from 399.83 million VND in 2004 to 425.36 million VND in 2005). However, the revenues of the former group decreased from 558.9 million VND in 2004 to 505.1 million VND in 2005, while in the latter group the the total operational revenue in two years was almost stable because the effect of the fuel hike was dwarfed by the corresponding decline in labor costs.

The remarkable decrease in revenue for the 60 – 90 HP capacity group was also derived from the fact that offshore tuna catches recorded a slumpdown in certain times of the year of the survey and this vessel capacity group did not resort to other supplementary activities for extra compensation. It should be noted that in 2005, most vessels experienced a fall in profits, except for the capacity group of over 140 HP. Revenues of this capacity group was 693.33 million VND in 2004 and increased to 786.67 million VND in 2005 at an increasing rate of 13.46%. This sends a signal for the other capacity groups having only a minimum increase or even a fall in revenues, to invest in bigger size vessels. The advantage brought about by high engine capacity led to an increase in the size and radius of their fishing operations, enabling the vessels to harvest in offshore areas especially in the underexploited fishing grounds, thus resulting in higher production. The increase in their revenues shows that vessels of over 140 HP capacity group can operate with a profit of 9.43% although the total costs were higher in 2005 relative to that of the previous year.

However, the vessels of the 90-140 HP capacity group still had the best earnings at a level of twice as much as those of the over 140 HP capacity group. Therefore, from the data collected in two years, the vessels of the 90-140 HP capacity group enjoyed the highest financial efficiency. The Returns on Equity (ROE) in the tuna long-line operations of this capacity group was highest, 42.4% in 2004 although its ROE decreased to 39.2% in 2005, still it had the highest ROE in 2005 from among the capacity groups compared. This ROE was still much higher than interest rates of 8% - 9%/year offered by banks. In summary, the highest efficient operators were those from the 90-140 HP capacity group because of their ROE of 42.4% in 2004 and 39.2% in 2005.

Due to increased in profit, the ROE of the vessels from the over 140 HP capacity group increased from 25.9% in 2004 to 28.3% in 2005. This made the vessels from the over 140 HP capacity group rank second among the efficient operators, next to the 90-140 HP capacity group. Considering the two indicators (returns on capital and returns on equity) in 2005, the earnings of the over 140 HP capacity group was 13.4% whereas the ROE was 28.3%, the same pattern was also observed in 2004 (12.2% and 25.9%, respectively). Debt ratios may be a significant determinant causing the variations of the two indicators considered. The over 140 HP capacity group often gets higher loans (52.83%) compared to the other groups that get only less than 10%.

Table 6. Earnings of the long-line vessels

Earnings (Unit: Million VND)							
Capacity group	**Vessel Number**	**Revenues**	**Variable costs**	**Fixed costs**	**Earnings**	**Returns/ Total capital**	**Returns on Equity (ROE)**
2004							
HP<60	5	475.00	358.24	41.59	75.17	26.6%	29.1%
60<HP<90	11	558.91	423.25	50.37	85.29	22.7%	24.9%
90<HP<140	9	995.56	745.49	56.09	193.97	38.8%	42.4%
140<HP	6	693.33	531.21	86.23	75.89	12.2%	25.9%
Average	31	698.16	527.21	57.55	113.40	25.5%	32.1%
2005							
HP<60	5	474.00	382.27	43.09	48.64	17.2%	18.8%
60<HP<90	11	505.09	420.88	52.06	32.15	8.6%	9.4%
90<HP<140	9	1098.89	861.09	58.65	179.15	35.9%	39.2%
140<HP	6	786.67	610.05	93.56	83.05	13.4%	28.3%
Average	31	726.97	579.07	60.56	87.34	19.7%	24.8%

In principle, the higher the debt ratio, the larger is the ROE and vice versa.

Therefore, to some extent, loans also contribute to the capital efficiency, but not in all cases because when the lendings are granted excessively, the fishers are put under enormous pressure as they are at risk of getting bankrupt especially when the catch is low.

Conclusion

The initial findings revealed that high engine capacity does not automatically translate into large profits. Vessels of 90–140 HP prove to be the best performers from among the capacity groups sampled. Those vessels of greater than 140 HP capacity group had increase in earnings and their ROE indicator stayed fairly high in 2005. Inspite of this, investment decisions for this capacity group need to be carefully considered since the estimated earnings seem to be not satisfactory vis-ñ -vis the required total investment. Furthermore, the effect of loans on the ROE should be included when the performance efficiency of this vessel capacity group is examined in future studies. In addition to the impact of fuel prices – an external contributor to the rise in costs could have also caused the profits to plunge down. There must be other components causing the drop in the revenues or production that need further investigation. However, the identification of the elements influencing operational efficiency of offshore tuna long-liners could be established from the initial results of this study. Hopefully, the efforts of the authors will form an integral part in the sustainable development of offshore tuna long-line fishery in a wider scale in Nha Trang, Vietnam.

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INSTITUTIONALIZING FISHERIES R&D IN THE PHILIPPINES: THE ESTABLISHMENT OF NFRDI

Westly R. Rosario

Recognizing the need to institutionalize the country's fisheries R&D and considering the important role that it plays in the management and conservation of fisheries and aquatic resources, the Philippine Government instituted into law by virtue of Sec. 82 of the Philippine Fisheries Code of 1998 (Republic Act 8550), the establishment of the National Fisheries Research and Development Institute (NFRDI). Pending the release of its own budgetary allocation from the government, the NFRDI remains as the R&D arm of the Philippine Bureau of Fisheries and Aquatic Resources (BFAR).

While responding to the Philippine fisheries agenda and in addressing the food security and poverty alleviation concerns of the Philippine Government, the NFRDI is committed to be "a prime institution that ensures the country of sustainable fisheries through continuing excellence in research and development." Thus, the NFRDI envisions to generate scientific information and knowledge as basis for sustainable fisheries management and policy formulation; and to develop and improve fisheries technologies pro-active and responsive to the needs of the industry and the fisherfolk.

Goals of NFRDI

With food security and poverty alleviation as overriding considerations in the development and management of the country's fishery resource, and as mandated in Sec. 84 of the Philippine Fisheries Code of 1998, the NFRDI aspires:

- To conduct research to raise the income of the fisherfolk and to elevate the Philippines among the top five (5) in the world ranking in the fish production;
- To make the country's fishing industry in the high seas competitive;
- To conduct social research on fisherfolk families for a better understanding of their conditions and needs; and
- To establish linkages with state colleges and universities on upstream research and with training agencies, LGUs and private sector for the maximum promotion of fisheries technologies.

Functions of NFRDI

As the primary research arm of BFAR, the NFRDI has the following core functions:

- Provide continuing assessment of the growth and performance of the fisheries sector and the factors contributing to its status;
- Develop through a highly participatory process a national research and development agenda as the framework for national R&D for the fisheries sector;
- Provide leadership in the development and operation of a network of institutions involved in fisheries research and development to promote synergy and effective partnership;
- Focus its R&D on upstream research in the generation of public goods in critical areas outside of the comparative advantage of the State Colleges and Universities (SCU's) as defined and approved by Philippine Agency for Research and Development in Agriculture and Fisheries (PARDAF);
- Provide the leadership in the development and operation of the National Fisheries Germplasm and Seed System in partnership with research institutions, Local Government Units (LGUs), the private sector, the small fisherfolk, and other stakeholders; and
- Provide technical assistance to BFAR in the development and operation of a sustainable National Fishery Health Advisory Services (NAFAS) closely linking with the LGUs and the fish farmers and in close partnership with other government agencies and other stakeholders.

Challenges and Opportunities

Considering that the Philippines is rich in fishery resources and that its fisheries production has been consistently increasing (ave. of 24%) during the past 10 years, the NFRDI is therefore faced with the challenge of elevating the Philippines to among the top five fish producing countries in the world. Thus, the NFRDI considers it an opportunity to be able to attain this goal through the rational and sustainable management of the country's fishery resources. Since aquaculture contributed the most sustainable increase in production from 2005 to 2006 (about 13% annually), the

NFRDI is setting its priority towards increasing fish production from aquaculture. The NFRDI envisioned that this could be achieved by promoting nationwide the country's Code of Practice for Aquaculture as this outlines the general principles of environmentally-sound designs and operations for sustainable development. The NFRDI also endeavors to extend technical assistance to the commercial fisheries sector through technology development on the optimal use of offshore and deep sea resources. This is aimed at boosting the production from commercial fisheries, which showed a downward trend in 2005-2006. At the same time, NFRDI also continues to provide technical assistance to the municipal fisheries sector through its program on the development of sustainable fishing boats for marginal fisheries.

NFRDI Executive Director Westly Rosario discussing the Philippine National Seaweeds Development Program with a visitor at the NIFTDC seaweeds culture tanks

Five-year Program of NFRDI

Having been institutionalized only recently and complying its main function as the R&D arm of BFAR, the NFRDI formulated the following priority programs for the five-year period from 2006 to 2010:

1. Improvement of Aquaculture Systems
2. Development of Improved Strains and New Species for Aquaculture
3. Investigation of Pollution and Environmental Concerns
4. Formulation of Quality and Safety Criteria for Fish and Fishery Products
5. Reduction of Environmental Impacts and Development of Responsible Harvesting Technology
6. Assessment of Aquatic Biodiversity for Sustainable Use
7. Development of Sustainable Fishing Crafts for Marginal Fisheries

Priority R&D Species

1. Seaweeds

Since seaweeds, which is abundant throughout the Philippines, has consistently been the first and major contributor to the Philippines' fisheries production, the NFRDI continues to develop this resource through an intensified R&D on seaweeds. Consistent with this, the NFRDI has established the National Seaweeds Development Program, which aims to among others, generate baseline information on the country's seaweed resources. The information collated would serve as basis for the formulation of management policies for the proper utilization, conservation and protection of the resource. The information would also provide basis for concerned institutions in the country as well as the LGUs in the formulation of their respective municipal development plans and ordinances on the proper management of the seaweed resource in their respective localities.

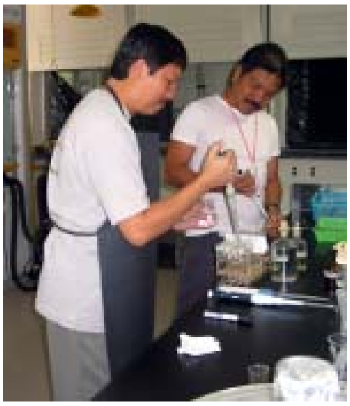
2. Milkfish

Considering that milkfish (bangus) is the second most important commodity in the Philippine economy based on the most recent Philippine Fisheries Production Data, R&D on bangus will be intensified by the NFRDI including the promotion of services for the industry, e.g., technology and innovations, human capacity development, marketing, credit assistance, licensing of ponds, pens and cages, etc. Moreover, with the problems constraining the sustainable development and management of the bangus resources in the country, especially bangus fry importation and unsustainable farming practices, the NFRDI will focus its efforts in addressing these concerns by improving the culture technology as well as through massive information dissemination.

Milkfish harvest

3. Tilapia

Having contributed an average production of 8% to the country's fish production over the last five years, the NFRDI will continue to intensify its R&D on tilapia. Based on findings that tilapia aquaculture in the country is constrained with problems on fry quality, unsustainable farming practices, and other ecological concerns, the NFRDI envisions to carry



NFRDI Researchers doing research on tilapia feeds at the DA-BFAR-NFRDI Biotechnology Laboratory at SEAFDEC Aquaculture Department in Iloilo, Philippines

out an expanded tilapia R&D including production of high value tilapia species that are more resistant to diseases, etc.

4. Penaied Shrimps and Prawns

The Philippine fisheries trade data shows that shrimps and prawns are among the major commodities that contribute to the top fishery exports of the country. This trend will be boosted soon because of the recent lifting of the ban to culture the Pacific white shrimp, *Penaeus vannamei* in the country. The lifting of the ban was recognized by the private sector in the Philippines as a giant step towards the responsible development of this resource. Together with the intensified R&D on *P. vannamei* to be spearheaded by NFRDI, the export of this commodity is expected to leap in bounds.

The NFRDI, which has been assigned by the Philippine Government to establish the country's development program for *P. vannamei*, will carry out activities that include monitoring and surveillance of shrimp diseases in the country. With the culture technology of *P. vannamei* already developed in the Asian countries, the NFRDI will continue to improve such technology for adoption in Philippine conditions. The country's *P. vannamei* development program under the NFRDI will also include projects aimed at developing appropriate handling techniques, quality criteria and grades, and processing techniques.

The culture of the giant freshwater prawn is an emerging industry in the Philippines. Considering the abundance of the giant freshwater prawn throughout the country, the NFRDI has been tasked to carry out the R&D on the giant freshwater prawn, *Macrobrachium rosenbergii*. This is aimed at developing a hybrid and improved strain of *M. rosenbergii* that will have better growth performance and higher survival rate during culture. In order to conserve the country's giant freshwater prawn resource, the NFRDI has established a Gene Bank for Macrobrachium based at BFAR's National Integrated Fisheries Technology and Development Center (NIFTDC) in Dagupan City, Philippines.

5. Tuna

Tuna remains as the Philippines' top export commodity hence, the Philippines deemed it necessary for NFRDI to conduct continuing R&D on sustainable harvesting of tuna as well as on the reduction of post-harvest losses in the handling chain of sashimi-grade tuna. As a general consequence, through the post-harvest and processing activities of NFRDI, the country will be able to establish standards for fish and fishery products for sustainable increase in the country's foreign exchange earnings.

6. Sea Cucumber

Another fast emerging commodity in the Philippines, due to its considerable contribution to the country's fisheries export, is sea cucumber. Since a number of commercially-important species of sea cucumber is abundant in the Philippines, this has prompted the Philippine Government to promote the culture of sea cucumber with NFRDI spearheading the R&D. As an initial step towards the development of the sea cucumber industry, NFRDI is carrying out investigations on the biology of the various commercially important species of sea cucumber. In addition, a study is also being conducted by NFRDI, on the

About-to-be completed Philippine Gene Bank for Macrobrachium to be operated by NFRDI at NIFTDC in Dagupan City, Philippines (left) molecular application for the conservation, management and development of the country's sea cucumber species.

7. Freshwater Ornamental Fishes

Freshwater ornamental fishes have emerged as new commodities contributing considerably to the country's economy. In the latest Philippine fisheries export data, the ornamental fish industry has contributed largely to the fish trade of the country. Thus, the Philippine Government has assigned the NFRDI to establish an Ornamental Fish Development Program in order to promote the technology on the breeding and culture of freshwater ornamental fishes as an alternative form of livelihood. The program also intends to conduct training and transfer of technology on the breeding and culture of freshwater ornamental fishes to fisherfolk and other interested cooperators.

8. Ludong

"Ludong", *Cestraeus* spp. is an endemic, rare and indigenous migratory fish species and commands very high price in the local market of the country. At present, there is very little information available on the fisheries and biology of this commercially valuable fish. Research on the habitat and spawning requirements of this fish has setbacks due to fragility of its survival in captivity. With increasing threat of overexploitation and environmental degradation, NFRDI was tasked to conduct biological studies and assessment of this indigenous species for conservation purposes and sustainability; and to establish the Ludong Fisheries Development Program.

Other Related R&D Activities

1. Trap Development Program

The NFRDI has also been tasked to also carry out R&D activities for the refinement and improvement of fishing gears for local environment. This is being pursued through the establishment of the Trap Development Program, which aims to ensure the sustainable development, management and conservation of the fishery resource of the Philippines including the country's Exclusive Economic Zone (EEZ). The specific activities include improving the methods of harvesting, collecting, and handling of the fishes in accordance with approved technologies consistent with the objective of maintaining a sound ecological balance, and in protecting and enhancing the quality of the environment.

2. Post-harvest Technology

In order to make fish and fisheries products from the Philippines more competitive in the fish trading arena, the NFRDI was tasked to also conduct R&D on post-harvest technology aimed at formulating quality and safety criteria for fish and fishery products. These activities are expected to lead to the reduction of fish harvest losses and preserving the good quality of fish being exported by the country.

3. Human Capacity Building

The NFRDI has been mandated to continue disseminating technologies developed and or refined, to the fishworkers and investors through training, extension and information dissemination activities.

Organization Structure of NFRDI

NFRDI is headed by the Executive Director, and is assisted by the Deputy Executive Director for Research and the Deputy Executive Director for Technical Support. Directly under the Executive Director are four divisions, namely: Administration and Services, Financial Management, Planning and Budget Programming, and Program Monitoring and Evaluation.

Under the Deputy Executive Director for Research are six divisions, namely: Socio-economics, Fish Health, Biology, Ecology, Genetics and Biotechnology, and Biochemistry. Under the Deputy Executive Director for Technical Support are three divisions, namely: Knowledge Management, Laboratory Services, and Gernplasm Conservation.

Also directly under the Executive Director are five centers, namely: Central Fisheries Research Center (Dagupan City, La Union), Center for Freshwater Research (Science City of Muñ oz, Nueva Ecija), Center for Lake Resources Research (Taal, Batangas), Center for Brackishwater Research (Lala, Lanao del Norte), and Center for Marine Research (Guiuan, Eastern Samar).

Progress of Activities in 2006

The 34 studies conducted by NFRDI in 2006 were grouped into: Aquaculture (5), Fishing Technology (5), Post-Harvest Technology (4), Marine Fisheries (5), and studies carried out at the four NFRDI Centers in Taal, Batangas (4), Dagupan City (4), Lala, Lanao del Norte (3), and Guiuan, Eastern, Samar (4).

Plans for 2007

1. Aquaculture
   1.1 Philippine Seaweeds Development Program
   - *Kappaphycus* spp.
   - *Eucheuma* spp.
   - *Gracilaria* spp.

   1.2 *P. vannamei* Development Program
   - Disease surveillance and monitoring

   1.3 Ludong and Other Commercially Important Indigenous Fishes Development Program
   - Biology
   - Population genetics
   - Broodstock development and seed production

   1.4 Improvement of aquaculture systems
2. Fishing Technology
   2.1 Trap Development Program
   - Floating trap gear
   - Mid-water and surface trap nets
   - Gear modification on portable traps
   - Small-scale set net
   - Tuna drift gill net
   - Square mesh windows
   - Gear for harvesting live indigenous fish species
3. Post-harvest Technology
   3.1 *P. vannamei*
   - Development of quality standards for handling, grading, transport, and processing of *Penaeus vannamei*

   3.2 Tilapia
   - Quality assessment and storage life in ice of selected tilapia species from different culture environments

   3.3 Tuna
   - Quality assessment of filtered/tasteless smoke and CO gas-treated tuna meat products
   - Reduction of post-harvest losses in the handling chain of sashimi grade yellowfin tuna (*Thunnus albacares*)
4. Marine Fisheries
   4.1 GIS Application on capture fisheries
   4.2 Identification of indicators for the management of Philippine capture fisheries (with SEAFDEC)
5. Center for Lake Resources Research (Butong, Taal, Batangas)
   5.1 Lake conservation and management
   5.2 Breeding of *Caranx ignobilis*
   5.3 Breeding of freshwater ornamental fishes
6. Central Fisheries Research Center (Dagupan City)
   6.1 Breeding of Molobicus Salt*Uno* tilapia
   6.2 Gene Bank for *Macrobrachium rosenbergii*
   6.3 Oyster culture
7. Center for Brackishwater Research (Lala, Lanao del Norte)
   7.1 Culture of Molobicus saline tilapia
   7.2 *P. vannamei* culture
   7.3 Polyculture of fishes and clams
8. Center for Marine Research (Guiuan, Eastern Samar)
   8.1 Soft-shell blue crab production
   8.2 Abalone culture
   8.3 Sea cucumber culture
   8.4 Pearl oyster culture

About The Author

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Against all odds:

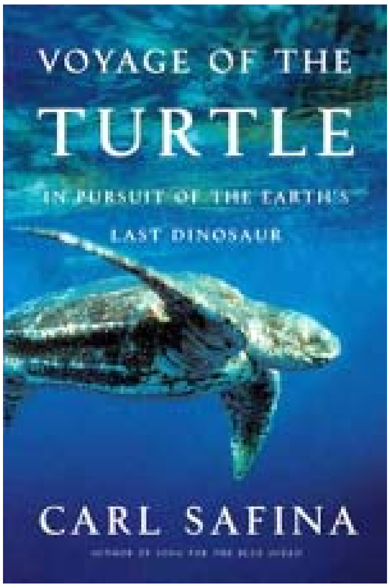
The fight for the survival of the Leatherback Turtle

Having been around for more than 65 million years and witnessed the demise of the dinosaurs, Leatherback Turtles, they are now at the brink of extinction. "For millions of years they swam in a world without people, and in the peopled world they remain unaccustomed and too often unaccommodated. It could not be said of us that we are accustomed to a world without turtles...Yet now, through the darker side of our human genius, we can envision that day coming", Carl Safina writes in his latest book, "Voyage of the Turtle."

In this book, marine biologist and conservationist Carl Safina, introduces the reader to the rapidly shrinking world of these marine giants, who are the "earth's last warm-blooded monster reptiles." The world into which Safina takes the reader is a world of mysteries and wonder, few of which are only beginning to be unraveled by biologists and marine scientists. It's a world of fishers, coastal dwellers, scientists and strange marine creatures whose lives and fates are somehow connected.

Carl Safina: Voyage of the Turtle. In pursuit of the Earth's last Dinosaur

Henry Holt 2006
ISBN-13: 978-0-8050-7891-6



The ambition of the author is "to fully understand the Leatherback and what it means to people". To achieve this, he invites the reader to accompany him on a journey across the oceans, quietly observing turtles struggling to lay their eggs, stalking them from the air and by boat and exploring the biology and ecology of the earth's "last dinosaurs", as Safina calls them.

Once at home around the globe in all oceans, ranging from Labrador and Alaska to Chile, the Cape of Good Hope and the Southern end of New Zealand, world-wide nesting populations have declined from an estimated 115,000 in 1980 to about 26,000. The reasons for this dramatic decline are easily identified as human activities that set up obstacles and boundaries turtles are unable to cope with. While fishing is identified as a major threat, the impacts from poaching of eggs, degradation and disappearance of nesting places are the major causes for the global decline of Leatherbacks and other marine turtles.

The stories about the people who are seeking to understand the lives of turtles and who are seeking ways to help turtles surviving their encounter with humans, are interlaced with the latest scientific knowledge and interesting details about turtle biology and behavioral patterns. But more than that, they are stories of hope. In the general and common doom and gloom scenarios about life in the world's oceans, Safina's book offers a pleasantly alternative and positive view, showing that human effort can make a difference. Though pacific turtle populations are still declining, the signs of hope Safina sees, emerge from the efforts to protect turtles in the Atlantic, where, after years of decline, nesting populations seem to be increasing again.

Safina's account of his travels into the world of marine turtles provides interesting, informative and enjoyable reading. "Voyage of the Turtle" is not a scientific textbook, and the reader may find its language occasionally too elaborate or stylish, but it is a captivating read for anybody interested not only in marine turtles, but also in marine life in general, fisheries, biology, ecology and conservation, and how people can make a difference.

Events Calendar

Date	Venue	Events	Organizer
		2007	
29 Jan–4 Feb	Myanmar	Training Workshop on Fish Health Management	AQD
1 Feb – 15 Mar	Myanmar	Fisheries Resources Survey in the Andaman Sea: Waters of Myanmar by the M.V. SEAFDEC 2, cruise 12-1/2007	TD
5-7 February	Chiangmai, Thailand	ASEAN-SEAFDEC Regional Technical Consultation on International Fisheries Related Issues (2007)	Secretariat
5-9 February	Myanmar	Training Workshop on Shrimp and Prawn Health Management	AQD
19 Feb-23 Mar	Philippines	Training Course on Tissue Culture and Sporulation of *Kappaphycus*	AQD
4-15 March	Thailand	A Study Program on Tilapia Aquaculture in Thailand	TD
7-9 March	Singapore	Mid-Term Review Meeting on Chemical and Drug Residues in Fish and Fish Products in Southeast Asia	MFRD
12 March	Philippines	Progress Meeting of the Regional Program on Stock Enhancement for Threatened Species of International Concern	AQD
15 Mar-23 Apr	Thailand	Fisheries Resources Survey in the Andaman Sea: Waters of Thailand by the M.V.SEAFDEC 2, cruise 24-2/2007	TD
16 March	Philippines	The Annual Progress and Planning Meeting on the Development of Surveillance Systems of Aquatic Animal Diseases	AQD
19 March	Thailand	1st Meeting for scientific, technical and educational exchange between the SEAFDEC and the Faculty of Fisheries Sciences, Hokkaido University	Secretariat
19-23 March	Thailand	FAO-SEAFDEC Regional Workshop on Assessing the Relative Importance of Sea Turtle Mortality due to Fisheries in Southeast Asia	TD
27 March	Malaysia	On-site Training on Sea Turtle Tagging	MFRDMD
4-7 April	Cambodia	39th Meeting of the Council of SEAFDEC	Secretariat
18 Apr – 8 May	Philippines	Training on Abalone Hatchery and Grow-out	AQD
1-3 May	Thailand	Demonstration and 1st Core Expert Meeting on Tagging for Small Pelagic in the South China Sea and Andaman Sea	TD, MFRDMD
18-31 May	Thailand	Regional Training Course on Larval Fish Identification (in collaboration with UNEP-GEF in South China Sea Project)	TD
22 May – 5 July	Philippines	Training Course on Marine Fish Hatchery	AQD
10-24 June	Thailand	International Training Course on Coastal Fisheries Management for Fisheries Managers	TD
24-28 June	Malaysia	Training on Hatchery Management of Sea Turtles	MFRDMD
2-15 July	Lao PDR	Joint Regional Training on Community-Based Aquaculture for Remote Rural Areas of Southeast Asia	Secretariat
2 Jul – 15 Aug	Malaysia	Technical Cooperation Programme on Fishery Resources Management	MFRDMD
9 July	Malaysia	Training on Hydroacoustics	MFRDMD
20 Aug – 20 Sep	Thailand	International Training Course on Coastal Fisheries Management and Extension Methodologies	TD
November	Philippines	10th Meeting of the ASEAN-SEAFDEC Fisheries Consultative Group	Secretariat
November	Philippines	30th Meeting of the SEAFDEC Program Committee	AQD, Secretariat

Southeast Asian Fisheries Development Center (SEAFDEC)

What is SEAFDEC?

SEAFDEC is an autonomous intergovernmental body established as a regional treaty organization in 1967 to promote sustainable fisheries development in Southeast Asia.

Objectives

SEAFDEC aims specifically to develop fishery potentials in the region through training, research and information services in order to improve food supply through rational utilization of fisheries resources in the region.

Functions

To achieve its objectives the Center has the following functions:

1. To offer training courses, and to organize workshops and seminars, in fishing technology, marine engineering, extension methodology, post-harvest technology, and aquaculture;
2. To conduct research and development in fishing gear technology, fishing ground surveys, post-harvest technology and aquaculture, to examine problems related to the handling of fish at sea and quality control, and to undertake studies on the fisheries resources in the region; and
3. To arrange for the transfer of technology to the countries in the region and to make available the printed and non-printed media, which include the publication of statistical bulletins for the exchange and dissemination related to fisheries and aquaculture development.

Membership

SEAFDEC members are the ASEAN Member Countries (Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam) and Japan.

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In the occasion of the Millennium Conference, a drawing contest was organized for the children among ASEAN-SEAFDEC Member Countries, on the theme of "*Fish and the Culture*". This is the best drawing from Brunei Darussalam.