SEAFDEC support to aquaculture programmes in southeast Asian countries

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BACKGROUND AND RATIONAL

The Southeast Asian Fisheries Development Center (SEAFDEC) is an autonomous intergovernmental body established as a regional treaty organization in 1967 to promote sustainable fisheries development in Southeast Asia. SEAFDEC has a Secretariat as its administrative arm, and four technical departments including the Training Department (TD), which is in Thailand; the Marine Fisheries Research Department (MFRD) in Singapore; the Aquaculture Department (AQD) in the Philippines and the Marine Fisheries Resource Development and Management Department (MFRDMD) in Malaysia.

SEAFDEC focuses on developing fisheries potential through training, research and information services to secure the food supply by rational utilization and sustainable development of the fisheries resources within the region. Its Member countries are Brunei Darussalam, Cambodia, Indonesia, Japan, the Lao People's Democratic Republic, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Viet Nam.

The Aquaculture Department (AQD) was established to develop aquaculture potentials of the region with four research stations covering marine, brackishwater and freshwater areas. AQD has carried out research, technology verification, training and information programmes on several aquaculture aspects, e.g. managing broodstock and improving seed quality, developing responsible aquaculture techniques and stock enhancement.

In 2001 ministers and senior officials responsible for fisheries in the Association of Southeast Asian Nations (ASEAN)-SEAFDEC Member Countries adopted the "Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region (RES & POA)", at the ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security in the New Millennium: "Fish for the People". The RES & POA are recognized as the common regional policy framework and guidelines for promoting and ensuring sustainable fisheries in the region. The Resolution in relation to aquaculture is cited as follows:

"Increase aquaculture production in a sustainable and environment-friendly manner by ensuring a stable supply of quality seeds and feeds, effectively controlling disease, promoting good farm management and transferring appropriate technology." (No. 12); and

"Promote aquaculture for rural development, which is compatible with the rational use of land and water resources, to increase fish supplies and improve the livelihoods of rural people." (No. 13)

STATUS OF AQUACULTURE PRODUCTION IN SOUTHEAST ASIA

Marine and coastal aquaculture production

In 2003 the world marine/coastal aquaculture production was 59 354 268 tonnes, while the Asia-Pacific region produced 27 222 394 tonnes or 45.86 percent of world production. The Southeast Asian region produced 3 227 634 tonnes or 5.44 percent of global output (Table 1 and Figure 1).

TABLE 1
Marine and coastal aquaculture production, 2003

Area	Production (tonnes)	Percent
World	59 354 268	-
Other regions	32 131 874	54.14%
Asia-Pacific	27 222 394	45.86%
Southeast Asia	3 227 634	5.44%

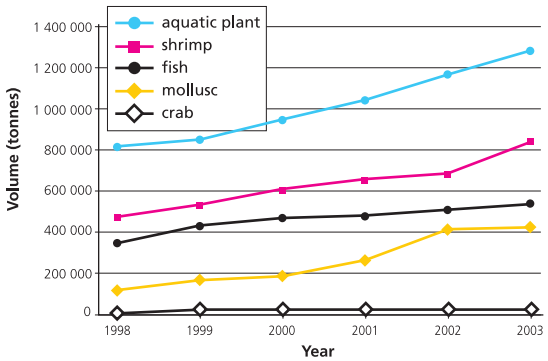
Marine/coastal aquaculture production in Asia-Pacific

For the Asia-Pacific region, the People's Republic of China (including Taiwan Province of China and China, Hong Kong Special Administrative Region) contributed the most production. In 2003 China ranked first with 21 052 292 tonnes or 77.33 percent of the total regional production. This was followed by the Southeast Asian countries with 3 227 634 tonnes or 11.86 percent, while other Asian countries (Japan, Mongolia, the Islamic Republic of Iran, Republic of Korea etc.) were third with a production of 2 655 083 tonnes or 9.75 percent. South Asia (India, Bangladesh, Nepal, Sri Lanka and Maldives) shared 0.65 percent, followed by Oceania with 0.41 percent (Table 2).

TABLE 2
Marine and coastal aquaculture production in Asia-Pacific, 2003

Subregion	Production (tonnes)	Percent
China	21 052 292	77.33%
Southeast Asia	3 227 634	11.86%
Other Asia	2 655 083	9.75%
South Asia	175 796	0.65%
Oceania	111 589	0.41%

Figure 1
Mariculture output by species in southeast Asia, 1998–2003



Cultured marine species in Southeast Asia

During 1998–2003, aquatic plants ranked first in quantity, and their share of production has been growing continuously since 1998 to 56.83 percent. The second group is shrimp – from 1998 to 2003, shrimp production increased by 76.69 percent. Marine fish farming placed third with an increase of 52 percent from 1998 to 2003. The lowest production is crab, but the six-year trend showed a 76.69 percent increase (Table 3 and Figure 1).

TABLE 3
Production of marine aquaculture species in Southeast Asia, 1998–2003

Species	1998	1999	2000	2001	2002	2003	% Increase
Aquatic plant	814 546	855 179	943 391	1 040 631	1 165 458	1 277 460	56.83
Shrimp	473 252	528 039	600 704	654 352	675 009	836 183	76.69
Crab	7 259	13 828	14 088	10 294	15 479	13 945	92.11
Mollusc	117 281	170 117	188 101	261 633	410 740	432 295	90.16
Fish	348 232	427 706	464 275	477 428	505 473	529 285	51.99
Total	1 760 570	1 994 869	2 210 559	2 444 338	2 772 159	3 089 168	-

SEAFDEC SUPPORT TO AQUACULTURE PROGRAMMES IN SOUTHEAST ASIA

Plan of action for aquaculture activities

The Plan of Action, which includes a component on aquaculture and is used as a guideline to develop programmes, projects and activities for the implementation of the Resolution, is as follows:

- Ensure that national policies and regulatory frameworks on aquaculture development are directed towards sustainability and avoidance of conflicts by incorporating consultations with stakeholder groups, implementing aquaculture zoning, considering social and environmental impact and regulating rights of access to, and use of, open water sites for mariculture.
- Ensure production of high-quality seed on a consistent and sustainable basis by providing government support for public and private hatchery development and research, developing domesticated broodstocks and fish reproductive technologies and promoting responsible collection and use of wild broodstock and seed.
- Promote good farm management practices that reduce effluent pollution load and comply with relevant effluent standards through appropriate treatment.
- Reduce the risks of negative environmental impacts, loss of biodiversity and disease transfer by regulating the introduction and transfer of aquatic organisms in accordance with the Regional Guidelines on the Responsible Movement of Live Aquatic Animals and Plants.
- Improve the efficient use of aquatic feeds by regulating the quality of manufactured feed and feed ingredients, providing guidelines on farm-level food conversion ratios and levels of aquaculture effluents and supporting research into developing suitable alternative protein sources to reduce dependence on fish meal and other fish-based products.
- Improve capabilities in the diagnosis and control of fish diseases within the region by developing technology and techniques for disease identification, reliable field-side diagnostics and harmonized diagnostic procedures, and establishing regional and inter-regional referral systems, including designation of reference laboratories and timely access to disease control experts within the region.
- Formulate guidelines for the use of chemicals in aquaculture, establish quality standards and take measures to reduce or eliminate the use of harmful chemicals.
- Build human resource capabilities for environmentally friendly, healthy, wholesome and sustainable aquaculture through closer public and private sector collaboration in research and development, paying particular attention to the emerging need for skills in biotechnology and effectively implementing aquaculture education and extension services.
- Promote aquaculture as an integrated rural development activity within multiple-use of land and water resources available through inter-agency coordination in policy formulation, project planning and implementation, stakeholder consultation, extension services and technology transfer.

Implementation of the SEAFDEC programme

In line with the Resolution and Plan of Action, SEAFDEC launched various regional programmes to support Member Countries. The programmes and their activities in relation to marine and coastal aquaculture are summarized as follows.

Promotion of mangrove-friendly aquaculture: Mangrove-friendly shrimp culture project (2000–2005)

Shrimp culture has been identified as one of major causes of destruction of mangrove forest, and effluents from intensive shrimp culture resulted in negative impacts on mangrove ecosystems. Thus, the programme was initiated with the aim of developing sustainable culture technology packages for shrimp farming that are friendly to mangroves and the environment, and to disseminate such packages to the region through actual demonstration and training.

As part of the programme, verification and refinement of intensive shrimp culture techniques were conducted in Thailand and the Philippines, whereas similar activities for semi-intensive culture were run in Viet Nam and Myanmar. In Thailand, the physical and biological technology for water recycling was studied, which indicated that an integration of bivalves, trickling filter land seaweeds was useful for effluent treatment. The reason is that bivalves could improve the effluent water by removing suspended matter, while seaweeds have the ability to absorb dissolved nutrients. These series of studies also demonstrated the seawater irrigation facility to ensure the proper release of water from shrimp ponds to the sea, as well as plantation for enhancing the food web in water recycling shrimp farms. It served as the basis for the estimation of suitable density of mangrove trees and suitable species of weeds to prevent erosion of pond dikes.

The environmentally friendly schemes verified in the Philippine sites are capable of achieving high productivity and return on investment. The activity in Viet Nam aimed to develop a model for semi-intensive culture and demonstrate a system that can effectively increase production. In Myanmar, the project aimed to promote the most appropriate culture system that could avoid occurrence of viruses and disease in shrimp.

SEAFDEC also conducted research on the nutrient dynamics, environmental impacts and waste inputs resulting from an integrated, closed recirculating, intensive farming system. Under the theme of nutrient research, the study assessed the capacity of mangrove forests to process aquaculture pond effluents. The results confirmed the efficacy of fish as a bio-manipulator in a green-water system to control potentially pathogenic luminous bacteria in shrimp culture.

Training under the scope of the mangrove-friendly shrimp aquaculture project was conducted at both the regional and national levels. On-site training was conducted in Viet Nam, Myanmar and Cambodia. The outcomes from meetings and consultations were also published, and manuals and publications on project achievements disseminated to the public.

Development of fish disease surveillance system (2005–2008)

Antibiotics and other chemicals are often used to control fish disease; however, some of these substances are harmful to human health or can give rise to resistant pathogens in cultured organisms. Therefore, the aquaculture products must be safe for human consumption and a monitoring system for the presence of chemical residues in such products needs to be developed. The programme was developed to enhance disease diagnosis and health management of cultured animals, promote the healthy and wholesome trading of aquaculture products and develop a fish disease surveillance network in the region.

SEAFDEC succeeded in conducting the research to establish and standardize diagnostic techniques for a) detection of white spot syndrome virus (WSSV) in tiger

shrimp using polymerase chain reaction (PCR), b) detection of viral nervous necrosis (VNN) in marine fish using cell lines; and c) detection of two serious pathogens of tiger shrimp – *monodon* baculovirus (MBV) and hepatopancreatic parvovirus (HPV). The biology of disease agents and their pathogenesis were also studied to screen economically important fish for the presence of parasites, determine diagnostic methods and study the pathology of infection. Some parasites were detected and identified from grouper, snapper, milkfish and rabbitfish.

The results of studies on the diagnostic methods and parasites contributed to establishment of disease prevention and control methods. Research studies on luminous vibriosis, a major bacterial disease of tiger shrimp, were conducted to develop husbandry techniques such as the use of live bacteria (probiotics) and a green-water culture system as alternatives to chemotherapy in the control of vibriosis. SEAFDEC also established evaluation methods for chemical residues in aquaculture products. The activity addressed the development and standardization of detection methods for chemical residues, especially pesticides and antibiotics, in aquaculture products. The use of antibiotics in shrimp culture was also monitored.

Hands-on training on important viral diseases of shrimp and marine fish was conducted in collaboration with the World Organization for Animal Health (Office international des épizooties, OIE). Various meetings and symposia were organized under the programme to share the most current experience and knowledge on fish disease issues.

As the next-step on fish disease work by SEAFDEC, a programme on "Development of Fish Disease Surveillance System" was developed based on the experiences of the former programme. Its objective is to develop a surveillance system for diseases of aquatic animals in Southeast Asia. Highlighted activities are as follows:

- research and development on the refinement of diagnostic methods and development of new prevention methods for aquatic animal disease;
- surveillance for important viral diseases of fish and shrimp and "mobile clinic" to identify causative agents of serious or unknown infectious diseases; and
- e-learning and hands-on training.

In 2005, surveys and collection of white shrimp samples were conducted to monitor shrimp viruses in Indonesia and the Philippines. The first sampling of rock oyster was taken in Thailand to investigate the presence of OIE-listed parasitic diseases and macro-parasites. Disease diagnosis activities on tiger shrimp were also implemented in Myanmar, Cambodia and Viet Nam. The samples from Myanmar were positive for MBV and HPV but negative for other tested pathogens.

Regionalization of the CCRF: aquaculture development

After the adoption of the Code of Conduct for Responsible Fisheries (CCRF) in 1995, the need to regionalize the Code was examined to clarify and elaborate the generic articles of the CCRF by establishing a set of guidelines taking into consideration regional specificities, including fishery structure; ecosystems; cultural, social and economic factors and other issues of importance in Southeast Asia. Further, the regionalization process was also intended to facilitate the implementation of the CCRF at the national level, where it matters most.

SEAFDEC successfully implemented a programme for formulation and dissemination of a "Regional Guidelines for Responsible Fisheries in Southeast Asia: Responsible Aquaculture". These regional guidelines were based on Article 9 of the CCRF, which aims to forestall or mitigate the negative effects of aquaculture, from both human and ecosystem perspectives. The regional necessity to promote the implementation of responsible aquaculture was accommodated in the guidelines. Due to the fact that aquaculture farms in the region are generally small, the guidelines also

provided specific guidance for efficient use of inputs (fry, broodstock, feed, etc.) to improve production and facilitate responsible practices. In particular, the guidelines elaborated the following principles within the CCRF:

- responsible development of aquaculture, including culture-based fisheries, in areas under national jurisdiction;
- responsible development of aquaculture, including culture-based fisheries, within transboundary aquatic ecosystems;
- use of aquatic genetic resources for purposes of aquaculture, including culture-based fisheries; and
- responsible aquaculture at the production level.

Integrated Regional Aquaculture Program (IRAP): Aquaculture for rural development and supply of good quality seeds (2000–2005)

In response to the need for promotion of sustainable aquaculture in the region, this programme was initiated to assure a supply of quality seed stocks of various aquatic commodities and that aquaculture development will benefit the rural populace through consultations, demonstration and dissemination of specific aquaculture technologies.

The programme on "Aquaculture for Rural Development" is expected to come up with appropriate responsible aquaculture technologies that will help alleviate poverty and ensure food security for people in the rural areas. The other programme, called "Supply of Good Quality Seeds", focuses on appropriate responsible seed production technologies in support of aquaculture and stock enhancement in the region. These two components of IRAP were implemented together and linked with each other. The activities under IRAP covered pilot demonstration, research, training and information dissemination. The benefiting countries expressed their interests in specific aquatic species. Although most priority activities identified by ASEAN countries involved freshwater systems, marine species were selected as the interest of Malaysia, Myanmar, Thailand and Viet Nam.

Grouper, seabass and mud crab were species selected to be included in both activities in Myanmar, which were aimed at utilizing the coastal and marine resources for aquaculture in order to alleviate the social economy of the rural communities. Viet Nam considered milkfish and siganids as priorities for both activities, aiming at promoting the adoption of their culture technologies in coastal areas. Malaysia focused on the production of disease-free grouper, with the aim of producing such grouper seeds by improving broodstock management. Thailand was interested in cage culture of abalone and Babylonia snail, including studies on their growth, survival rates and food conversion ratios (FCRs) to assess the possibility of extending the techniques to fishers in coastal areas.

Broodstock management and seed quality improvement of cultured species; and development of responsible and sustainable aquaculture techniques

The programme on "Broodstock Management and Seed Quality Improvement of Cultured Species" addresses problem areas related to broodstock management, genetic improvement and improvement of hatchery production technologies for major cultured species. The other programme, "Development of Responsible and Sustainable Aquaculture Techniques", aims to develop sustainable aquaculture technologies having minimal impact on the ecosystems by promoting efficient aquaculture systems and designs for maximum sustainable productivity. The studies focused on abalone, mud crab, shrimp and marine fish.

Integrated abalone production

This consists of four components:

- seed production to study the enhancement of natural flora conducive for settlement and microbial communities;

- intermediate culture to assess the economic viability of land-based nursery in tanks as well as the technical and economic viability of open-water nursery in cages;
- grow-out culture in bottom-set and suspended cages; and
- stock enhancement to evaluate the results of SEAFDEC stock enhancement trials conducted earlier.

Mud crab seed production

This programme has the following objectives:

- to refine broodstock management and hatchery-nursery techniques;
- to develop production of mud crab juveniles from hatchery-produced megalopae as a new industry;
- to determine populations and fisheries to quantify growth, migration and mortality rates of *Scylla* species; and
- to develop mangrove pond aqua-silviculture production systems and trials of stock enhancement through release of hatchery-reared juveniles into mangrove habitats.

Shrimp domestication

The programme aims to produce broodstock of native shrimp species – *Penaeus monodon*, P. *indicus*, and *P. merguiensis* – genetically selected for desired heritable traits. Specifically, it is expected to come up with:

- technology development to produce viable *P. monodon*, *P. indicus* and *P. merguiensis* broodstock in captivity and determine its economic viability;
- evaluation of the commercial viability of *P. indicus* and *P. merguiensis* hatcheries and;
- technology development for production of known live feed for shrimp broodstock such as the brine shrimp and marine polychaetes.

Marine fish seed production

This aims to:

- develop, refine and package marine fish seed production technologies;
- test the economic feasibility of marine fish seed production;
- develop and improve broodstock diets of marine fish; and
- develop test kits for egg/larval quality and VNN diagnostics.

The activities in relation to marine and coastal aquaculture include:

- pathogenesis and control of subclinical infection of VNN in broodstock of grouper;
- insulin-like growth factor II as molecular markers for egg quality in finfish and mud crab; and
- reproductive and larval performance of rabbitfish.

Research and development of stock enhancement for species of international concern: stock enhancement for threatened species of international concern (2005–2009)

Heightened public interest in environmental protection and resource conservation has become an important factor in fisheries development. To address these environmental concerns, particularly those related to threatened or endangered species, SEAFDEC has undertaken a programme whose aim is to develop ecologically sound strategies for stock enhancement, including hatchery production and release of genetically diverse and disease-free juveniles. It is also expected that stock enhancement technologies and social strategies will be transferred to the countries in the region.

The programme initially focuses on depleted species for which hatchery technologies have already been developed. The activities include:

- a regional workshop to review the status of stock enhancement in Southeast Asia, identify threatened species and assess the existing technologies for such species;
- research on strategies for sea ranching and stock enhancement;

- verification of developed and established technologies; and
- training and information dissemination on stock enhancement.

In 2005 a consultation was organized and the two selected species were abalone and seahorse. As part of research and development, seed production of abalone and its marketing have been conducted in AQD. The assessment of potential sites for stock enhancement for abalone and seahorse has been implemented.

Collaboration with other organizations

Research institutes and universities in the Philippines
A collaborative programme on "Aquaculture Biotechnology" is being implemented under cooperation with the National Fisheries Research and Development Institute (NFRDI), Mindanao State University (MSU), the University of the Philippines in the Visayas (UPV) and the University of Eastern Philippines (UEP). The programme, which is implemented through training courses to transfer knowledge and skills in aquaculture biotechnology, aims to develop:

- methods for enhancing growth and reproduction in commercially important aquaculture species;
- superior stocks for aquaculture; and
- rapid diagnostic techniques for fish diseases.

Private sector and concerned government agencies in Philippines
With collaboration from the above agencies, a programme on "Technology Verification and Dissemination" was developed aiming at fast tracking the commercialization of environmentally friendly aquaculture technologies for economically important cultured species, i.e. shrimp, crabs and groupers. This is done through demonstration and hands-on training on technical and economic viability and sustainability of the technologies in the Philippines and also in other Member Countries. The programme intensifies technology transfer activities for sustainable aquaculture to improve fish production and generate employment, livelihood and export revenues.

WorldFish Center and Bureau of Fisheries and Aquatic Resource of the Philippines
The programme on "Dissemination and Adoption of Milkfish Aquaculture Technology in the Philippines" has been implemented to analyse the production, market and policy structures of the milkfish industry in the Philippines. It will identify the constraints and opportunities for future growth of the industry, with emphasis on the adoption and impact of technological development. Case studies in hatchery and grow-out production systems were conducted and documented for transfer or replication in other parts of the Philippines.

ASEAN (ASEAN Foundation through ASEAN-Japan Solidarity Fund)
The collaborative programme with ASEAN presently focuses on human resource development (HRD). The programme on HRD for Sustainable Development of Fisheries in Brunei Darussalam-Indonesia-Malaysia-Philippines East ASEAN Growth Area (BIMP-EAGA) Region has been implemented as of March 2005. SEAFDEC launched this project, which includes the area of HRD in aquaculture. A series of *in-situ* participatory workshops will be conducted in various localities of the BIMP-EAGA region. Target participants are front-line fisheries and agriculture officers assigned to promote and assist in aquaculture development at the local level. In December 2005 SEAFDEC successfully implemented the Participatory Workshop for Responsible Aquaculture for Fisheries Officers from Sabah, Malaysia. The topics covered included responsible aquaculture development, mangrove-friendly shrimp

culture, marine fish culture in cages, mangrove crab culture, seaweed culture and mollusc culture.

Another programme on HRD on Poverty Alleviation and Food Security by Fisheries Intervention in the ASEAN Region is planned for implementation in the year 2006. The objective of this project is to enhance human capacity of both relevant government fisheries agencies and selected rural fishery communities so as to alleviate the identified poverty status through fisheries intervention covering the areas of rural aquaculture A special focus will also be given to the areas for the rural poor and communities affected by the tsunami disaster in the ASEAN region. The envisaged activities will be to further identify the specific requirements for HRD at each respective site. Various simple technologies to develop rural small-scale aquaculture will be provided to the participants.

Future operations

To support Member Countries, SEAFDEC will effectively continue the implementation of its programmes in line with regional priority issues and needs, particularly for rural development and sustainable aquaculture development that contributes to poverty alleviation. The programmes will include research and development (R&D) and the transfer of knowledge and technology, as well as training and dissemination of information. The future programmes will address the following regional priorities:

- development of a fish disease surveillance system;
- promotion of sustainable aquaculture for rural communities;
- R&D of stock enhancement for species of international concern;
- broodstock management and seed quality improvement for cultured species;
- development of responsible and sustainable aquaculture techniques; and
- research and analysis of chemical residuals and contamination in fish, fish products and the environment, such as fishing grounds and aquaculture fields.

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