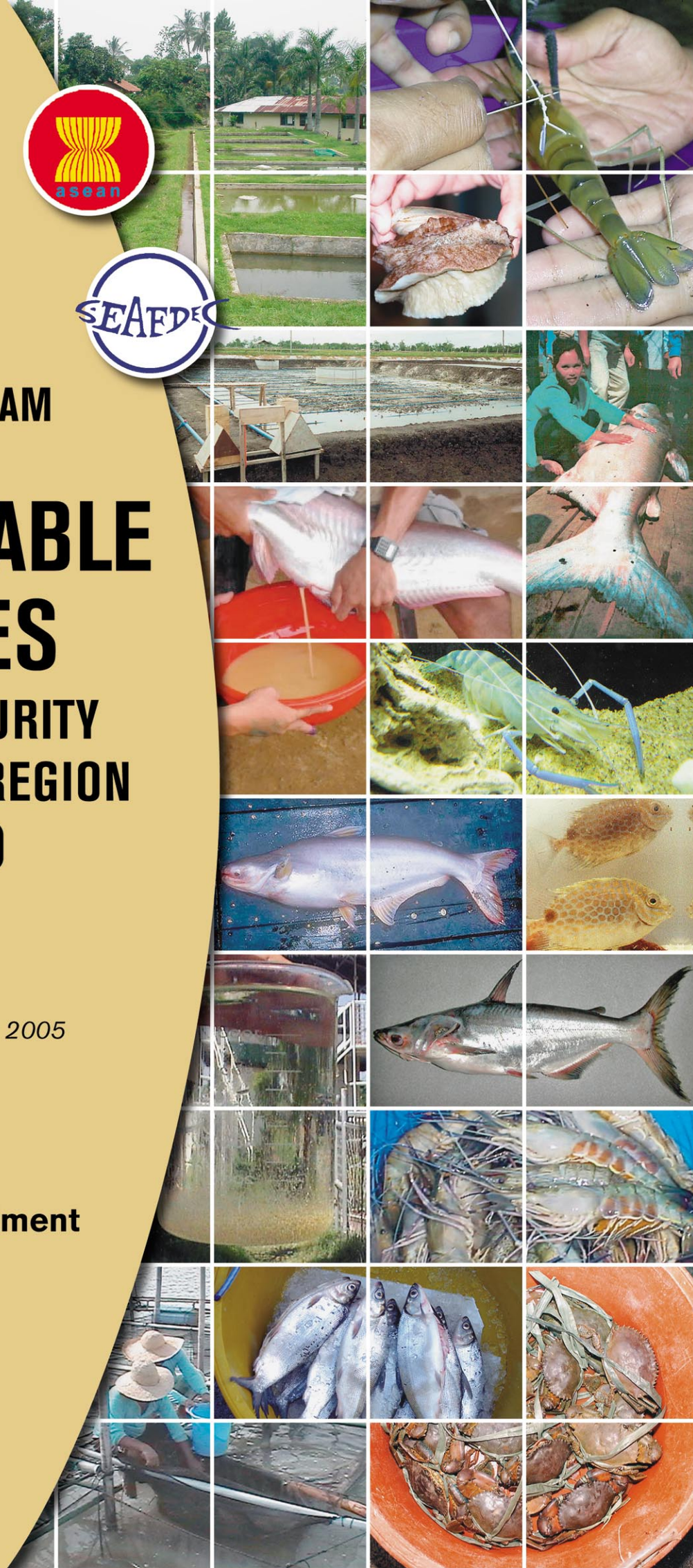
REPORT OF THE PLANNING WORKSHOP FOR THE SPECIAL FIVE-YEAR PROGRAM ON

SUSTAINABLE FISHERIES FOR FOOD SECURITY IN THE ASEAN REGION (AQUACULTURE) 2006-2010

Bangkok, Thailand
30 November–2 December 2005



Aquaculture Department
Southeast Asian Fisheries
Development Center
Tigbauan, Iloilo, Philippines

January 2006

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The Report of the Regional Planning Workshop for Special Five-Year Program (Aquaculture Component): 2006-2010, Bangkok, Thailand, 30 November-2 December 2005 was prepared by the Workshop Secretariat comprising:

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From the Office of the Department Chief

As a follow-up of the outcome of the ASEAN-SEAFDEC Conference on Sustainable Fisheries in the Third Millennium: Fish for the People in Bangkok, Thailand in November 2001, SEAFDEC implemented the Special Five-Year Program on Sustainable Fisheries in the ASEAN Region from 2002 to 2005. We have been tasked to implement the Aquaculture Component which we aptly termed the Integrated Regional Aquaculture Program (IRAP), which has two components, namely: Aquaculture for Rural Development, and Supply of Good Quality Seeds.

For the past three years, IRAP was able to provide technical assistance to the ASEAN countries especially on broodstock development, seed production and sustainable aquaculture of their respective country's priority aquaculture species. This we did through mobilization of expertise, training, and information dissemination, taking into consideration the priority species and activities that the countries identified during the IRAP Workshop in September 2002. In the implementation of IRAP, we are again happy to report that countries with developed aquaculture technologies provided technical support in order for us to reach out to the ASEAN countries with the much needed aquaculture technologies.

After the evaluation of the outcome of the IRAP during the Regional Planning Meeting for the Special Five-year Program in Bangkok, Thailand in February 2005, we are happy to report that the ASEAN countries considered the implementation of IRAP a success. However, in the implementation of their aquaculture activities, the countries were faced with problems on specific aquaculture areas that require further development. Member Countries that have ongoing activities on aquaculture research and technology development still expressed the need for some aspects of aquaculture to be developed further.

Thus, the Planning Workshop for the Special Five-Year Program (Aquaculture Component): 2006-2010 was convened by AQD from 30 November to 2 December 2005 in Bangkok, Thailand in order to develop the detailed plan of action that will respond to the concerns of the ASEAN countries considering the limited financial support that was to be expected from the Program. We are happy to note that the country representatives did their best to prioritize their concerns and thus, a very comprehensive plan of action and program of activities was developed.

Although with very limited funding, we could not prioritize the activities much further because we also had to consider the needs of the ASEAN countries for aquaculture technologies. So with much optimism, we submitted the Program of Activities for the Special Five-Year Program (Aquaculture Component): 2006-2010 for review by the SEAFDEC Program Committee during its 28th Meeting in Bangkok, Thailand in December 2005.

We were lucky to gain the support of the SEAFDEC Program Committee and we are happy to note that the Aquaculture Component of the Special Five-Year Program which is the Promotion of Sustainable Aquaculture in the ASEAN Region, has been placed under the ASEAN-SEAFDEC Fisheries Consultative Group (FCG) collaborative mechanism assuring us of funding for 2006 from the Government of Japan Trust Fund. Under this project, we will continue to provide the ASEAN countries with sustainable aquaculture technologies by programming the activities into two major parts, Development of Technologies and Human Capacity Building for Sustainable Aquaculture.

In order to elucidate the plan of action for the project, this Report is published, which include the output of the Planning Workshop and the country reports based on a pre-determined format showing the R&D areas of concern and the needs for human resource development of the respective ASEAN countries. At this point in time, I wish to thank again the country representatives for their active participation in the Planning Workshop. Their cooperation was instrumental in the success of the Workshop and their inputs were necessary for this Report.

ROLANDO R. PLATON, Ph.D.
Chief
SEAFDEC Aquaculture Department

REPORT OF THE PLANNING WORKSHOP FOR THE SPECIAL FIVE-YEAR PROGRAM (AQUACULTURE COMPONENT) 2006-2010

Bangkok, Thailand
30 November – 2 December 2005

INTRODUCTION

The Special Five-Year Program on Sustainable Fisheries for Food Security in the ASEAN Region has been conducted by SEAFDEC from 2002 to 2005 as a follow-up of the outcome of the ASEAN-SEAFDEC Conference on Sustainable Fisheries in the Third Millennium: Fish for the People in Bangkok, Thailand in November 2001. The Integrated Regional Aquaculture Program (IRAP), which is the Aquaculture Component of the Special Five-Year Program, has two components, namely, SDII-1: Aquaculture for Rural Development, and SDII-2: Supply of Good Quality Seeds.

The evaluation of the outcome of the IRAP as the Aquaculture Component of the Special Five-year Program from 2002 to 2005 was done during the Regional Planning Meeting for the Special Five-year Program held in Bangkok, Thailand in February 2005. In that Meeting, the member countries considered the implementation of the Aquaculture Component a success however there were still specific areas that require further development. Member Countries that have ongoing activities on aquaculture research and technology development still expressed the need for some aspects of aquaculture to be developed further.

Thus, during the Regional Planning Meeting in February 2005, aquaculture R&D areas of concern that need to be considered in the second phase of the Program, were identified and these include: (1) freshwater aquaculture of indigenous species; (2) integrated agri-aqua culture systems; (3) coastal aquaculture and mariculture; and (4) captive broodstock development. It was also agreed during the February 2005 Planning Meeting that research and verification activities under each area of concern will be conducted on priority species of the region. Likewise and in order to optimize resources, culture technology packages known to be economically-viable and environment-friendly that are well developed in one country should be considered for verification in another country.

The Planning Workshop for the Special Five-Year Program (Aquaculture Component): 2006-2010 was therefore convened by AQD from 30 November to 2 December 2005 in Bangkok, Thailand in order to confirm the priority species as well as identify the developed culture technologies for specific species and the core countries for each activity under the four areas of concern.

The main objective of the Planning Workshop was to develop a five-year plan of action for 2006-2010 that would address the various aquaculture areas of concern identified during the February 2005 Planning Meeting. Specifically, the Planning Workshop was convened to:

1. discuss the output of the Special Five-year Program (Aquaculture Component): 2003-2005 and to identify further constraints that would be addressed through the second phase of the Program;
2. develop the detailed plan of action for the Program with component activities that may include research, verification, training and information dissemination through publications, study visits and farm demonstration; and
3. identify the core countries to be involved in the various activities, such that countries that have common interest in specific species will be grouped to conduct the collaborative projects on such species while countries that have developed technologies for identified species can serve as core countries or serve as the source for technical assistance.

OPENING OF THE PLANNING WORKSHOP

SEAFDEC Secretary-General Dr. Siri (middle) with AQD Deputy Chief Dr. Koichi Okuzawa (left) and AQD Chief Dr. Rolando Platon (right) during the Opneing of the Workshop

SEAFDEC Secretary General *Dr. Siri Ekmaharaj* welcomed the participants to Thailand and to the workshop. He briefly noted the background of the Project and explained the need to convene the Workshop for the Project's Phase II from 2006 to 2010. The success of Phase I, he emphasized was due to the cooperation of the member countries.

Dr. Siri recalled that the activities in Phase I were developed during a workshop which AQD also convened in Bangkok, Thailand in September 2002. The development of the project's framework was based on the needs of the ASEAN countries for specific aquaculture technologies. He stressed that even with limited resources, AQD managed to implement the project. He then hoped that another project framework would be drawn from the output of the present workshop and that core countries to be involved would have to be identified. He also encouraged the participants to openly discuss and share their insights as these would be a significant contribution for the success of the workshop.

PARTICIPATION

The Workshop had 44 participants comprising representatives from the ASEAN-SEAFDEC Member Countries as well as from the SEAFDEC Secretariat and the SEAFDEC Training and Aquaculture Departments.

The participants of the Planning Workshop held in Bangkok, Thailand, 3-4 December 2005

THE WORKSHOP

Project Assistant Manager for AQD *Mr. Wilfredo Yap*, reported briefly the progress of the Project's activities in the member countries. He started with the information that during the IRAP Seminar-Workshop in 2002, the ASEAN countries identified priority activities for implementation under IRAP (shown in the following table); and continued with a presentation on the Project's activities conducted for the ASEAN countries from 2002 to 2005.

Priority activities identified by ASEAN countries for IRAP (2002-2005)

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 and milkfish hatchery and nursery
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

Progress of Activities (2002-2005)

Brunei Darussalam

The activities included (1) attachment training on Seed Production and Culture of *M. rosenbergii* in Surat Thani Inland Fisheries Research and Development Center, Thailand, 13 September-9 October 2004 for two Technical Officers from Brunei Darussalam.; and (2) training at AQD on Mud Crab Seed Production, 14 September-13 October 2005. Resource Persons were from DOF Thailand and AQD, respectively. Moreover, Brunei Darussalam also participated in AQD's distance learning program, specifically the Basic Principles of Aquaculture Nutrition, July-November 2003 (one participant); and the Principles of Health Management in Aquaculture August–December 2005 (one participant).

Officers from Brunei Darussalam during their training in Surat Thani, Thailand (left and middle), and one Officer during the training on mud crab seed production at AQD (right)

Cambodia

Activities included: (1) on-site training on propagation of *Pangasius* sp. at Bati Fish Seed Production & Research Station, Prey Veng, Cambodia, 4-17 August 2003, with seven participants (4 farmers, 3 technicians); (2) as a follow-up to the *Pangasius* training, technical assistance was provided through DOF Thailand, end of August 2003; (3) attachment training on tilapia and carp breeding at SEAFDEC/AQD's Jalajala Project Site, Philippines, 1-18 October 2003, with two participants (technicians) from Cambodia; (4) attachment training on commercial propagation of tilapia at Surat Thani Inland Fisheries Research and Development Center, Thailand, 1-30 October 2003 with four participants (3 Farmers, 1 Technician); (5) on-site training on water quality analysis using standard methods at DOF, Phnom Penh on 30 Nov–4 Dec 2003 with 14 participants; (6) Training at AQD on mud crab seed production (one participant), 7 September-6 October 2004; (7) attachment training at AQD for one participant on tilapia culture, 1-10 August 2005. Resource persons were provided by DOF Thailand and AQD.

Cambodian trainees during their training on seed production and propagation of Pangasius at Bati Station, Prey Veng, Cambodia

Representatives from Cambodia also participated in AQD's distance learning program such as the Principles of Health Management in Aquaculture, August–November 2004 (one participant); and the Principles of Health Management in Aquaculture, August–December 2005 (one participant).

Cambodian trainees in action: at Surat Thani, Thailand (left and middle, above), at AQD (right above and left below), and in Cambodia (right below)

Indonesia

The activities included: (1) promotion of "patin" products in Jambi, Sumatra, 20-22 October 2003 attended by more than 30 participants; (2) on-site training on grow-out culture of *Pangasius* ("patin") in Jambi, Sumatra, 13-17 April 2004 with 22 participants; (3) training at AQD on abalone seed production and culture, 17-28 November 2004; and (4) training at AQD on crab seed production, 14 September-13 October 2005. Resource persons were from DOF Thailand and AQD.

Moreover, representatives from Indonesia also participated in AQD's distance learning program such as Principles of Health Management in Aquaculture, June-September 2003 (one participant); Basic Principles of Aquaculture Nutrition, July-November 2003 (one participant); Principles of Health Management in Aquaculture, August–November 2004 (one participant); Principles of Health Management in Aquaculture, August–December 2005 (one participant)

Patin products promotion in Jambi, Sumatra with DOF Thailand's Ms. Sunee showing products from patin (middle photos); at AQD on mud crab seed production (above); and on grow-out culture of Pangasius in Jambi (left photos)

Lao PDR

The activities for Lao PDR included: (1) attachment training at AQD's Binangonan Freshwater Station on tilapia and carp breeding, 1-18 October 2003 with three participants (2 technicians, 1 farmer); (2) on-site training on water quality analysis using standard methods in Vientiane, 25-29 November 2003 with 16 participants; (3) attachment training at AQD for two participants from Lao PDR on rice-fish culture and small pond aquaculture with field trip at the Central Luzon State University in Muñoz, Nueva Ecija, 7-19 December 2003. Resource persons were from AQD.

One representative from Lao PDR also participated in the Principles of Health Management in Aquaculture (on-line training), August–November 2004 (one participant)

The trainees from Lao PDR at AQD's Binangonan Freshwater Station (above), in Vientiane (below left), at AQD's Project site in Jalajala (below middle) and at the Central Luzon State University (below right)

Malaysia

Activities included: (1) attachment training at AQD on detection of VNN using PCR for one Malaysian participant, 12-18 December 2003, resource persons provided by AQD; (2) on-site training on grouper seed production in Terengganu, Malaysia with 32 participants and resource person provided by Directorate General of Aquaculture, Indonesia, 7-13 December 2003; (3) attachment training for four Technical Officers from the Department of Fisheries Malaysia at Surat Thani Inland Fisheries Research and Development Center, Thailand, 1-12 December 2003 with resource persons provided by DOF Thailand.

Representatives from Malaysia also participated in AQD's distance learning program such as the Principles of Health Management in Aquaculture, June-September 2003 (one participant); Basic Principles of Aquaculture Nutrition (on-line training), July-November 2003 (one participant); Principles of Health Management in Aquaculture, August–November 2004 (one participant); Principles of Health Management in Aquaculture, August–December 2005 (one participant)

Malaysian trainees in Surat Thani, Thailand (above and below left) and one Malaysian trainee at AQD (below right)

Myanmar

The activities for Myanmar included: (1) attachment training at AQD on hatchery and nursery operations of marine fishes for one participant, 2 June-27 July 2003; (2) training at AQD on mud crab seed production for one participant, 7 September-6 October 2004; (3) training on tilapia culture at AQD's Binangonan Freshwater Station for one participant, 1-10 August 2005; (4) on-site training on proper handling and transport of sea bass broodstock in Yangon, Myanmar, 23-27 October 2003 with 33 participants.

Moreover, representatives from Myanmar also participated in the distance learning program of AQD such as the Principles of Health Management in Aquaculture (on-line training), June-September 2003 (one participant); Basic Principles of Aquaculture Nutrition, July-November 2003 (one participant); Principles of Health Management in Aquaculture, August–November 2004 (one participant); Principles of Health Management in Aquaculture, August–December 2005 (one participant)

Trainees from Myanmar at AQD (above photo), in Yangon during on-site training on sea bass handling (left upper photo), at AQD during marine fish training (right upper photo), in Ayarwaddy (Myanmar) during sea bass transport on-site training (far left photo), and a Burmese participant in AQD's distance learning program

Philippines

The activities included: (1) Attendance in International Freshwater Prawn Symposium, Kerala, India, 21-23 August 2003, for two participants; (2) Seed production and grow-out culture of *M. rosenbergii* at the Surat Thani Inland Fisheries Research and Development Center (STIFRD), Thailand, 1-30 December 2005 (two technicians). Resource persons from DOF Thailand; (3) Freshwater prawn seed production and culture (AQD's Binangonan Freshwater Station, April 2006).

The Philippines also took part in AQD's distance learning program, such as Principles of Health Management in Aquaculture, June-September 2003 (one participant); Basic Principles of Aquaculture Nutrition, July-November 2003 (one participant); Principles of Health Management in Aquaculture, August–November 2004 (one participant); Principles of Health Management in Aquaculture, August–December 2005 (one participant).

Filipino trainees on seed production and grow-out culture of M. rosenbergii in Surat Thani, Thailand

Singapore

Representatives from Singapore participated in AQD's distance learning program, such as: Principles of Health Management in Aquaculture (on-line training), August–November 2004 (one participant); and Principles of Health Management in Aquaculture (on-line training), August–December 2005 (one participant).

Thailand

The activities for Thailand included: (1) attachment training at AQD on cage culture of abalone, 18-28 November 2003 with one participant; (2) on-site training on the culture of abalone and Babylonia snail (*Babylonia areolata*) in Rayong Province, Thailand, 27-30 September 2004 with 34 participants. The Resource Persons for the on-site training were from DOF Thailand and the Research Institute of Aquaculture-3 (RIA-3), Vietnam.

In addition, representatives from Thailand also participated in AQD's distance learning program, such as: Principles of Health Management in Aquaculture, June-September 2003 (one participant); Basic Principles of Aquaculture Nutrition, July-November 2003 (one participant); Principles of Health Management in Aquaculture, August–November 2004 (one participant); Principles of Health Management in Aquaculture, August–December 2005 (one participant).

Abalone training at AQD attended by one representative from Thailand

Vietnam

Activities for Vietnam included: (1) attachment training at AQD on siganid larval rearing, 30 October–11 November 2003 for one participant; (2) training at AQD on hatchery and nursery operations for marine fishes, 2 June-16 July 2004 for one participant; (3) training at AQD on mud crab seed production, 7 September-6 October 2004 for one participant; (4) on-site training on milkfish fry collection, handling, transport and nursery operations in Qui Nhon, Binh Dinh, 19-23 October 2003 with 27 participants;

Hands-on training on milkfish fry collection, handling, transport and nursery operations in Binh Dinh

(5) on-site training on siganid hatchery and nursery operations in Hue City, 10-24 November 2004 with 12 participants from Thua Thien Hue Fishery Department; (6) technical assistance on siganid hatchery and nursery operations was provided by AQD after the training in Hue City through AQD; (7) Hands-on training on milkfish larval rearing in Ho Chi Minh, Bac Lieu and Van Thau, 24-31 May 2005; (8) Hands-on training on siganid hatchery and nursery operations at the Thua Thien Hue Fishery Department, 1-15 June 2005

Representatives from Vietnam also participated in AQD's distance learning program, such as: Principles of Health Management in Aquaculture (on-line training), June-September 2003 (one participant); Basic Principles of Aquaculture Nutrition (on-line training), July-November 2003 (one participant); Principles of Health Management in Aquaculture (on-line training), August–November 2004 (one participant); Principles of Health Management in Aquaculture (on-line training), August–December 2005 (one participant)

The training sessions conducted for Vietnam included milkfish and siganids aquaculture as well as hatchery facilities improvement

STATUS OF AQUACULTURE DEVELOPMENT: SUMMARY

During the Planning Workshop, the country representatives presented papers on the status of R&D in their respective countries on the four areas of concern that were identified earlier. The country reports were mainly based on a pro-forma survey where the countries were asked to: (1) confirm or specify priority species for each R&D area; (2) indicate the status of aquaculture technologies available in their respective countries for each R&D area; (3) identify the training needs for each area and to indicate whether the training should be: (a) at AQD, (b) on-site in host country, (c) attachment in another country, or (d) study visits for farmers; (4) identify the information needs for each area and to indicate whether the needs are either (a) publication of manuals or handbooks, (b) farm demonstration/mobilization of expertise, (c) workshops/ meetings, or (d) other information materials which should be specified.

Brunei Darussalam

Aquaculture in Brunei Darussalam is relatively new industry starting with freshwater culture in 1960s and marine culture in 1980s. Today pond culture of shrimp is a leading industry. Brunei identified priority aquaculture species such as *Macrobrachium rosenbergii* and Tilapia for genetic improvement and mud crab.

The country report of Brunei Darussalam indicated that there are 35 fish farmers operating 1230 cages in Brunei Darussalam since 2002 culturing grouper, red snapper, carangidae and red Tilapia. There is a need, however, to improve the cage structure of such species to withstand strong waves and water current. Its DOF is now domesticating *P. stylirostris* broodstock, but generally aquaculture practices are mostly experimental although at present tilapia culture is already being commercialized. Training needs include sessions at AQD, on-site in host country, attachment in another country, and study visits for farmers while information needs range from copies of manuals or handbooks to farm demonstration and mobilization of expertise, and workshops and meetings to exchange information on the aquaculture of the country's priority species.

Representative from Brunei Darussalam, Haji Abd. Rajid Haji Metali (left) presenting the country report during the Planning Workshop

Cambodia

Aquaculture is a major sub-sector in Cambodia contributing 10.40% to the national GDP in 2004. It has been growing for the last two decades with about 16% increase per year. Inland aquaculture is the most prevalent aquaculture practiced in the country with *Pangasius* spp and *Channa* spp as the most important culture species.

Representative from Cambodia, Hav Viseth, presenting the status of aquaculture in Cambodia

Pond culture which was practiced only recently is either semi-intensive or extensive. Among the priority indigenous species for freshwater aquaculture in Cambodia are *Macrobrachium rosenbergii*, *Pangasianodon hypophthalmus, P. kremfi, P. bocourti, Mystus wyckiodes,* sand goby (*Oxyeleotris marmoratus*), Nile Tilapia, Silver barb, giant gourami, *Leptobarbus hoeveni*, climbing perch. Most of these species are also potential for integrated aquaculture system.

Coastal aquaculture is relatively a new development in Cambodia especially in Koh Kong and Sihanoukville. Starting with shrimps, it significantly expanded to marine finfishes. Cambodia believes that shrimp farming if well planned could provide employment for thousands of poor coastal farmers and alleviate poverty in coastal communities. Giant mud crab, green mussel, grouper, snapper and sea bass were identified to be potential culture species. Cambodia still needs to develop captive broodstock for *P. monodon* and grouper spp to address the increasing need for quality seeds.

Indonesia

Macrobrachium rosenbergii is one of the potential culture species and is found in almost all rivers in Indonesia. The good market for this prawn prompted the government to further improve its culture technology and selective breeding program and eventually came up with the development of GI-macro (Genetically-improved Macrobrachium). As efforts are still being done to further improve the selection process, promotion of this technology to farmers is done in various parts of the country. Other potential species for freshwater culture include *Pangasius djambal*, Tilapia, catfish, carp and sand goby.

It was reported at the Planning Workshop that the country's Integrated Aquaculture Program aims to increase fishery production through optimum usage of soil and water resources. This is integrating aquaculture with rice culture, animal husbandry and other agriculture activities. In this program, the farmers are encouraged to develop seed production techniques to address their own supply for quality seeds.

Indonesia's representative Anto Sunaryanto presenting the country paper during the Planning Workshop

The Culture-based Fishery Program of the Directorate General of Aquaculture empowers local people to culture fish in reservoirs. Training and information needs include on-site in host country, study visit for farmers, farm demonstration, manuals and handbooks, etc. The country report also indicated that there is ongoing study in Indonesia which is aimed at improving the culture and breeding of *Scylla serrata*. Although there has been success in some areas, there is still need to improve the developed breeding techniques. On mollusk culture, the problem is mainly social brought about by the economic crisis. Despite the creation of PROKSIMAS that encourages people to go into small scale aquaculture, lack of capital for farmers is most often a constraint. The report also added that mariculture and reef tourism is being promoted in the country especially in Bali and West Nusa Tenggara.. The priority species for captive broodstock development include those of tiger prawn, *P. vannamei* and *P. stylirostris*, grouper, barramundi and "bawal bintang" (*Trachinocus blochii,* Lacepede).

Japan

Aquaculture is a very important industry in Japan with more than 3600 fish species being cultured, involving 61 prefectural and 16 national hatcheries.

Japan representative Kazumasa Ikuta presenting the country paper during the Planning Workshop

The country's priority indigenous species for freshwater include tilapia which has been cultured since the 70s but its industry declined due to the cost in heating. Salmonids and eel seed production is now established while carp culture in irrigation reservoirs is being strongly promoted. Mud crab seed production technology was established in 1980s while mollusks show potential in aquaculture and abalone used mainly for stock enhancement.

R&D for offshore cage aquaculture has been established and promoted but there is difficulty in commercialization aspect. Mariculture is mainly for recreational fishing in many places. Captive broodstock development of shrimps like *P. japonicus, P. vannamei* and spiny lobster and fishes like seabream, Japanese flounder, "torafugu", Kelp grouper, yellow tail, bluefin tuna and many other species have already been developed. The status of aquaculture technologies vary from verification to mostly commercialized stages.

Lao PDR

The fishery sub-sector of Lao PDR contributes 8% to the GDP in 2001, a significant share to the country's economy. With the current shortfall in fish production, however, any substantial increase maybe achieved through aquaculture as the best alternative to improve fish production.

Lao PDR representatives Nouhak Liepvisay (left) and Bouaphanh Konedavong, (right) presenting the country paper during the Planning Workshop

Aquaculture is relatively new in the country. Fishers relied heavily on wild catch until 1960s when US Aid assistance provided funds for aquaculture. The main fish farming systems were pond fish culture, integrated farming with livestock, rice cum fish culture and fish seed production. Most recently, cage farming is becoming popular in small water bodies.

There are about 23 freshwater species being cultured in the country. Pond culture areas significantly increased from 6000 ha in 1990 to 10,300 ha in 2001. With the growing interest in aquaculture, the country needs technologies on seed production to provide the increasing need for seeds.

The vast water resources of Lao PDR is also a potential for fish culture development and can contribute towards food security, nutrition and generate income especially in the rural areas. Using a multidisciplinary systems approach, Lao PDR recognized that technical, economic, social and environmental issues as well as manpower and institutional factors have been considered in the country's aquaculture development process and aquaculture management.

Malaysia

Aquaculture production in Malaysia contributes 15% to the total fish production. The country is now implementing a development program to realize a three-fold increase in aquaculture production by 2010. The country has given priority to aquaculture R&D activities to achieve this goal. This includes improving technologies on seed production, culture and efficient technology transfer to target groups.

Malaysia is giving due consideration to development of coastal aquaculture, mariculture (shrimps, finfish, mollusks and seaweeds), and freshwater aquaculture. Fishfarmers are very responsive and adapt well to new production and culture technologies. The Malaysian Government through the DOF is adopting an effective mechanism to transfer technology to various target groups.

As a prerequisite, human resource development is needed through training at AQD, on-site or attachment training. Information dissemination is essential in providing adequate knowledge for fish farmers. Manuals and handbooks as well as workshop and meetings are considered essential too.

Malaysia's representative Subramaniam Kathamuthu presenting the country paper

Myanmar

Although freshwater aquaculture in Myanmar has been developed in the last five years, constraints like seeds, feeds and technology has yet to be addressed. The over production of rohu (*Labeo rohita*) that led to the excess in market demand prompted the government to consider other culture species as alternatives. The country's Tilapia Program includes activities like broodstock development and genetic improvement, quality seed production, improvement of grow out technology, development of low cost feed and production of pure strain tilapia species.

Practiced since 1983, rice-fish farming is being promoted by DOF in several states in Myanmar. Realizing the benefits of rice farming to farmers, Myanmar is giving priority to the integrated aquaculture technology.

Representative from Myanmar Khin Ko Lay presenting the country paper during the Planning Workshop

Coastal aquaculture is still at its infancy stage due to abundance of the natural resources. Although these resources are renewable, there is a need to supplement its natural stock and to sustain the supply of export market especially mud crab. Development of mud crab culture technology needs to be promoted as the best way to increase production without necessarily depleting the natural stocks. *Macrobrachium rosenbergii* and *Penaeus monodon* are the priority species for captive broodstock development in Myanmar.

Philippines

The high potential of aquaculture in the Philippines is making it a dominant sector in food production. The status of aquaculture technologies vary from experimental to commercialized stages. There are a number of priority species for different R&D areas for freshwater, integrated agri-aqua, coastal aquaculture and captive broodstock development. Training and information needs have also been identified in these areas.

The Philippines has the following specific aquaculture issues and concerns that needs to be continuously addressed: available supply of quality seeds, develop captive broodstock technologies, ecologically sound farm management, conservation of ecosystem and biodiversity, development of low fish meal, cost-efficient and environment friendly aquafeeds, diagnosis and control of aquatic diseases, monitoring and surveillance of occurrence of aquatic disease. Since commercialization of invertebrates will soon take off especially on the sea urchin, the establishment of a seed production program for such species will be of utmost priority.

Philippine representative Gil Adora presenting the country paper

The country paper also indicated the need for the culture of seaweeds to be improved so as to prevent the occurrence of diseases as well as the development of nurseries to ensure year round supply of propagules. Other priority R&D areas include disease management of aquaculture/mariculture species especially shrimps and grouper; breeding and hatchery technologies on red grouper, humpback, Napoleon wrasse, *Caranx* spp and tuna. All these endeavors will surely need financial support for their implementation.

Philippines' Jonathan Dickson discussing the status of the country's aquaculture industry during the Planning Workshop

Singapore

Due to the limited land resource, Singapore focused its aquaculture activities in the culture of aquarium fishes and mariculture in floating net cages. Priority species include sea bass, grouper, snapper and Pompano for small-scale aquaculture in offshore cages and captive broodstock development for marine fishes.

Status of aquaculture technologies vary from experimental to commercialized stages, while information and training needs were identified accordingly with specified R&D areas.

Singapore representative Wee Joo Yong presenting the status of aquaculture in her country

Thailand

Aquaculture is well-developed in Thailand contributing significantly in the country's economy. Status of aquaculture technologies is to some extent commercialized especially for *Pangasius* spp., *Channa* spp and tilapia which are now being promoted to the rural areas. There is still a need though to conduct genetic improvement in shrimps and fishes.

Priority species for coastal aquaculture and mariculture include *Scylla serrata*, *Babylonia areolata*, *Haliotis asinina*, *Plectropomus maculates,* and *Rachycentron canadum*. Thailand still needs to develop captive broodstock for *Penaeus monodon, P. vannamei, Epinephelus* spp. and *Chanos chanos.* Training and information needs vary from training at AQD, on-site or attachment in other countries, and manuals, farm demonstration/ mobilization of expertise and workshops or meeting in specific R&D areas.

Thailand representatives Supattra Uraiwan (left) and Wimol Jantrarotai (right) during the discussion on Thailand's aquaculture industry, where Thailand has commended for being the source of technical expertise for the Project

Vietnam

Aquaculture is an important industry in Vietnam with potentials to generate jobs and income. There are currently1.2 M ha of aquaculture areas in the country, 520,000 ha of which are brackishwater. The total production of 1.2 M mt includes 320,000 mt of shrimps and 300,000 mt of catfish. The National Fishery and Aquaculture Development is presently implementing aquaculture programs for 2000-2010. Priority species for marine and brackishwater aquaculture are grouper, cobia, sea bass, and mud crab while for freshwater are Tilapia, catfish and *Macrobrachium rosenbergii*, among others. There are also indigenous species that are of high economic value but not much research has been done on these species. There is still so much to do for Vietnam to further develop its aquaculture potential. The need for technical assistance and training of staff were identified to be an immediate concern of the country.

Vietnam's Tran Van Qynh presenting the country paper

THE PLAN OF ACTION

During the development of the plan of action for the Program for 2006-2010, the participants came up with priorities under each aquaculture R&D areas of concern, and identified the core countries to be involved in each activity under each area. The country recommendations, which were adopted at the Workshop will form part of the Program of Activities of the Special Five-Year Program on Sustainable Fisheries for Food Security in the ASEAN Region (Aquaculture): 2006-2010. This was later presented to the 28th Meeting of the Program Committee of SEAFDEC from 7 to 9 December 2005 for endorsement to the Council of SEAFDEC.

The Proposed Program of Activities comprises two parts: (1) Development of Technologies for Sustainable Aquaculture; and (2) Human Capacity Building for Sustainable Aquaculture. Moreover, the activities on the Genetic Improvement of *Macrobrachium rosenbergii* under Freshwater Aquaculture of Indigenous Species were prioritized further during the subsequent Third Roundtable Discussion on the Development of Genetically-Improved Strain of Macrobrachium convened also in Bangkok, Thailand from 3 to 4 December 2005. The Report of the Third Roundtable Discussion on the Development of Genetically-Improved Strain of Macrobrachium is in another cover.

SEAFDEC Advisor Yasuhisa Kato explaining to the Planning Workshop participants the limited budget that will be possibly allocated for the Project

PROPOSED PROGRAM OF ACTIVITIES

Special Five-Year Program on Sustainable Fisheries for Food Security in the Asean Region (Aquaculture): 2006-2010

"PROMOTION OF SUSTAINABLE AQUACULTURE IN THE ASEAN REGION"

Development of Technologies for Sustainable Aquaculture (R&D)

Priority Projects/Activities/Species	Duration	Responsible Country/Agency
1. Freshwater Aquaculture of Indigenous Species		
1.1 Genetic Improvement of *M. rosenbergii*[1]		
1.1.1 Strains of *M. rosenbergii* with better seed production traits and grow-out characteristics		Thailand, Indonesia, Philippines
Indonesia (1) Collection of wild stock from Sulawesi to construct a base population GI Macro II, and another potential populations such as Kalimantan (2006) (2) Evaluation and characterization of GI Macro II, Sulawesi and Kalimantan using molecular marker (2006) (3) Selective breeding program on the synthetic population (2007-2009)	**2006-2009**	
Philippines (1) Evaluation and characterization using molecular markers (2006-2009) (2) Domestication and selective breeding (2006-2010)	**2006-2010**	
Thailand (1) Appropriate selective breeding program to improve growth of *Macrobrachium rosenbergii* in different parts of Thailand (2) Use of allozyme marker to detect genetic variation in *Macrobrachium rosenbergii* together with growth performance in selective breeding program	**2006-2009**	

[1] Prioritized further during the Third Roundtable Discussion on the Development of Genetically-Improved Strain of Macrobrachium, Bangkok, Thailand, 3-4 December 2005

Priority Projects/Activities/Species	Duration	Responsible Country/Agency
1.1.2 Genetic characterization of *M. rosenbergii* in member countries (*Thailand, Indonesia and Philippines*)	**2006-2008**	AQD (coordinating) in consultation with Thailand and Indonesia; Member countries
2. Coastal Aquaculture and Mariculture		
2.1 Grouper seed production		
2.1.1 Economic analysis on grouper seed production in Indonesia (AQD to look for Socio-economists to study and document the economics of grouper seed production in Indonesia)	**2006**	Indonesia and AQD
3. Captive Broodstock Development		
3.1 Development of SPF shrimp (*P. monodon, P. vannamei)* broodstock		
3.1.1 Genetic characterization of *P. monodon* broodstock in member countries	**2006-2010**	Thailand and AQD

Human Capacity Building for Sustainable Aquaculture

Priority Projects/Activities/Species	Duration	Responsible Country/Agency
4. Integrated Aquaculture System		
4.1 Culture Technologies for Tilapia		
4.1.1 Translation of Tilapia manuals of AQD to different languages (2 languages in 2006, 3 in 2007)	**2006-2008**	Member countries
5. Coastal Aquaculture and Mariculture		
5.1 Mud crab seed production and grow-out culture (includes fattening and soft shell culture)		
5.1.1 Manual on mud crab larval rearing		
Translation to English of the Vietnamese manual	**2006**	Vietnam
5.2 Seed production and grow-out culture of abalone		
5.2.1 Training on seed production of abalone	**2006-2010**	AQD
5.3 Milkfish and Siganid seed production and grow-out		
5.3.1 Training on hatchery and nursery of marine fishes (AQD regular training program)	**2006-2010**	AQD
5.3.2 Study visit to milkfish facilities in Philippines for Thailand and Vietnam	**2006**	Philippines and AQD
5.3.3 Technical assistance for siganid hatchery: Cost-sharing to be promoted (AQD to provide resource person)	**2007-2009**	Member Countries (starting with Vietnam and Myanmar)
8. Captive Broodstock Development		
8.1 Development of SPF shrimp (*P. monodon, P. vannamei)* broodstock		
8.1.1 Information exchange on status of *P. monodon* captive broodstock development in the region and on possible impact of introduction of *P. vannamei* in the region	**2006-2010**	Member Countries starting with Thailand and AQD

GUIDELINES FOR THE COUNTRY REPORTS

From the initial output of the Regional Planning Meeting for the Special Five-Year Program in February 2005, the following R&D areas were proposed for the Special Five-Year Program (Aquaculture) for 2006-2010:

1. **Freshwater Aquaculture of Indigenous Species**
   - 1.1 Genetic improvement of *Macrobrachium rosenbergii*
   - 1.2 Broodstock development and seed production of *Pangasius* spp.
   - 1.3 Culture technologies for tilapia
   - 1.4 Aquaculture of other indigenous species
2. **Integrated Agri-Aqua Culture System**
   - 2.1 Seed production of initial species identified for the activity
   - 2.2 Study on climatic conditions and rice culture practices in participating or core countries
   - 2.3 Integrated aquaculture technologies
   - 2.4 Fish culture in small-farm reservoirs
3. **Coastal Aquaculture and Mariculture**
   - 3.1 Mud crab culture technologies
   - 3.2 Mollusks culture technologies
   - 3.3 Small-scale aquaculture including offshore cages
   - 3.4 Mariculture park scheme
4. **Captive Broodstock Development**
   - 4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*, etc.)
   - 4.2 Captive broodstock development for marine fishes, e.g., siganids, grouper, etc.

For each of the abovementioned R&D areas considered as Part I, human resource development was considered in the form of training, farm demonstration, production of information materials, and mobilization of experts within the region. Thus, the activities of Part II (human resource development) shall have four components, namely: (1) production of manuals and handbooks; (2) training of technical staff; (3) study visits for farmers; and (4) farm demonstrations.

Therefore the country reports presented during the Planning Workshop included description or in outline form the following aspects:

A. Priority species for each R&D area listed above
B. Status of aquaculture technologies available for each R&D area
C. Training needs for each R&D area and preferred mode of training, i.e., at AQD or on-site in host country or attachment in another country
D. Information and technical assistance needs, e.g., publication of manuals, workshops, provision of technical expertise in specific field, etc.
E. Other Concerns and Recommendations

The outline form of the country reports followed the Guide Framework distributed to the countries prior to the Planning Workshop.

COUNTRY: BRUNEI DARUSSALAM

A. Priority species for each R&D area

R&D Areas	Confirm or Specify Species
1. Freshwater Aquaculture of Indigenous Species	
1.1 Genetic improvement of *Macrobrachium rosenbergii*	No genetic improvement being done so far but source of broodstock for production of *M.rosenbergii* are from wild
1.2 Broodstock development and seed production of *Pangasius* spp.	No activity being done for this species.
1.3 Culture technologies for tilapia	Production of all-male seeds using 17α-methyl testosterone. Cultured in ponds and cages either in freshwater or brackishwater
1.4 Aquaculture of other indigenous species (*specify species*)	None.
2. Integrated Agri-Aqua Culture System	
2.1 Seed production of initial species identified for the activity (*specify species*)	None
2.2 Study on climatic conditions and rice culture practices in participating or core countries (*specify species*)	None
2.3 Agri-aqua culture technologies (*specify species*)	None
2.4 Fish culture in small-farm reservoirs	None
3. Coastal Aquaculture and Mariculture	
3.1 Mud crab culture technologies	Crablets are from wild and imported but mostly cultured for fattening. Cultured in earthen ponds and integrated with fish (Silvo-fisheries)
3.2 Mollusks culture technologies	No activity being done
3.3 Small-scale aquaculture including offshore cages (*specify species*)	A total of 35 operators operating in-shore cages totaling about 1230 cages. Species cultured include sea bass, grouper, red snapper, carangidae and red tilapia. Offshore cages were tested in 2002 but the structure which could withstand with the high waves and strong current, DOF is now considering to use an appropriate and possible technology using robust structure.
3.4 Mariculture Park scheme (*specify species*)	No activity being done.
4. Captive Broodstock Development	
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*, etc.)	No activity being done for *P .monodon*. But DOF is now developing domesticated *P. stylirostris* broodstock.
4.2 Captive broodstock development for marine fishes, e.g., siganids, grouper, etc.	Sea bass and grouper in cages.

B. Status of aquaculture technologies available for each R&D area: (1) not being done - (x) interested or (y) not interested; (2) experimental; (3) verification stage; (4) commercialized; please check (√) appropriate cell

R&D Areas	Status of aquaculture technologies				
	(1)		(2)	(3)	(4)
	(x)	(y)			
1.Freshwater Aquaculture of Indigenous Species					
1.1 Genetic improvement of *Macrobrachium rosenbergii*	/				
1.2 Broodstock development and seed production of *Pangasius* spp.		/			
1.3 Culture technologies for tilapia					/
1.4 Aquaculture of other indigenous species	/				
2. Integrated Agri-Aqua Culture System					
2.1 Seed production of initial species identified for the activity		/			
2.2 Study on climatic conditions and rice culture practices in participating or core countries	/				
2.3 Agri-aqua culture technologies	/				
2.4 Fish culture in small-farm reservoirs	/				

R&D Areas	Status of aquaculture technologies				
	(1)		(2)	(3)	(4)
	(x)	(y)			
3. Coastal Aquaculture and Mariculture					
3.1 Mud crab culture technologies			/		
3.2 Mollusks culture technologies	/				
3.3 Small-scale aquaculture including offshore cages			/		
3.4 Mariculture Park scheme	/				
4. Captive Broodstock Development					
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*, etc.)		/			
4.2 Captive broodstock development for marine fishes (siganids, grouper, etc.)		/			

C. Training needs: (1) at AQD; (2) on-site in host country; (3) attachment in another country, (4) study visits for farmers, please check (√) appropriate cell

R&D Areas	Training Needs			
	(1)	(2)	(3)	(4)
1.Freshwater Aquaculture of Indigenous Species				
1.1 Genetic improvement of *Macrobrachium rosenbergii*	/			
1.2 Broodstock development and seed production of *Pangasius* spp.				/
1.3 Culture technologies for tilapia			/	
1.4 Aquaculture of other indigenous species			/	
2. Integrated Agri-Aqua Culture System				
2.1 Seed production of initial species identified for the activity				/
2.2 Study on climatic conditions and rice culture practices in participating or core countries				/
2.3 Agri-aqua culture technologies				/
2.4 Fish culture in small-farm reservoirs				/
3. Coastal Aquaculture and Mariculture				
3.1 Mud crab culture technologies	/			
3.2 Mollusks culture technologies	/			
3.3 Small-scale aquaculture including offshore cages			/	
3.4 Mariculture Park scheme			/	
4. Captive Broodstock Development				
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*, etc.)		/		
4.2 Captive broodstock development for marine fishes, e.g., siganids, grouper, etc.		/		

D. Information needs: (1) manuals or handbooks; (2) farm demonstration/mobilization of expertise; (3) workshops/meetings, (4) other info materials, please check (√) appropriate cell

R&D Areas	Information Needs			
	(1)	(2)	(3)	(4)
1.Freshwater Aquaculture of Indigenous Species				
1.1 Genetic improvement of *Macrobrachium rosenbergii*		/		
1.2 Broodstock development and seed production of *Pangasius* spp.	/			
1.3 Culture technologies for tilapia		/		
1.4 Aquaculture of other indigenous species		/		
2. Integrated Agri-Aqua Culture System				
2.1 Seed production of initial species identified for the activity	/			
2.2 Study on climatic conditions and rice culture practices in participating or core countries	/			
2.3 Agri-aqua culture technologies	/			
2.4 Fish culture in small-farm reservoirs	/			
3. Coastal Aquaculture and Mariculture				
3.1 Mud crab culture technologies		/		
3.2 Mollusks culture technologies			/	
3.3 Small-scale aquaculture including offshore cages		/		
3.4 Mariculture Park scheme	/		/	
4. Captive Broodstock Development				
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*, etc.)		/		
4.2 Captive broodstock development for marine fishes, e.g., siganids, grouper, etc.		/		

E. Other Concerns and Recommendations (use additional pages if necessary)

COUNTRY: CAMBODIA

A. Priority species for each R&D area

R&D Areas	Confirm or Specify Species
1. Freshwater Aquaculture of Indigenous Species	
1.1 Genetic improvement of *Macrobrachium rosenbergii*	*Macrobrachium rosenbergii*
1.2 Broodstock development and seed production of *Pangasius* spp.	*Pangasianodon hypopthalmus* *P. kremfi* *P. bocourti* *Mystus wyckiodes* Sand goby *(Oxyeleotris marmoratus)*
1.3 Culture technologies for tilapia	Nile Tilapia (*Oreochromis niloticus*)
1.4 Aquaculture of other indigenous species (*specify species*)	Silver barb (*Barbodes gonionotus*) Giant gourami (*Osphronemus gourami*) Kissing gourami (*Helostoma temmincki*) *Leptobarbus hoeveni* Climbing perch (*Anabas testudineus*)
2. Integrated Agri-Aqua Culture System	
2.1 Seed production of initial species identified for the activity (*specify species*)	Freshwater prawn (*Macrobrachium rosenbergii*) Climbing perch (*Anabas testudineus*) *Leptobarbus hoeveni*
2.2 Study on climatic conditions and rice culture practices in participating or core countries (*specify species*)	
2.3 Agri-aqua culture technologies (*specify species*)	Silver barb (*Barbodes gonionotus*) Giant gourami (*Osphronemus gourami*) Tilapia (*Oreochromis niloticus*) Silver carp (*Hypophthalmichys molitrix*) Bighead carp Mrigal (*Cirrhina mrigal*) Common carp (*Cyprinus carpio)*
2.4 Fish culture in small-farm reservoirs (*specify species*)	Silver barb (*Barbodes gonionotus)* *Leptobarbus hoeveni* Giant gourami (*Osphronemus gourami*) Kissing gourami (*Helostoma temmincki*)
3. Coastal Aquaculture and Mariculture	
3.1 Mud crab culture technologies	Giant mud crab (*Scylla serrata*)
3.2 Mollusks culture technologies	Green mussel
3.3 Small-scale aquaculture including offshore cages (*specify species*)	Grouper Snapper Sea bass
3.4 Mariculture Park scheme (*specify species*)	
4. Captive Broodstock Development	
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*, etc.)	*P. monodon*
4.2 Captive broodstock development for marine fishes, e.g., siganids, grouper, etc.	Grouper

B. Status of aquaculture technologies available for each R&D area: (1) not being done - (x) interested or (y) not interested; (2) experimental; (3) verification stage; (4) commercialized; please check (√) appropriate cell

R&D Areas	Status of aquaculture technologies				
	(1)		(2)	(3)	(4)
	(x)	(y)			
1.Freshwater Aquaculture of Indigenous Species					
1.1 Genetic improvement of *Macrobrachium rosenbergii*	/				
1.2 Broodstock development and seed production of *Pangasius* spp.				/	
1.3 Culture technologies for tilapia				/	
1.4 Aquaculture of other indigenous species				/	
2. Integrated Agri-Aqua Culture System					
2.1 Seed production of initial species identified for the activity	/				
2.2 Study on climatic conditions and rice culture practices in participating or core countries					
2.3 Agri-aqua culture technologies				/	
2.4 Fish culture in small-farm reservoirs	/				

R&D Areas	Status of aquaculture technologies				
	(1)		(2)	(3)	(4)
	(x)	(y)			
3. Coastal Aquaculture and Mariculture					
3.1 Mud crab culture technologies			/		
3.2 Mollusks culture technologies			/		
3.3 Small-scale aquaculture including offshore cages			/		
3.4 Mariculture Park scheme	/				
4. Captive Broodstock Development					
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*, etc.)	/				
4.2 Captive broodstock development for marine fishes, e.g., siganids, grouper, etc.	/				

C. Training needs: (1) at AQD; (2) on-site in host country; (3) attachment in another country, (4) study visits for farmers, please check (√) appropriate cell

R&D Areas	Training Needs			
	(1)	(2)	(3)	(4)
1.Freshwater Aquaculture of Indigenous Species				
1.1 Genetic improvement of *Macrobrachium rosenbergii*	/		/	
1.2 Broodstock development and seed production of *Pangasius* spp.		/	/	
1.3 Culture technologies for tilapia			/	
1.4 Aquaculture of other indigenous species			/	/
2. Integrated Agri-Aqua Culture System				
2.1 Seed production of initial species identified for the activity	/	/	/	
2.2 Study on climatic conditions and rice culture practices in participating or core countries				
2.3 Agri-aqua culture technologies	/			/
2.4 Fish culture in small-farm reservoirs			/	/
3. Coastal Aquaculture and Mariculture				
3.1 Mud crab culture technologies	/	/	/	/
3.2 Mollusks culture technologies	/	/	/	/
3.3 Small-scale aquaculture including offshore cages	/	/	/	/
3.4 Mariculture Park scheme				
4. Captive Broodstock Development				
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*)	/	/	/	/
4.2 Captive broodstock development for marine fishes (siganids, grouper)	/	/	/	/

D. Information needs: (1) manuals or handbooks; (2) farm demonstration/mobilization of expertise; (3) workshops/meetings, (4) other info materials, please check (√) appropriate cell

R&D Areas	Information Needs			
	(1)	(2)	(3)	(4)
1.Freshwater Aquaculture of Indigenous Species	/	/	/	/
1.1 Genetic improvement of *Macrobrachium rosenbergii*	/	/	/	/
1.2 Broodstock development and seed production of *Pangasius* spp.	/	/	/	/
1.3 Culture technologies for tilapia	/	/	/	/
1.4 Aquaculture of other indigenous species	/	/	/	/
2. Integrated Agri-Aqua Culture System				
2.1 Seed production of initial species identified for the activity	/	/	/	/
2.2 Study on climatic conditions and rice culture practices in participating or core countries	/	/	/	/
2.3 Agri-aqua culture technologies	/	/	/	/
2.4 Fish culture in small-farm reservoirs	/	/	/	/
3. Coastal Aquaculture and Mariculture				
3.1 Mud crab culture technologies	/	/	/	/
3.2 Mollusks culture technologies	/	/	/	/
3.3 Small-scale aquaculture including offshore cages	/	/	/	/
3.4 Mariculture Park scheme	/	/	/	/
4. Captive Broodstock Development				
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*, etc.)	/	/	/	/
4.2 Captive broodstock development for marine fishes, e.g., siganids, grouper, etc.	/	/	/	/

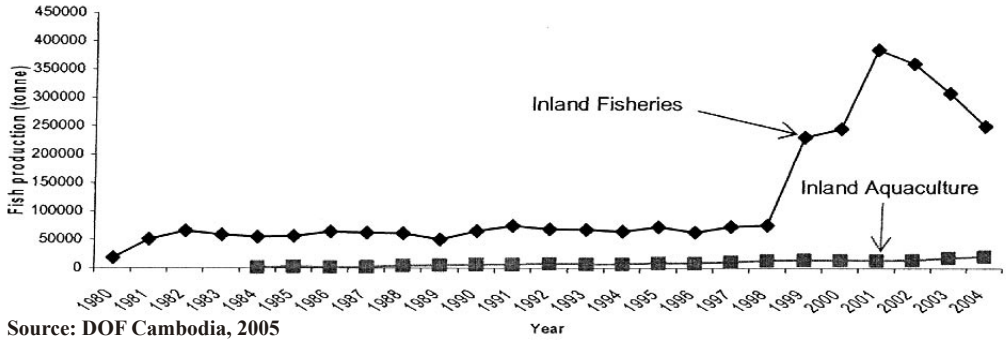
E. Other Concerns and Recommendations (use additional pages if necessary)

STATUS OF AQUACULTURE DEVELOPMENT IN CAMBODIA

Introduction

Fishery has been regarded as one of the most important sectors in the Cambodian economy. Besides providing employment for at least 2 million people working in fisheries and related industries, the fisheries sector has contributed highly to the country's export earning, sharing about 10.40% of national GDP in 2004.

In the fisheries sector, aquaculture is one of the main sub-sectors. Aquaculture production continued to grow over the past two decades increasing exponentially from 1610 mt in 1984 to 20, 835 mt in 2004, representing 11.9 times growth of 16.3%/year. Freshwater aquaculture and marine aquaculture represented 97% and 3% of the total, respectively. The most important species in terms of volume and value from inland aquaculture are *Pangasius* spp. and *Channa* spp. (snakehead). Presently, inland and marine aquaculture is estimated to contribute around 97% and 3% of the total aquaculture production, respectively, representing 8.3% of the total inland fisheries production in 2004.



Source: DOF Cambodia, 2005

Fig. 1 Production trends of Inland fisheries and aquaculture in Cambodia, 1980-2004

It is predicted that the contribution of aquaculture will continue to increase and will become more important in the future as a result of increasing demand for fishery products in both domestic and export market.

Inland Aquaculture

Inland or freshwater fish culture in cages is the most prevalent aquaculture in Cambodia. It is practiced by fishing communities especially in the Great Lake and is undertaken in a number of provinces bordering the Great Lake as well as in rivers and streams. Pond culture is done only recently, around the 1960s. Traditionally, this is the main supply source of animal protein for the people in the country. Most farming systems are extensive and semi-intensive. In extensive culture systems, pond management involves feeding and fertilization. Commonly, there is no or little provision of feeds. Whenever feeding is made, it is totally dependent on the availability of on-farm inputs such as rice bran, manure, and green leaves.

For the semi-intensive, farmers formulate feeds on their own using locally available ingredients such as fishmeal, rice bran, soy meal and corn meal. However, feeding ration still depends on the cash available and not on the fish growth requirement. Fish can be cultured in small-ponds, cages and rice field. Table 1 presents a list of commonly cultured species and culture methods in inland aquaculture. Among these, *P. hypopthalmus* and snakehead fish (*C. micropeltes)* are the major cultured species.

The main constraints to inland aquaculture are: *(1) seasonal variation in seed supply; (2) unavailability of hatchery-produced seeds for high value cultured species; (3) poor knowledge about feeds and feeding technology on the part of the farmers; and (4) high cost of commercial feeds.* In *Pangasius* and snakehead culture, the sharp decline of wild seed led to a shortage of seeds for stocking while hatchery-produced seeds have not been available.

Coastal Aquaculture

Coastal aquaculture is a relatively new development in Cambodia. It started in 1989 with the setting up of several shrimp farms, and since then has significantly expanded starting in 1991(Nam and Thuok, 1999). Marine finfish culture followed especially in Koh Kong and Sihanoukville. The main shrimp species cultured are tiger prawn *(Penaeus monodon)* and *Penaeus merguensis,* with the post larvae collected from wild or imported from neighboring countries. During the early 1990s, *Penaeus monodon* was a popular cultured species, with production increasing from 500 mt in 1993 to 731 mt in 1995. But this rise was short-lived as diseases set in leading to the decline in shrimp production. The production decreased to 75 mt in 2004.

Most shrimp farming systems are extensive. Comparing with the other countries in Southeast Asia, shrimp culture development occurred very slowly in Cambodia. If well planned, shrimp farming could provide employment for thousands of poor coastal farmers, contributing to poverty alleviation in the coastal communities. The problems in shrimp culture include: (1) unavailability of hatchery-produced shrimp post larvae; (2) reliance on imported post larvae from neighboring countries; (3) diseases that are linked to farm pollution, high soil acidity and viral/bacterial infections in shrimps; (4) lack of special extension programs focusing on shrimp farming.

Hanging oyster and green mussel culture systems started in 1994, however, these are no longer practiced or if practiced, only very few farmers are engaged in the culture due to lack of financial viability. The constraints on mollusk culture include: (1) insufficient seeds for stocking while commercial hatcheries are not available; (2) area suitable for mollusk culture has not been identified; (3) lack of extension and training programs on mollusk culture.

The culture of seaweeds, *Eucheuma cottonii* was introduced in the country in 1999 by a Malaysian company. Seaweed culture has created jobs and offered income earning opportunities to the fishers and the local people in the coastal areas. Some fishers who were hard up became professional seaweed farmers. In 2004, there were about 1200 families in Kampot Province who left fishing and farming to become full time seaweed farmers.

Table 1: Culture species (with Khmer and scientific names) and culture methods in inland aquaculture in Cambodia

Khmer Name	Scientific Name	Culture Method	Culture Volume
Pra	*Pangasianodon hypophthalmus*	P, FC, HS, WS	high
Pra Khchau	*Pangasianodon bocouti*	FC, WS	high
Po	*Pangasianodon larnaudiei*	FC, WS	low
Kair	*Pangasianodon conchophilus*	FC, WS	low
Chpin	*Barbodes gonionotus*	P, RF, FC, HS	high
Kar Hai	*Barbodes altus*	P, RF, HS	low
Chdaur	*Channa micropeltes*	FC, WS	high
Ros	*C. striatus*	FC, WS	high
Dom Rey	*Oxyeleotris marmoratus*	WS	low
Khya	*Mystus wyckiodes*	FC, WS	low
Kanthor	*Trichogaster pectroralis*	P, RF, HS	low
Proloung	*Leptobarbus hoeveni*	P, FC, HS, WS	low
Nile tilapia	*Oreochromis niloticus*	P, RF, FC, HS	high
Carp Sor	*Hypophthalmichhys molitrix*	P,HS	medium
Carp Samanh	*Cyprinus carpio*	P, RF, HS	medium
Carp Khbalthom	*Aristichtys nobilis*	P,HS	low
Mrigal	*Cirrihina mrigal*	P,HS	low
Andaing Konkat	*Clarias batrachus* x *C. gariepinus*	P, HS	low

Note: P: pond; RF: rice-fish; FC: Floating cage; HS: hatchery seed; WS: wild seed

Marine Aquaculture

Mariculture in Cambodia at present is less developed compared to the neighboring countries. So far, mariculture consists of only cage culture of valuable marine fish species for domestic consumption rather than exporting. There are two main types of culture, namely fry/fish holding and fry/fish on growing. Common cultured species are groupers and snappers. In 2004, there were about 204 small-scale marine fish cages, of which 124 cages located in Sihanouk vile and 80 cages in Koh Kong province. The production of marine fish produced from aquaculture is about 100 tons annually.

Unlike freshwater hatcheries, hatchery technology for marine species has not been established in Cambodia. All marine fish fry used in cage culture are collected from the wild. Marine fish cage culture is a good way to generate incomes and employment for coastal farmers, however, there are still several constraints for the development of this activity, such as: (1) unavailability of hatchery-produced seeds; (2) unavailability of commercial feeds for marine cage culture, (currently the use of trash fish for feeding not only cause environmental pollution but also pressure on the natural fish stock); (3) lack of training and extension programs focusing on marine aquaculture; and (4) although farmers could identify the outbreak of diseases, the lack of knowledge to address this issue is still a problem.

Developing Domestic Broodstock, Genetic Improvement and Seed Production Technologies

Aquaculture can not be sustained without seeds to grow. Hence, fish seeds should be readily available in reliable quantity and quality to farmers. At present most seeds for aquaculture in Cambodia are still dependent on the natural seed habitats. However, many of these habitats have increasingly become degraded, contributing further to the scarcity of seed supply. Therefore, fish hatcheries play the key role in supplying seeds for aquaculture development.

Therefore, research on the development of domestic broodstock, genetic improvement and seed production technologies of some valuable freshwater and marine finfish species are necessary and constitute very important issues in aquaculture expansion. The following are aquatic commodities species that the Department of Fisheries has identified and prioritized for the captive broodstock development and reproductive technologies:

Freshwater species: *Macrobrachium rosenbergii, Pangasianodon hypophthalmus, P. kremfi*, *P. bocourti, Mystus wyckiodes,* Sand goby *(Oxyeleotris marmoratus)*

Marine species*:* *P. monodon,* Grouper, Snapper

Due to limited knowledge to conduct research on the development of domestic broodstock, genetic improvement and reproductive technology of the above selected species, support for research, training and information from other experienced countries in the region is very important in order to strengthen the capacity of Cambodian researchers.

Conclusion

Aquaculture not only performs a significant role in the economic development of Cambodia, but also plays an important contribution to local nutritional needs especially for the rural poor. Aquaculture can benefit the people in several ways, including bringing in food, employment, income and improve women's work situation.

Further development of aquaculture is expected in Cambodia. In this context, aquaculture production through extensive or intensive farming systems should be sustainable, widely applicable and important in raising income among impoverished farmers. However, there are still constraints in the development of aquaculture as mentioned above, such as unavailability of quantity and quality seeds, insufficient hatchery technology for high value cultured species, poor knowledge of farmers in feed and feeding techniques, and lack of extension programs on aquaculture operations.

COUNTRY: INDONESIA

A. Priority species for each R&D area

R&D Areas	Confirm or Specify Species
1. Freshwater Aquaculture of Indigenous Species	
1.1 Genetic improvement of *Macrobrachium rosenbergii*	Udang galah (*Macrobrachium rosenbergii)*
1.2 Broodstock development and seed production of *Pangasius* spp.	Patin siam – Thai pangas (*Pangasianodon hypophthalmus*) and patin djambal (*Pangasius djambal*)
1.3 Culture technologies for tilapia	*Tilapia niloticus*
1.4 Aquaculture of other indigenous species (*specify species*)	Baung–catfish (*Hemibagrus nemurus* C.V.), Jelawat–carp (*Leptobarbus hoevani* Blkr), Lele–catfish (*Clarias* sp) and Betutu–Sand goby (*Oxyeleotris marmorata*)
2. Integrated Agri-Aqua Culture System	
2.1 Seed production of initial species identified for the activity (*specify species*)	Lele–Catifsh (*Clarias* sp), *Tilapia niloticus* and Golden carp (*Cyprinus carpio*)
2.2 Study on climatic conditions and rice culture practices in participating or core countries (*specify species*)	Lele–Catifsh (*Clarias* sp), *Tilapia niloticus* and Golden carp (*Cyprinus carpio*)
2.3 Agri-aqua culture technologies (*specify species*)	Lele – Catifsh (*Clarias* sp), *Tilapia niloticus* and Golden carp (*Cyprinus carpio*)
2.4 Fish culture in small-farm reservoirs (*specify species*)	Batak (*Torsoro* sp.), grass carp, Tawes (*Punctius javanicus*), udang galah (*Macrobrachium rosenbergii*) and common carp (*Cyprinus carpio)*
3. Coastal Aquaculture and Mariculture	
3.1 Mud crab culture technologies	*Scylla serrata*
3.2 Mollusks culture technologies	*Perna viridis*, Abalone
3.3 Small-scale aquaculture including offshore cages (*specify species*)	Shrimp, baramundi, *Pangasius*, common carp, catfish, gouramy, shell fish, seaweeds
3.4 Mariculture Park scheme (*specify species*)	Pearl oyster, coral reef fishes
4. Captive Broodstock Development	
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*, etc.)	*P. monodon, P. merguiensis*, Rostris shrimp (*Litopenaeus stylirostris*), *P. vannamei*
4.2 Captive broodstock development for marine fishes, e.g., siganids, grouper, etc.	Greasy grouper (*Epinephelus tauvina*, Humpback grouper (*Cromileptes altivelis*), brown-marbled grouper (*Epinephelus fuscoguttatus)*, Humphead wrasse (*Cheilinus undulatus*), Baramundi (*Lates calcarifer*)

B. Status of aquaculture technologies available for each R&D area: (1) not being done - (x) interested or (y) not interested; (2) experimental; (3) verification stage; (4) commercialized; please check (√) appropriate cell

R&D Areas	Status of aquaculture technologies				
	(1)		(2)	(3)	(4)
	(x)	(y)			
1.Freshwater Aquaculture of Indigenous Species				/	
1.1 Genetic improvement of *Macrobrachium rosenbergii*			/	/	/
1.2 Broodstock development and seed production of *Pangasius* spp.			/	/	/
1.3 Culture technologies for tilapia			/		/
1.4 Aquaculture of other indigenous species			/	/	/
2. Integrated Agri-Aqua Culture System					
2.1 Seed production of initial species identified for the activity			/	/	/
2.2 Study on climatic conditions and rice culture practices in participating or core countries	/				
2.3 Agri-aqua culture technologies			/	/	/
2.4 Fish culture in small-farm reservoirs			/	/	/
3. Coastal Aquaculture and Mariculture					
3.1 Mud crab culture technologies				/	/
3.2 Mollusks culture technologies				/	/

R&D Areas	Status of aquaculture technologies				
	(1)		(2)	(3)	(4)
	(x)	(y)			
3.3 Small-scale aquaculture including offshore cages					/
3.4 Mariculture Park scheme			/		
4. Captive Broodstock Development					
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*)			/	/	/
4.2 Captive broodstock development for marine fishes (siganids, grouper, etc.)			/	/	/

C. Training needs: (1) at AQD; (2) on-site in host country; (3) attachment in another country, (4) study visits for farmers, please check (√) appropriate cell

R&D Areas	Training Needs			
	(1)	(2)	(3)	(4)
1.Freshwater Aquaculture of Indigenous Species				
1.1 Genetic improvement of *Macrobrachium rosenbergii*	/	/		/
1.2 Broodstock development and seed production of *Pangasius* spp.	/	/		/
1.3 Culture technologies for tilapia	/	/		/
1.4 Aquaculture of other indigenous species	/	/		/
2. Integrated Agri-Aqua Culture System	/	/		/
2.1 Seed production of initial species identified for the activity	/	/		/
2.2 Study on climatic conditions and rice culture practices in participating or core countries	/	/		/
2.3 Agri-aqua culture technologies	/	/		/
2.4 Fish culture in small-farm reservoirs	/	/		/
3. Coastal Aquaculture and Mariculture				
3.1 Mud crab culture technologies		/	/	
3.2 Mollusks culture technologies		/	/	
3.3 Small-scale aquaculture including offshore cages			/	/
3.4 Mariculture Park scheme	/	/	/	/
4. Captive Broodstock Development				
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*)	/	/	/	/
4.2 Captive broodstock development for marine fishes (siganids, grouper, etc.)	/	/	/	/

D. Information needs: (1) manuals or handbooks; (2) farm demonstration/mobilization of expertise; (3) workshops/meetings, (4) other info materials, please check (√) appropriate cell

R&D Areas	Information Needs			
	(1)	(2)	(3)	(4)
1.Freshwater Aquaculture of Indigenous Species				
1.1 Genetic improvement of *Macrobrachium rosenbergii*	/	/		/
1.2 Broodstock development and seed production of *Pangasius* spp.	/	/		/
1.3 Culture technologies for tilapia		/		/
1.4 Aquaculture of other indigenous species	/	/		/
2. Integrated Agri-Aqua Culture System				
2.1 Seed production of initial species identified for the activity	/	/		/
2.2 Study on climatic conditions and rice culture practices in participating or core countries	/	/		/
2.3 Agri-aqua culture technologies	/	/		/
2.4 Fish culture in small-farm reservoirs	/	/		/
3. Coastal Aquaculture and Mariculture				
3.1 Mud crab culture technologies	/	/		/
3.2 Mollusks culture technologies	/	/		/
3.3 Small-scale aquaculture including offshore cages	/	/		/
3.4 Mariculture Park scheme	/	/	/	/
4. Captive Broodstock Development	/	/	/	/
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*)	/	/	/	/
4.2 Captive broodstock development for marine fishes (siganids, grouper, etc.)	/	/	/	/

E. Other Concerns and Recommendations (use additional pages if necessary)

AQUACULTURE DEVELOPMENT IN INDONESIA

Freshwater Aquaculture of Indigenous Species

Genetic Improvement of *Macrobrachium rosenbergii*

Macrobrachium rosenbergii is one of the potential commodities for freshwater culture in almost all river areas in Indonesia. It has been cultured by Indonesian farmers and its potential is now starting especially in increasing the farmers' income. The freshwater prawn is presently having a good market in hotels and restaurants as well as for export. With the rich preferring this seafood, there is now an increase in the market potential of the species. Bali is one of the provinces in Indonesia that produces good taste of this prawn making it popular for tourists. Its good taste and popularity led to its increased cost.

In 2001, the Freshwater Aquaculture Research Center (Balitkanwar) in Sukamandi, West Java succeeded in breeding the prawn (also known as baby lobster) coming from three different locations. This enabled the Center to produce better quality prawn including its smaller-size head, heavier weight, better survival rate, and higher productivity. It was then launched to the public by the Minister of Marine Affairs and Fisheries in July 2001 and called as Genetically Improved Macrobrachium or GI-Macro. After the launching, the broodstock was forwarded by the Directorate General of Aquaculture to three Provincial Centers for *Macrobrachium* culture m Yogyakarta, West Java and East Java Provinces in order to develop grandparent stock, which can be distributed to the farmers as parent stock for aquaculture.

In order to support the development of the GI-Macro, the Regional Research Center for Freshwater Aquaculture (Loriskanwar) in West Java is conducting tests and research to produce new broodstock of GI-Macro that is called GI-Macro 2. The selection program conducted in the Loriskanwar includes physical test, average reference selection, and potential selection. The main obstacles that hinder the development of GI-Macro in the Centers are: (1) technical problems in the breeding process, especially related to: (a) cannibalism of the shrimp since its larval stage resulting to problem in getting certain amount of broodstock needed; (b) high mortality rate from broodstock to mature broodstock; (c) easy conversion of GI -Macro to become broodstock without genetic engineering in its relatively young age (5-6 months); (d) productive age of GI –Macro could not be determined as there is no valid research to help or better understand this issue; (e) broodstock transport for GI -Macro not established causing stress during transport phase, and mortality of about 50%; and (2) the broodstock in the Centers from the parent stock (FI) may not be genetically suitable to serve as broodstock.

The priority locations for GI-Macro R&D are West Java, Yogyakarta and East Java provinces, where many farmers are culturing the species. The aquaculture technologies for GI-Macro R&D are still experimental, or to certain extent still in the verification and very few in commercial stages. Training needed for the R&D could be those at development centers like AQD, both on-site in host country, and study visits for farmers. Information needed for the R&D are manuals or handbooks, farm_demonstration/ mobilization of expertise and other info materials.

Broodstock Development and Seed Production of *Pangasius* spp.

Patin siam - Thai pangas *(Pangasianodon hypopthalmus)*

Tangkit Baru Village in Jambi Province, is one of the patin siam or catfish *(Pangasianodon hypopthalmus)* culture areas. The people in the local community are very enthusiastic about culturing the fish because of its market potential which increases depending on the number of hatcheries developed, the number of farmers involved and the total production. The culture areas were previously swamp areas. There were only three (3) ponds in 1997 (total area: 600 m^2), now the number has reached 815 ponds (with the total area of more than 20 ha). The production capacity also increased from 5 mt/year (1997) to 1.0-1.5 mt/day. The broodstock used is a result of the cross-breeding. With the increase in the production capacity, there is also an increase in the need for seeds while feed requirements reached 61.600 kg/month (FCR=1.2). In succeeding years, the country will need 1.2 million seeds every 6 months, while feeds needed would be about 125 mt/6 mo. The Ministry of Marine Affairs and Fisheries supports the initiative of the people to develop this catfish culture through the program of seed grants, aquaculture technology assistance, training on aquaculture techniques as well as health and environmental monitoring.

Patin Djambal *(Pangasius djambal)*

Among the local type of patin fish in Indonesia, *Pangasius djambal* is one of the species that favors the consumers especially in Sumatera and Kalimantan Islands. This fish can grow up to 20 kg and its white meat could be a potential product for the international market. In 1996, a collaborative research between IRD France and Indonesia entitled "Catfish Asia Project" using recirculating water system gave a significant result in the systematic distribution, biological aspects and culturing of this pangasid fish. It showed that *Pangasius djambal* has zootechnical attributes which is better than *Pangasinodon hypophthalmus.*

BBAT Jambi has succeeded in producing the future seeds which have been distributed to potential aquaculture areas for "patin djambal" such as in BBAT Sukabumi, where it can produce good quality broodstocks. The tota1 number of broods tacks availab1e in BBAT Jambi is 2000 pieces. Currently, the R&D for both "patin siam" and "patin djambal" is conducted in various provinces, namely: Jambi, South Sumatera, South Kalimantan, and West Kalimantan, and in other provinces.

Aquaculture technologies available for patin R&D are in experimental, verification and/or commercial stages. Training needs for the R&D would be available at development centers, especially for product processing, both on-site in host country, and study visits for farmers. Information needed for the R&D are manuals or handbooks, farm demonstration/mobilization of expertise and other info materials.

Culture Technologies for Tilapia
Oreochromis niloticus

The National Tilapia Broodstock Center (PPIINN) was formed in 2003 and located in BBAT Sukabumi to coordinate with the Regional Tilapia Broodstock Center (PPIINR). The program of PPIINN supports the development of aquaculture in relation to product improvement of the freshwater aquaculture through the Production Improvement Program for Export (called PROPEKAN) and Increasing Aquaculture Production for Domestic Consumption (PROKSIMAS).

PPIINN has developed guidelines on breeding program through genetic engineering such as chromosome manipulation, hybridization and selective breeding. PPIINN and PPIINR are currently conducting research on the implementation of aquaculture technology in order to increase the quality of Nile tilapia through: (1) selective breeding, such as family selection and individual selection although this process is still at early stage in 2004-2005, and is done to produce the Fl and F2; (2) YY-Supermale Indigo, has managed to get 17 pieces of YY male and 2 pieces of female YY and currently a feminization effort is conducted through cross breeding; (3) Hybridization in the quality improvement through introgression hybridization, which has produced broodstock for F2. Effort to produce the hybrid seeds is still awaiting the process of introgression of the white tilapia.

Through this breeding program, PPIINN/PPIINR plans to produce the male broodstock of YY in 2007, potential strain of Nile tilapia in 2009, broodstock for hybrid of red tilapia in 2008, Genetic Male in 2008, and high quality brood stock every year. The priority areas for Tilapia R&D are Jambi, South Kalimantan, North Sulawesi, West Java, Yogyakarta, East Java and Central Java. The status of aquaculture technologies available for Tilapia R&D are in experimental and commercial stages. Training needed for the R&D are available at tilapia reference centers, on site in host country, and study visits for farmers. Information needed for the R&D include manuals or handbooks, farm demonstration/mobilization of expertise and other info materials.

Aquaculture of Other Indigenous Species
Baung - Catfish *(Hemibagrus nemurus* C.V.)

Baung *(Hemibagrus nemurus* C. V.) is one among the many species of Green Catfish with high economical value found in open waters. It is one of the preferred fish in Jambi because of its good taste. The price of Baung in Jambi market is getting higher so the demand is also increasing. People usually catch small size of Baung (1-3 inches) towards the end of the rainy season to be cultured in ponds. Anticipating the rarity of Baung in the future, the Freshwater Aquaculture Development Center in Jambi initiated collecting Baung in 1999 from Batanghari river in Jambi. Later on, the Center was able to establish domestication, protocol, gonad maturity and later the grow-out culture of Baung. With the success of the culture technology, Baung has potential to become another alternative fish for aquaculture.

The culture efforts for Baung at Jambi Center include domestication, maintenance of broodstock and maturity of gonad, cross breeding, eggs incubation, larval management, breeding in the ponds and broodstock development. The technology improvement in breeding Baung enabled the Center to produce 40-50% of eggs, 50- 60% survival of larvae and 40-70% survival during breeding in the ponds. The future development will be on improvement in the gonad maturity, ovulation and larval rearing. The next experiment will involve some methods of eggs incubation, breeding and multi-location of breeding in Sumatera. The activity in 2006 will include promotion of culture technology of Baung in all stages of development. The priority areas for Baung R&D are in Jambi and South Kalimantan. The status of aquaculture technologies are experimental and verification stages. Training needed for the R&D are available at development centers. Information needed are manuals or handbooks, farm demonstration/mobilization of expertise and other information materials.

Jelawat - Carp *(Leptobarbus hoevani* Blkr)

As original Indonesian fish found in many rivers, lakes and other aquatic areas in Kalimantan and Sumatera, Jelawat has good economical value and potential for further development since the need for the animal protein is also increasing. Its culture should be promoted in order to fill the people's needs for animal protein. Another reason is the fluctuation and decreasing number of catch of this species from natural aquatic resources.

Although Jelawat culture has been developed for some time, the supply of seeds as the main production factor is still dependent on the wild and the availability of the broodstock is seasonal. This fish grows easily in the river in early rainy season, however, the supply of seeds is still limited and is not able to fill the increasing demand for culture. With limited seed supply as a constraint to Jelawat culture development, Loka Mandiangin, the Regional Freshwater Aquaculture Development Center in South Kalimantan, is giving Jelawat breeding program a priority for R&D in order to fill the market demand.

The status of aquaculture technologies for Jelawat R&D is still in experimental and verification stages. Training needed for the R&D may be available at development centers, and on site in host country. Information needed for the R&D are manuals or handbooks, farm demonstration/mobilization of expertise and other information materials.

Lele - Catfish *(Clarias sp)*

Lele or catfish is one of the freshwater fishes commercially cultured in Indonesia especially in Java. The aquaculture of the catfish is highly developed due to the following: (1) the fish can be cultured in areas with limited water supply; (2) the aquaculture technology is easy to adopt by the people; (3) it is relatively easy to market; (4) it needs small capital. The aquaculture of Lele increased further since the entry of "Lele Dumbo" strain in Indonesia in 1985.

The better attributes of Lele Dumbo strain compared to the local Lele are the following: fast growing, produces more eggs and more resistant against diseases. However, the lack of techniques in broodstock management resulted in degradation of the quality of Lele Dumbo. Thus, in order to improve the quality of Lele Dumbo, BBAT Sukabumi has developed a new strain called "Lele Sangkuriang" through genetic engineering.

Aquaculture of Lele Sangkuriang can be done in any area even at the height of 1 m-800 m above sea level with no specific requirements in terms of soil quality or water. Its culture, both breeding and grow-out can be done in ponds, ground buckets, plastic buckets or other marginal places. The priority R&D for the aquaculture technology of the catfish can be throughout Indonesia since this species is relatively easy to culture. The status of aquaculture technologies is already in commercial stages. Training needs could be in the form of study visits for farmers. Information needed are manuals or handbooks, farm demonstration/mobilization of expertise and other information materials.

Betutu - Sand Goby *(Oxyeleotris marmorata)*

Betutu has a good taste and is relatively more expensive compared with other freshwater fishes. The demand for Betutu and its seeds are relatively high especially those from the wild. Fishing is usually done around July–October. Overfishing poses a problem of the farmers, hence the need for conservation efforts to be done especially in the spawning ground. Aquaculture needs to be encouraged in order to reduce the dependency on the natural habitat. Betutu are commonly found in Southeast Asia. In Indonesia, it can be found in areas such as: (1) Sumatera: Palembang, Muara Kumpeh, Gunung Sahilan, Jambi, Danau Kota, Sungai Si Russu, Enggano, (Bua-bua), Riau and Lampung; (2) Kalimantan: Banjarmasin, Sintang, Montrado, batuPangal, Smitau, Danau Baram,Danau Jempang, Pontianak, Kapuas river, Barito river, Mahakam river, Serawak, Kinabatangan, Lahad Datu and Tenom; (3) Java Rivers around Java sea such as, Cisadane, Citarum (Saguling and CirataReservoir)

.Reservoirs, lakes and big rivers in Indonesia are potential areas for aquaculture. Breeding of Betutu can be done in the ponds while grow-out can be in embankments. Its growth is not different from the other freshwater fishes, i.e., polyculture or monoculture. Culture can be done in cages placed at the bottom of the waters, as usually found in riverbanks in South Kalimantan, East Kalimantan and Jambi. Pen culture is one of the alternative culture methods for Betutu. All the aforementioned areas could be priority R&D areas for the culture of Betutu. The aquaculture technologies available for Betutu are in experimental and verification stages. Training needs could be on site in host country. Information needed include manuals, handbooks, farm demonstration/mobilization of expertise and other information materials.

Integrated Agri-Aqua Culture System

Seed Production of Initial Species Identified for the Activity

The Directorate General of Aquaculture through the Integrated Aquaculture Program aims to accelerate the development of the fisheries sector by collaborating with other sectors through aquaculture. The specific objective of this program is to increase fish production through optimum usage of soil resources and water; and to improve the production efficiency and value added products for the people. The program is conducted by integrating aquaculture with rice farming, animal husbandry and other agriculture activities.

Species involved in this Integrated Aquaculture are: lele catfish, tilapia and common carp. The seeds for the agri-aqua culture system is mostly from the wild or hatchery located around the aquaculture area. Wild seeds can be found in rivers, swamps or other freshwater areas. West Java, Central Java, West Sumatera and East Java could be the priority R&D areas for the seed production for the agri-aqua culture system. Status of aquaculture technologies available for seed production of agri-aqua culture system is still experimental or to certain extent verification and commercial stages. Training needs include reference centers, on site in host country and study visits for farmers. Information needed include manuals or handbooks, farm demonstration/ mobilization of expertise and other information materials.

Study on Climatic Conditions and Rice Culture Practices in Participating or Core Countries

There has been no study on the climatic conditions and rice culture practices in participating or core countries. This study is very important to support the rice field culture (mina padi), and determine the feasibility of the activity in certain climatic conditions in order to minimize the failure of this type of aquaculture.

This study will also establish protocols for planting rice and stocking fish to maximize the usage of the paddy field. Priority R&D areas for study on climatic conditions and rice culture practices could be in West Java, Central Java, West Sumatera and East Java. Training needs include training at reference centers, on site in host country and study visits for farmers. Information needs are manuals, or handbooks, farm demonstration/mobilization of expertise and other information materials.

Agri-Aqua Culture Technologies

Indonesian farmers are practicing integrated aquaculture to augment their income from rice farming. The seeds of the fish are available from rivers, swamps or freshwater around the area or from nearby hatcheries, since farmers do not have the skills to do seed production. The fish usually does not need large quantity of feeds, since they fed on the plankton and small aquatic animals in the paddy field. West Java, Central Java, West Sumatera and East Java could be the priority R&D areas for agri-aqua culture technologies. Aquaculture technologies available for agri-aqua culture are still in experimental or to some extent verification and commercial stages. Training needs for these R&D areas are at reference centers, on site in host country and study visits for farmers. Information needs include manuals or handbooks, farm demonstration/mobilization of expertise and other information materials.

Fish Culture in Small-farm Reservoirs

Fish aquaculture is done in floating net cages installed in Cirata, Saguling and Jatiluhur reservoirs. The suitable species for aquaculture in these three reservoirs are tilapia, carps, catfishes and gouramy. The Directorate General of Aquaculture operates a Culture Based Fisheries (CBF) program aimed at improving: (a) the productivity of natural waters by stocking fish to increase catch of fishers and paying attention to the ecosystem and habitat of local fish; (b) the awareness and ability of the people surrounding the natural waters to be able to manage and conserve the productivity in their respective areas; (c) the advocacy of the people near the natural waters on natural waters conservation in their respective areas.

The main component of CBF includes empowerment of the local people; stocking of fish suitable to the local condition; identifying areas as limited, conservation/forbidden; making available fish seeds; and sustainably managing the environmental area. The fish species used in this CBF activity are Batak fish *(Torsoro sp.)* in Toba Lake-North Sumatera, grass carp in Curug Walahar-West Java, Tawes *(Puntius javanicus)* and Giant prawn *(Macrobrachium rosenbergii)* in Bade reservoirs in Central Java, carp in Riam Kanan reservoirs-South Kalimantan and few other fish species. Aquaculture technologies available for fish culture in small-farm reservoirs R&D are still in experimental, verification and commercial stages. Training needs are at reference centers, on site in host country and study visits for farmers. Information needs are manuals or handbooks, farm demonstration/mobilization of expertise and other information materials.

Coastal Aquaculture and Mariculture

Mud Crab Culture Technology

Efforts to improve the culture of mud crab have been conducted, both in terms of breeding and grow-out. The mud crab cultured in Indonesia is *Scylla serrata.* Although some degree of success has been attained in breeding the mud crab, there is still a need to do further research to strengthen previous findings. The country's mud crab culture technology may be in mature stage and is now being adopted in the communities. The main problem facing the development of mud crab is dependence on wild seeds, the supply of which is already decreasing just as capture of mud crab is also decreasing due to degradation of its habitat.

Therefore, efforts need to be done should be on: (1) strengthening of breeding technology; (2) development of conservation and environmental program; (3) development of culture technology in fish pond and net cages in target areas like Nanggroe Aceh Darussalam, North Sumatra, Java, South Sulawesi and East Kalimantan; (4) training on mud crab culture for extension workers and farmers; (5) exchanging information materials such as manuals and hand books; (6) farm demonstration and mobilization of expertise.

The breeding technique for mud crab has been adopted from the tiger prawn, *Penaeus monodon* after certain modifications of the technology. The emphasis of this activity includes broodstock selection, improvement of the nutritional quality, manipulation and improvement of environmental quality as well as minimizing cannibalism. Grow-out culture can be done in embankments with sandy clay ground. The required site is the same as in shrimp or milkfish culture which include: abundant water supply, topography, shape of the land, mangrove protection from flood and erosion; accessibility to transportation and market. The acidity of the soil suitable for the culture of mud crab is around 6.5 – 7.5. An area between 0.1 – 0.5 hectare rectangular embankment should be surrounded with fence. This should also be equipped with additional shelter made of rocks, water pipes to serve as hiding place or escape route from attacks of other mud crabs, especially those undergoing molting.

Mollusk Culture Technology

Certain mollusks have potentials for further improvement such as the green mussel *(Perna viridis), Anadara granosa,* pearl oyster *(Pictada maxima),* abalone *(Haliotis* sp*)* and many others. Those four types of mollusks have high economical value, especially abalone with export price reaching US$25/kg.

Research and development for the culture (both for breeding and development) of *Perna viridis* and *Haliotis* sp. are under way and there are plans for *Anadara granosa* to be conducted in the near future. The main problem facing the pearl oyster culture is security, especially since the start of the economic crisis that resulted to massive unemployment and other social problems. The high standard for product quality is also a constraint for the development of the mollusk industry.

Efforts for the development of shellfish culture have been done in order to increase aquaculture production for domestic consumption (PROKSIMAS), certification, allocation of reservation area, monitoring of environmental quality, application of hygiene culture and depuration. Skills development on shellfish culture is through training and farm demonstration. Manuals, handbooks and other information materials are also needed.

The culture of *Perna viridis* can be done by using 4 methods namely post method, raft method, rack method and long line method. The culture of pearl oyster has become a good business especially in the eastern part of Indonesia. The business is usually done by people with good access to capital, since this is a capital intensive venture.

During the last few years, the progress between the core and plasma relationship was feasible, where the core is the company that provides the spat for culture by farmers as plasma. The pearl oyster produced will be purchased back by the company as the core. This small scale culture business has also been developed in Sorong Papua. The main development area includes: Lampung, West Nusa Tenggara, East Nusa Tenggara, North Sulawesi, North Maluku, Maluku, West Papua.

Small Scale Aquaculture

Small scale aquaculture was developed through PROKSIMAS with the aim of optimizing the usage of marine, brakishwater, and freshwater areas by integrating them with the village development; improving revenues and improving nutrition of the community and providing them food security; encouraging the active role of the family members to improve the economy of the community in the villages. The activities of PROKSIMAS include: intensification, extension and diversification of the culture of shrimp, baramundi, *Pangasius*, common crap, catfish, gouramy, shellfish, seaweeds and many others that are potential major species in the area.

The seaweeds that have economic value which have been cultivated include *Eucheuma* sp. and *Gracilaria* sp. from the species of red algae. *Eucheuma* sp are cultivated in the coastal/sea area, whereas *Gracilaria* sp. are already cultivated in the embankment. From the family of red algae that have high economic value but have not been cultivated are *Giledium* sp*., Sargassum* sp and *Turbinaria* sp.

The culture methods used are: (1) Post Method for sandy or muddy sandy areas for easy installation of poles; (2) Raft Method for coastal areas to withstand strong waves; (3) Long Line Method, most preferred by people since the equipment and the materials used are long lasting and readily available; (4) Rack Method, which is the combination of the Raft Method and Long Line Method.

The small scale culture of shrimp is done through mass-area development project empowering certain groups of people that are located in the same area. The groups undergo technical training, prototype activity, capital improvement, technological advice and field meeting.

Fish production from culture technology is far from satisfactory due to lack of capital of the farmers. The farmers usually do not have access to capital since they are required to put up collateral to avail of loans. Other problems are lack of support from the banking community. Based on this reality the cooperation and support from other countries or international agencies, in terms of training, staff and information exchange are strongly needed to improve production from small-scale aquaculture.

Mariculture Park Scheme

Mariculture-Tourism is one of the integrated culture systems with more emphasis on tourism. Mariculture has not been fully developed in Indonesia although pearl oyster culture tourism and coral reef tourism are now in place. The main problem for the development of this mariculture tourism is the lack of promotional activities and experience. The coral reef tourism (plantation) is done through the transplantation of man-made coral reef on the seabed by way of diving; and where tourists are given the opportunity to put their names or initial in this man-made coral reef. This is intended to attract them to return to witness the growth and development of their corals. The reef tourism is developed in the province of Bali and West Nusa Tenggara.

The pearl oyster tourism was initiated by the Indonesian Association of Pearl Oyster Culture in Bali. The tourists are led to the pearl oyster culture areas and are briefed on the techniques used for culture and harvesting as well as evaluating the quality of the pearl. At the end of the visit, the tourists are brought to the market/showroom which showcased the pearl from the culture, and attracting them to pearl products on sale.

Captive Broodstock Development
Development of Shrimp Broodstock

Some of the shrimps that are cultured in Indonesia are the tiger shrimp *(P. monodon),* vannamei shrimp *(P. vannamei)* and rostris *(Litopenaeus stylirostris)*. The problem in shrimp culture in Indonesia is its dependence of broodstock supply on the wild and its deteriorating quality. For vannamei shrimp and other type of shrimps, their qualities are also deteriorating due to the usage of poor quality imported broodstock as a result of in-breeding. The catchment areas for *P. monodon* are in East Aceh, Lampung, Java Sea, West and South Coastal of Kalimantan, coastal area of East Kalimantan, coastal area of West Nusa Tenggara (Sumbawa Regency), coastal area of South Sulawesi and coastal area around Papua.

Efforts are done by the Government to overcome the problem of shrimp broodstock, ie: (1) maintaining the quality of broodstock from the wild by improving harvest and transportation techniques, storage and broodstock management in the hatchery; (2) improving and implementing genetics management by designating a Technical Implementing Unit (Unit Pelaksana Teknis - UPT) under the Directorate General of Aquaculture, which is also acting as the Regional and National Development Center of Shrimp Broodstock and Network of Broodstock and Genetics of Shrimps.

The Technical Implementing Units appointed as National and Regional Centers for Broodstock Development are: (1) the Regional Brakishwater Aquaculture Development Center (RBADC) in Ujung Battee as broodstock center for *P. monodon;* (2) the National Brakishwater Aquaculture Development Center (NBADC) in Jepara as broodstock center for *P. monodon* and rostris shrimp *{Litopenaeus stylirostris);* (3) NBADC in Situbondo as broodstock center for *P. monodon* and *P. vanname*i; and (4) RBADC in Takalar as broodstock center for *P. monodon*.

With the inception of the broodstock centers, it is expected that the need for broodstocks and good quality shrimp larvae can be supplanted in order to increase production. Apart from the quality of broodstock and benur to be maintained through proper management and monitoring, harvest of broodstock from the wild is now being regulated. The physical attributes of shrimp broodstock in the four broodstock centers are shown in the following table:

The Physical Attributes of the Shrimp Broodstock in the Broodstock Center, Year 2004

Type of Broodstock	NBADC Jepara	RBADC Ujung Batee	NBADC Situbondo	RBADC Takalar
P. monodon	Collection consists of 30 pairs of broodstock from the coasts of Aceh, Cilacap and West Nusa Tenggara	500 species	300 species	70 species
P. vannamei			100 pairs of F1 from Hawaii 15,000 F1 from Florida 100 pcs of broodstock from Florida	
Litopenaeus stylirostris	The maintenance of the broodstock was started in 2003 using the rostris shrimp with consumption size in the embankment using tagging application.			

Captive Broodstock Development for Marine Fishes
Grouper

Grouper species with high economic value and good potential for further development in Indonesia include: *Cromileptes altivelis, Plectopomus leopardus, Ephinephelus fuscoguttatus, Epinephelus coioides,* and *Chelinius undulatus.* Almost all of the broodstock used in hatcheries come from the wild caught by farmers who also export them to other countries.

In Indonesia, the broodstock for *Cromileptes altivelis* and *Ephinephelus fuscoguttatus* are mainly found in the coastal areas of Nanggroe Aceh Darussalam, West Sumatera Coastal of Riau, Thousand Islands, Java (Banten Teluk, Ujung Kulon, Islands of Karimun Jawa, Madura), East Kalimantan, West Kalimantan, South Kalimantan, Bali, East Nusa Tenggara (Cempi Teluk), East Nusa Tenggara, South Sulawesi (Island of Sinjai, Island of Pangkep, Selayar, Luwuk Banggai), South East of Sulawesi (Kendari), North Sulawesi (Manado), Central Sulawesi, Gorontalo, Maluku, North Maluku, Burn, and Ambon. Domestication for certain type of grouper means harvesting them from the wild and maintaining them in hatcheries. The culture of *Cromileptes altivelis* and *Ephinephelus fuscoguttatus* are the most advanced culture system for grouper in Indonesia.

The government and the private sector have been trying to improve the quality of the broodstock of grouper by cross breeding and adopting other culture techniques. Through these culture efforts, seeds grow better and develop higher resistance towards disease, give higher fecundities for broodstock, and better adaptability to the environment. The National Center for Grouper Broodstock is the Regional Mariculture Development Center (NMDC) located in Lampung, NBADC Situbondo, RMDC Batam and RBADC Takalar.

Baramundi *(Lates calcarifer)*

Baramundi *(Lates calcarifer)* is also a marine fish with high economic value, although lower compared to grouper. Its culture, however, is relatively easier for both breeding and grow-out. The culture of *Lates calcarifer* is not yet fully established due to limited access to overseas market. Efforts are done to further the development of *Lates calcarifer* culture in net cages in rivers, in the coastal areas and in embankments at the development center in Riau and Islands of Riau.

Development of *Bawal Bintang (Trachinocus blochii,* Lacepede)

The culture of marine fishes has been developed in Indonesia but still could not supply the market demand in Indonesia. Although culture is still limited to grouper and Kakap fish, it is necessary to try other fishes such as Bawal Bintang *(Trachinocus blochii,* Lacepede) which is done by Loka Budidaya Laut Batam. Bawal Bintang is one of the fishes that grow easily, its is easy to culture and has good market potentials. So far, the culture of Bawal Bintang in Indonesia has not been fully developed due to limited supply of broodstock and lack of aquaculture technology.

However, the culture of bawal bintang has been done in some areas in Indonesia such as in the Islands of Riau and the Thousand Islands. Production from these areas has been fluctuating due to a number of reasons such as price fluctuation, availability of broodstocks and other culture related problems. The broodstock of bawal bintang mainly comes from Regional Marine Culture Development Center in Batam and some comes from Taiwan.

COUNTRY: JAPAN

A. Priority species for each R&D area

R&D Areas	Confirm or Specify Species
1. Freshwater Aquaculture of Indigenous Species	
1.1 Genetic improvement of *Macrobrachium rosenbergii*	No research for genetics, but basic research for reproduction and development has been conducted. Cooperative research for Agri-Aqua Culture System has been conducted in Vietnam.
1.2 Broodstock development and seed production of *Pangasius* spp.	No
1.3 Culture technologies for tilapia	Tilapia culture technology was established in the 70s, but its industry declined due to heating cost. Recently this species has been used only for basic science.
1.4 Aquaculture of other indigenous species (*specify species*)	Salmonids seed production and aquaculture technology have been completely established. Eel seed production technology was established three years ago. Research projects of carp KHV and Ayu *plecoglossus* cold-water disease have been strongly promoted.
2. Integrated Agri-Aqua Culture System	
2.1 Seed production of initial species identified for the activity (*specify species*)	Carp, Koi
2.2 Study on climatic conditions and rice culture practices in participating or core countries (*specify species*)	No
2.3 Agri-aqua culture technologies (*specify species*)	Paddy field aquaculture of carp used to be conducted, but efforts now have declined
2.4 Fish culture in small-farm reservoirs (*specify species*)	Carp aquaculture using irrigation reservoirs is conducted in some areas.
3. Coastal Aquaculture and Mariculture	
3.1 Mud crab culture technologies	Japanese mud crab seed production technologies was established in the 80s.
3.2 Mollusks culture technologies	Oyster, scallop, clam, pearl oyster, etc. are very important for aquaculture while abalone seed production is mainly for stock enhancement. Recently cattle fish seed production technology has been established.
3.3 Small-scale aquaculture including offshore cages (*specify species*)	R&D of offshore cage aquaculture has been promoted, but its commercialization is still difficult.
3.4 Mariculture Park scheme (*specify species*)	Mariculture cages (red sea bream, yellow tail, etc.) are used for recreational fishing in many places.
4. Captive Broodstock Development	
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*, etc.)	*P. japonicus* seed production and aquaculture technology have been established. *P. vannamei* seed production and enclosed aquaculture technology have been developed. Japanese spiny lobster seed production technology has been developed.
4.2 Captive broodstock development for marine fishes, e.g., siganids, grouper, etc.	Broodstock of red sea bream, Japanese flounder, torafugu, etc. were already established. Seed production technology of red spotted grouper was established in the 90s. Kelp grouper seed production was also recently realized. Yellow tail seed production was established in 2000s. Complete aquaculture system of Pacific bluefin tuna was established in 2005. Captive broodstock development for many other species has been conducted.

B. Status of aquaculture technologies available for each R&D area: (1) not being done - (x) interested or (y) not interested; (2) experimental; (3) verification stage; (4) commercialized; please check (√) appropriate cell

R&D Areas	Status of aquaculture technologies				
	(1)	(2)	(3)	(4)	
	(x)	(y)			
1. Freshwater Aquaculture of Indigenous Species					
1.1 Genetic improvement of *Macrobrachium rosenbergii*		/			
1.2 Broodstock development and seed production of *Pangasius* spp.		/			

R&D Areas	Status of aquaculture technologies				
	(1)		(2)	(3)	(4)
	(x)	(y)			
1.3 Culture technologies for tilapia					/
1.4 Aquaculture of other indigenous species					/
2. Integrated Agri-Aqua Culture System					
2.1 Seed production of initial species identified for the activity					/
2.2 Study on climatic conditions and rice culture practices in participating or core countries					/
2.3 Agri-aqua culture technologies					/
2.4 Fish culture in small-farm reservoirs					/
3. Coastal Aquaculture and Mariculture					
3.1 Mud crab culture technologies				/	
3.2 Mollusks culture technologies					/
3.3 Small-scale aquaculture including offshore cages				/	
3.4 Mariculture Park scheme					/
4. Captive Broodstock Development					
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*, etc.)			/	/	
4.2 Captive broodstock development for marine fishes, e.g., siganids, grouper, etc.			/	/	/

C. Training needs: (1) at AQD; (2) on-site in host country; (3) attachment in another country, (4) study visits for farmers, please check (√) appropriate cell

R&D Areas	Training Needs			
	(1)	(2)	(3)	(4)
1. Freshwater Aquaculture of Indigenous Species				
1.1 Genetic improvement of *Macrobrachium rosenbergii*				
1.2 Broodstock development and seed production of *Pangasius* spp.				
1.3 Culture technologies for tilapia				
1.4 Aquaculture of other indigenous species				
2. Integrated Agri-Aqua Culture System				
2.1 Seed production of initial species identified for the activity				
2.2 Study on climatic conditions and rice culture practices in participating or core countries				
2.3 Agri-aqua culture technologies				
2.4 Fish culture in small-farm reservoirs				
3. Coastal Aquaculture and Mariculture				
3.1 Mud crab culture technologies				
3.2 Mollusks culture technologies				
3.3 Small-scale aquaculture including offshore cages				
3.4 Mariculture Park scheme				
4. Captive Broodstock Development				
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*, etc.)				
4.2 Captive broodstock development for marine fishes, e.g., siganids, grouper, etc.				

D. Information needs: (1) manuals or handbooks; (2) farm demonstration/mobilization of expertise; (3) workshops/meetings, (4) other info materials, please check (√) appropriate cell

R&D Areas	Information Needs			
	(1)	(2)	(3)	(4)
1. Freshwater Aquaculture of Indigenous Species				
1.1 Genetic improvement of *Macrobrachium rosenbergii*				
1.2 Broodstock development and seed production of *Pangasius* spp.				
1.3 Culture technologies for tilapia				
1.4 Aquaculture of other indigenous species				
2. Integrated Agri-Aqua Culture System				
2.1 Seed production of initial species identified for the activity				
2.2 Study on climatic conditions and rice culture practices in participating or core countries				
2.3 Agri-aqua culture technologies				
2.4 Fish culture in small-farm reservoirs				
3. Coastal Aquaculture and Mariculture				
3.1 Mud crab culture technologies				
3.2 Mollusks culture technologies				
3.3 Small-scale aquaculture including offshore cages				
3.4 Mariculture Park scheme				
4. Captive Broodstock Development				
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*, etc.)				
4.2 Captive broodstock development for marine fishes, e.g., siganids, grouper, etc.				

E. Other Concerns and Recommendations (use additional pages if necessary)

OVERVIEW OF SUSTAINABLE AQUACULTURE DEVELOPMENT IN LAO PDR

Introduction

The Main Government Orientation for the Agro-forestry based economy is aiming at improving and increasing the productivity of all types of agricultural commodities including fish products. This is in order to satisfy the national food security requirements following increased population growth, urbanization process, improved living standard of the people, specific market incentives, and the future possibility for export.

Under the New Economic Mechanism, efforts to move from subsistence fish farming to more diversified farming and intensive farming are being made in the fishery sub-sector. Fishery sub-sector plays an important contribution in the economy accounting for 8% of the GDP from fishery sub-sector in the year 2001 (Phonvisay 2001). In addition, fishery has a multiple role in food security contributing to income generation by providing employment and other opportunities.

Since it is believed that substantial increases in production from capture fisheries may be difficult to achieve, any planned increase in fish production has to come from aquaculture or enhanced fisheries. In current situation ponds, rice fields hold potential for fish culture, while small and large scale reservoirs and main rivers have been developed for cage culture.

Major Aquaculture Species of Economic Importance

Status of Aquaculture Development

Current shortfalls in fish production caused by inappropriate catch of wild fish and rapidly increasing human population are considered the major causes of the growing and increased interest in aquaculture in the country. Comparing to other neighboring countries fish farming does not have a long history in Lao PDR. Before 1960 there were no fish hatcheries in the country. Few farmers traditionally caught wild fry of indigenous fish species for introduction into paddy fields or water impoundments as well as in ponds. Since 1960 small fish seed farms were established in Vientiane, Luanprabang, Xayaboury, Savannakhet, and Pakse Provinces with USAID assistance. Subsequently in early 1970s some hatcheries were built in Houaphanh, Xiengkhuang and Oudomxay Provinces with assistance from Vietnam and China. During that time these farms produced common carps and tilapia. Later, a number of fund donors have been assisting the Government in aquaculture development. Now there are 30 hatcheries including state and private farms in the country operating on fish seed production. The government encourages agencies to establish more fish production centers in order to fill the demand for seeds.

Fish Farming Systems and Fish Species

The main fish farming systems being practiced in the country are: pond fish culture, integrated farming with livestock, rice-cum-fish culture, and fish seed production. The abovementioned fish farming systems are generally adopted by the farmers following the traditional methods as prevalent in the respective areas according to their own experience and that of their neighbors. However, other fish culture systems are now getting popular in the country, namely: cage culture in main streams and reservoirs, hatchery and nursery, farming systems, and fish stock enhancement in small water bodies. The indigenous species currently being bred and cultured extensively by farmers is “pa paak” (*Barbodes gonionotus*). While snakehead (*Channa* sp.), and gourami (*Osphronemus gourami*) are cultured by few farmers. Fingerlings of *Barbodes gonionotus* were introduced in Nongteng fish farm in 1978 from Nongkhai Fisheries Station and were successfully bred for the first time in Laos in 1980. Subsequently “pa eun” (*Probarbus julieni*), “pa keng” (*Osteochilus prosemion*), “pa phone” (*Cirrhinus microlepis*), “pa ka ho” (*Catlacarpio siamensis*), “pa hou mat” (*Pangasius larnaudii*), “pa phear” (*Morulius*), “pa men” (*Osphronemous gourami*) and “pa sueo” (*Pangasius sutchi*) were later introduced. In addition, the long tradition of fish culture in paddy fields in Northern Lao PDR and surrounding countries suggested that it has a long history in the region. *Carassius carassius* known locally as “Pa fek” (or possibly *Carassius auratus*) is another species that appears to be popular in northern Lao PDR especially in upland streams and paddy field systems.

Pond Fish Culture

The types of culture being introduced are polyculture and monoculture. Reportedly 23 species of freshwater fish are cultured in the country, of which the most popularly cultured species are: Tilapia, common carp, silver carp (*Hypophthalmichthys molitrix*), bighead carp (*Aristichthys nobilis*), grass carp (*Ctenopharyngodon idella*), rohu (*Labeo rohita*), mrigal (*Cirrhinus mrigala*), African catfish (*Clarias gariepinus*), snake head (*Channa micropeltis*), silver barb (*Barbodes gonionotus*), *Cirrhinus microlepis*, *Cirrhinus molitorella*, *Morulius chrysophekadion*, *Oshoronemus exodon* and *Clarias macrocephalus*, etc.

Integrated Fish Livestock Farming

In addition to rice farming livestock-raising is a traditional practice in rural households in Lao PDR. Fish culture with livestock (pig and poultry) has been introduced in the county so that the waste from one system could be recycled to be used in the other system in order to optimize production, diversify products, reduce costs and risks. Fish production in demonstration areas has increased from 100-500 kg/ha without integration compared to 1200-2500 kg/ha with integration (Gupta, 2000).

Rice-cum-fish Culture

Traditionally, Lao farmers used to catch wild fish from natural sources to be introduced to their paddy fields. However, due to the declining fish supply from natural sources and given the importance of rice farming, there has been growing interest in recent years in integrating aquaculture with rice farming in the country. This farming is quite common in the northern part of the country. Only indigenous fish species have been introduced in the country's rice-cum-fish farming system.

In recent year, fish culture in cages is developed largely in the central part to southern part of the country, namely: in Vientiane Municipality, Vientiane Province; Khammouane; Savannakhet; and Champasak Provinces. The farmers culture fish in cages in reservoirs (Nam Ngum, Nam Houm, Namxuang) and along the Mekong River and Ngum River. The most popular fingerlings being raised are the sex-reversed Nile tilapia. Production from fish cage culture is quite encouraging especially for the farmers who do not have access to ponds.

Fish Production

There are no data available on fish production by species. However, the total production of aquaculture has significantly increased each year. The table below shows the total fish production from aquaculture from 1995 to 2004.

Year	1995	2000	2001	2002	2003	2004
Production (mt)	10,000	24,000	43,900	46,000	51,000	65,000

Seed production of Indigenous Freshwater Species

Broodstock Development and Management

The basic element of a profitable fish production is sufficient and good quality of breeding materials including broodfish, eggs, larvae, nursed fry and fingerling, suitable to supply to the farmers. The important part of broodstock management includes: (1) proper procurement, development, rearing and maintaining of broodstock; (2) ensuring optimal living conditions for the young and adult fishes including broodstock; (3) selection and basic genetic improvement of broodstock; (4) proper preparation procedures for spawners for reproduction; (5) planning a good breeding program and providing fish to the farmers from good quality of seeds.

Broodstock management as a substantial component of fish farming is highly dependent on the hatchery managers, technicians and fish farmers who are responsible for maintaining, selecting, and producing the locally available broodfish. Hatchery managers should take the responsibility of the breeding work. Rearing and production environmental conditions are essential for strongly determining the spawning potential of broodfish, feeding and manuring system, treating and handling methods should also be proper.

Nursery Systems

The stocking density for fry depends very much on the fish species used and the types of nursing system. The table below shows the recommended stocking rate for young fry (one week old) of the different species commonly cultured in the country. The assumed value given for earthen ponds is a depth of more than 60 cm for the nursery ponds. Values for cement tanks, net cages assume that water depth in tanks and cages are more then 50 cm.

Fish fry can be stocked at these densities for up to one month or until they reach a size of 2 to 3 cm. After this size the stocking densities should be reduced since fry will deteriorate. Once the fry reach 2 to 3 cm, then intensive nursing in net cages is an option if flowing water and aeration is available.

Stocking rate for nursing specific fish species is shown below:

Fish Species	Earthen Pond (pc/m^2)	Cement Tank (pc/m^2)
Silver barb	500	250
Cirrhinus microlepis	400	200
Brobarbus julieni	400	200

Estimated Annual Production of Fry/Fingerlings

In Lao PDR, three types of hatchery managements are operating, namely: state hatchery, private hatchery and farmer group hatchery. The total indigenous fingerling production in 2001 was 20 million of which 19 million was *Barbodus gonionotus*, and 1.0 million was *Cirrhinus microlepis*, and other speciess.

Problems and Constraints

The main constraints identified for aquaculture development in Lao PDR are:

(1) Inadequate production and supply of fry or fingerlings for the farmers: The demand for fingerling is about 500 million per year, but the present production is only 185 million. The gap between supply and demand is bridged by the entry of fry and fingerlings from neighboring countries (Thailand, Vietnam, and China).

(2) Low survival rate of fry in nurseries

(3) Lack of transportation and distribution system for fingerlings or fry within district/provinces is a discouraging factor for farmers going into aquaculture

(4) Inadequate availability of feeds, fertilizers and hormones

(5) Weak fisheries manpower especially on extension system and limited capacity of provincial and district level authorities in disseminating the technologies to rural farmers

(6) The principal constraints for broodstock management are poor nutrition of broodstock, undersized and too young broodfish used for breeding, lack of genetic improvement and over-used broodfish

(7) Poor fertilization conditions, overstocking of spawning tanks, incorrect hormone dosages and poor water flow/water quality limiting the success of egg fertilization and release

(8) Wet fertilization method may have limited spawning/fertilization success and causing physical damage to eggs and poor water quality leading to high egg mortalities

(9) Newly hatched fry are transferred to nursery ponds too quickly, and inadequate food in ponds results in high mortalities.

Potentials for Further Development

Lao PDR has high potentials for fish culture development that can contribute towards the country's economy by optimizing the use of its vast water resources. The country consists of about 202,000 km^2 of the total Mekong catchment basin which accounts for about 97% of the total area of the country. It contributes some 35% of the average annual flow of the Mekong (Caotes, 2002).

Over 92% of the agricultural households who own ponds practice some sort of aquaculture and 8% of the households integrate aquaculture with rice farming (Agriculture Census 2000). According to the record of the Department of Livestock and Fishery, the ponds used for aquaculture has significantly increased from 6000 ha in 1990 to 10,300 ha in 2001.

There is an enormous potential for further development of the sector through improvement in production systems in existing ponds and expansion of pond areas; integrating fish culture into better farming systems practiced by farmers in different agro-ecosystems; extensive and semi-intensive culture of fish in reservoir and rivers with low cost supplementary feeds; enhanced fisheries or culture-based capture fisheries in the community based management in the communal water bodies. Parallel with rural fish culture development, the private sector should be encouraged to invest in peri-urban semi-intensive aquaculture ventures in order to increase the national fish production.

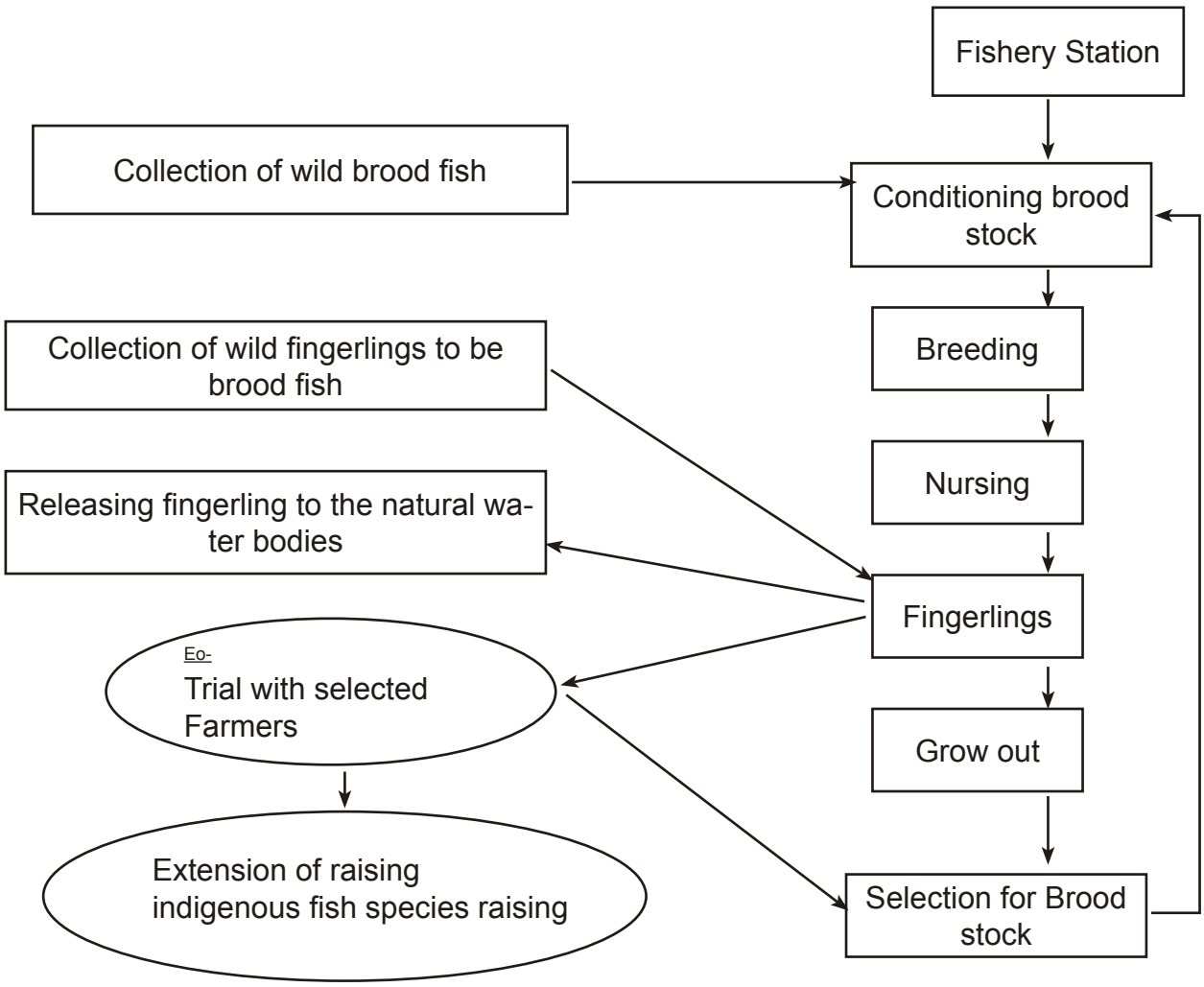
Conclusion

In general terms, aquaculture may benefit the livelihood of the rural people through an improved food supply and through employment and increased income. In a multidisciplinary systems approach the technical, economic, social and environmental issues, as well as manpower and institutional factors are considered in aquaculture development process and aquaculture management.

Lao PDR needs to strengthen its capacity building in sustainable aquaculture development both in terms of research and development activities. The aquaculture research has to give much more attention to interaction with end users and meeting the development requirements. The skills of aquaculture workers and management of the farmers should be upgraded. Looking for appropriate technology to increase the yields as well as production per unit area by using low cost of feeds that are available in local areas should be pursued by the Government.

The Government has developed a procedure for the propagation of indigenous fish species, which is shown in the accompanying figure.

The procedure in the propagation of indigenous fish species



COUNTRY: MALAYSIA

A. Priority species for each R&D area

R&D Areas	Confirm or Specify Species
1. Freshwater Aquaculture of Indigenous Species	
1.1 Genetic improvement of *Macrobrachium rosenbergii*	*Macrobrachium rosenbergii*
1.2 Broodstock development and seed production of *Pangasius* spp.	*Pangasius micronemus*
1.3 Culture technologies for tilapia	*Oreochromis niloticus*
1.4 Aquaculture of other indigenous species (*specify species*)	
2. Integrated Agri-Aqua Culture System	
2.1 Seed production of initial species identified for the activity (*specify species*)	
2.2 Study on climatic conditions and rice culture practices in participating or core countries (*specify species*)	
2.3 Agri-aqua culture technologies (*specify species*)	
2.4 Fish culture in small-farm reservoirs (*specify species*)	
3. Coastal Aquaculture and Mariculture	
3.1 Mud crab culture technologies	Yes
3.2 Mollusks culture technologies	Yes
3.3 Small-scale aquaculture including offshore cages (*specify species*)	Yes
3.4 Mariculture Park scheme (*specify species*)	Yes
4. Captive Broodstock Development	
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei)*	Yes for *P. monodon*
4.2 Captive broodstock development for marine fishes (siganids, grouper, etc.)	Yes, Grouper and snapper

B. Status of aquaculture technologies available for each R&D area: (1) not being done (x) interested or (y) not interested; (2) experimental; (3) verification stage; (4) commercialized; please check (√) appropriate cell

R&D Areas	Status of aquaculture technologies				
	(1)		(2)	(3)	(4)
	(x)	(y)			
1.Freshwater Aquaculture of Indigenous Species					
1.1 Genetic improvement of *Macrobrachium rosenbergii*			/		
1.2 Broodstock development and seed production of *Pangasius* spp.				/	
1.3 Culture technologies for tilapia				/	
1.4 Aquaculture of other indigenous species			/		
2. Integrated Agri-Aqua Culture System					
2.1 Seed production of initial species identified for the activity		/			
2.2 Study on climatic conditions and rice culture practices in participating or core countries		/			
2.3 Agri-aqua culture technologies		/			
2.4 Fish culture in small-farm reservoirs	/				
3. Coastal Aquaculture and Mariculture					
3.1 Mud crab culture technologies			/		
3.2 Mollusks culture technologies			/		
3.3 Small-scale aquaculture including offshore cages (specify species)				/	
3.4 Mariculture Park scheme			/		
4. Captive Broodstock Development					
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*, etc.)			/		
4.2 Captive broodstock development for marine fishes, e.g., siganids, grouper, etc.			/		

C. Training needs: (1) at AQD; (2) on-site in host country; (3) attachment in another country, (4) study visits for farmers, please check (√) appropriate cell

R&D Areas	Training Needs			
	(1)	(2)	(3)	(4)
1.Freshwater Aquaculture of Indigenous Species				
1.1 Genetic improvement of *Macrobrachium rosenbergii*	/		/	
1.2 Broodstock development and seed production of *Pangasius* spp.		/		
1.3 Culture technologies for tilapia				/
1.4 Aquaculture of other indigenous species (*Catlocarpio siamensis*, *Probarbus* spp)		/		
2. Integrated Agri-Aqua Culture System				
2.1 Seed production of initial species identified for the activity				
2.2 Study on climatic conditions and rice culture practices in participating or core countries				
2.3 Agri-aqua culture technologies				
2.4 Fish culture in small-farm reservoirs			/	
3. Coastal Aquaculture and Mariculture				
3.1 Mud crab culture technologies	/			
3.2 Mollusks culture technologies	/		/	
3.3 Small-scale aquaculture including offshore cages			/	/
3.4 Mariculture Park scheme			/	/
4. Captive Broodstock Development				
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*, etc.)			/	
4.2 Captive broodstock development for marine fishes, e.g., siganids, grouper, etc.	/		/	

D. Information needs: (1) manuals or handbooks; (2) farm demonstration/mobilization of expertise; (3) workshops/meetings, (4) other info materials, please check (√) appropriate cell

R&D Areas	Information Needs			
	(1)	(2)	(3)	(4)
1.Freshwater Aquaculture of Indigenous Species				
1.1 Genetic improvement of *Macrobrachium rosenbergii*	/	/	/	
1.2 Broodstock development and seed production of *Pangasius* spp.			/	
1.3 Culture technologies for tilapia			/	
1.4 Aquaculture of other indigenous species	/	/		
2. Integrated Agri-Aqua Culture System				
2.1 Seed production of initial species identified for the activity				
2.2 Study on climatic conditions and rice culture practices in participating or core countries				
2.3 Agri-aqua culture technologies				
2.4 Fish culture in small farm reservoirs			/	
3. Coastal Aquaculture and Mariculture				
3.1 Mud crab culture technologies			/	
3.2 Mollusks culture technologies			/	
3.3 Small-scale aquaculture including offshore cages		/		
3.4 Mariculture Park scheme		/		
4. Captive Broodstock Development				
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*)	/	/	/	
4.2 Captive broodstock development for marine fishes (siganids, grouper, etc.)	/		/	

E. Other Concerns and Recommendations (use additional pages if necessary)

RESEARCH AND DEVELOPMENT ON MAJOR AQUACULTURE SPECIES IN MALAYSIA

Introduction

Aquaculture production in Malaysia was 200,000 mt in 2004 contributing about 15% to the total fish production in the country. Malaysia is currently embarking on development programs to realize the goal of about three-fold increase in aquaculture production by 2010. Aquaculture research and development (R&D) activities in Malaysia play a major role in this development program with regard to seed production technology, improvement of existing culture technology and technology transfer to target groups. The Government has given due consideration to aquaculture R&D activities for both coastal aquaculture and mariculture (marine shrimp, finfish, mollusks and seaweeds) and the freshwater aquaculture (finfishes and crustaceans) to realize the production target. Major emphasis is being given to captive broodstock development and disease prevention. Integrated agri-aquaculture system has been phased out in the country.

Implementation of Aquaculture Research and Development in Malaysia

Aquaculture R&D programs in Malaysia is carried out by five major aquaculture research centers, regulated by the Fisheries Research Institute (FRI) in Batu Maung, Penang under the purview of the Department of Fisheries (DoF) Malaysia. These Centers are located strategically in different parts of Malaysia having separate roles.

The Centers include Brackishwater and Aquaculture Research Center (BARC) in Gelang Patah, Johor at the southern region, the Freshwater Fisheries Research Center (FFRC), Batu Berendam, Malacca in the central region, the National Prawn Fry Production and Research Center (NAPFRE) at Pulau Sayak, Kedah in the northern region, the Marine Fish Production and Research Center (MAFRE) at Tanjung Demong, Terengganu in the east coast of Peninsular Malaysia, and the FRI Sarawak Branch in East Malaysia. The different centers carry out aquaculture R&D programs extensively with some R&D work on mollusks being done by FRI proper in Batu Maung, Penang.

Status of Aquaculture Technology and Priority Species for R&D

Fish farmers in Malaysia are very responsive and adapt well to new production and culture technologies. As such, the aquaculture technology available in Malaysia is well in advance and in some cases well ahead. However, the adoption of the technology by fish farmers, vary considerably, with regards to their capacity especially among small-scale operators. The Malaysian Government through DoF, institutions of higher learning and fisheries colleges embarked on effective mechanisms to transfer technologies to the groups. This is done to ensure good aquaculture practices, for sustainable environment and aquaculture production. The priority species for R&D and the status of aquaculture technology available in the country are thus discussed for all the four R&D areas proposed for 2006-2010.

Freshwater Aquaculture of Indigenous Species

Indigenous fish species has great potential to become the main species for aquaculture. As oppose to exotic species, indigenous species stand as natural ecosystem-friendly, and they contribute towards the richness of biodiversity. There is a global concern for exotic species impacting the environment, especially genetics when they are used in aquaculture. Studies in Thailand and Bangladesh showed that indigenous species *Clarias macrocephalus* is disturbed by genes introduced by exotic species *Clarias gariepinus* as this species escaped into the natural waters. In Malaysia, the local Keli Bunga *(Clarias macrocephalus)* is observed to lose its original characteristics and morphology due to genetics drift and dilution as experienced by other countries.

The Freshwater Fisheries Research Center at Batu Berendam, Melaka is currently focusing on the R & D on captive-breeding of few selected species, namely: the Pangasid catfish *(Pangasius nasutus),* Malaysian Mahseer *(Tor* sp.) and Tenggalan *(Puntius bulu).* Breeding of indigenous species for food or for biodiversity-related and conservation is the current thrust of countries in the region. In Malaysia, candidate species for aquaculture are based on their potential and prospects.

An ongoing study on genetic improvement of *Macrobrachium rosenbergii* involves collecting wild broodstocks from four different populations. All of them are taken to NAPFRE, Pulau Sayak for mating. Dialelle cross is conducted to form a heterogeneous, outbred base population for the breeding program. All mating are strain-crossed, using all possible combinations in 4 by 4 complete crossing design without pure-breeds (Table 1). For each of the 12 reciprocal crosses, 3 pairs are mated separately, producing at least 36 full sib families. Cross-bred between 3 different populations have been conducted and produced F1 from each combination. Data collection on breeding performance, growth, survival rate, larviculture period and size of post larvae are regularly monitored.

Table 1. Mating Combinations for *Machrobrachium rosenbergii*

	Base population of male prawn			
Female prawn	Ml	M2	M3	M4
Fl	X	FIM2	FIM3	FIM4
F2	F2Ml	X	F2M3	F2M3
F3	F3Ml	F3M2	X	F3M4
F4	F4Ml	F4M2	F4M3	X

The current Tilapia production of 60 kg/m³ may still increase to 80 kg/m³. However, these production rates are attained in cage culture system. For ponds, it used to be at only 0.5 kg/m³ but due to recent development and improvement in feeding and aeration systems, about 20 mt/ha/year has been produced. The study on genetic improvement of *Tilapia* sp. for genetically improved farm tilapia (GIFT) variety is being carried out in collaboration with WORLDFISH, Freshwater Fisheries Center in Jitra, Kedah, and NAPFRE in Pulau Sayak. Improvement of red tilapia strain is being done at FFRC, Batu Berendam with selective breeding program.

Aquaculture R&D for Integrated Agri-Aqua Culture System

Malaysia started practicing integrated agri-aqua culture system in the 70s by raising Chinese carps and Indian major carps in abandoned tin mining pools, alongside raising ducks/chicken with some tapioca along the bund. This was phased-out gradually due to the introduction of intensive culture system for higher yield using formulated feeds as major input. Rice-fish culture was also practiced in the early 70s but was also phased out when double cropping was introduced in Malaysia. Short period for paddy cultivation and growing as well as use of pesticides did not allow the continuation of this practice. Hence, not much R&D works have been done in this field. Some preliminary works on catfish culture in rice field proved that the fish grows better in the drainage canal than in rice fields.

R&D for Coastal Aquaculture and Mariculture

Coastal aquaculture and mariculture in Malaysia mainly involve culture of marine shrimps, finfishes, mollusks and seaweeds. Different R&D works on these groups are discussed separately under appropriate sub-topics

Marine shrimps

Shrimp culture industry in Malaysia is undergoing rapid development with *Penaeus monodon* and *P. merguiensis* and the Pacific white shrimp as the main species. *P. vannamei* was officially allowed to be raised in ponds only in April 2005, after a long period of ban. Shrimp production in the country was 29,000 mt at the end of 2004.

Lately, however, successful shrimp production in the country is increasingly being hampered by factors like pollution, poor management and viral diseases. Since mid 1994, mass mortality of tiger shrimp *(Penaeus monodon)* in many aquaculture zones of Peninsular Malaysia was experienced and became significant. WSSV (White Spot Syndrome Virus) was the deadliest disease in the country, that resulted to 100% mortality of the cultured stocks in all stages.

There are various sustainable culture practices recommended to prevent the outbreak of white spot viral disease. The use of close re-circulating system with sedimentation and treatment ponds would require minimal water change hence could reduce entry of disease carriers through incoming waters. The ponds are also lined with 0.5m high plastic sheets to prevent disease carriers such as crabs from entering the pond. Two meter plastic or nylon ropes are stretched across the pond with wooden support at either end strategically placed at the foot interval to drive away migratory birds. With high quality and disease free post larvae stocked, such culture system is effective in preventing WSSV diseases. Some large scale commercial farms have embarked in the Specific Pathogen Free (SPF) and Specific Pathogen Resistance (SPR) broodstock program to provide high quality and disease-free post larvae.

Several R&D works are being carried out to address WSSV disease problems. These include the development of bio-security culture system, production of high quality and disease-free post larvae and development of SPF/SPR broodstock. Institutions of higher learning like the University Putra Malaysia, in collaboration with DoF are also developing research consortia on beneficial bacteria which could assist in pond water and bottom sediment treatments. The bacteria with some enzymes are considered to improve shrimp health. Some immuno-stimulants like glucans are also used in feeds to enhance disease resistance in shrimp.

BARC in Gelang Patah has started a domestication program for local white shrimp *(P. merguiensis)* with selective breeding. Currently the second generation (F_2) has attained an average of 22 g in 76 days culture period. This is a significant improvement over the initial stock and the program will be continued to further improve the growth rate.

Marine finfish

Seed production technologies for 13 species had been acquired and practiced in Malaysia since 1982 but only half of them have been adopted by the private hatcheries producing at the rate of 10 million juveniles/year. Hence, the national demand of more than 80% of the 70 million juvenile has to be imported from countries such as Taiwan, Thailand and Indonesia. To be able to produce 120,000 mt by the end of Third National Agricultural Policy (2010), Malaysia needs 500 million juvenile of various species. It has been estimated that 400 medium-sized hatcheries would be able to meet the target.

Although about 20 species had been cultured or presently being cultured, only few of them are selected in the program due to inadequacy of seeds supply, lack of culture technology and marketing constraints. Species specially selected and prioritized for this program are: sea bass *(Lates calcarifer),* groupers (Tiger Grouper, *Epinephelus fuscoguttatyus,* Giant Grouper, *Epinephelus* lanceolatus), golden-stripe snapper *(Lutjanus erythropterus*) Cobia *(Rachecentron* canadum). Other species with lesser importance are also included in the program, they are pompano *(Trachinotus blochii),* red drum *(Sciaenops ocellatus),* golden snapper *(Lutjanus johnii)* and Napoleon Wrasse *(Chilinus undulates).*

Too much dependence on imported seeds hampers development of aquaculture industry in Malaysia, thus, improvement of local seed production is the main concern of the DOF. It is expected that the program will be able to offer five species of broodstock having some desirable characteristics and thus producing consistent high quality seeds. The success of this program will also offer more choices of species to be cultured and thus increase productivity.

The R & D program includes five main projects, these are:

- Development of the broodstock through genetic and environmental manipulation to produce juveniles of desirable characteristics for five priority species bred in cages, ponds and tanks.
- Development of production technology for good quality seeds in ponds and tanks using semi-static water management, direct-flow and re-cycle systems, and mechanization and automation of the equipment
- Development of sustainable and productive culture technology in cages, ponds and tanks
- Promotion of technologies through *in-situ* training on hatchery establishment or model farm in Aquaculture Industrial Zone or in Permanent Park for Food Production.
- Information dissemination of technology through seminars and publications

In an effort to fully utilize the vast resources of the country, a new off shore cage culture project was introduced in early 2000. Located in Langkawi, the project is aimed at increasing national fish production through utilization of open-sea area estimated at 100,000 ha nationwide. This pioneer project in Langkawi is also conducting research to achieve production of more than 20 kg/m^3. Characteristics of suitable species identified for off-shore cage culture include the following:

- Adaptable to surrounding environment.
- Strong and sturdy to overcome stress during farm management such as changing of nets, grading, treating and others.
- Acceptable size and quantity of seeds and supply
- Robust to overcome stress during handling and transportation from hatchery/nursery to project area.
- Resistant to high stocking rate to produce satisfactory production
- Less impact to surrounding environment

The Langkawi project is focusrd on several species such as sea bass, snappers (four species), Pompano, Groupers (five species), Cobia, Threadfin and others. Other studies are also conducted to improve the effectiveness of culture management practices such as (1) suitability of net materials; (2) methods of net management to reduce fish damage; (3) identification of proper method of fish health management especially in controlling ecto-parasites infection; (4) developing feed types and proper feeding management routine. At the moment two species, sea bass and cobia have been successfully cultured to produce the intended target of 20 kg/m^3.

Mollusks

The main mollusk species of commercial significance in Malaysia are the blood cockle *(Anadara granosa),* the slipper oyster *(Crassostrea iredalei),* the green mussel *(Perna viridis)* and recently the abalone *(Haliotis asinina)* which are still at an experimental stage. The culture of the blood cockle industry is entirely dependent on the natural spatfall. The culture technique used is still the conventional method. For oyster, research has been undertaken to produce oysters under IRPA program, which was approved in 2004. Triploids in slipper oysters were induced using Cytochalasin band, and several batches of triploid oysters have been successfully produced both on experimental and commercial scales. A comparison of the diploid and triploid showed that the triploids not only grow faster but they also have better meat content.

Similar to blood cockles, the green mussels industry is also dependent on the natural spat supply. However, during the past few years, the spat supply had been very unpredictable. As such, trials on the propagation of mussel spat in the hatchery were attempted by NAPFRE at Pulau Sayak. Preliminary results seem to indicate that the spat can be produced in the laboratory, but it is still uneconomical to produce in commercial scale. Therefore, further study is needed so that the production could satisfy the needs of the industry in large scale and economical at the same time.

The study on the tropical abalone is still at an experimental stage where abalone spat has been successfully produced in the laboratory. Work on improving the low setting rates (<8%) is still continuing. Pilot scale production techniques have yet to be established before disseminating the technology to the interested parties.

Seaweed

There are about 56 species in the genera Chlorophyta, 53 species of Rhodophyta, 43 species of Phaephyta and 3 genera of Cynophyta in the country. The main species cultured in Malaysia is *Euchema* and *Kappaphycus* sp. Seaweeds culture in Malaysia started in the 70s in Sabah where there are 3000 seaweed farmers utilizing 1000 acres in 2003. The total seaweed production in the country is 4716 mt valued at RM 11.3 million. Institutions of higher learning, e.g., the Universiti Sabah Malaysia is involved in the R&D of seaweeds. The works being done are mostly in tissue culture, disease prevention and product development.

Captive Broodstock Development

The R & D components in the captive breeding program include: (1) Application of molecular biology in genetics and genetic improvement of captive broodstocks; (2) Reproductive biology (endocrinology) to determine the hormonal pattern of species as an indicator to predict spawning; (3) Development and standardization of the induced breeding techniques using hormones and drugs available in the market; (4) Formulation of suitable maturation diets to enhance broodstock development, growth and maturity; (5) Development of viable larval rearing techniques at hatchery level; (6) Culture trial to gather basic data on growth, survival and mortality of species.

Works on the Specific Pathogen Free (SPF) and Specific Pathogen Resistance (SPR) broodstock program to provide high quality and disease free post larvae are being done in collaboration with two commercial hatchery operators in the country. Some broodstock from Mozambique and Tanzania are imported for cross breeding to improve the gene pool. Meanwhile a domestication program for local white shrimp *(P. merguiensis)* with selective breeding is ongoing in BARC, Gelang Patah. There is a significant improvement over the initial stock and the program is being continued to further improve the growth rate.

As for marine finfishes, Table 2 shows the current works being done on captive broodstock development in MAFRE, Tanjung Demong. The first five species are the priority species intended to be thoroughly researched. However, the R&D works on Cobia species has been undertaken by NAPFRE in Pulau Sayak under the Offshore Cage Culture Project in Langkawi Island.

Table 2. Current works on captive broodstock development for marine fishes

No.	Species	R & D Aspect
1	Sea bass	Determination of strains of wild stock, Genetic improvement through cross breeding, Natural spawning
2	Tiger Grouper	Collection of brood stock, Raising of F1 fish, Improvement of larval rearing techniques
		Improvement of induced spawning techniques using hormone injection
3	Giant Grouper	Collection of matured broodstock, fry production will begin next year
4	Golden-stripped Snapper	Collection of matured broodstock, Improvement of fry production techniques in in-door & out-door facilities
5	Cobia	Carried out by Offshore Cage Culture Project in Langkawi
6	Pompano	Maintaining the minimum number of F2 broodstock
7	Red Drum	Maintaining the minimum number of F2 brood stock
8	Golden Snapper	Induced spawning in cages
9	Napoleaon Wrasse	Acquiring juveniles for future broodstock.

Training Needs for the R&D Areas

Human resource development is a pre-requisite for any R&D works. Although considerable experts are available in the country, some training are required at the Aquaculture Department (AQD) of SEAFDEC for technicians, especially in the field of giant freshwater prawn culture, mud crab culture and mollusk culture technology. On-site training in the host country is also required for *Pangasius* sp. and some freshwater indigenous species like *Tor* sp. Attachment training in neighboring countries are required for giant freshwater prawn culture, mollusk culture technology, small-scale aquaculture like offshore cages, mariculture park scheme and captive broodstock development for shrimps like the *P. monodon* and *P merguiensis,* and marine finfish like groupers and snappers. Study visits for farmers are also required for tilapia culture, small-scale aquaculture like off shore cages, mariculture park scheme.

Information and Technical Assistance Needed for the R&D Areas

Dissemination of information is essential in providing adequate knowledge for fish farmers. Manual or handbooks are necessary especially in subject matters related to giant freshwater prawn culture, some freshwater indigenous species like *Tor* sp., captive broodstock development for shrimps like *P. monodon* and *P. merguiensis* and marine finfish like groupers and snappers. Farm demonstrations or mobilization of experts are also in need for technologies on giant freshwater prawn culture, tilapia culture, small scale aquaculture like off shore cages, mariculture park and captive broodstock development for shrimps like *P. monodon* and *P. merguiensis* and marine finfish like groupers and snappers. Workshop and meetings are essential in the field of giant freshwater prawn culture, some freshwater indigenous species like *Tor* sp. and *Pangasius* sp., mud crab culture technology, mollusk culture technology and captive broodstock development for shrimps like *P. monodon* and *P merguiensis* and marine finfish like groupers and snappers.

Other Concerns and Recommendations

- Local freshwater indigenous species should be protected from extinction, thus a study at the molecular stage is proposed. This technique could ensure the enhancement of breeding technology and in increasing the quality of the stocks (broodstock and seeds) for species like Catfish *(Batrachus* sp. and *Pangasius* sp.).
- Recent studies showed that excessive aeration with the intention of increasing production does not bring much profit than moderate aeration that increases water quality and food conversion ratio efficiency. Concentrating on production alone is no longer the main concern as a recent move is towards sustainability in aquaculture. The 'eco-footprint' concept has been used to measure sustainability since the ecosystem is restricted in accepting the wastes due to its long decomposition processes. A study on developing non-polluting feeds and re-cycling the trapped nutrients in pond bottom sediments for agricultural use and live food production is proposed.
- Some fish farmers adopt culture system that exceeds the carrying capacity of the ecosystem, which leads to disease outbreak, parasite contamination or mass mortality due to unstable culture environment. Therefore, in general, studies should emphasize on the optimum level of production that is acceptable by the environment.

COUNTRY: MYANMAR

A. Priority species for each R&D area

R&D Areas	Confirm or Specify Species
1. Freshwater Aquaculture of Indigenous Species	
1.1 Genetic improvement of *Macrobrachium rosenbergii*	*Macrobrachium rosenbergii*
1.2 Broodstock development and seed production of *Pangasius* spp.	*Pangasius hypothalamus*
1.3 Culture technologies for tilapia	*Oreochromis niloticus*
1.4 Aquaculture of other indigenous species (*specify species*)	*Labeo rohita , Catla catla, Chrrhina mrigala*
2. Integrated Agri-Aqua Culture System	
2.1 Seed production of initial species identified for the activity (*specify species*)	*Cyprinus carpio, Oreochromis niloticus Barbodes gonionotus*
2.2 Study on climatic conditions and rice culture practices in participating or core countries (*specify species*)	*Cyprinus carpio, Oreochromis niloticus Barbodes gonionotus*
2.3 Agri-aqua culture technologies (*specify species*)	*Cyprinus carpio, Oreochromis niloticus Barbodes gonionotus*
2.4 Fish culture in small-farm reservoirs (*specify species*)	*Oreochromis niloticus, Pangasius hypophthalmus*
2.5 Genetic Improvement	*Seaweeds*
3. Coastal Aquaculture and Mariculture	
3.1 Mud crab culture technologies	*Scylla serrata*
3.2 Mollusks culture technologies	*Babylonia oreolata, Trochus niloticus*
3.3 Small-scale aquaculture including offshore cages (*specify species*)	*Lates calcarifer, Epinephelus* spp
3.4 Mariculture Park scheme (*specify species*)	*Epinephelus* spp*, Panulirus ornatus Octopus* spp, *Dasyatis* spp
4. Captive Broodstock Development	
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*, etc.)	*Penaeus vannamei, P. monodon*
4.2 Captive broodstock development for marine fishes, e.g., siganids, grouper, etc.	*Epinephelus* spp

B. Status of aquaculture technologies available for each R&D area: (1) not being done - (x) interested or (y) not interested; (2) experimental; (3) verification stage; (4) commercialized; please check (√) appropriate cell

R&D Areas	Status of aquaculture technologies				
	(1)		(2)	(3)	(4)
	(x)	(y)			
1. Freshwater Aquaculture of Indigenous Species					
1.1 Genetic improvement of *Macrobrachium rosenbergii*	/				
1.2 Broodstock development and seed production of *Pangasius* spp.					/
1.3 Culture technologies for tilapia			/		
1.4 Aquaculture of other indigenous species					/
2. Integrated Agri-Aqua Culture System					
2.1 Seed production of initial species identified for the activity					/
2.2 Study on climatic conditions and rice culture practices in participating or core countries			/		
2.3 Agri-aqua culture technologies			/		
2.4 Fish culture in small-farm reservoirs	/				
3. Coastal Aquaculture and Mariculture					
3.1 Mud crab culture technologies	/				
3.2 Mollusks culture technologies	/				
3.3 Small-scale aquaculture including offshore cages	/				
3.4 Mariculture Park scheme **(has not been introduced in the region but the scheme is good)**	/				
4. Captive Broodstock Development					
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei)*	/				
4.2 Captive broodstock development for marine fishes, e.g., siganids, grouper, etc.			/		

C. Training needs: (1) at AQD; (2) on-site in host country; (3) attachment in another country, (4) study visits for farmers, please check (√) appropriate cell

R&D Areas	Training Needs			
	(1)	(2)	(3)	(4)
1.Freshwater Aquaculture of Indigenous Species				
1.1 Genetic improvement of *Macrobrachium rosenbergii*	/	/	/	
1.2 Broodstock development and seed production of *Pangasius* spp.		/	/	
1.3 Culture technologies for tilapia	/	/	/	
1.4 Aquaculture of other indigenous species		/	/	
2. Integrated Agri-Aqua Culture System				
2.1 Seed production of initial species identified for the activity		/		
2.2 Study on climatic conditions and rice culture practices in participating or core countries		/		
2.3 Agri-aqua culture technologies		/		
2.4 Fish culture in small-farm reservoirs		/		
3. Coastal Aquaculture and Mariculture				
3.1 Mud crab culture technologies	/	/		
3.2 Mollusks culture technologies	/	/		
3.3 Small-scale aquaculture including offshore cages			/	
3.4 Mariculture Park scheme		/		
4. Captive Broodstock Development				
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*, etc.)		/	/	
4.2 Captive broodstock development for marine fishes, e.g., siganids, grouper, etc.		/	/	

D. Information needs: (1) manuals or handbooks; (2) farm demonstration/mobilization of expertise; (3) workshops/meetings, (4) other info materials, please check (√) appropriate cell

R&D Areas	Information Needs			
	(1)	(2)	(3)	(4)
1.Freshwater Aquaculture of Indigenous Species				
1.1 Genetic improvement of *Macrobrachium rosenbergii*	/	/	/	/
1.2 Broodstock development and seed production of *Pangasius* spp.	/	/	/	/
1.3 Culture technologies for tilapia	/	/	/	/
1.4 Aquaculture of other indigenous species	/	/	/	/
2. Integrated Agri-Aqua Culture System				
2.1 Seed production of initial species identified for the activity	/	/	/	/
2.2 Study on climatic conditions and rice culture practices in participating or core countries	/	/	/	/
2.3 Agri-aqua culture technologies	/	/	/	/
2.4 Fish culture in small-farm reservoirs	/	/	/	/
3. Coastal Aquaculture and Mariculture	/	/	/	/
3.1 Mud crab culture technologies	/	/	/	/
3.2 Mollusks culture technologies	/	/	/	/
3.3 Small-scale aquaculture including offshore cages	/	/	/	/
3.4 Mariculture Park scheme	/	/	/	/
4. Captive Broodstock Development	/	/	/	/
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*, etc.)	/	/	/	/
4.2 Captive broodstock development for marine fishes, e.g., siganids, grouper, etc.	/	/	/	/

E. Other Concerns and Recommendations (use additional pages if necessary)

STATUS OF AQUACULTURE R&D IN MYANMAR

Introduction

Myanmar aquaculture, especially freshwater fish culture, has been significantly developed since the last five years but there are still problems and constraints in some areas such as seeds, feeds, technology, capital, etc. The Department of Fisheries is responsible for the sustainable development of aquaculture and in addressing said problems and constraints.

The country is sharing experiences and technology with other SEAFDEC member countries through program cooperation with the SEAFDEC Departments. Myanmar has been implementing the first phase of special five year program on Aquaculture 2002-2005. The program has sourced experiences and expertise from every country in the region, in order to keep up with its achievement and utilize the experiences gained from the first phase to further achieve development in the implementation of the second phase of the program for 2006-2010.

R&D Areas

The following areas of aquaculture components will be implemented under the second phase of the program.

Freshwater Aquaculture of Indigenous Species

There are currently 15 kinds of freshwater fish species being cultured in Myanmar, with Rohu (Labeo *rohita)* as the most dominant species being cultured together with Catla and Mrigal.

Over 90% of fishponds are stocked with Rohu that led to overproduction and excess in market demand. Most of the farmers want to try other potential species such as Tilapia, Ompork, Ayar in place of Rohu. Myanmar farmers are much aware that Tilapia is being considered as alternative species for its advantages in terms of relatively shorter culture period, better international market demand, and better return of investment and popularity of its fillets.

Tilapia is getting popular among farmers thus the Government is giving priority to Tilapia culture. Activities include seed production and grow-out. Farming of mono-sex Tilapia with hormonal sex reversed Tilapia seeds is in high demand at present.

Myanmar would like to propose the following projects/activities under the Culture Technology of Tilapia program:

a. Tilapia brood stock development and genetic improvement

b. Ample amount of quality seeds production

c. Development and improvement of current grow-out system

d. Development of low-cost Tilapia feed

e. Production of pure strain Tilapia species

Integrated Agri-aqua Culture Systems

Integrated fish farming system, using grass and aquatic plants as fish feed, is commonly found in many parts of Myanmar as the excreta of herbivorous fish fertilizes and improves the pond water quality to support the growth of the fish. Since 1980s, integrated fish farming has been practiced in Myanmar with rice-fish culture system. This system benefits families by providing sufficient supply of protein and additional income for the rural communities.

The Department of Fisheries initiated and implemented rice-fish culture program in 2003 in seven States and Divisions using 5000 acres. At the initial stage, paddy farmers get 500 fish/acre free of charge from the Department of Fisheries. Under the rice-fish culture program, rice farmers can get not only rice but also fish at the same time from the same field. Realizing the benefits of agri-aqua systems, Myanmar is proposing to give priority to the agri-aqua culture technology in the following activity/projects.

a. Evaluation of the impact of rice-fish culture

b. Verification of the rice-fish culture technology

c. Identification offish and paddy species for rice-fish culture

Coastal Aquaculture and Mariculture

Myanmar has a long coastal line of about 2832 km facing the Indian Ocean. But Myanmar coastal aquaculture is just at an infancy stage due to abundance of its marine resources. The aquatic natural resources are renewable but there is a need to maintain its current state and aquaculture is the best option to produce fish food. Myanmar would like to give first priority to mud crab culture technology to continue exporting live mud crabs to China, Thailand and Singapore without compromising the natural mud crab stocks. Giant mud crab *(Scylla serrata)* is an indigenous species, and are well-known and abundant in Myanmar waters along the coast. Myanmar would like to prioritize the mud crab *(Scylla serrata)* for coastal aquaculture development.

Lack of technologies and hatchery facilities are the main constraints in the development of mud crab culture in Myanmar. So the artificial propagation of mud crab species and nursery technologies are urgently needed in order to conserve the crab resources in the wild at the same time develop mud crab culture technology. In order to improve the aquatic resources situation and provide livelihood for fishery communities, the following activity/ projects are necessary for 2006-2010:

a. Mud crab (Scylla *serrata)* seed production

b. Soft-shell Mud crab culture technology

c. Stock Enhancement of mud crab in mangrove areas

Captive Broodstock Development

Myanmar has been exploiting aquatic resources including utilizing the broodstock of marine shrimps and finfishes for mariculture hatchery for a long time. For sustainability, the development of captive broodstock of shrimps and finfishes is significantly important for future seed production activities. The Department of Fisheries is pursuing the development of coastal aquaculture and trying to upgrade the technology on shrimp culture. It is envisage that acquired knowledge and technology from the program should contribute the development of shrimp culture in Myanmar. Myanmar would like to prioritize *M rosenbergii* species for that program followed by *P. monodon*. For the sustainable fisheries development the following activities/projects are necessary for 2006-2010:

a. Domestication of brood stock

b. Management of brood stock in farm

c. Genetic development of *Penaeus monodon* and *M. rosenbergii* brood stock

d. Collaborative research on production of SPF and SPR brood stock of *P. monodon* and *M. rosenbergii*

Aquaculture Training and Information Needed for 2006-2010

- Marine Finfish (*Lates calcarifer)* Hatchery Training
- Mud Crab (*Scylla serrata)* Hatchery Training
- Natural Food Training
- Training on *P. monodon and M. rosenbergii* to include Genetic Selection and Brood Stock Management
- Feed Development Training Course for Small Scale Aquaculture
- Environment-friendly culture of indigenous species
- Health management in aquaculture
- Rice-fish culture technology
- Seed production technology of genetically improved Tilapia (*T. nilotica)*
- Tilapia grow-out culture technology

COUNTRY: PHILIPPINES

A. Priority species for each R&D area

R&D Areas	Confirm or Specify Species
1. Freshwater Aquaculture of Indigenous Species	
1.1 Genetic improvement of *Macrobrachium rosenbergii*	*Macrobrachium rosenbergii*
1.2 Broodstock development and seed production of *Pangasius* spp.	*Clarias gariepinus* (African catfish), *Pangasius sutchi, Pangasius hypophthalamus*
1.3 Culture technologies for tilapia	*Oreochromis mossambicus, T. nilotica, Tilapia malabaricus* F1 Hybrid (saline tolerant tilapia), Tilapia Get Excel
1.4 Aquaculture of other indigenous species (*specify species*)	Ludong – *Cestraeus plicatilis*, *Caranx ignobilis,Trichogaster trichopterus*, *Clarias macrocephalus*, *Clarias gariepinus*, *Clarias batrachus*, Eel perch, *Cyprinus carpio*, *Anabas testudineus*, *Channa striata*, *Anguila anguila*, *Monopterus albus*, *Mospristes cancellates*
2. Integrated Agri-Aqua Culture System	
2.1 Seed production of initial species identified for the activity (*specify species*)	Tilapia Get Excel, Saline tolerant tilapia, *Channa striata*, *Macrobrachium rosenbergii*, *Clarias batrachus, Clarias macrocephalus, Oreochromis niloticus, Monopterus albus, Trichogaster trichopterus, Haliotis asinina, Siganus guttatus, Scylla serrata, S. oceanica, Lates calcarifer*
2.2 Study on climatic conditions and rice culture practices in participating or core countries (*specify species*)	Tilapia, *M. rosenbergii, Monopterus albus,* Dojo – *Misgurnus anguillicaudatus*
2.3 Agri-aqua culture technologies (*specify species*)	*Cyprinus carpio,* Tilapia Get Excel, *Tilapia niloticus*, Red tilapia, *Clarias batrachus*, *M. rosenbergii, Monopterus albus*
2.4 Fish culture in small-farm reservoirs (*specify species*)	Tilapia Get Excel, Red Tilapia, *Oreochromis niloticus, Clarias batrachus, M. rosenbergii, Cyprinus carpio, Aristicthys nobilis, Clarias gariepinus*
2.5 Genetic Improvement	Seaweeds
3. Coastal Aquaculture and Mariculture	
3.1 Mud crab culture technologies	*Scylla serrata, S. tranguebarica, S. olivacea, Scylla oceanica*
3.2 Mollusks culture technologies	*Perna viridis, Haliothis asinina, Pinctada maxima, Pinctada margaritifera, Pteria penguin*, Scallops, *Pecten* sp., *Placuna placenta*, Giant Clam, *S. malabonensis, S. cucullata*
3.3 Small-scale aquaculture including offshore cages (*specify species*)	*Chanos chanos, Caranx ignobilis, Caranx sexfasciatus, Carangoides malabaricus, Lates calcarifer, Siganus guttatus, Siganus canaliculatus, S. vermiculatus, Epinephelus coioides, E. tauvina, Hippocampus* sp., *Portunus pelagicus, Kappaphycus alvarezii, Trachenotus blochii, Rachycentron canadus, Scatophagus argus, Alectis ciliaris*
3.4 Mariculture Park scheme (*specify species*)	*Chanos chanos, Caranx ignobilis, Siganus guttatus, S. vermiculatus, Epinephelus coioides, Lutjanus argentimaculatus, P. leopardus, T. blochii*
4. Captive Broodstock Development	
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*, etc.)	*Penaeus vannamei, P. monodon*
4.2 Captive broodstock development for marine fishes, e.g., siganids, grouper, etc.	*Epinephelus coioides, Scatophagus argus,* Humphead wrasse*, Epinephelus tauvina, E. fuscoguttatus, Caranx sexfasciatus, Chanos chanos,* Tuna*, Haliotis asinina, Panulirus* spp. *Lates calcarifer, Plectropomus leopardus, Siganus guttatus, Siganus vermiculatus, Caranx ignobilis,* Lutjanus argentimaculatus

B. Status of aquaculture technologies available for each R&D area: (1) not being done - (x) interested or (y) not interested; (2) experimental; (3) verification stage; (4) commercialized; please check (√) appropriate cell

R&D Areas	Status of aquaculture technologies				
	(1)		(2)	(3)	(4)
	(x)	(y)			
1.Freshwater Aquaculture of Indigenous Species					
1.1 Genetic improvement of *Macrobrachium rosenbergii*	/	/	/	/	/
1.2 Broodstock development and seed production of *Pangasius* spp.	/	/		/	/
1.3 Culture technologies for tilapia	/		/	/	/
1.4 Aquaculture of other indigenous species	/	/	/	/	/
2. Integrated Agri-Aqua Culture System					
2.1 Seed production of initial species identified for the activity	/	/	/	/	/
2.2 Study on climatic conditions and rice culture practices in participating or core countries	/	/		/	

R&D Areas	Status of aquaculture technologies				
	(1)		(2)	(3)	(4)
	(x)	(y)			
2.3 Agri-aqua culture technologies	/		/	/	/
2.4 Fish culture in small-farm reservoirs	/		/	/	/
3. Coastal Aquaculture and Mariculture					
3.1 Mud crab culture technologies	/		/	/	/
3.2 Mollusks culture technologies	/		/	/	/
3.3 Small-scale aquaculture including offshore cages	/	/	/	/	/
3.4 Mariculture Park scheme **(has not been introduced in the region but the scheme is good)**	/		/	/	/
4. Captive Broodstock Development					
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei)*	/	/vannamei	/	/	/monodon
4.2 Captive broodstock development for marine fishes (siganids, grouper, etc.)	/	/	/	/	/

C. Training needs: (1) at AQD; (2) on-site in host country; (3) attachment in another country, (4) study visits for farmers, please check (√) appropriate cell

R&D Areas	Training Needs			
	(1)	(2)	(3)	(4)
1.Freshwater Aquaculture of Indigenous Species				
1.1 Genetic improvement of *Macrobrachium rosenbergii*	/	/	/	/
1.2 Broodstock development and seed production of *Pangasius* spp.	/	/	/	/
1.3 Culture technologies for tilapia	/	/	/	/
1.4 Aquaculture of other indigenous species	/	/	/	/
2. Integrated Agri-Aqua Culture System				
2.1 Seed production of initial species identified for the activity	/	/	/	/
2.2 Study on climatic conditions and rice culture practices in participating or core countries	/	/	/	/
2.3 Agri-aqua culture technologies	/	/	/	/
2.4 Fish culture in small-farm reservoirs	/	/	/	/
3. Coastal Aquaculture and Mariculture				
3.1 Mud crab culture technologies	/	/	/	/
3.2 Mollusks culture technologies	/	/	/	/
3.3 Small-scale aquaculture including offshore cages	/	/	/	/
3.4 Mariculture Park scheme	/	/	/	/
4. Captive Broodstock Development				
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei)*	/	/	/	/
4.2 Captive broodstock development for marine fishes (siganids, grouper, etc.)	/	/	/	/

D. Information needs: (1) manuals or handbooks; (2) farm demonstration/mobilization of expertise; (3) workshops/meetings, (4) other info materials, please check (√) appropriate cell

R&D Areas	Information Needs			
	(1)	(2)	(3)	(4)
1.Freshwater Aquaculture of Indigenous Species				
1.1 Genetic improvement of *Macrobrachium rosenbergii*	/	/	/	/
1.2 Broodstock development and seed production of *Pangasius* spp.	/	/	/	/
1.3 Culture technologies for tilapia	/	/	/	/
1.4 Aquaculture of other indigenous species	/	/	/	/
2. Integrated Agri-Aqua Culture System				
2.1 Seed production of initial species identified for the activity	/	/	/	/
2.2 Study on climatic conditions and rice culture practices in participating or core countries	/	/	/	/
2.3 Agri-aqua culture technologies	/	/	/	/
2.4 Fish culture in small-farm reservoirs	/	/	/	/
3. Coastal Aquaculture and Mariculture				
3.1 Mud crab culture technologies	/	/	/	/
3.2 Mollusks culture technologies	/	/	/	/
3.3 Small-scale aquaculture including offshore cages	/	/	/	/
3.4 Mariculture Park scheme	/	/	/	/
4. Captive Broodstock Development				
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*, etc.)	/	/	/	/
4.2 Captive broodstock development for marine fishes, e.g., siganids, grouper, etc.	/	/	/	/

E. Other Concerns and Recommendations (use additional pages if necessary)

E.1 Specific Aquaculture Issues to be Continuously Addressed

1. Available supply of quality seeds
2. Developed captive broodstock technologies
3. Environment friendly culture technologies
4. Ecologically sound farm management
5. Conservation of ecosystem and biodiversity
6. Development of low fish meal, cost-efficient and environment friendly aquafeeds
7. Diagnosis and control of aquatic diseases
8. Monitoring and surveillance of occurrence of aquatic diseases

E.2 Others

1. Since commercialization of invertebrates will take off especially on the sea urchin, establishment of hatcheries is hereby recommended
2. Improvement of culture practices for seaweeds (*Kappaphycus* sp.) in order to prevent the occurrence of diseases
3. Establishment of seaweed nurseries to ensure source of propagules for year round supply
4. Establishment of hatcheries for invertebrates specifically the sea urchin
5. Broodstock development, breeding and grow out culture for invertebrates specifically the sea cucumber (*Holothuria scabra* and *Stichopus chloronatus*), spiny lobster (*Panulirus* spp.), blue crab (*Portunus pelagicus*), pearl oyster, scallop, carpet shell, "capiz" shell (*Placuna placenta*), "agihis"
6. Improvement of cultural practices of seaweeds (*Kappaphycus* spp.) disease prevention
7. Establishment of seaweed nurseries to ensure year round supply propagules
8. Financial support for R&D implementation in the Bicol Region
9. R&D on disease management of aquaculture/mariculture species especially on shrimps and grouper
10. R&D on breeding and hatchery technologies on red grouper (*Plectropomus*), Humpback grouper (*Cromileptis altivelis*), Napoleon wrasse (*Cheilinus undulates*), *Caranx* spp. and Tuna (*Thunnus albacore*)
11. Marketing surveys/researches for commercially cultured species

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***Source of Information:**

BFAR RFO 1, 2,4,5,6,7, 8, 9,10, 11, 12, 13, CAR, ARMM, CARAGA

BFAR Centers – Dagupan (NIFTDC), Muñoz, N.E. (NFFDTC), Tanay (NIFTC), Pagbilao (NBATRC)

BFAR Central Office – Aquaculture Division

COUNTRY: SINGAPORE

A. Priority species for each R&D area

R&D Areas	Confirm or Specify Species
1. Freshwater Aquaculture of Indigenous Species	
1.1 Genetic improvement of *Macrobrachium rosenbergii*	Nil
1.2 Broodstock development and seed production of *Pangasius* spp.	Nil
1.3 Culture technologies for tilapia	Nil
1.4 Aquaculture of other indigenous species (*specify species*)	Nil
2. Integrated Agri-Aqua Culture System	
2.1 Seed production of initial species identified for the activity (*specify species*)	Nil
2.2 Study on climatic conditions and rice culture practices in participating or core countries (*specify species*)	NA
2.3 Agri-aqua culture technologies (*specify species*)	Nil
2.4 Fish culture in small-farm reservoirs (*specify species*)	NA
3. Coastal Aquaculture and Mariculture	
3.1 Mud crab culture technologies	Nil
3.2 Mollusks culture technologies	Nil
3.3 Small-scale aquaculture including offshore cages (*specify species*)	Seabass (*Lates calcarifer*), Snapper (*Lutjanus species*), Grouper (*Epinephelus fuscoguttatus; E. coioides*). Pompano (*Trachinotus blochii)*
3.4 Mariculture Park scheme (*specify species*)	Nil
4. Captive Broodstock Development	
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*, etc.)	Nil
4.2 Captive broodstock development for marine fishes, e.g., siganids, grouper, etc.	Seabass (*Lates calcarifer*), Pompano (*Trachinotus blochii*), Snapper (*Lutjanus erythropterus; L. johni;*) Grouper (*Epinephelus fuscoguttatus, E. coioides*)

B. Status of aquaculture technologies available for each R&D area: (1) not being done - (x) interested or (y) not interested; (2) experimental; (3) verification stage; (4) commercialized; please check (√) appropriate cell

R&D Areas	Status of aquaculture technologies				
	(1)		(2)	(3)	(4)
	(x)	(y)			
1.Freshwater Aquaculture of Indigenous Species					
1.1 Genetic improvement of *Macrobrachium rosenbergii*		/			
1.2 Broodstock development and seed production of *Pangasius* spp.		/			
1.3 Culture technologies for tilapia					/
1.4 Aquaculture of other indigenous species					/
2. Integrated Agri-Aqua Culture System					
2.1 Seed production of initial species identified for the activity		/			
2.2 Study on climatic conditions and rice culture practices in participating or core countries		/			
2.3 Agri-aqua culture technologies		/			
2.4 Fish culture in small-farm reservoirs		/			
3. Coastal Aquaculture and Mariculture					
3.1 Mud crab culture technologies	/				
3.2 Mollusks culture technologies					/
3.3 Small-scale aquaculture including offshore cages				/	/
3.4 Mariculture Park scheme	/				
4. Captive Broodstock Development					
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*, etc.)	/				
4.2 Captive broodstock development for marine fishes, e.g., siganids, grouper, etc.			/		/

C. Training needs: (1) at AQD; (2) on-site in host country; (3) attachment in another country, (4) study visits for farmers, please check (√) appropriate cell

R&D Areas	Training Needs			
	(1)	(2)	(3)	(4)
1.Freshwater Aquaculture of Indigenous Species				
1.1 Genetic improvement of *Macrobrachium rosenbergii*				
1.2 Broodstock development and seed production of *Pangasius* spp.				
1.3 Culture technologies for tilapia				
1.4 Aquaculture of other indigenous species				
2. Integrated Agri-Aqua Culture System				
2.1 Seed production of initial species identified for the activity				
2.2 Study on climatic conditions and rice culture practices in participating or core countries				
2.3 Agri-aqua culture technologies				
2.4 Fish culture in small-farm reservoirs				
3. Coastal Aquaculture and Mariculture				
3.1 Mud crab culture technologies	/		/	
3.2 Mollusks culture technologies			/	/
3.3 Small-scale aquaculture including offshore cages	/	/	/	/
3.4 Mariculture Park scheme				
4. Captive Broodstock Development				
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*, etc.)	/		/	
4.2 Captive broodstock development for marine fishes, e.g., siganids, grouper, etc.	/		/	/

D. Information needs: (1) manuals or handbooks; (2) farm demonstration/mobilization of expertise; (3) workshops/meetings, (4) other info materials, please check (√) appropriate cell

R&D Areas	Information Needs			
	(1)	(2)	(3)	(4)
1.Freshwater Aquaculture of Indigenous Species				
1.1 Genetic improvement of *Macrobrachium rosenbergii*				
1.2 Broodstock development and seed production of *Pangasius* spp.				
1.3 Culture technologies for tilapia				
1.4 Aquaculture of other indigenous species				
2. Integrated Agri-Aqua Culture System				
2.1 Seed production of initial species identified for the activity				
2.2 Study on climatic conditions and rice culture practices in participating or core countries				
2.3 Agri-aqua culture technologies				
2.4 Fish culture in small-farm reservoirs				
3. Coastal Aquaculture and Mariculture				
3.1 Mud crab culture technologies	/		/	/
3.2 Mollusks culture technologies	/		/	/
3.3 Small-scale aquaculture including offshore cages	/		/	/
3.4 Mariculture Park scheme				
4. Captive Broodstock Development				
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*, etc.)	/		/	/
4.2 Captive broodstock development for marine fishes, e.g., siganids, grouper, etc.	/		/	/

E. Other Concerns and Recommendations (use additional pages if necessary)

COUNTRY: THAILAND

A. Priority species for each R&D area

R&D Areas	Confirm or Specify Species
1. Freshwater Aquaculture of Indigenous Species	
1.1 Genetic improvement of *Macrobrachium rosenbergii*	*Macrobrachium rosenbergii*
1.2 Broodstock development and seed production of *Pangasius* spp.	*Pangasius bocourti*
1.3 Culture technologies for tilapia	*Oreochromis niloticus*
1.4 Aquaculture of other indigenous species (*specify species*)	*Channa microlepis*
2. Integrated Agri-Aqua Culture System	
2.1 Seed production of initial species identified for the activity (*specify species*)	
2.2 Study on climatic conditions and rice culture practices in participating or core countries (*specify species*)	
2.3 Agri-aqua culture technologies (*specify species*)	
2.4 Fish culture in small-farm reservoirs (*specify species*)	
2.5 Genetic Improvement	
3. Coastal Aquaculture and Mariculture	
3.1 Mud crab culture technologies	*Scylla serrata*
3.2 Mollusks culture technologies	*Babylonia areolata, Haliotis asinina*
3.3 Small-scale aquaculture including offshore cages (*specify species*)	*Plectropomus maculatus* *Rachycentron canadum*
3.4 Mariculture Park scheme (*specify species*)	
4. Captive Broodstock Development	
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*, etc.)	*Penaeus vannamei, P. monodon*
4.2 Captive broodstock development for marine fishes, e.g., siganids, grouper, etc.	*Epinephelus* spp. *Chanos chanos*

B. Status of aquaculture technologies available for each R&D area: (1) not being done - (x) interested or (y) not interested; (2) experimental; (3) verification stage; (4) commercialized; please check (√) appropriate cell

R&D Areas	Status of aquaculture technologies				
	(1)		(2)	(3)	(4)
Pond culture of Shrimp and bangus	**(x)**	**(y)**			
1.Freshwater Aquaculture of Indigenous Species					
1.1 Genetic improvement of *Macrobrachium rosenbergii*			/	/	
1.2 Broodstock development and seed production of *Pangasius* spp.				/	/
1.3 Culture technologies for tilapia					/
1.4 Aquaculture of other indigenous species			/		
2. Integrated Agri-Aqua Culture System					
2.1 Seed production of initial species identified for the activity					/
2.2 Study on climatic conditions and rice culture practices in participating or core countries					/
2.3 Agri-aqua culture technologies					/
2.4 Fish culture in small-farm reservoirs					/
3. Coastal Aquaculture and Mariculture					
3.1 Mud crab culture technologies			/		
3.2 Mollusks culture technologies			/	/	
3.3 Small-scale aquaculture including offshore cages			/		
3.4 Mariculture Park scheme	/				
4. Captive Broodstock Development					
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*, etc.)			/		
4.2 Captive broodstock development for marine fishes, e.g., siganids, grouper, etc.			/		

C. Training needs: (1) at AQD; (2) on-site in host country; (3) attachment in another country, (4) study visits for farmers, please check (√) appropriate cell

R&D Areas	Training Needs			
	(1)	(2)	(3)	(4)
1.Freshwater Aquaculture of Indigenous Species				
1.1 Genetic improvement of *Macrobrachium rosenbergii*		/	/	
1.2 Broodstock development and seed production of *Pangasius* spp.			/	/
1.3 Culture technologies for tilapia		/		
1.4 Aquaculture of other indigenous species		/		
2. Integrated Agri-Aqua Culture System				
2.1 Seed production of initial species identified for the activity	/			
2.2 Study on climatic conditions and rice culture practices in participating or core countries				
2.3 Agri-aqua culture technologies				
2.4 Fish culture in small-farm reservoirs				
3. Coastal Aquaculture and Mariculture				
3.1 Mud crab culture technologies	/			
3.2 Mollusks culture technologies			/	
3.3 Small-scale aquaculture including offshore cages			/	
3.4 Mariculture Park scheme				
4. Captive Broodstock Development				
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*, etc.)				/
4.2 Captive broodstock development for marine fishes, e.g., siganids, grouper, etc.				/

D. Information needs: (1) manuals or handbooks; (2) farm demonstration/mobilization of expertise; (3) workshops/meetings, (4) other info materials, please check (√) appropriate cell

R&D Areas	Information Needs			
	(1)	(2)	(3)	(4)
1.Freshwater Aquaculture of Indigenous Species				
1.1 Genetic improvement of *Macrobrachium rosenbergii*	/		/	
1.2 Broodstock development and seed production of *Pangasius* spp.		/	/	
1.3 Culture technologies for tilapia			/	
1.4 Aquaculture of other indigenous species			/	
2. Integrated Agri-Aqua Culture System				
2.1 Seed production of initial species identified for the activity	/			
2.2 Study on climatic conditions and rice culture practices in participating or core countries				
2.3 Agri-aqua culture technologies	/			
2.4 Mariculture park scheme (specify species)	/			
3. Coastal Aquaculture and Mariculture				
3.1 Mud crab culture technologies		/	/	
3.2 Mollusks culture technologies		/	/	
3.3 Small-scale aquaculture including offshore cages		/	/	
3.4 Mariculture Park scheme				
4. Captive Broodstock Development				
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*, etc.)		/	/	
4.2 Captive broodstock development for marine fishes, e.g., siganids, grouper, etc.		/	/	

E. Other Concerns and Recommendations (use additional pages if necessary)

COUNTRY: VIETNAM

A. Priority species for each R&D area

R&D Areas	Confirm or Specify Species
1. Freshwater Aquaculture of Indigenous Species	
1.1 Genetic improvement of *Macrobrachium rosenbergii*	*Macrobrachium rosenbergii*
1.2 Broodstock development and seed production of *Pangasius* spp.	*Pangasius micronemus*
1.3 Culture technologies for tilapia	*Oreochromis niloticus*
1.4 Aquaculture of other indigenous species (*specify species*)	**RIA 2. In the Mekong Delta of VN**: giant Mekong Carp: (*Catlocarpio siamensis*), *Probarbus spp., Cirrhinus microlepis, Cychlocheilichthys enoplos, Anabas testudineus Trichogaster pectoralis, Notopterus notopterus, Chitala ornata* **RIA 3:** Thai mahseer (*tor tambroides*), *Probarbus jullieni, Elephant ear gourami*
2. Integrated Agri-Aqua Culture System	
2.1 Seed production of initial species identified for the activity (*specify species*)	**RIA 2:** *Trichogaster pectoralis, Anabas testudineus, Clarias spp., Tilapia, Ospharonemus gourami, Barbodes gonionotus, Chitala ornate, Notopterus notopterus, Macrobrachium rosenbergii* **RIA 3:** Marble goby (*Oxyeleotris marmorata*)
2.2 Study on climatic conditions and rice culture practices in participating or core countries (*specify species*)	*Channa* spp. Culture in flooded area
2.3 Agri-aqua culture technologies (*specify species*)	*Macrobrachium rosenbergii* in rice fields, freshwater fish and Giant tiger prawn
2.4 Fish culture in small-farm reservoirs (*specify species*)	Asian redtail catfish (*Hemibagsus nemurus*)
3. Coastal Aquaculture and Mariculture	
3.1 Mud crab culture technologies	yes
3.2 Mollusks culture technologies	yes
3.3 Small-scale aquaculture including offshore cages (*specify species*)	*Lates calcarifer, Epinephelus* spp. culture in ponds and small cages*, Chanos chanos* culture in ponds, sea bass,cobia, grouper, Crimson snapper, ornate rock lobster
3.4 Mariculture Park scheme (*specify species*)	
4. Captive Broodstock Development	
4.1 Captive broodstock development of shrimps *P. monodon, P. vannamei*, etc.)	Yes for *P. monodon*
4.2 Captive broodstock development for marine fishes, e.g., siganids, grouper, etc.	yes

B. Status of aquaculture technologies available for each R&D area: (1) not being done - (x) interested or (y) not interested; (2) experimental; (3) verification stage; (4) commercialized; please check (√) appropriate cell

R&D Areas	Status of aquaculture technologies				
	(1)		(2)	(3)	(4)
	(x)	(y)			
1.Freshwater Aquaculture of Indigenous Species					
1.1 Genetic improvement of *Macrobrachium rosenbergii*	/				
1.2 Broodstock development and seed production of *Pangasius* spp.					/
1.3 Culture technologies for tilapia				/	
1.4 Aquaculture of other indigenous species			/		
- Snake head (in ponds)					/
- *Chitala ornate, Notoperus notoperus Trichogaster pectoralis*					/
- *Anabas testudineus (in rice fields)*			/		
- *Cyclochelichthys enoplos, Cirrhinus microlepis, Labeo chrysphekadion, Leptobarbus hoevenii*	/				
- *Catlocarpio siamensis*	/				

R&D Areas	Status of aquaculture technologies				
	(1)		(2)	(3)	(4)
	(x)	(y)			
2. Integrated Agri-Aqua Culture System					
2.1 Seed production of initial species identified for the activity					
- *Anabas testudineus* (in rice fields)					/
- *Barbodes gonionotus,*					/
- *Trichogaster pectoralis,*				/	
- *Chitala ornata*				/	
- *Notoperus notoperus*				/	
- *Osphronemus gourami*				/	
- *Oxyekeotrus marmoratus*				/	
- *Clarias spp.*					/
- *Tilapia*					/
- *Macrobrachium rosenbergii*					/
2.2 Study on climatic conditions and rice culture practices in participating or core countries					
2.3 Agri-aqua culture technologies (specify species)					
- Macrobrachium rosenbergii in rice fields, giant prawn, freshwater fish, giant tiger prawn				/	
2.4 Fish culture in small-farm reservoirs					/
3. Coastal Aquaculture and Mariculture					
3.1 Mud crab culture technologies			/		
3.2 Mollusks culture technologies			/		
3.3 Small-scale aquaculture including offshore cages (specify species)					
- *Lates calcarifer* culture in ponds and small cages			/		
- *Epinephelus* spp. culture in ponds and small cages			/		
- *Chanos chanos* culture in ponds	/				
3.4 Mariculture Park scheme					
4. Captive Broodstock Development					
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*, etc.)			/		
4.2 Captive broodstock development for marine fishes, e.g., siganids, grouper, etc.			/		

C. Training needs: (1) at AQD; (2) on-site in host country; (3) attachment in another country, (4) study visits for farmers, please check (√) appropriate cell

R&D Areas	Training Needs			
	(1)	(2)	(3)	(4)
1.Freshwater Aquaculture of Indigenous Species				
1.1 Genetic improvement of *Macrobrachium rosenbergii*	/	/	/	
1.2 Broodstock development and seed production of *Pangasius* spp.				/
1.3 Culture technologies for tilapia	/			/
1.4 Aquaculture of other indigenous species				
- Catlocarpio siamensis			/	
- Probarbus spp			/	
2. Integrated Agri-Aqua Culture System		/		
2.1 Seed production of initial species identified for the activity				
2.2 Study on climatic conditions and rice culture practices in participating or core countries			/	
2.3 Agri-aqua culture technologies		/		
2.4 Fish culture in small-farm reservoirs		/		
3. Coastal Aquaculture and Mariculture				
3.1 Mud crab culture technologies			/	/
3.2 Mollusks culture technologies			/	/
3.3 Small-scale aquaculture including offshore cages				
- *Lates calcarifer* culture in ponds and small cages	/		/	
- *Epinephelus* spp. culture in ponds and small cages	/		/	
- *Chanos chanos* culture in ponds	/		/	
3.4 Mariculture Park scheme				
4. Captive Broodstock Development				
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*, etc.)	/			
4.2 Captive broodstock development for marine fishes, e.g., siganids, grouper, etc.	/			

D. Information needs: (1) manuals or handbooks; (2) farm demonstration/mobilization of expertise; (3) workshops/meetings, (4) other info materials, please check (√) appropriate cell

R&D Areas	Information Needs			
	(1)	(2)	(3)	(4)
1.Freshwater Aquaculture of Indigenous Species				
1.1 Genetic improvement of *Macrobrachium rosenbergii*	/	/		
1.2 Broodstock development and seed production of *Pangasius* spp.		/	/	
1.3 Culture technologies for tilapia	/	/		
1.4 Aquaculture of other indigenous species	/		/	
- *Catlocarpio siamensis*		/		
- *Probarbus* spp.		/		
2. Integrated Agri-Aqua Culture System				
2.1 Seed production of initial species identified for the activity	/		/	
2.2 Study on climatic conditions and rice culture practices in participating or core countries			/	/
2.3 Agri-aqua culture technologies	/			
2.4 Mariculture park scheme (specify species)	/			/
3. Coastal Aquaculture and Mariculture				
3.1 Mud crab culture technologies	/	/	/	
3.2 Mollusks culture technologies	/	/	/	
3.3 Small-scale aquaculture including offshore cages				
- *Lates calcarifer* cultured in ponds and small cages	/	/		
- *Epinephelus* spp. cultured in ponds and small cages	/	/		
- *Chanos chanos*	/	/		
3.4 Mariculture Park scheme				
4. Captive Broodstock Development				
4.1 Captive broodstock development of shrimps (*P. monodon, P. vannamei*, etc.)		/	/	
4.2 Captive broodstock development for marine fishes, e.g., siganids, grouper, etc.		/	/	

E. Other Concerns and Recommendations (use additional pages if necessary)

CONSOLIDATION OF TECHNOLOGY TRANSFER NEEDS BASED ON IDENTIFIED AREAS OF CONCERN

Confirmed by the Country Representatives on 1 December 2005

Areas of Concerns	Priority Projects/ Species	Core Countries	Training Needs	Information Needs
• **Freshwater Aquaculture of Indigenous Species**				
	Genetic improvement of *M. rosenbergii*	Thailand, Indonesia, Philippines	Attachment training in another country on hatchery, nursery and broodstock development for *M. rosenbergii*	For technology on hatchery, nursery and broodstock development of *M. rosenbergii*: manuals/workshops, farm demo/ mobilization of experts, workshops/meetings
	Genetic characterization of local *Pangasius* spp.	Thailand	Attachment training in another country on nursery and genetic characterization of *Pangasius* spp.	For nursery and genetic characterization of *Pangasius* spp.: manuals/workshops, farm demo/ mobilization of experts, workshops/meetings
	Tilapia aquaculture		Attachment training in another country on grow-out culture of tilapia	Manuals/workshops, farm demo/mobilization of experts, workshops/meetings on technology refinement and grow-out culture of tilapia
	Aquaculture of other indigenous species			Exchange of information on local species available in each country and technology if any
• **Integrated Aquaculture System**				
Integrated Rice-Fish Culture	Economic study on the production of fingerlings in rice fields	Indonesia, Philippines		
	Pesticide analysis on fish grown in rice fields	Indonesia, Philippines		
Small-Farm Reservoir	Carrying capacity of small farm reservoir	Indonesia, Philippines, Thailand	Attachment training in another country and on-site training	Manuals/workshops, farm demo/mobilization of experts, workshops/meetings on cage culture in reservoir (resource persons from Japan)
	Comparative socio-economics of community-fishpond vs. cage-based culture	Thailand, Philippines	Attachment training in another country and on-site training	Farm demo/mobilization of experts for community-fishpond and cage-based culture
• **Coastal Aquaculture and Mariculture**				
Mud crab	Mud crab culture larval rearing	Vietnam	Training at AQD, on-site training and attachment training in another country on mud crab larval rearing	Manuals/workshops, farm demo/mobilization of experts, workshops/meetings on mud crab seed production
	Mud crab grow-out culture		On-site training and attachment training in another country on mud crab culture	Farm demo on mud crab culture in Myanmar, mobilization of experts, workshops/meetings on mud crab culture
Mollusks	Grow-out culture of abalone		Training at AQD, on-site training and attachment training in another country on abalone culture with technical support from Japan	Manuals/workshops, farm demo/mobilization of experts, workshops/meetings on abalone production

Areas of Concerns	Priority Projects/ Species	Core Countries	Training Needs	Information Needs
Marine Fishes	Milkfish grow-out		Training at AQD, on-site training and attachment training in another country on milkfish culture	Manuals/workshops, farm demo/mobilization of experts, workshops/meetings on milkfish culture
	Grouper seed production		Training at AQD, on-site training and attachment training in another country on grouper seed production and diseases in grouper	Manuals/workshops, farm demo/mobilization of experts, workshops/meetings on grouper seed production and diseases in grouper
	Siganids grow-out		Training at AQD, on-site training and attachment training in another country on siganids grow-out culture	Manuals/workshops, farm demo/mobilization of experts, workshops/meetings on siganids culture
Seaweeds	Diseases in seaweeds			Manuals/workshops, farm demo/mobilization of experts, workshops/meetings on diseases in grouper
Mariculture Park			Training at AQD, on-site training and attachment training in another country on mariculture scheme	Manuals/workshops, farm demo/mobilization of experts, workshops/meetings on mariculture technology
• **Captive Broodstock Development**				
Shrimps	*P. monodon*	Thailand	Training at AQD, on-site training and attachment training in another country on *P. monodon* broodstock development	Manuals/workshops, farm demo/mobilization of experts, workshops/meetings on *P. monodon* broodstock development to be coordinated by AQD
	P. vannamei	Thailand		Exchange of information among countries doing *P. vannamei* culture
Marine Fishes				
Siganids		Indonesia	Training at AQD, on-site training and attachment training on siganids culture	Manuals/workshops, farm demo/mobilization of experts, workshops/meetings on siganids culture
Grouper	Continuing studies on diseases and nutrition	Indonesia	Training at AQD, on-site training and attachment training on sex reversal of grouper	Manuals/workshops, farm demo/mobilization of experts, workshops/meetings on diseases in grouper
Milkfish	Development of milkfish broodstock	Philippines	Training at AQD, on-site training and attachment training on sex reversal of grouper	Manuals/workshops, farm demo/mobilization of experts, workshops/meetings on milkfish aquaculture and broodstock management

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