

Regional Technical Consultation on the Aquaculture of *Penaeus vannamei* and Other Exotic Shrimps in Southeast Asia

Manila, Philippines,
1-2 March 2005



Aquaculture Department
Southeast Asian Fisheries Development Center
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on the Aquaculture of *P. vannamei*
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in Southeast Asia was prepared by:

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FOREWORD

It was indeed an opportune time for SEAFDEC to come up with an assessment of the status of *Penaeus vannamei* aquaculture in Southeast Asia since many shrimp growers have already shifted to *P. vannamei* culture, for the reason that it is easier to culture than the black tiger shrimp. Because of this trend, it has become necessary for SEAFDEC to conduct the Regional Technical Consultation on the Aquaculture of *P. vannamei* and Other Exotic Shrimps in Southeast Asia in March 2005, in order that countries in the region could assess and evaluate the risk and benefits from the farming of *P. vannamei* in their respective countries.

As we are already aware of, the region's shrimp industry had been dominated by the black tiger shrimp, *Penaeus monodon* – for a very long time. But during the past few years the dominance of *P. monodon* waned because of the introduction of the Pacific white shrimp, *Penaeus vannamei*, now becoming the most important farmed shrimp species in Asia. SEAFDEC does not want to ignore this shift in the preferred shrimp species for farming. This is especially so since in Southeast Asia there are a few countries that either have a policy of excluding exotic shrimp species or have not made up their minds as to whether or not to join the Asian trend of farming exotic shrimp species.

While the issue of *P. vannamei* introduction in Asia has been taken up in various meetings in the past, these were more in the context of the introduction of exotic species and the possible introduction of diseases. It was deemed necessary to have a forum where a comprehensive discussion focused on the experiences of countries that have already been farming *P. vannamei* and their respective assessments of risks and benefits.

It has been the consensus in the Consultation that the main impetus for the introduction and farming of *P. vannamei* in the region is the perceived superiority of the exotic species over the native stock of shrimp in terms of ease in farming, availability of broodstock and high potential yield. It was noted that countries farming *P. vannamei* have recognized the benefits outweighing the risks. It is commendable that the countries recognized the need to follow the international guidelines for the importation of live shrimps and the country-to-country rules and regulations.

Since the output of the Consultation was a Plan of Action to implement strategies in addressing problems and constraints on the introduction of *P. vannamei* and other exotic shrimp species in the region, it is hoped that future shrimp farming activities in the region could be based on such Plan of Action. In this way, the region could attain sustainability in shrimp aquaculture.



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RATIONALE

The shrimp industry in Asia has long been dominated by *Penaeus monodon* until it slumped in the 90s due to serious disease outbreaks causing significant losses to producers. There were several attempts by shrimp growers to shift to other culture species while others opted to stop operation. The dominance of *P. monodon* in Asia has obviously waned paving way to two non-native shrimp species – *P. vannamei* and *P. stylirostris*. These culture species have found their way to Asia and are now fast becoming the most preferred culture species in the region.

Penaeus vannamei is being considered for culture for the following reasons: (1) it is relatively easier to culture; (2) it performs better in terms of survival, and (3) it requires less protein in its diet which means lower cost of feeds. All these translate to lower cost production and therefore cheaper shrimps in the market.

Another compelling reason for the widespread culture of *P. vannamei* in Asia today is the commercial availability of spawners making it easy for hatchery operators to order the mother shrimps. The species is fully domesticated so that Specific Pathogen Free (SPF) broodstock that is also Specific Pathogen Resistant (SPR) is now readily available. This is actually competitive with the price of wild-caught natural *P. monodon* spawners, which is getting scarcer and more expensive aside from the fact that many wild stocks are already infected by viruses. SPF *P. vannamei* or *P. stylirostris* are certified free from six known shrimp diseases.

Despite the perceived industry benefits, many Asian countries have legislation against the introduction and culture of *P. vannamei* and other exotic shrimp species mainly for fear that they may be carrying new diseases. These diseases are feared to be transmitted to native wild penaeid shrimp populations through pond effluents.

While the issue of the introduction of *P. vannamei* has been taken up in various forums in the past, these were always in the context of introduction of exotic species and the possible introduction of diseases. In spite of the urgency of the issue, there has been no comprehensive discussion among the countries that focused on exotic shrimps particularly *P. vannamei* and all possible ramification of its introduction beyond diseases. Thus, the need to conduct the Regional Technical Consultation on the Aquaculture of *P. vannamei* and Other Exotic Shrimps in Southeast Asia in order to draw up guidelines on the culture of these exotic species in the region.



OBJECTIVES

The Regional Technical Consultation aimed to:

1. evaluate the extent and status of *P. vannamei* and *P. stylirostris* aquaculture in Southeast Asia and in other parts of Asia.
2. assess the impact of the introduction of *P. vannamei* and *P. stylirostris* aquaculture in the region: social, economic, market, and ecological;
3. identify problems and constraints in the culture of *P. vannamei* and *P. stylirostris* and other exotic shrimp species in the region;
4. develop a strategy to address the problems and constraints identified; and
5. establish a Plan of Action for the implementation of such strategy at the regional level.

PARTICIPANTS

For this Consultation, AQD has invited participants from each ASEAN-SEAFDEC member country, who have a good background on shrimp farming and especially on the aquaculture of *P. vannamei* and/or other exotic shrimps. Each country representative presented country paper on the status of *P. vannamei* aquaculture.

In addition, a resource person from China presented a paper on status of *P. vannamei* aquaculture in China and other Asian countries. The resource paper presented focused on: (1) sources of *P. vannamei* or other exotic shrimp species breeders including marketing of breeders; (2) effect of *P. vannamei* production in the Asian economy including the global supply/pricing of shrimps in general, etc.; and (3) health aspects of exotic shrimp species.



There were a total of 58 participants and observers who attended the Technical Regional Consultation on the Aquaculture of Exotic Shrimp Species in Southeast Asia. Participants included representatives from Cambodia, China, Japan, Indonesia, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam. Other participants included private shrimp growers in the Philippines and researchers of SEAFDEC/AQD and the Bureau of Fisheries and Aquatic Resources (BFAR).

THE REGIONAL TECHNICAL CONSULTATION ON THE AQUACULTURE OF *P. VANNAMEI* AND OTHER EXOTIC SHRIMPS

The Consultation was convened in Manila, Philippines on 1-2 March 2005 at Dusit Hotel Nikko and attended by representatives of each ASEAN-SEAFDEC member-countries. Dr. Rolando R. Platon, Chief of SEAFDEC Aquaculture Department, gave a brief overview of the status of the program activities which somehow indicates the need to assess and evaluate the risk and benefits of *P. vannamei* culture in Southeast Asia. He then designated Mr. Wilfredo G. Yap as Chairman of the Consultation.

Mr. Junichiro Okamoto, SEAFDEC Deputy Secretary General, formally opened the Consultation. In his message, he assured the participants of the support of SEAFDEC and the Government of Japan for this kind of endeavor. He stressed the need for SEAFDEC to come up with a policy guideline regarding introduction of exotic species in Southeast Asia. He also thanked the participants for their cooperation and hoped for the success of the Consultation.

Department of Agriculture Undersecretary for Fisheries Cesar M. Drilon Jr., in his message for the participants, welcomed and exhorted them to weigh very carefully the pros and cons of *P. vannamei* culture. He cited the bad experience of the Philippines years after the introduction of golden snails. There had been no serious discussions about the exotic species then before allowing its introduction, and now the golden snails have become pests giving farmers a hard time eradicating them.



Workshop Chair, Wilfredo Yap of AQD (left) together with SEAFDEC Deputy Secretary General Junichiro Okamoto (middle) and AQD Chief Rolando Platon (right) during the Technical Consultation on Vannamei

Mr. Yap as Chairman presented the agenda for adoption, after which, he explained the background and introduction to the Consultation, including the urgency to discuss the status of aquaculture of *P. vannamei*, its advantages and disadvantages. He also added that the shift in the preferred shrimp species by some shrimp growers could not be ignored. The issue of *P. vannamei* introduction in Asia has been the subject of several international workshops and forums. However, Mr. Yap said, the discussion had only been a part of the topics on aquatic health and diseases and/or only as one among several other species. He also enjoined the participants to share their experiences and ideas for the success of the Consultation.



The participants in the Regional Technical Consultation on Vannamei



COUNTRY PAPERS

Each representative presented papers on the status of aquaculture of *P. vannamei* and other exotic shrimps in their respective countries.

CAMBODIA

Cambodia has 435 km coastlines in the Gulf of Thailand and stretches between Vietnamese border in the south to Thai border in the west.

The fisheries sector in Cambodia plays a vital function in the people's food supply and the country's national economy. The total commercial fisheries production in 2002 was 424,400 metric tons. Of the total production, 85% came from freshwater fish, 11% from marine capture fisheries and only 4% from aquaculture.

Shrimp Farming

Shrimp culture is a relatively new development in Cambodia. *Penaeus monodon* and *vannamei* are the two species being cultured along the coastlines of Kep, Kompot, Koh Kong and Sihanouk Ville.

Farming of Penaeus monodon

P. monodon is a native species in the coasts of Cambodia. Its farming started in 1989 and significantly expanded since 1991 using two culture methods: intensive and traditionally extensive shrimp farming. In Kompot and Sihanouk Ville, the farms are mostly extensive using traditional methods and another two intensive farms in Kompot (16 and 30 has). Extensive farms rely on natural supply of feed and seed. With no feeding, fertilization, or stocking, the pond productivity remains low with less than 100 kg./ha/yr.

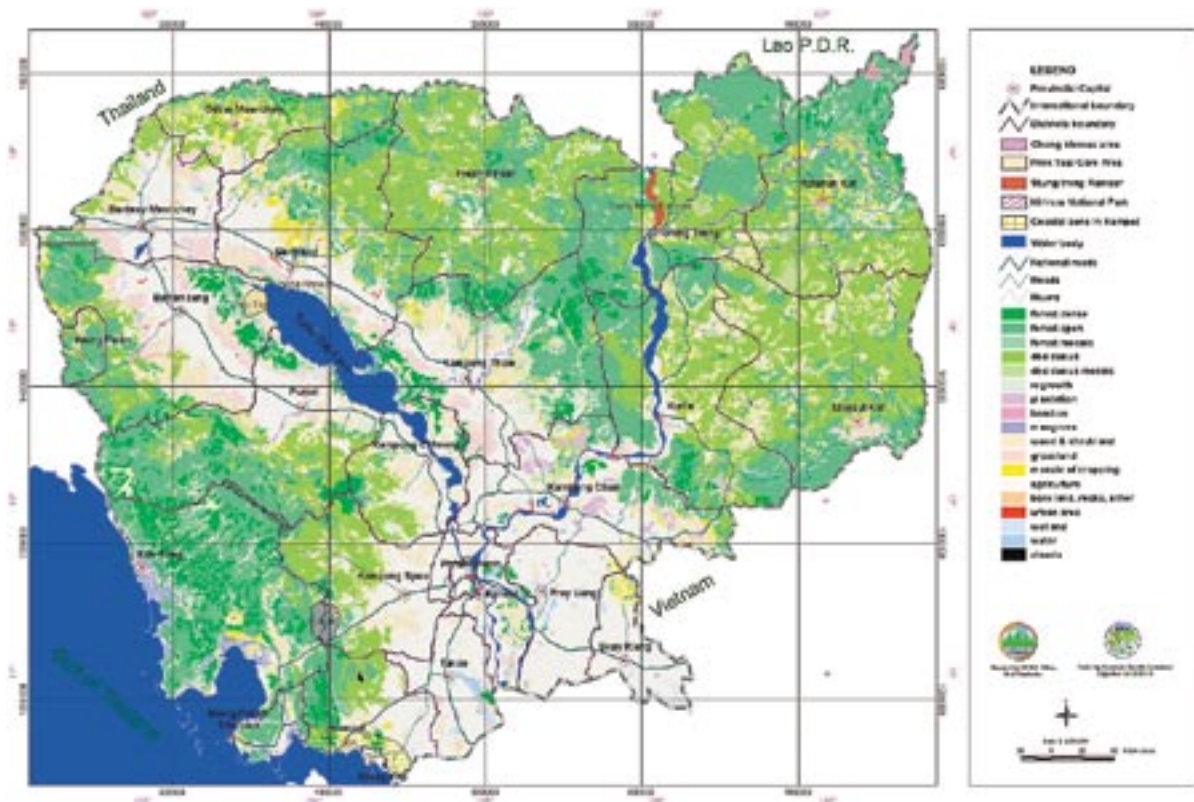
In Koh Kong, the shrimp farms are mostly intensive which rely mainly on Thailand for the supply of most inputs, such as feed, seed, chemical and equipment and also for the market of harvested shrimps. Intensive shrimp techniques involve high stocking density, formulated feed, aeration, and regular water exchange. Pond yield was reportedly high at 7 to 8 mt/ha/crop for new farms attracting further investments until the disease outbreaks that caused significant economic losses to growers.

A private hatchery was established in Koh Kong in 1994 and reportedly produced about 2.5 million post-larvae to supply their own needs. The hatchery produced irregularly due to technical constraints such as seeds and broodstock.

Extensive farms had low pond yield at 32 kg/ha/yr with sale value at \$25M/yr, while intensive farms has 7,545 kg/ha/yr with sale value at \$42M/yr. Shrimp farms in Koh Kong Province increased to 1000 ha until the onset of white spot virus (wssv) that caused the country \$14.5M losses each year. This resulted to decrease of shrimp farms to 850 has in 2000.



Department of Fisheries of Cambodia Officer *Haing Leap* presenting the status of *P. vannamei* culture in his country (left photo) and one fish farm in Sihanouk Ville, Cambodia (right photo) where *P. vannamei* culture has been tried.



Location of ARCBC research sites in Cambodia

Farming of *Penaeus vannamei*

P. vannamei is not an indigenous species in the coasts of Cambodia. It was first imported to the country as postlarvae from Thailand in 2000 for a trial stocking in Otres of Sihanouk Ville, and then imported from Taiwan in 2003. Currently, there are two shrimp farms (6 ha) in Sihanouk Ville stocking *P. vannamei*. Since there are no shrimp hatcheries and formulated feeds, all these inputs have to be imported from Thailand or Taiwan. The pond yield ranges between 2 and 5 tons/ha/crop with harvest size ranging at 50-100 heads of shrimps/kg. The small shrimp production is mostly marketed locally with price ranging at \$8-10/kg. The first trial showed positive result.

Impact of introduction of *P. vannamei*

Since the introduction of *P. vannamei* into the country, no information on catch is available, hence no clear evidence of this species causing any risks to Cambodian coastal areas. There are also no reports from fishermen on escapes of the species that led to any negative impact on wild shrimp population. However, it is believed that *P. vannamei* may cause some negative impact to the economy and biodiversity.

Existing Policies on the introduction of aquatic exotic/alien species

Cambodia has no detailed guidelines or regulations for the movement or importation of aquatic animals for culture, hence, the development of aquaculture raises the question of potential impacts of introduction of exotic species on native fish stocks.

In order to reduce or avoid the negative impact caused by the introduction of exotic/alien aquatic species into non-native areas, the following points were considered:

- Establish the code of practice or guidelines on the importation/movement of aquatic animals;
- Have strict rules for importing of aquatic exotic animal species into the country;
- Take into account the implementation of the international codes of practice and guidelines;
- Release only indigenous species

- Conduct risk assessment studies before allowing introduction of new aquatic animals species;
- Establish quarantine systems for aquatic animal diseases;
- Conduct capacity building in risk analysis, procedures for monitoring and disease surveillance; and
- Enhance public awareness on negative impacts of alien species.

INDONESIA

Shrimp culture is a major contributor to foreign exchange earnings in Indonesia. However, in 1985 to 1994, the average annual production of shrimps (*P. monodon*) had drastically decreased from 180,000 mt to 35,058 mt, although total production of shrimp from both capture and aquaculture increased in 10 years, obtaining an annual growth rate of 3.50%, from 170,563 mt in 1993 up to 477,332 mt in 2003. Production from aquaculture itself has merely grown to 2.80%. This was due to disease problem caused mainly by viral disease called Monodon Baculovirus (MBV) and White Spot Syndrome Virus (wssv), which started in 2000. However, the total shrimp export showed a significant increase in ten years for both volume and value with growth rate of 4.91% for volume and 0.78% for value, gaining 98,569 mt worth US\$867,703 in 1993 to 137,636 mt worth US\$850,222 in 2003.

Because shrimp culture is a potential in increasing foreign exchange earnings, the Government through the Directorate General of Aquaculture, Ministry of Marine Affairs and Fisheries (DGA-MOMAF) is considering other shrimp culture species as alternative. In 2000, DGA authorized the private sectors to import *P. vannamei* broodstock and postlarvae and since then, this species has been cultured in potential provinces in Indonesia.

The success story of *P. vannamei* culture has encouraged many tiger prawn growers to try culturing the exotic species. This was then attributed to the increase in shrimp aquaculture production, contributing 37.11% to national production in 1999 and 41.2% in 2003.

The private sector after given the license, imported 2,000 broodstock and 5.1 million *P. vannamei* PL from Hawaii and 2,000 *P. stylirostris* PL from Taiwan and Indonesia. The experimental *P. vannamei* culture at Gondol Research Institute for Mariculture in Bali (GRIM) paved the way for the official release of *P. vannamei* by the Minister of Marine Affairs and Fisheries, in Banyuwangi district of East Java Province. The Ministerial Decree Number: KEP. 41/MEN/2001 concerning Releasing *Vannamei* Shrimp as the Superior Variety of Shrimp, controls production and distribution of the species.

The development of shrimp culture is different from one province to another. In East Java, it is relatively faster than the others as indicated by the faster growth in the number of hatcheries as well as grow out activities in brackishwater ponds. To some extent, this province is currently the main source of broodstock. Despite disease occurrences, particularly TSV (Taura Syndrome Virus) in November 2001, most shrimp farmers continue to indulge in the business. The success of *P. vannamei* culture in Banyuwangi (East Java) has encouraged other shrimp farmers in the region particularly in the provinces of Bali, Lampung, West Java, Central Java, South Sumatera, North Sumatera, Bangka, Belitung, Riau, West Kalimantan, East Kalimantan and West Nusatenggara and Bengkulu to go into *P. vannamei* culture. However, the Monitoring Surveillance and Evaluation Team of the DGA, found some constraints in the development of the culture industry – disease problem.



Regulatory and Policy Support

There are several regulatory and policy support for shrimp culture, among others are: Seed Regulations; Live Movement Regulations; Feeds; Drugs; Program Implementation.

Implementation and Development of *P. vannamei* Culture

Hatchery

Success story of the culture of *P. vannamei* in many regions has resulted to high demand of seeds and consequently, broodstocks. In some areas, farmers have tried producing their own broodstock and sold to shrimp hatcheries. The price is certainly lower compared to imported broodstock although local broodstocks have the potential to carry diseases. The price of broodstock varies from one site to another, ranging from 25,000 to 40,000 rupiah compared to imported broodstock with price ranging from US\$22-32 (US\$1.00 = 9,200 rupiah). The price of market size *P. vannamei* (60 shrimps/kg) is 50,000 to 60,000 rupiah per kg.

The low price of broodstock subsequently results to cheaper postlarvae, ranging from 15-17 rupiah while the imported ones cost 33-35 rupiah. There are 13 large-scale hatcheries producing good quality larvae using imported broodstock in Indonesia.

Grow-out

Within less than one year of development, *P. vannamei* shrimp culture could seemingly overtake the tiger shrimp. Intensification of tiger shrimp culture has slowed down in favor of the exotic species. *P. vannamei* is perceived to be more advantageous than other species due to: faster growth, shorter culture period, more resistant to disease and environment change; and more efficient feed conversion rate. In addition, culture practices of *P. vannamei* are also similar to that of tiger shrimp, although *P. vannamei* culture requires water maintenance more often. Ease in management and to some extent promising good harvest encourage more farmers to culture white shrimp rather than tiger shrimp. Production of white shrimp has increased significantly from 29.3% in 2002 to 47.6% in 2004 and could be 66.7% in 2005 and will be two-thirds of the national aquaculture shrimp production. The *P. vannamei* culture may be promising but not without problems where in Bali and East Java, harvest failures were reported due to viral diseases.

Problems and Constraints

Quantity and quality of broodstock

Imported *P. vannamei* broodstock perform better those taken from ponds because they can produce better quality postlarvae. However, they are costly, time consuming and mostly not available. Local broodstock, although available, are risky. Encouraging breeders to use PCR-tested broodstock is also time consuming, and their understanding about PCR test is very limited.

Stocking Density

Culture of *P. vannamei* will enable farmers to produce large volume of shrimps because of its potential for high stocking density. A farmer reportedly produced 40-50 mt of shrimp per crop from a pond stocked at 4,000,000 PL per hectare. It is however, reasonable to maintain optimum stocking density at a maximum of 150 PL per m².

Strategies for Development

There are 419,282 hectares of brackishwater ponds and potential areas of 913,000 ha in Indonesia. The country has made both short, middle and long term strategies toward development of shrimp industry if only to become one of the biggest shrimp producers and exporters of the world. Developing the new culture species may enhance the shrimp industry but the native species such as tiger shrimp and other penaeid shrimps remains promising for development.

MALAYSIA

Overview of Fisheries

Malaysia has a long coastline of 4,055 km, 1640 km of which is in Peninsular Malaysia and 2,415 km is in the state of Sabah and Sarawak. With extensive fishing area, fishery is a significant sector in the Malaysian economy contributing 1.5 metric tons of fish valued at about RM5.0B in 2003. The marine fisheries production was 1.3 million tons valued at RM4.0B, constituting 1.4% of the GDP. The aquaculture production was 196,874 tons valued at over RM1.0B constituting only 13% of the total fisheries production.

In 2002, Malaysia exported an estimated 198,892 tons of fishery products valued at RM1.5B to Japan, Singapore and USA while Thailand is mainly the source of imported products valued at RM1.3B.

Role and Importance of Aquaculture

Freshwater fish culture and coastal aquaculture were only introduced in the early twenties but have significantly expanded in the last two decades. Aquaculture varied from culture in ponds, mud flats, cages and rafts. There are 94 shrimp hatcheries with a production capacity of 12 billion fry a year and some 79 freshwater fish hatcheries/nursery producing 50 million fry per year.

Shrimp production had its set of high and low production where it peaked at 126,405 tons in 1992 and slightly declined in 1993 to 1994. Shrimp farming registered a creditable growth comprising about 28.6% of the total shrimp production in 2003.

Overview of Shrimp Farming

Background

Traditional shrimp farming began in Malaysia in 1930s until the successful larviculture of shrimp in the late 1960s, which led to the large-scale shrimp seed production. The ample hatchery-produced seeds paved the way for the development of shrimp farming in the late 1970s.

The problems encountered by shrimp farmers using traditional pond culture was minimized in 1980s after new and more modern farms were constructed thereby bringing the industry to its new phase. Shrimp production increased from 60 tons in 1984 to 3,057 tons in 1991 and 30,000 tons in 2003. It slightly decreased in 1992. The bulk of the production consists of the tiger shrimp, *Penaeus monodon* and the rest banana shrimp, *P. merguensis*, and the Indian white shrimp, *P. indicus*.

The number of shrimp farms has steadily increased over the years due to the active participation of farmers, intensive training, technology, easy access to credit facilities, government support and consistent good market price. The potential development of shrimp aquaculture industry in Malaysia is promising.



A typical shrimp hatchery in Malaysia (left photo), a main source of seeds for shrimp grow-out culture in ponds (right)



Harvest from shrimp hatchery for stocking in shrimp ponds

Development of Shrimp Hatchery

There are 94 shrimp hatcheries in Malaysia, most of them located in Peninsular Malaysia and Sabah. The hatchery designs vary from simple low budget to more sophisticated ones. All hatcheries are dependent on wild broodstock and spawners while a few have their own maturation programs to supplement wild broodstock supply. *Vibrio* is the most common disease problem in shrimp hatcheries. Use of antibiotics is still common although being discouraged.

Grow-out

Semi-intensive and intensive culture systems are widely practiced in *P. monodon* culture. Malaysia applies the same culture protocol being done in other countries, i.e. pond preparation, fertilizing, feeding, aeration, harvesting, water management, etc. Common diseases affecting shrimps during grow-out are Bacterial Black Spot, vibriosis and viral diseases.

Major Issues of Shrimp Farming

Diseases

Disease outbreaks may occur in all stages, hence, proper pond management and disease preventive measures against these disease-causing organisms should be done.

Environmental Impacts

The negative impact of shrimp culture activities on coastal resources of Malaysia is now being addressed. The country had to learn the costly lessons of shrimp producers in Asia. Farmers and investors are advised to follow the Code of Practice and Farm Certification Scheme Guidelines.

Competitiveness

Cost of production is a major factor that may likely affect the future expansion of shrimp farming in Malaysia. More efficient pond management measures must be adopted to reduce production cost and increase productivity.

Conflict of Interests

Land for expansion has become more expensive and difficult to acquire especially in Peninsular Malaysia. Thus, the Department of Fisheries has proposed zoning areas for aquaculture.

Shrimp Processing and Marketing

Farmed shrimps are marketed either as raw or processed products. Processed shrimps are exported to Japan, Europe, USA, Australia and New Zealand. Malaysia complies with the international trade and

World Trade Organization requirements by obtaining a certificate for Hazard Analysis Critical Control Point (HACCP) from the Ministry of Health.

Status of Aquaculture of *P. vannamei* and other Exotic species

There was an official application from a foreign investor in 2000 to introduce *P. vannamei* as alternative to *P. monodon* in Malaysia but was rejected by the Department of Fisheries. Importation of *P. vannamei* broodstock as well as producing postlarvae in hatcheries is not allowed in the country. Despite an indefinite ban on introduction of *P. vannamei*, there are reported importations of the exotic species in the Peninsular Malaysia and Sabah, hence there are pockets of illegal culture operations in said places.

Conclusion

There is a good potential for the development of the shrimp culture industry in Malaysia if resources and technical expertise in the country are well utilized. Malaysia is committed to developing SPF/SPR broodstock in collaboration with the industry. And with a target production of 150,000 tons by 2010, there is a need to explore alternative species to *P. monodon*, i.e. *P. merguensis* and *P. indicus*.

Although DoF of Malaysia does not officially favor *P. vannamei*, it is still open to views and experiences from neighboring countries. Due consideration would be given if there are established protocols, guidelines and management practices to avoid introduction of TSV and other viral pathogens in the country.

MYANMAR

The traditional trap and hold shrimp culture commenced in Myanmar in 1970s in the western coastal areas. The natural post-larvae of *Penaeus monodon* were trapped into the ponds during high tide. Despite lack of pond preparation, eradication of predators, water fertilization, feeding etc., 30 to 50 kilograms of large size shrimps were harvested. Because the ponds were usually large (50 to 100 hectares), the shrimp production could provide more than enough money for the shrimp farmers. Having no laws concerned with aquaculture, those shrimp ponds existed as illegal ponds. In 2000, the Shrimp Aquaculture Development Committee was formulated and implemented a three-year project plan of the shrimp aquaculture development in Myanmar.

According to that plan, existing shrimp pond area of 26,978 ha can be increased to 48,000 ha. Thus in 2003, the total shrimp pond area was 79,984 ha, 2100 ha of which were semi-intensive or intensive shrimp ponds.

Shrimp Export

In 1989, Myanmar promulgated a Law Relating to Aquaculture and since then illegal fishponds and shrimp ponds have become legal culture ponds under the umbrella of the said law. It is only after the promulgation of this law that the established statistical figures were available. Thus, the shrimp exports of Myanmar in terms of quantity and value including capture and culture were properly reported, where shrimp production from aquaculture was estimated to be only 25% of the total export.

Problems in the industry

Disease outbreak

By the time the three-year project plan was implemented, there emerged many private companies that became involved in shrimp aquaculture. Fast development in the shrimp culture resulted in inadequate supply of shrimp seeds. Importation of shrimp seeds must have caused the entry of uncertified shrimp seeds, which eventually resulted to the outbreak of white spot viral disease and also caused the horizontal transmission of the disease.

Shrimp market price

Through the normal trade, shrimps are exported to many countries. But head-on chilled shrimps are normally exported through the border trade. The price of the shrimp has been very unstable and because of the low price, some farmers stopped using the intensive method. The cost of fuel for operating paddle wheels has also increased tremendously, thus the selling price of the culture shrimp cannot compensate with the production cost.

Policy Issues on the Import and Culture of Exotic Shrimps

Existing laws and regulations

There were no specific fishery laws until 1989. But the Government of the Union of Myanmar has promulgated four fisheries laws including a Law Relating to Aquaculture. Under this Law, section 35 states that approval shall be obtained from the Department of Fisheries in terms of import or export of live fishes into and out of the country.

Meanwhile, basic concepts of the section in terms of conservation and preventive measures are also explained to potential importers of live fish in order to facilitate their application. Thus, the importer has to comply with this section and the corresponding regulations mandated by the Department of Fisheries.

Apart from section 35 in the Law Relating to Aquaculture, section 39 A and B states that the Minister for Livestock and Fisheries has the right to issue the proceedings with the approval of the Government and the Director-General of the Department of Fisheries also has the right to issue notifications with the approval of the Ministry of Livestock and Fisheries. Up to the present no proceedings and notifications with respect to Invasive Alien Species (IAS) have been issued yet. However, the Department of Fisheries is taking utmost care and commensurate safeguard on the importation of alien fish to Myanmar.

Status of Implementation and Enforcement

At present, the import of exotic or alien shrimp species including *P. vannamei* and *P. stylirostris* is strictly prohibited in Myanmar to safeguard its natural ecosystem.

Culture of *P. vannamei* and Other Exotic Penaeid Species

At the beginning of the three-year project plan in 2000, the Department of Fisheries has allowed the importation and culture of *P. vannamei*. The DOF, as the sole competent authority of the fisheries sector, fully understand that vannamei has many advantages for culture but may also cause negative impact to the other shrimp aquaculture industry. Also the Department of Fisheries has been aware that vannamei may carry the taura syndrome virus. However, the post larvae of blue shrimp *P. stylirostris* were imported in 2000 and experimental culture was initiated. Due to very low salinity during rainy season the survival was very poor and the species was no longer of interest among the shrimp farmers.

On the other side, the shrimp farmers made several requests to DOF to allow the importation and culture of *P. vannamei*. In 2001, one private company was permitted to import 500 parent stocks of *P. vannamei* from Hawaii. Unfortunately or fortunately all the parent stocks died on the way to the hatchery because of prolonged transport time. At the same time another shrimp farming company was allowed to culture *P. vannamei* in a far isolated area. That company imported one million post-larvae of *P. vannamei*, but only 4 tons were harvested. Since then, no request to import the species was made.



The Department of Fisheries of Myanmar consulted with the scientists from FAO, NACA, SEAFDEC and other agencies to import and culture *P. vannamei*. Almost all recommended that it was still very early to start vannamei culture, hence, the DOF Myanmar has suspended the culture of vannamei. At this moment, the shrimp farmers became fed-up with culturing *P. monodon* because of heavy losses caused by white spot syndrome virus. They are now very much eager to culture *P. vannamei*.

Labor and Employment Generated

Normally, the DOF organizes a basic training on hatchery and grow-out culture operation for laborers once or twice a year, where they are assigned to the private hatcheries and culture ponds. For graduates of B.Sc. or M.Sc., an advanced training course mainly on *P. monodon* hatchery and grow-out culture operation are conducted every year or two.

R&D Activities on *P. vannamei* and Other Exotic Shrimps

Introduction of exotic shrimps including *P. vannamei* has not been allowed in Myanmar, hence there are no activities related to research and development on *P. vannamei* and other exotic shrimps.

Development of local capability to produce broodstock including SPF and SPR

Local shrimp hatchery operators are operating hatchery management including collection of broodstock from the wild, ablation, broodstock management in the hatcheries, spawning, larval rearing etc. Supposing that *P. vannamei* and other exotic shrimps are introduced, there is a need to educate the operators to enhance their capability, and demonstrate to them the production of SPF or SPR broodstocks. This type of training and demonstration should be collaborated among SEAFDEC scientists and the host country.

Monitoring coastal areas and fish catch for occurrence of exotics species in the catch

Currently, there is no report on the occurrence of exotic shrimp species in coastal areas and fish catch. However, when exotic shrimp species including *P. vannamei* are introduced, regular monitoring in the coastal areas and fish catch and assessment of the negative impact on native species should be conducted. Principally, the introduction of exotic shrimp species is mainly for the purpose of aquaculture and the escape of those exotic shrimp species should be strictly and carefully prevented.

Disease Out-break and Management

Presently, Myanmar has no source of taura syndrome virus since it has not allowed the introduction of *P. vannamei*. If ever the country would allow the introduction of *P. vannamei*, the best quality of SPF and SPR broodstock shall have to be imported and the newly introduced broodstocks are to be kept in confined and isolated areas.

Proposed Guidelines for the Introduction and Culture of Exotic Shrimps

Despite some characteristics of carrying new virus like taura syndrome, *P. vannamei* is still a suitable species for introduction and culture. It can tolerate low salinity and also low temperature. It can be cultured at a very high stocking density. Unlike the *P. monodon*, *P. vannamei* needs low protein in its diet and daily feeds. It can grow fast within 100 days of culture and can attain market size thus resulting to high production.

The shrimp farmers willingly request DOF to allow the culture of *P. vannamei* in Myanmar. If the Asian and SEAFDEC countries have decisive recommendations on the introduction and culture of *P. vannamei*, Myanmar shall also comply with the workshop decision in order to be in line with other Asian countries.

In such situation, the Department of Fisheries is the only competent authority for fisheries development. It should be mainly responsible for the introduction of SPF and SPR broodstocks of *P. vannamei*.

In consultation with SEAFDEC/AQD and NACA, Myanmar would get the source of best quality SPF and SPR broodstocks.

Special training and/or workshops concerned with technology on hatchery and grow-out culture operation should be conducted in the host countries prior to the introduction of *P. vannamei* and other exotic shrimps. At the same time, the DOF and other competent fishery authorities should issue some appropriate guidelines to increase pond production and also safeguard the environment in the respective countries.

PHILIPPINES

Overview of Shrimp Culture Industry

Shrimp industry in the Philippines refers only to *P. monodon*, the only penaeid species being exported. Grown in almost all over the country, tiger shrimp, locally known as “sugpo,” was only secondary species to milkfish. It was only in 1951, when the first propagation of *P. monodon* in brackishwater grow out pond was documented. Its full commercialization however was realized in the 1980s.

Production, Yield and Export/Import

Black tiger shrimp production peaked in the 80s and started declining in the 90s due to the widespread occurrence of bacterial diseases such as vibriosis, luminous bacterial (Lumbac) infections, white spot syndrome (wss). This caused prawn growers heavy losses after several failed runs.

The biggest share in tiger prawn production in aquaculture came from brackishwater pond and minimal contribution from marine fish cage and marine fish pen. The increasing trend from 1998 to 2001 was due mainly to the shifting of milkfish growers to tiger prawn culture because of its rising demand, both at domestic and foreign markets. In 2002, production however registered to a record low of 12.79% decrease due to poor quality of post larvae resulting to high mortality rate brought about by “Lumbac” and also by erratic high salinity of water and hot temperature as an effect of the El Niño phenomenon.

The top five producing provinces for the last five years in terms of volume were Pampanga, Zamboanga del Sur/Sibuguey, Lanao del Norte, Bataan and Bohol. From 1998 to 2001, the annual average yield per hectare of tiger prawn grew from 0.42 mt to 0.51 mt. It decreased by 9.8 percent to 0.46 percent in 2002. Pampanga, Lanao and Bataan showed increasing yields per hectare from 1998 to 2001 but declined slightly in 2002 due to poor quality of post larvae. Bohol had the highest yield of 1.0 mt/ha from 1998 to 2000 but it decreased to 0.84 and 0.93 mt/ha in 2001 and 2002, respectively. Pampanga, which ranked number one among the top five provinces, remarkably recorded a negative growth rate of 38.57 percent in yield.

The volume of shrimps exported from 1998 to 2002 exhibited an upward movement. An average growth rate of 12.83 percent was registered during the last five years. The export to Japan was reduced to 1.0% from 52% of the total in 2002. Likewise, exports to the USA went down by about 24 percent. The decrease, however, was offset by the combined exportation to Korea, Hong Kong, Guam and other countries which



White shrimp broodstock being maintained at a Philippine Government hatchery in northern Philippines

went up by almost 229 percent in 2002 against 2001 resulting in an overall increase of 32.6%. Similarly, the 2002 export value of shrimps and tiger prawn grew by 12.02% compared with 2001. Export earnings had an annual growth rate of 2.56 percent.

The country's importation of shrimps and tiger prawn was less than one percent of its exports in 1998 to 2001. However, the import volume and value of shrimps abruptly increased in 2002 and the trend is going upward although the ratio of import to export remained low. Importation went up and augmented domestic supply. Lower world price also encouraged importation. China, the number one source of shrimp imports in 2002 sold 1,285 mt (in frozen form) to the Philippines. During the year, shrimps were also sourced from Thailand, Singapore, Taiwan, the USA and other countries. The country imported 144 mt from Thailand, 44 mt from Singapore, 16 mt from Taiwan and 4 mt from USA. About 85 mt were sourced from other countries.



Problems in the Industry

The major losses that devastated the shrimp industry were:

- Reduction of culture area from 47,776 has in 1992 to 36,658 has in 1993;
- Reduction in the number of shrimp processors and exporters from 53 in 1992 to 18 in 1995; and
- Our country that produced about 90,000 mt to 100,000 mt lost the 4th slot in the world producers of shrimp which means billions of pesos.

Other Constraints in the Shrimp Industry

- Many shrimp producers are not yet ready to invest huge amount of capital to adopt the environment-friendly shrimp culture;
- Likewise, most operators are not financially capable to adopt the said technology;
- Poor performance, growth and susceptibility of *P. monodon* to diseases;
- The rapid development of *P. vannamei* in the world market makes the operators more aggressive to pressure the government to lift the ban on the controversial shrimp. The white leg shrimp head-on is now in global markets and being sold also in Japan, where more than 50% of our black tiger are being exported;
- Lack of financing program to support the industry;
- The cheaper cost and shorter period of culturing *P. vannamei* make the shrimp growers think that it is the best alternative to our high valued monodon;
- The entry of *P. vannamei* cannot be effectively controlled for some reasons, making uncertified and uncheck fry enter the country which could be carriers of the dreaded bacterial/virus/diseases;
- Many stakeholders are already dissatisfied for the slow and sluggish recovery of the shrimp industry;
- Illegal entries/importations of vannamei were recorded, documented and apprehended.

Policy Issues on the Import and Culture of Exotic Shrimps

Existing Laws and Regulations

There are existing policies governing shrimp farming in the Philippines including import and export regulations and related policies to address the major problems and constraints besetting the industry:

1. The Department of Agriculture/BFAR organized the “Oplan Sagip Sugpo” on September 16, 1996 with SEAFDEC/AQD Chief, Dr. Rolando R. Platon, as Chair;
2. In the early 2000, BFAR further strengthened its fight against shrimp diseases with the upgrading of its 24 regional fish health laboratories – 16 of these are equipped with PCR (Polymerase Chain Reaction) that could detect the dreaded WSS virus;
3. BFAR has acquired the ELISA equipment to detect the presence of banned antibiotic residues such as nitrofurans and chloramphenicol even in minute quantities;
4. BFAR formulated FAO 207 series of 2001, further strengthening FAO 189 series of 1993, which among others prohibit the importation of exotic shrimps,
5. A Code of Practice for Sustainable Shrimp Farming was prepared by the joint effort of BFAR, SEAFDEC and PCAMRD;
6. Implementation of Surveillance Program – SIMS – Shrimp Importation, Monitoring and Surveillance Team;
7. Organization of an inter-agency Task Force – BFAR, ISAFP, BID and PNP; and
8. Creation of an ad-hoc team known as the Task Force Vannamei.

Status of Implementation and Enforcement

1. Even with the strict implementation of the above-mentioned FAO 207 and strict surveillance in airports, traders are finding other ways in bringing the illegal shrimp inside the country without passing through the airports
2. SIMS spearheaded six major confiscations in late 2002 up to 2003
3. Likewise, in August 30 and September 3 of 2003, SIMS Team successfully completed operations on the illegal culture of imported shrimp conducted in two sites in Zambales. Yet there is a report that there are about 700 has farms already culturing *P. vannamei* in Luzon.

Experimental Culture of *P. vannamei*

In August 2004, DA-BFAR and Agrifisheries World Inc., a private entity engaged in the culture of various species such as *P. vannamei*, agreed to undertake research and verification studies on the use of Specific Pathogen Free (SPF) and Specific Pathogen Resistant (SPR) *P. vannamei* for hatchery and grow-out purposes at BFAR-NIFTDC, Bonuan Binloc, Dagupan City.

The project promotes partnership between the government and the private sector towards increased shrimp production by introduction of new high-yielding species.

SINGAPORE

The shrimp industry in Singapore began in the 80s and slumped in the 90s due to serious disease outbreaks and urbanization. Shrimp production which was then dominated by black tiger prawn was 60 mt in 2000 and increased to 114 mt in 2001. It drastically reduced from 115 mt in 2002 to 46 tons in 2004. Imported shrimps to Singapore in 2003 reached 21,157 mt valued at \$129.57 M. Domestic market alone required 16,359 mt valued at \$106.5 M. Imported raw shrimps are processed and exported. Shrimp culture in Singapore suffered significant losses in the 90s due to the Yellowhead Virus (YHV) and the White Spot Syndrome Virus (WSSV). Urbanization was also attributed to the reduction of production.

Under the Wholesome Meat and Fish Act, the existing laws and regulations are to ensure wholesome food safety. Seafood products are regularly tested for preservatives and contaminants such as heavy metals and drug residues. All imported fish products shall comply with prevailing regulations by the Agri-Food & Veterinary Authority of Singapore (AVA).

Culture of *P. vannamei* commenced in 2002 and majority of the fry were purchased from Taiwan. The grow-out culture areas at about 3 hectares produced 8 tons of live *P. vannamei*. The shrimp culture generates employment of less than 10 persons. R&D activities on *P. vannamei* and other exotic shrimps are not well established, although shrimp production on coastal areas and fishing catch for occurrence of exotic species have been monitored and investigated. A field survey of *P. vannamei* culture was conducted on two shrimp farms (round concrete pond system and rectangular concrete pond system). The stocking biomass was 185 pcs/m³ and 120 pcs/m³, respectively. At the end of the 2-month culture, the mean body weight of the shrimps reached 10 g with survival rate of 60% in the round pond and 72% in the rectangular pond. The biomass of the round pond was 2.6 kg/m³ while the rectangular pond was 1.2 kg/m³. The results from both systems indicate the potential of *P. vannamei* culture in this region.



The dominant species that were cultured since the 90s were the black tiger shrimp (*Penaeus monodon*) and the banana shrimp (*P. merguensis*). *P. vannamei* was only introduced to Singapore in 2002. Due to their greater ease to culture, adaptability to the local environment, high growth performance with less protein requirements and better survival rate, the production costs lowered and *P. vannamei* became the cheapest shrimps in the market. Experimental introduction of specific pathogen free (SPF) *P. stylirostris*, also known as “supershrimp,” was introduced to Singapore in 2001, however there has been no further development on this species since then.

Problems in the shrimp culture industry

The shrimp industry in Singapore in 1990s was perceived to be poor due to slow growth rate and disease susceptibility in the major indigenous shrimp culture species. *P. monodon* and *P. merguensis* were virtually characterized by serious viral pathogens causing significant losses to the culture industries. In Asia, the native shrimp culture industries suffered heavy losses in 1992 first due to the Yellowhead Virus (YHV) and later in 1994 due to the White Spot Syndrome Virus (WSSV).

Policy issues on the import and culture of exotic shrimps

Existing laws and regulations

An import permit issued by the Agri-Food & Veterinary is required for every consignment of imported fish products. Traders may apply for permit by declaring the import through the TradeNet system. For fish products, documents such as invoices and airway bill would need to be submitted. Imported fish products are subjected to inspections. Samples may be taken for laboratory analysis.

Status of implementation and enforcement

All fish products for import shall comply with prevailing regulations of the Agri-Food & Veterinary Authority of Singapore (AVA). Health requirements governing the importation of the high risk items are available upon request. The transshipment procedures of fish products for export from Singapore are similar to that for import for a fee of \$18 per consignment.

AVA regularly samples and tests all types of fish and seafood products for preservatives as well as contaminants such as heavy metals and drug residues. In addition, AVA has stationed officers at the fishing ports to spot and take action against any illegal activities including the use of preservatives. Under the Wholesome Meat and Fish Act, any person who is convicted of selling or supplying fish or fish products that are adulterated is liable to a fine not exceeding \$50,000 or imprisonment for a term not exceeding 2 years, or both.

Culture of *P. vannamei* and other exotic penaeid species

History of introduction and source of broodstock

P. stylirostris and *P. vannamei* were introduced into Singapore in years 2001 and 2002, respectively. The *P. stylirostris*, also known as “supershrimp,” was introduced into various Asian countries from 2000 but no further developments were made in Singapore after 2001. For *P. stylirostris*, a hatchery was set up in 2001 and the broodstock was imported directly from USA. The hatchery was unsuccessful and the operation was moved to Brunei Darussalam. For *P. vannamei*, no hatchery was set up and the juveniles were purchased directly from Taiwan.

Grow-out culture and location of ponds and area used for culture

In Singapore, only one farm was involved in *P. stylirostris* grow-out culture in 2001, producing 4 mt of shrimps before the operation was terminated. Two farms (3 ha) in Singapore have been actively involved in *P. vannamei* culture since 2002. The total production for the past three years was 18 mt and the produce was sold to domestic live fish markets with the selling prices ranging from \$16 to \$18 per kilogram. The field survey of *P. vannamei* culture was conducted on two shrimp farms in Singapore from September-December 2004. A standardized economic questionnaire that included costs, returns and growers’ perceptions of constraints was used for the study. Economic estimates were developed for representative production systems. Juveniles of *P. vannamei* were reared in two farms using different culture systems. The first farm used a round concrete pond with a water capacity of 700 metric tons while the second farm used a rectangular concrete pond with a water capacity of 2500 metric tons. The stocking biomass of the round tanks system was 185 pcs/m³ while the rectangular tank system was 120 pcs/m³. At the end of the 2-month culture period, the mean body weight of the shrimps reached 10 g with the round pond having a 60% survival rate and the rectangular pond having a 72% survival rate. The biomass of the round pond was 2.6 kg/m³ while the rectangular pond was 1.2 kg/m³. The results from both systems indicate the potential of *P. vannamei* culture in this region.

Production and Market

The total production of *P. vannamei* in 2003 was 6 mt, valued at \$99,000 and 8 mt valued at \$145,000 in 2004. Domestic market requires 21,157 metric tons with price ranging from \$6 to \$12 per kg depending on the sizes and freshness of the shrimp.

The processing industry needs 5,000 mt annually to support export demand. Shrimps and prawns exported in 2003 was 4,913 mt valued at \$42.38 M.



P. vannamei cultured in rectangular pond, Stocking Biomass = 120pcs/1.2kg/m³.
Survival Rate = 72%



Preparation of *P. Vannamei* for the live fish market



Dr Nagasawa visited the *P.vannamei* culture farm.



P. vannamei cultured in round concrete pond, Stocking Biomass = 185pcs/2.6kg/m³.
Survival Rate = 60%



R&D activities on *P. vannamei* and other exotic shrimps

R&D activities on *P. monodon* and *P. merguensis* have been carried out since early 90s while on *P. vannamei* and other exotic shrimps, in early 2000s. The experimental study on shrimp hatchery gained strong foothold during early 90s but has not been sustained in 2000.

Disease outbreak and management of *P. vannamei*

So far there was no major disease outbreak reported for the past three years.

Proposed guidelines for the introduction and culture of exotic shrimps

There are no currently specific guidelines for the introduction and culture of exotic shrimps. However, a survey that used a standardized economic questionnaire that included costs, returns and growers' perceptions of constraints was conducted to determine economic estimates and status of production systems.

THAILAND

Aquaculture has been practiced for a long time in Thailand. It has a huge flood plain, long riverine stretches, natural lakes, reservoirs and brackishwater areas along the coastline. Its total production area is 75,000 ha generating 30,800 farmers and producing 330,000 mt in 2003. The natural resources and other key factors brought Thailand as the world's major producer of shrimps (*P. monodon* and *P. vannamei*) since 1991. More than 95 percent of marine farming production has been exported frozen to the United States, Japan, Europe, Canada, etc.

Success factors for shrimp farming in Thailand

Thailand has been raising marine shrimps using traditional or extensive shrimp culture systems for the past 80 years. Intensive shrimp farming started in the 80s and has been so for the last 20 years. The expansion and rapid increase of production made Thailand the leading marine shrimp producer since 1991. Success is attributed to factors that include: (1) suitable sites, (2) availability of wild broodstock, (3) extensive experience in aquaculture, (4) well-developed infrastructure and supporting industries, (5) small-scale industry, (6) less destructive environmental impact, and (7) research and development program.

Aquaculture of White Shrimp

P. vannamei (white shrimp) was first introduced to Thailand in 1999. The shrimp fry were illegally brought for culture in Surajthani province, Southern Thailand and was reportedly successful. However, in order to sell the product, it has to be transported to Singapore. Since then, fry had been illegally brought into the country for culture until 2002 when the Royal Thai Government through the Department of Fisheries (DOF) launched the regulation for white shrimp spawner importation that would require for disease free of WSSV, IHNV, TSV and YHV certification.

The first imported white shrimp have had some problems of disease outbreak, especially of TSV and IHNV. The importation regulation was ended in early 2003. The shortage of good quality broodstock prompted the DOF to allow again importation of broodstock but required all importers to register the sources of the shrimps to be approved by the DOF prior to the importation. Hatchery operators have to meet several requirements before importing shrimp spawners.

There are at present 6 certified hatcheries/sources of white shrimp spawners in USA where 30,000 both male and female, have already been imported to Thailand. Thailand needs around 100,000 spawners per year for shrimp culture.



Spawning tanks



White shrimp pond

The production of white shrimp from aquaculture has rapidly increased since 2002. The production was around 30,000 tons in 2002, 170,000 tons in 2003 and 300,000 tons in 2004 which is around 80% of the total marine shrimp production.

Culture Techniques of White Shrimp

Since February 2002, the Department of Fisheries has permitted importation of White Shrimp broodstock from certified worldwide sources to produce seedlings and support grow-out farming. Each lot of imported shrimp is possible to maintain a 6-month period and needed for renewable recruitment. The hatchery operators would be registered by the DoF process and require them to comply with the standard production process.

Like *P. monodon*, female ablation is done on white shrimp to induce maturation. Male and female shrimps are stocked (1:1) and fed on live organisms with high concentration of highly unsaturated fatty acid. Periodic check of virus infection is done throughout the stocking period.

Culture techniques in almost all stages of white shrimp development are basically similar with that in *P. monodon*. *P. vannamei*, however, requires lower protein than *P. monodon* and *P. vannamei* can feed on natural food grown in the pond.

Disease and Prevention

Few diseases have caused significant damage on *P. vannamei* shrimp culture, i.e. White Spot Syndrome Virus (wssv), Infectious Hypodermal and Hematopoietic Virus (IHHNV) and Taura Syndrome Virus (TSV). Selection of good quality shrimp fry from certified sources has been required, while some required the PCR check.

Research and Development Activities on White Shrimp Aquaculture

White shrimp aquaculture production shares the bulk in marine shrimp production, which is approximately 80% of the total production (300,000 mt in 2004). The production is expected to increase up to 350,000 mt in 2005.

The Royal Thai Government through the Department of Fisheries has the following Research and Development plans on white shrimp:

- Developing capability of producing white shrimp broodstock locally including SPF and SPR strains.
- Establishing a program for SPF white shrimp hatcheries. This program is voluntary where private hatcheries can apply for SPF hatcheries certification.
- Permitting private hatcheries to import white shrimp spawners, and requiring them to keep 10 percent of shrimp fry in their own areas to produce SPF and/or SPR broodstock.
- Developing SPF and/or SPR white shrimp broodstock.
- Evaluating and monitoring coastal areas on habitation of white shrimp in natural waters.

VIETNAM

Overview of Shrimp Culture *P. merguensis* and *Metapenaeus ensis*

The most important shrimp species for culture are *P. monodon*., *P. merguensis* and *Metapenaeus ensis*. Shrimp culture has rapidly developed in the last decade as indicated by the increase of the total production of PL, number of hatcheries, and production areas from 2000 to 2004. Total shrimp production increased from 104,519 to 295,660 tons; PL production from 10,000 to 25,000 M; number of hatcheries from 2,669 to 5,094 and culture areas from 224,407 to 592,585 ha.

Policy issues on the import and culture of exotic shrimps

Vietnam Fisheries Law that was enforced starting July 1, 2004 contains a chapter on aquaculture (Chapter IV) that stipulates provisions related to aquaculture activities.

Article 23: Masterplan on aquaculture development

1. The masterplan on aquaculture development shall be a part of the overall development of fisheries sector approved by the Government.
2. Ministry of Fisheries shall chair the coordination with relevant Ministries and provincial People's Committee in formulating the masterplan on aquaculture development nationwide and of specific province and city under central level. Provincial People's Committees, on the basis of the masterplan approved by the Government and in accordance with guidance of Ministry of Fisheries, shall formulate specific masterplan to submit to the People's Council at the same level for passage and to report to the Ministry of Fisheries.
3. Change and supplement of the masterplan on aquaculture development shall be decided by agency dealing with masterplan approval.

Article 24: Aquaculture conditions

1. Organizations and individuals engaged in aquaculture shall meet the following conditions:
 - a. Construction sites for aquaculture facilities shall be placed in accordance with the masterplan.
 - b. Aquaculture facilities shall be complied with the technical and conditional requirements, veterinary sanitary standards and environmental protection as stated by legislation.
 - c. Should use feed and veterinary drugs that are up to standards as regulated by legislation regarding veterinary service.
2. Ministry of Fisheries shall issue standards, process and procedures of aquaculture sites, shall chair the coordination with relevant Ministries and ministerial-level agencies, provincial People's Committees to provide guidance, examination and recognition of qualified aquaculture sites conducted by means of semi-intensive and intensive methods that meet the food hygiene and safety standards.

Article 27: Allocation, lease and revocation of aquaculture land

1. The allocation, lease and revocation of aquaculture land shall be done in compliance with the Land Law and other relevant legislation.
2. Organizations and individuals to whom aquaculture land is allocated and leased shall comply with the rights and obligations as set out by this Law, Land Law and other regulations of relevant legislation.

Article 32: Concentrated aquaculture areas

1. The State shall support the establishment of infrastructure for concentrated aquaculture areas in accordance with the development masterplan and plans of fisheries sector, and shall invest in the setting up of monitoring stations for fisheries environment and fish disease control stations.

2. Organizations and individuals conducting aquaculture in concentrated aquaculture areas shall comply with the regulations of concentrated aquaculture areas, professional technical requirements on aquaculture construction, aquaculture techniques and farming environmental protection.
3. The Ministry of Fisheries shall make regulations relating to water quality standards on aquaculture, specialized technical standards on aquaculture construction; shall issue rules on organization and operation of concentrated aquaculture areas as well as closed-harvest time to ensure food hygiene and safety.
4. The Provincial People's Committee shall have the responsibility to manage concentrated aquaculture areas.

Article 33: Fish Fry

1. The quality of fish fry for aquaculture, rehabilitation and development of fisheries resources shall be ensured in accordance with criteria system of Vietnam.
2. Organizations and individuals who produce and trade fish fry shall meet all the trade conditions as regulated by the Government, and shall ensure that fish fry production is in accordance with the sector's standard requirements.
3. New fish fry and firstly-introduced fish fry used in aquaculture shall be recognized and allowed to be produced by the Ministry of Fisheries.
4. The State shall issue policies to promote the research of precious and rare fish fry and the creation of new fish fry, shall invest in the establishment of national hatcheries. The Ministry of Fisheries shall coordinate with provincial People's Committees to examine the fish fry quality in hatcheries.

Article 34: Import and Export of fish fry

1. The imported fish fry shall be subject to quarantine as regulated by legislation regarding veterinary service and plant protection and quarantine legislation.
2. New fish fry imported for the first time shall be approved in writing by the Ministry of Fisheries.
3. The transit of fish fry through Vietnam shall be done in accordance with legislation relating to veterinary service, plant protection and quarantine as well as other relevant legislation.
4. Exported fish fry shall be under the list of specialized exportable fishery products except the exchange of fish fry, scientific and technical research cooperation, gifts or other special cases as regulated by Ministry of Fisheries.

Article 36: Prevention and control of fish disease

1. Organizations and individuals engaged in fish fry production and aquaculture shall apply measures to prevent fish disease. Where fish disease occurs, treatment shall be timely applied and local authorities and specialized agencies shall be informed at the same time.
Diseased farmed fish shall be treated in accordance with legislation on veterinary service and plant protection and quarantine.
2. The Ministry of Fisheries and People's Committees at all its levels shall be responsible for prevention of fish disease. The proclamation of fish disease and its cancellation, the proclamation of the list on fish disease and epidemic shall be done in accordance with legislation relating to veterinary service.

Culture of *P. vannamei* and other exotic penaeid species

The only exotic culture shrimp species in Vietnam is *P. vannamei*, which have been imported from Taiwan into Bac Lieu province on January 4, 2001. Broodstocks and postlarvae were later imported from Taiwan, Hawaii, and Mainland China. The total PL production is small with some hatcheries producing PL in provinces of Quang Ninh (150 M), Phu Yen (71 M), Ha Tinh (35 M), Bac Lieu (8 M).

The area for *P. vannamei* is still very limited, hence, production is also very small. The shrimps are cultured in the provinces of Quang Ngai (800 MT), Phu Yen (615 MT), Bin Dinh (167 MT), Quang Tri (150 MT), Thua Thien-Hue (24 MT), Ninh Binh (10 MT), and Quang Ninh, Bin Thuan, Dong Nai.

R&D activities on *P. vannamei* and other exotic shrimps

P. vannamei is not yet popular in Vietnam. The Research Institute for Aquaculture has yet to learn its culture techniques.

Disease outbreak and management

There is no record of occurrence of Taura syndrome on *P. vannamei* in Vietnam. There are other common shrimp diseases appearing in other species, which the National Fisheries Quality Assurance and Veterinary Directorate (NAFIQAVED) is addressing.

Proposed Guidelines for the introduction and culture of the exotic shrimps

- The Ministry of Fisheries would elaborate the technical standards for the white leg shrimp hatchery
- SEAFDEC should conduct some projects on disease control in shrimp culture in the ASEAN Region.

JAPAN

The representative from Japan explained in brief that the R&D activities on *P. vannamei* in Japan are being carried out by the Japan International Center for Agricultural Sciences (JIRCAS).

CHINA

Overview of Shrimp Culture Industry

Historical Development of Shrimp Culture Industry

China is a country with longest history of aquaculture in the world. However, shrimp culture is a relatively new industry in China. The earliest national production figure of culture shrimp was 79 mt in 1970. It took more than 10 years for the production to reach 10,000 mt. The cultured shrimp production reached 10,093 mt in 1981.

In 1981-1988, China experienced the first golden period of shrimp culture industry development after the full maturation of mass production hatchery techniques for shrimp (*P. chinensis*). The total production of cultured shrimps unbelievably increased to 199,418 mt in 1988 from 10,093 mt in 1981. However, the good times did not last long. The peak production maintained for 5 years only, ending in 1992 with production of 206,866 mt.

The serious outbreak of shrimp diseases along with other shrimp producers in Asia, resulted to the drop of shrimp production to 87,856 mt in 1993 until 1994 (63,872 mt). The modification in the culture system and techniques enabled the industry to recover very slowly in the next three years, and regained its production to more than 100,000 mt in 1997. Since 1998, China has been into a new era in cultured shrimp production keeping a very fast growth from 143,080 mt in 1998 to 760,430 mt in 2003. The rapid growth of production during the last several years was mainly due to the rapid expansion of culture of *P. vannamei*.

The abrupt increase of cultured shrimp production in 2003 in China was attributed firstly to the unreported freshwater production on *P. vannamei* before 2003. It was estimated that production of cultured *P. vannamei* in freshwater environment reached 160,000 mt in China in 2002. This production figure, however, was not included in the total cultured shrimp production of that year. Secondly, it was only in 2003 when brackish and freshwater production of *P. vannamei* was separately reported.

Contribution of Different Shrimp Species to the Total Production

Several shrimp species have been cultured in China in the past two decades. Due to the structure of statistical system for aquatic products, shrimp production was included in the national statistics as aggregate production of all species until 2003. It was only then when production figure for four major cultured shrimp species, *P. vannamei*, *P. chinensis*, *P. monodon* and *P. japonicus* was reported separately. *P. vannamei* accounted for about 80% in the total production. It dominates the shrimp culture industry in recent years.

Value of Cultured Shrimps in China

Shrimps have the highest commercial value among all cultured species in China. In 2002, the cultured shrimp production increased by nearly 100% compared with the 1988 figure, but the total value increased only by little more than 50%.

Contribution of Shrimp Culture to Overall Aquaculture Sector

Shrimp culture industry takes a very small share in the total aquaculture sector in China. The highest was in 1988 when cultured shrimp production accounted for 2.85% of the total aquaculture production. When the product value is considered, the role of shrimp culture industry becomes much more important in the whole aquaculture sector. The largest contribution was also in 1988 when cultured shrimp production value accounted for 17.72% of the total aquaculture output value.

The contribution of shrimp culture industry in China in 2002 decreased by 60.38% (by volume) and 63.17% (by value) compared with that in 1988 despite of the 92.63% increase in production quantity. Such contrast is mainly due to the expansion of other culture species other than shrimps, which were seriously cumbered by the disease problems. However, the trend in recent years indicates a steady increase, although the question of sustainability remains.

Shrimp Export

Shrimp has been one of the most important exported aquatic products in China. However, no data is available for specific commodity from different sources (wild catch vs. aquaculture). Shrimp export from China was 6.45% of the total production in 2002. Cultured shrimps, the important export commodity after river eel, accounted for about 11% of the total shrimp production in 2003.

Problems in the Industry

China is presently facing several major problems in shrimp culture. The first is disease problem, especially White Spot Syndrome Virus, which seriously impacted the traditionally cultured species, *P. monodon* and *P. chinensis*. Although tremendous efforts (both financial and human resource input) have been invested in tackling the problem in China, there have been no established systematic measures that can effectively prevent and control the outbreak of the disease. The disease associated with *P. vannamei* (especially Taura Virus disease) is also an unpredictable factor determining the success or failure of the farmer. *Vibrio* spp is another disease of *P. vannamei*

The quality of shrimp fry is another problem significantly affecting the performance of the industry. Due to the very limited efforts in breeding techniques by the hatchery operators and repeated use of broodstocks, the degradation of shrimp fry quality results in slow growth rate, prolonged culture period and susceptibility to diseases.

Shrimp export is facing strong pressure from non-tariff trade barrier (technical barrier) set by an anti-dumping action adopted by importing countries. In addition, domestic market is seasonal and the fast expansion of production affected the economic returns of the shrimp farmers due to the unreasonably low selling price.

Policy Issues on the Import and Culture of Exotic Shrimps

A series of laws and regulations have been established to regulate various aquaculture related activities. Fisheries Law deals on quarantine of imported and exported animals and plants. There are regulations on (1) management of feed and feed additives; (2) management of veterinary drugs; and (3) management of broodstock and seeds for aquaculture. The Ministry of Agriculture issued in 2001 a Technical Code for Shrimp Culture to produce healthy food.

Chinese government generally encourages introduction of exotic species for aquaculture purpose but stresses the importance to prevent introduction and spreading of new disease pathogens. The Government evaluates ecological risk before allowing introduction of exotic species thereby requiring approval by concerned ministry or provincial authority. The introduction process includes quarantine procedure.

Not all aquaculture laws and regulations are strictly implemented and enforced. China is currently establishing license system for aquaculture in order to have better control over the aquaculture environment.

Culture of *Penaeus vannamei*

History of Introduction

Penaeus vannamei is the major exotic shrimp species cultured in China now. It was first introduced to China from Hawaii by the Oceanography Research Institute of the Chinese Academy of Science in 1988. The successful trial on artificial propagation of the shrimp in 1992 was followed by production of post larvae in 1994 and the first culture in brackish water. The serious viral disease outbreak in brackish water prompted the shrimp farmers to try culturing desalinized shrimp fry in freshwater sometime in 2001. The freshwater culture expand rapidly after it was proven to be even more successful than in brackishwater environment.

Source of Broodstock

Despite the rapid expansion in culture area and growth in production, China has not established its capability to produce its own broodstock for the culture of *P. vannamei*. At the moment, most hatcheries are basically dependent on overseas supply of *P. vannamei* broodstock, particularly from Taiwan Province although few hatcheries started to develop their own broodstock. *P. vannamei* broodstock from Hawaii are believed to be 2nd or 3rd generation from the SPF populations.

Number of Hatcheries

China is a vast country and *P. vannamei* culture is a fast expanding industry. An accurate estimation on the total number of *P. vannamei* hatcheries currently operating is not possible. The rough estimation is at least more than one thousand hatcheries concentrated in Guangdong, Hainan and Fujian Province along the southeast coast of China. *P. vannamei* hatcheries have been established in 14 provinces/autonomous region/central government directed municipality.

Total Production of Fry

Production of *P. vannamei* fry was not included in the fisheries statistics data in China until 2003. The total fry production reached 112,634 B in 2003, mostly from the three provinces along the southeast coast of China (Guangdong, Hainan and Fujian) contributing 69.06% to the national fry production.

Grow-out Culture

Within a short period, grow-out culture of *P. vannamei* has spread extensively in China due to its advantages for culture. Basically, *P. vannamei* can now be cultured in two different environments: freshwater and brackish water. Out of the total 33 provinces/autonomous region/Central government directed municipality in the mainland China, 24 are into *P. vannamei* culture in freshwater in 2003 and 11 coastal provinces/utonomous regions/Central government directed municipalities are into *P. vannamei* culture in brackish water.

There is no available data on pond culture area for *P. vannamei*. Rough estimate of the total area may be around 60,000-80,000 ha while the total brackish pond culture area may be around 40,000-60,000 ha.

Marketable size *P. vannamei* used to be 50-80 pieces/kg. in China until recently, when the production growth of cultured shrimp significantly declined. In order to market the shrimp with more or less the same culture period, the marketable size is 60-100 pieces/kg.

The total production of cultured *P. vannamei* reached 605,159 mt of which 296,312 mt came from freshwater and 308,947 mt from brackish water. Guangdong province is the largest contributor to total *P. vannamei* production in 2003, which was about 40%, followed by Jiangsu province (freshwater culture) and Haina (brackish water). Only a rough estimate can be made according to the total export volume and species composition of the production.

It is very hard to assess the contribution of cultured *P. vannamei* to the shrimp export either by quantity or value as the exported shrimp only accounted for small proportion of the total shrimp production. The contribution, however, is very significant especially cultured *P. vannamei* from brackish environment.

Labor and Employment Generated

In addition to the contribution to domestic shrimp supply and shrimp export, *P. vannamei* culture also brings about significant social benefit in terms of job opportunity. *P. vannamei* culture industry employs about 150,000 laborers in hatchery operation (about 10,000) and grow-out culture (about 140,000).

R&D activities on *Penaeus vannamei*

Culture of *P. vannamei* has been carried out in large scale in China for 5-6 years, hence, scientific research and technology development activities are limited. Existing activities are mainly focused on mass seed production technique and fast methods to detect viral disease and determine whether shrimp post larvae carry virus.

Very limited efforts have been made to improve the quality seed of *P. vannamei* since China has not yet established its own *P. vannamei* SPF or SPR population at the moment.

Disease Outbreak and Management

There was a serious outbreak of diseases in brackish water culture of *P. vannamei* in 2001, due to Taura virus which caused tremendous loss to the farmers. Since then, disease problem has always been the number one threat to farmers. Comparatively, disease problem is more serious in brackish water than in freshwater.

DISCUSSIONS AND RECOMMENDATIONS

SEAFDEC specialists gave additional information on matters that may affect shrimp culture. Dr. Teodora Bagarinao discussed the impact of introduction of exotic species, while Dr. Leobert dela Peña talked about known shrimp diseases and prevention and Dr. Emillia Quinitio regarding R&D of shrimp seed production.

Due to time constraints, the participants agreed that more issues and concerns on *P. vannamei* culture would be included in the activities of SEAFDEC through the ASEAN-SEAFDEC Five Year Program.



AQD Researcher *Leobert de la Peña* stressing on some precautionary measures related to the introduction of exotic shrimp species

Consensus Reached at the Regional Technical Consultation

1. It is clear that the main impetus for the importation and culture of the exotic species is the perceived superiority of the exotic species over the native stock of shrimp in terms of ease in culture, resistance to disease and potential yield and that this demand was further heightened by the decreasing number of healthy wild broodstock and lack of captive broodstock of native species.
2. It is clear that the farming of *P. vannamei* has been of economic benefit to the producing countries.
3. To allow the entry and farming of *P. vannamei* and other exotic shrimp species is the decision of each country. Countries that share the same water resources may inform each other on the introduction of any exotic species. (*Refer to the Regional Guidelines for Responsible Fisheries in Southeast Asia: Responsible Aquaculture 9.2.3*)
4. All live imports of shrimps should follow international guidelines including country to country rules and regulations.
5. All farming of exotic shrimp species must be fully monitored, whether or not the entry was in accordance with the law, so that each country will know the full extent of farming and the health status of the farmed stocks. (*Refer to the Regional Guidelines for Responsible Fisheries in Southeast Asia: Responsible Aquaculture 9.3.2 (1)*)
6. There is a clear need for Southeast Asia to develop its own capability to produce captive shrimp broodstock with particular emphasis on the native species. In the short term however there is also a clear need for the region to develop its own capability to produce SPF/SPR stock of the exotic species.

Proposed Plan of Action

1. Adopt precautionary approach and formulate appropriate guidelines for the introduction and use of exotic shrimp species in aquaculture based on established international guidelines for species introduction and transfers.
2. Ascertain the extent of culture of exotic shrimp species within each country's national boundary whether or not such shrimp stock came in within the legal framework.
3. Determine actual production figures for exotic shrimp species and include information in national fisheries statistics.
4. Study should be done to determine whether the exotic shrimp species has established itself into the local ecosystem in order to assess its impact on the population of native species.
5. A regional collaborative project should be initiated for shrimp broodstock development for both native and exotic shrimp species of interest to the region including the development of Specific Pathogen Free (SPF) and/or Specific Pathogen Resistant (SPR) stocks. For such purpose a regional round-table discussion should be convened as soon as possible to formulate the above-mentioned project.
6. Support the implementation of the Asia Regional Technical Guidelines for Health Management and Responsible Movement of Live Aquatic Animals and the Beijing Consensus and Implementation Strategy.
7. Integrate national strategies on aquatic animal health management into the national aquaculture development plans.

ANNEXES

Regional Technical Consultation on the Aquaculture of *P. Vannamei* and Other Exotic Shrimps in Southeast Asia

*Manila, Philippines
28 February-3 March 2004*

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Status of Shrimp Farming In Cambodia

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INTRODUCTION

In the South-Western part of the country, Cambodia has 435 km coastline in the Gulf of Thailand, which stretches between the Vietnamese borders in the South to the Thai border in the West.

The fisheries sector plays a vital function in Cambodia's food supply, particularly the poor. It is also important for Cambodia's national economy that most national incomes come from this sector through exploitation and exportation. According to the latest official data recorded by the Department of Fisheries (DoF), the total commercial fisheries production in 2002 was 424,400 metric tons, which included the small scale and family scale freshwater fisheries and aquaculture production, except crocodile culture (DoF, 2003). In this case, freshwater fish capture dominates the production, which accounted for 85% of the total production in 2002, while marine capture fisheries was 11%. The total aquaculture production represented only more than 4%. Even fish production increased in fish capture fisheries. The increasing production trend of the capture fisheries indicates overexploitation of fishery resources, hence, there is a need to restore fishery resources. To address this, local fishers need alternative jobs in order to enhance their livelihood and encourage them to minimize over fishing and also from destructive fishing practices. One of the options also is to promote aquaculture.

FARMING OF PENAEID SHRIMP

Shrimp culture activity along the coastline of Cambodia is carried out in four different locations namely Kep, Kompot, Koh Kong and Sihanouk Ville. Farming of shrimp is a relatively new development in Cambodia. It began in the late 1980s and early 1990s, but never reached the level of inland aquaculture. Two species of penaeid shrimp (*Penaeus monodon* and *P. vannamei*) have been introduced for farming in Cambodia's coastal areas.

Farming of *Penaeus monodon*

Penaeus monodon is a native species in the coasts of Cambodia. Farming of this species started in 1989, and significantly expanded since 1991. It can be classified into two different culture methods: (1) intensive shrimp farming and (2) traditional extensive shrimp farming.

In Kompot and Sihanouk Vile, the shrimp farms are mostly extensive, using traditional methods, although there are two intensive farms in Kompot (one is 16 hectares and another is 30 hectares which is still under construction). These extensive farms rely on natural supply of feed and seed. With no feeding, fertilization, or stocking management, productivity remains low at less than 100 kg/ha/year. The shrimp ponds are often constructed in or close to the mangrove areas, with some farms leaving the mangroves in the ponds.

In Koh Kong, the shrimp farms are mostly intensive. Intensive shrimp farming system was introduced to Koh Kong province by a Thai shrimp farmer and businessman. The farms relied mainly on Thailand for the supply of most inputs, such as feed, seed, chemical and equipment, and also for market of harvested shrimps. The intensive techniques for shrimp farming in Koh Kong involve high stocking density, formulated feed, aeration, and regular water exchange. The main species for culture is *Penaeus monodon*. Pond yield was reported to be high, at 7 to 8 tons/ha/crop for new farms, and profits are attracting further investment. However, the industry in Koh Kong is facing disease problems common in intensive shrimp farming due to self pollution that caused farmers significant economic losses. Other problems include resource conflicts particularly with farms located in or near mangrove areas.



A private hatchery was established in Koh Kong in 1994, reportedly producing about 2.5 million post-larvae to supply their own need. The operation of this hatchery was irregular due to many factors such as technical constraints, the seed market and lack of broodstock.

Based on the survey on sustainable shrimp farming management conducted by NACA in 1995, it was concluded that the extensive farms had low pond yield of 32kg/ha/year and an overall national sale value of only \$25 million per year. In contrast, intensive farms had an average production of 7545kg/ha/year with a national sales value of \$42 million per year (Touch Sean Tana, 2002).

A review of this sector in 1995, showed that the intensive shrimp farms in Koh Kong Province increased up to 1 000 ha until the onset of white spot syndrome virus (wssv). This virus has been the most serious threat faced by the shrimp farmers in Cambodia and is probably the major cause of direct losses of up to \$14.5 million per year. Hence, the shrimp farming area declined to about 850 hectares in 2000, and decreasing gradually each year (Touch Seang Tana, 2002).

Shrimp production is shown in **Table 1** (in tons):

Year	Production by Province				Total Production
	Kep City	Kampot	Sihanoukvill	Koh Kong	
1993	0	0	0	500	500
1994	0	0	0	560	560
1995	0	0	1	730	731
1996	0	0	0	600	600
1997	0	2	0	264	266
1998	2	46	13	151	212
1999	1	5	6	50	62
2000	1	0	0	19	20
2001	3	50	60	30	143
2002	1	0	25	27	53
2003	2	8	53	27	90
2004	0	20	37	18	75

Farming of *Penaeus vannamei*

Penaeus vannamei is not indigenous species in the coasts of Cambodia. *P. vannamei* postlarvae were first imported to the country from Thailand in 2000 for trial stocking by a private shrimp farmer in Otres of Sihanouk Ville, and later from Taiwan of China in 2003. Currently, there are two shrimp farms (6 ha) in Sihanouk Ville stocking this white shrimp (*P. vannamei*).



P. vannamei farm in Prey Noup District of Sihanouk Ville.

Since there are no shrimp hatcheries and formulated feeds, all these inputs have to be imported from Thailand or Taiwan. The pond yield ranges between 2 and 5 tons/ha/crop with harvest size ranging at 50-100 heads of shrimps/kg. Because of the small shrimp production produced by the shrimp farms, most of the production are marketed only within the country with an average price of about 8-10\$/kg for local consumption.

After the first trial of stocking white shrimp, shrimp farmers showed positive response and suggested some good reasons for the introduction of *P. vannamei* such as:

- *P. vannamei* has potential to grow faster than *P. monodon*
- *P. vannamei* is easier to culture in higher density as compared to *P. monodon*
- *P. vannamei* requires lower protein feed and
- *P. vannamei* is considered to be more disease resistant than *P. monodon*, especially to white spot syndrome virus (wssv).

IMPACT OF INTRODUCING *P. VANNAMEI*

Since the introduction of *P. vannamei* to Cambodia, no information on catch is available; hence no clear evidence of this species causing any risks to Cambodian coastal areas. There is no report also from fishermen that escapes of *P. vannamei* have led to any negative impact on wild shrimp population. Hence, further ecological research is needed on *P. vannamei* in the wild and its impacts on native species. However, it is believed that *P. Vannamei* may cause some negative impact to economic and biodiversity, if *P. vannamei* find their way from shrimp farms into the surrounding environment during floods.

EXISTING POLICIES ON THE INTRODUCTION OF AQUATIC EXOTIC/ALIEN SPECIES

Presently, Cambodia has no detailed guidelines or regulations for the movement/importation of aquatic animals for culture. However, environmental impact studies are being done and require fish farmers to meet environmental standards in shrimp farming. Under these conditions, the development of aquaculture raises the question of potential negative impacts of introduced exotic/alien species on native fish stocks. But there are a number of regional codes of practice and guidelines assisting in this process such as FAO Code of Conduct for Responsible Fisheries (FAO CCRF), World Organization for Animal Health (OIE), International Council for the Exploration of the Sea (ICES), etc.

RECOMMENDATIONS FOR CONTROLLING THE INTRODUCTION OF AQUATIC ANIMAL EXOTIC/ALIEN SPECIES

In order to reduce or avoid the negative impact caused by the introduction of exotic/alien aquatic species into non-native areas, the following points should be prepared and considered:

- Establish the code of practice or guidelines on the importation/movement of aquatic animals;
- Have strict rules for importing of aquatic exotic animal species into the country. Allow importation only of species which have no negative impacts on the environments;
- Implement international codes of practice and guidelines;
- Release only indigenous species or aquatic animals during releasing/stocking ceremony
- Conduct risk assessment studies before allowing the introduction of new aquatic animal species;
- Establish quarantine systems to control the importation of aquatic animals;
- Develop national reporting systems for aquatic animal diseases;
- Conduct capacity building in risk analysis, procedures for monitoring and disease surveillance; and
- Enhance public awareness on negative impacts of alien species.

The Present Status of *Penaeus vannamei* and Other Exotic Shrimp Culture in Indonesia

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P. vannamei culture in East Java

I. INTRODUCTION

1.1. Background

Shrimp culture is playing an important role in the contribution of foreign exchange earnings in Indonesia. However, for two decades, particularly in 1985 to 1994 the production of shrimp (*P. monodon*) had drastically decreased from 180,000 mt in 1984 to 35,058 mt in 1994, although total production of shrimp from both capture and aquaculture increased in the next 10 years, obtaining annual growth rate of 3.50%, from 170,563 mt in 1993 up to 477,332 mt in 2003 (Table 1). Production from aquaculture itself has merely grown to 2.80%. This was due to disease problem caused mainly by viral diseases called *Monodon Baculovirus* (MBV) and White Spot Syndrome Virus (WSSV), which started in 2000.

Table 1. Production of Shrimp, 1993-2003 (in Metric Tons)

Production	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Aquaculture	13,786	135,058	146,608	151,759	167,445	118,111	140,946	143,721	149,168	159,597	168,662
Capture	156,777	177,734	181,954	187,269	213,252	222,550	238,865	249,032	263,037	241,485	308,670
Total	170,563	312,792	328,562	339,028	380,697	340,661	379,811	392,753	412,205	401,082	477,332

The total shrimp export showed a significant increase in ten years for both volume and value, with growth rate of 4.91% for volume and 0.78% for value, gaining 98,569 mt worth US \$ 867,703 in 1993 to 137,636 metric tonnes worth US \$ 850,222 in 2003 (Table 2).

Table 2. Total Shrimp Export, 1993-2003

Quantity & Value	Year										
	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Quantity (ton)	98,569	99,523	94,551	100,230	93,043	142,689	109,650	116,188	128,830	124,765	137,636
Value (US\$)	876,703	1,009,738	1,307,006	1,017,89	1,011,467	1,001,467	888,982	1,002,124	934,989	836,563	850,222

Taking into account that shrimp culture is one of the prime commodities, potential to increase foreign exchange earnings, the Government has made some efforts to cope with disease problems besetting the industry. In this regard, the Director General of Aquaculture, Ministry of Marine Affairs and Fisheries (DGA-MOMAF) is considering other shrimp culture species as alternative. In 2000, DGA made a business breakthrough by giving license to the private sectors to import broodstock and post larvae of *P. vannamei* into the country. Since then, the *P. vannamei* culture has been practiced in potential provinces in Indonesia.

The success story of *P. vannamei* culture has encouraged many farmers who used to culture *P. monodon*, to try the new shrimp species. This increased shrimp aquaculture production, contributing 37.11% to national production in 1999 and 41.2% in 2003.

1.2. The story of *P. vannamei* and *P. stylirostris* in Indonesia



P. vannamei (60-70 tails/kg)



P. Stylirostris (40-50 tails/kg)

After being given the license, the private sectors (PT Central Pertiwi Bahari, and PT Surya Adikumala Abadi) imported 2,000 *P. vannamei* brood stock and 5.1 million PL from Hawaii and Taiwan to Indonesia, while only one license given to PT Udang Super Indonesia to import 2,000 PL *P. stylirostris*. In line with the policy on species introduction to the private companies, The Gondol Research Institute for Mariculture in Bali (GRIM) has conducted experiments on *P. vannamei* culture. This paved the way for the official release of *P. vannamei*. Held in Banyuwangi District of East Java Province, the *P. vannamei* was released by the Minister of Marine Affairs and Fisheries as one of the commodities having advantages to support and generate shrimp farming industries. The Ministerial Decree Number: KEP. 41/MEN/2001 concerning Releasing Vannamei Shrimp as the Superior Variety of Shrimp controls production and distribution of the species. To protect and conserve fishery resources in Indonesia, the Ministry of Marine Affairs and Fisheries has taken action to regulate the introduction of exotic fish/shrimp to Indonesia, through the following procedures:

- Determine port of entry
- Risk analysis approach

- Empower Fish Quarantine System in the Port of Entry
- Seed testing to ensure better growth, free from disease, ecological test and socio-economic feasibility, mainly for new species.

Each importer should be provided with Documents of Import, consisting of:

- License of being aquaculture enterprise
- Official letter from Fishery District Office to support and allow import of new species to be cultured in particular district area,
- Recommendation letter from Director General of Aquaculture
- Certificate of Health and Certificate of Origin from The Country of Origin. Certificate of Health concerns to information status of epidemiology and information of pest and disease in the country of origin during the last two years, signed by authorized institution. Certificate of origin covering description species and or variety, biological character, genetic and ecological, as well as level of generation (F1, F2 or F3), signed by the authorized institution.
- Work Plan for production and distribution,
- Compliance with regulation on Fish Quarantine System, Import and Distribution of Seed and Brood-stock System

Development of shrimp culture varies from one province to another. In East Java, development of shrimp culture is relatively faster than the others as indicated by the faster growth in the number of hatcheries as well as grow out activities in brackishwater pond. To some extent, this province is currently the main source of broodstock. Despite occurrence of diseases, particularly of TSV (Taura Syndrome Virus) in November 2001, most of shrimp farmers are still interested to develop their business.

The success of *P. vannamei* culture in Banyuwangi (East Java) has encouraged other shrimp farmers in the region particularly in the provinces of Bali, Lampung, West Java, Central Java, South Sumatera, North Sumatera, Bangka Belitung, Riau, West Kalimantan, East Kalimantan and West Nusatenggara and Bengkulu to go into *P. vannamei* culture. However, the Monitoring Surveillance and Evaluation Team of the DGA, found some constraints in the development of the culture industry – and one of those is disease problem.

II. REGULATORY AND POLICY SUPPORT

2.1. Seed Regulations

- Ministerial Decree No. 26, 1998: Guideline for National Seed Development
- Ministerial Decree No. 810/KPTS/IK.210/7/1999: Testing, Evaluation, and Release on Fish Species and or Fish Variety;
- Ministerial Decree. No. 811/KPTS/IK.450/7/1999: Assignment of TIUs of DGA as 7 Certification Institutes on Seed Quality Control Management and Testing Laboratory.
- Ministerial Decree No. 812/KPTS/IK.110/1999: Forming Evaluation Team and Release on Fish Species and or Fish Variety.
- Ministerial Decree No. 41/2001 dan No. 15/2002): Release of *Litopenaeus vannamei* dan *P. stylirostris* as prime commodities.
- Decree of DGA: No. 6375/D/DPB.1110.D1/XII/03: NBADP–Jepara as National Shrimp Brood-stock Center and RBADP–Sitobondo, RBADP Takalar, RBADP Ujung Bate (Heavily Damage due to Tsunami) as The Regional Shrimp Broodstock Center.

2.2. Live Movement Regulations

- Ministerial Decree: 08/MEN/2004: Procedure to Introduce New species and New Variety of Fish to Indonesia Territory.
- SE DGA No. 213/DPB4/PB.420.D4/1/04: Live Shrimp Movement Free from TSV and wssv.

2.3. Feeds

- Ministerial Decree. No. 45/MEN/2004: Provision and Distribution of Fish Feed
- Strengthening Testing Laboratories of Technical Implementing Units (TIUs)

2.4. Drugs

- Ministerial Decree. No. 20/MEN/2002: Fish Drug Classification.
- Ministerial Decree. No. 26/MEN/2002: Provision, Distribution, Utilization and Surveillance for Fish Drugs.
- Ministerial Decree No. 27/MEN/2002 Forming Commission of Fish Drugs;
- Decree of DGA. No. 548/DPB4/TU.110.D4/II/03: Forming Evaluation Committee on Fish Drugs;

2.5. Program Implementation

- Shrimp Intensification Program
 - Ministerial Decree No. 09/MEN/2002: Intensification Program;
 - DGA Decree No. 1022/DPB.3/PB.320.D3/III/2003 Guideline of Intensification Program;
- Implementation of Shrimp Culture Guideline (Ministerial Decree No 28/MEN/2004)
- Principle of Shrimp Culture Certification (DGA Decree No. 2951/DPB.3/PB.140.D3/VII 2004: Shrimp Culture Certification.

III. IMPLEMENTATION AND DEVELOPMENT OF *P. vannamei* CULTURE

3.1. Hatchery



Success story of the culture of *P. vannamei* in many regions has resulted to high demand of seeds and consequently, broodstocks. In some areas, farmers have been attempting to produce their own broodstock taken from ponds, and sell to shrimp hatcheries. Some shrimp hatchery operators prefer local broodstock because they are much cheaper compared to imported ones unaware that they maybe are potential disease carriers. At present the price for brood stock varies from one site to another, ranging from 25,000 to 40,000 rupiahs while imported brood stocks, ranging from US \$ 22 - US \$ 32 (US \$ 1 equals to

9,200 rupiahs). On the other hand, the price of marketable size of *P. vannamei* (size 60 shrimps/kg) is 50,000 to 60,000 rupiahs per kg.

The low price of broodstock will subsequently result to cheaper post larva, but may ignore the Best Management Practice of Shrimp Culture, which DGA has been promoting to farmer groups in potential areas. Previously the price of PL is very cheap, ranging from 15-17 rupiahs, while from imported broodstock was 33-35 rupiahs. There are only 13 large scale hatcheries producing good quality larvae, with some maintaining their business by importing broodstock.

Table 3 on next page shows the licensed importer shrimp hatcheries during the year 2004, Table 4 gives an illustration on how activities on hatcheries of *P. vannamei* development was growing since the past 4 years.



Table 3. List of Licensed Importer Shrimp Hatcheries, January–December 2004

No	Shrimp Hatcheries	Species	Country of Origin	Male/ Female	Amount Recommended	Total import
					Female and Male	Female and Male
1	PT. Biru Laut Khatulistiwa	<i>Penaeus vannamei</i> , broodstock	Hawaii–USA	Male and Female	10,000	1,022
			Hawaii–USA	Female Male	4,133 3,978	867
2	PT. Tirta Mutiara Makmur	<i>Penaeus vannamei</i> , broodstock	Hawaii–USA	Male and Female	1,000	420
			Florida–USA	Male and Female	530	424
3	BBAP Situbondo	<i>Penaeus vannamei</i> , broodstock	Hawaii–USA	Male and Female	1,000	
4	PT. Surya Windu Pertiwi	<i>Penaeus vannamei</i> , broodstock	Hawaii/Florida-USA	Male	2,500	1,725
				Female	2,500	1,738
				Male	4,000	
				Female	4,000	
5	PT. Central Pertiwi Bahari	<i>Penaeus vannamei</i> , broodstock	Hawaii-USA Hawaii/Florida-USA	Male	7,500	6,715
				Female	7,500	6,743
				Male	10,000	-
				Female	10,000	-
6	PT. Alamanda Tjandra	<i>Penaeus vannamei</i> , broodstock	Hawaii-USA	Male and Female	2,000	-
7	PT. Suri Tani Pemuka	<i>Penaeus vannamei</i> , broodstock	SIS Florida-USA	Male and Female	3,000	400
						400
8	CV. Sumber Niaga Sejahtera	<i>P. vannamei</i> broodstock	Florida/Hawaii-USA	Male and Female	5,000	-
9	PT. Maju Tambak Sumur	<i>Penaeus vannamei</i> , broodstock	Florida/Hawaii-USA	Male and Female	3,000	
					3,000	
Total					84,641	20,454

Table 4. Development stage and Productivity of *P. vannamei* within the period 2001-2004

Stage of Culture	2001	2002	2003	2004
Broodstock	Imported Without tested by PCR	Imported Local broodstocks are initially produced Without tested by PCR	Imported Local broodstocks are started to be used Without tested by PCR	Imported Local broodstocks are commonly used Imported broodstocks are tested by PCR
Post Larva	Price, 25 Rp/PL Without tested by PCR	Price, 17 Rp/PL Price up to 20 Rp/PL Without tested by PCR	Price, 5-10 Rp/PL Seed are started to test by PCR	Price, 18-25 Rp/PL Seed are started to test by PCR
Productivity	Fecundity, 50,000 SR: 20 %	Fecundity: 75-100.000 SR: 20-30 %	Fecundity: 75-100.000 SR: 20-30 %	Fecundity: 75-100.000 SR: 20-30 %
Disease: White Spot TSV	Not detected Indicated	Not detected Found in broodstock at only one hatchery	Not detected Not detected	Not detected Not detected

3.2. Grow-out

Within less than one year of development, *P. vannamei* shrimp, culture could seemingly overtake the tiger shrimp. Intensification of tiger shrimp culture has slowed down with farmers considering shifting to new species. The farmers have a lot of experiences in producing white shrimp, and advantages of this species over others, include fast growth, shorter culture period, more resistant to disease and environment change, and more efficient feed conversion rate. Besides, culture practices of *P. vannamei* are also similar to that of tiger shrimp, although it is necessary to often maintain water circulation in the pond. Ease in management and to some extent promising good harvest, are encouraging more farmers to culture white shrimp rather than tiger shrimp. It was proven within the period of three years that production of white shrimp has increased significantly from 29.3 % in 2002 to 47.6 % in 2004, and expected to be 66,7 % in 2005, where production of white shrimp will be two-thirds of the national aquaculture shrimp production (Table 5).

Table 5. Production of Tiger Shrimp and *P. vannamei* from Aquaculture (in Metric Tons)

Species	2002	2003	2004*	2005**
Tiger Shrimp (<i>P. monodon</i>)	112,840 (70,7%)	119,249 (70,7%)	127.119 (52,4%)	100 (33,3%)
Others (<i>P. Indicus, P. vanammei</i>)	46,757 (29,3%)	49,413 (29,3%)	115,441 (47,6%)	200 (66,7%)
Total	159,597	168,662	115,568	300

* Estimated ** Projected

Although the culture of white shrimp is very promising, it does not mean that all business is fully successful. In Bali and East Java, harvest failures happened recently, and it was presumably due to viral diseases.

Table 6. Four Year Development Stage of *P. vannamei* Culture (Grow-out)

Items	2001	2002	2003	2004
Source of PL	imported broodstock	imported broodstock	imported broodstock	Imported broodstock
		Started to use PL from local broodstock	PL from local broodstock is much used	PL from local broodstock is much more used
Stocking Density	35–70 PL/m ²	40–100 PL/m ²	40–100 PL/m ² and more	70–100 PL/m ² and more
Culture period	2½–3 months	2½–3½ months	3–4 months	3–4 months
FCR	1,4–1,5	1,4–2,0	—	—
SR	> 90 %	80–90 %	80–90 %	80–90 %
Productivity	8–12 ton/ha/year	8–15 ton/ha/year	10–20 ton/ha/year and more	15–20 ton/ha/year and more
Harvested size	60–70/kg	60–80/kg	60–80/kg	60–80/kg
Price of marketable size	Rp 70,000/kg	Rp 27,000–Rp 35,000	Rp 27,000–Rp 35,000	Rp 35,000–Rp 50,000
Disease:				
White Spot	Not found	Not found	Not found	Not found
TSV	Found in Situbondo District, East Java	Not detected	Detected on February and March in Gresik District, East Java	Not detected

IV. PROBLEMS AND CONSTRAINTS

Within four years of development, some problems and constraints occurred to the industry, among others are:

a. Limited quantity and quality of broodstock

Imported *P. vannamei* broodstocks are better compared with those taken from ponds. The imported broodstock produce better quality post larvae. However, imported broodstock is costly and time consuming, and in certain period of time is not available. Obtaining broodstock from grow-out ponds is a viable alternative, but may be of high risk. Maintaining and encouraging breeders to use PCR-tested broodstock is also time consuming, and their understanding about PCR test is very limited. This is also true to hatchery operators who have limited working capital. Fortunately, in recent months most shrimp farmers are starting to understand the procedure to produce PL, prior to stocking their grow-out ponds. Most farmers have recently selected PCR-tested PL and started to purchase from certified hatcheries even if the price of PL is higher.

b. Stocking Density

Culture of *P. vannamei* will enable farmers to produce large volume of shrimps because of its potential to stock in a high density. As an example, an experience of a farmer in Lampung province, who stocked his ponds up to 4,000,000 PL per ha, could produce 40–50 tonnes of shrimp per crop. The tendency to stock in high density on culture practices, indeed will be able to produce high yield, but it is harmful due to waste product accumulating in rearing pond as well as in drain canal and to some extent also polluting source of water. The practice of stocking in high densities by tiger shrimp farmers exacerbated

the environmental condition surrounding the brackishwater ponds. Thus, causing mass mortalities of stocks and therefore, loss of investments. It is reasonable to maintain optimum stocking density, at a maximum of 150 PL *P. vannamei* per m².

V. STRATEGIES FOR DEVELOPMENT

As a shrimp producing country, Indonesia has developed strategies for the shrimp industry, and will be having an important role in ASEAN region as well as other parts of Asia. By having 419,282 hectares of brackishwater ponds, and potential areas of 913,000 ha (DGA, 2000), Indonesia could be one of the biggest shrimp producers and exporters of the world. Thus, foreign exchange earnings derived from aquaculture sector certainly increase revenues for the country. The new species is a viable option for culture, but the native species such as tiger shrimp as well other penaeid shrimps remain promising for development.

5.1. Short Term Strategies

- a. Import broodstock from reputable sources mainly from Hawaii and Florida. DGA will not allow any opportunity to import *P. vannamei* and *P. stylirostris* from anywhere other than USA. This is to obtain traceability measure for the animal being cultured. The broodstock will then be developed in good and certified hatcheries. However, only certain hatcheries having special license to import broodstock are allowed. Importing broodstock is important, since the need of PL for 2005 is more than 16.5 billion, equivalent to the need of around 110,000 imported broodstock.
- b. Develop Crash Program for Production of *P. vannamei* post larvae at Technical Implementing Unit (TIU) of DGA and Provincial Fisheries Office. More than 9 DGA's TIU and 4 Government Shrimp Hatcheries in West, Central, East Java and Bali will take part in producing PL of *P. vannamei*. Although their production will only be 100 million PL per annum, but at least contribute to development of shrimp industry.
- c. Implement Biosecurity on shrimp hatcheries followed by certification program. DGA has developed certain kind of certification for hatcheries based on ISO 9000 and HACCP approach. Five *P. vannamei* hatcheries among 13 producers have been certified in 2004 by Quality Control Management System developed by Technical Implementing Unit of DGA in cooperation with The Agency for National Standardization.
- d. Develop extension program to strengthen the implementation of Best Management Practice in many areas, particularly in area of Intensification Program;
- e. Establish PCR laboratories in targeted area, followed by development of shrimp culture monitoring system. DGA has assigned special staffs for monitoring and surveillance of seed quality and fish disease.
- f. Empower Shrimp Importer/Hatcheries Association

5.2. Middle and Long-term Strategy

- a. Produce SPF and SPR shrimp broodstock, by developing The National Shrimp Broodstock Centers in Jepara, Situbondo, Takalar and Ujung Batee (Aceh), but since the physical facility was damaged by Tsunami in Aceh, only three NBC continue to do the work on SPF/SPR Broodstock. All facilities in those NBC are set up to produce broodstock of *P. monodon*, *P. merguensis/indicus*, *P. vannamei* and *P. stylirostris*. Many hatcheries are now asking for broodstock from NBC Jepara, since the first generation of *P. stylirostris* was tested at private hatcheries in Lampung province and yielding better quality PL.
- b. Continue to promote shrimp intensification program
- c. Promote Best Hatchery Management Practices aimed to produce good quality PL.
- d. Revitalize brackishwater ponds and canal realignment as well as zoning improvement.
- e. Develop Technical Implementing Units with a specific task to produce high quality shrimp seeds.

Shrimp Farming in Malaysia

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Malaysia

1. OVERVIEW OF FISHERIES IN MALAYSIA

Malaysia has a long coastline of 4,055 kilometers (km), of which 1,640 km is in Peninsular Malaysia and 2,415 km is in the state of Sabah and Sarawak. With the declaration of the 200 miles Exclusive Economic Zone (EEZ), the total fishing area of Malaysia has expanded to 160,000 square nautical miles. Given this large fishing area, fisheries are a significant sector in the Malaysian economy. The sector produced 1.5 million mt of fish valued at about RM5 B in 2003. The marine fisheries production was 1.3 million mt valued at RM4 B, constituting 1.4 % of the Gross Domestic Production (GDP). The aquaculture production was 196,874 mt valued at over RM1.2 B constituting only 13 % of the total fisheries production. In the case of the marine capture fisheries, the bulk of the landings came from trawl nets (57%), purse-seine nets (21%) and traditional gerars (22%). Whereas in aquaculture, cockles (*Anadara granosa*) is the dominant harvest, accounting for 37% of the total aquaculture production. With regard to employment, the fishing industry involves about 89,400 fishermen and 21,100 aquaculturists giving a total of 110,500 people.

In 2002, Malaysia exported an estimated 198,892 mt of fisheries products valued at RM1.5B. The bulk of the exports were higher for chilled fresh fish and frozen crustaceans mainly shrimps to Japan, Singapore and USA. At the same time, Malaysia imported an estimated 353,794 mt from neighboring country Thailand valued at RM1.3 B. In terms of quantity, Malaysia was a net importer of fish but in terms of value there was a net gain in foreign exchange to the tune of RM156 M.

Traditionally, the mainstay or backbone of the Malaysian fisheries is the inshore sub-sector both in terms of production and socio-economic considerations. However, the inshore sub-sector has reached a saturation point as evidenced by declining catch rates in recent years. This is coupled with substantial fisheries resources in the EEZ waters of Malaysia and vast potentials for aquaculture development in the country. Focus of development has been shifted towards offshore fisheries and aquaculture.

2. ROLE AND IMPORTANCE OF AQUACULTURE IN MALAYSIA

Malaysia does not have a long-standing aquaculture tradition unlike its neighbors in the Indo-Pacific Region. Freshwater fish culture was only introduced in the early twenties while coastal aquaculture has even a shorter history. Nonetheless, the industry has expanded significantly in the last two decades. In 2003, a total of 14,200 hectares were used for pond culture, 7,447 hectares of mud-flats for cockle culture and 1,376,300 m² for cage and raft culture. There are 94 shrimp hatcheries with a production capacity of 12 billion fry a year and some 79 freshwater fish hatcheries/nursery producing 50 million fry per year.

Compared with shrimp production from aquaculture, landings of marine shrimp from capture fisheries were from 81,627 mt in 1984 to a peak of 107,550 mt in 1984 to a peak of 107,550 mt in 1989, and then fell slightly to 100,847 mt in 1991. The harvest rose in 1992 to 126,405 mt and fell again to 105,761 mt in 1993 and 100,545 in 1994. Overall, marine shrimp landings registered a growth rate of 2.7% indicating that the shrimp catch from capture fisheries was approaching its limit. This means that any substantial increase in shrimp production in the future will have to come from aquaculture. Shrimp farming has registered a creditable growth rate comprising about 28.6 % of total shrimp production in 2003.

Under the Third National Agriculture Policy (NAP 3), aquaculture is identified until 2010 as a key area for development to produce fish for the country both for local consumption and for export. At present, the marine resources of the country are being exploited at about the maximum sustainability and any significant increase in production from this sector is rather unlikely. The government has proposed an ambitious Aquaculture Development to increase aquaculture production in the country by nearly six-fold, to 600,000 mt with estimated value of RM6.5 billion by 2010. Under this plan a total area of 330,200 ha. of land and water resources suitable for aquaculture development has been identified. These areas are as follows:

Inland areas	105,000 ha.
Open seas	100,000 ha.
Coastal areas	28,000 ha.
Lakes and impounded water bodies	90,000 ha.
Protected coastal areas, lagoons	7,200 ha.
Total	330,200 ha.

3. OVERVIEW OF SHRIMP FARMING IN MALAYSIA

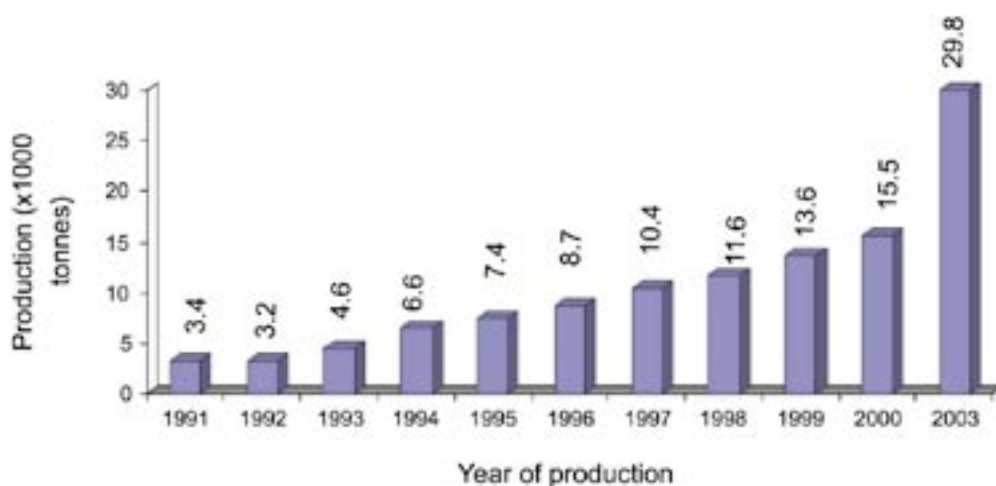
3.1 Background

Traditional shrimp farming began in Malaysia in the 1930s with the utilization of the trapping pond culture system that supply of wild fry depended on incoming tides. Successful larviculture of shrimp in the late 1960s led to large scale seed production and the establishment of government and private sector shrimp hatcheries in the late 1970s and early 1980s. The ample supply of hatchery produced seed facilitated the development of shrimp farming industry in the late 1970s.

It was not at all smooth sailing, though. Many of the earlier farms were excavated type, constructed within mangrove areas and depending totally on tides for water exchange. Consequently, these ponds encountered soil quality problem resulting in mass mortalities of shrimp. This problem was alleviated to a large extent with a shift to levee-type pond construction, involving little or no excavation; especially out-side mangrove areas, and the utilization of pumps for water exchange.

The improvement of the ponds in late 1980s, where engineering problems were minimized signaled a new phase in shrimp farming. In 1993 there were 1,877 ha of brackishwater ponds in the country.

Production of farm cultured penaeid shrimps increased from the mid-1980s, from 60 mt in 1984, to 3,057 mt in 1991. The production fell slightly in 1992 to 2,963 mt, but increased subsequent in two years. Production in 2003 stood at 30,000 mt of whole shrimp. The bulk of the production consists of the tiger shrimp, *Penaeus monodon*, although some banana shrimp, *P. merguensis*, and the Indian white shrimp, *P. indicus*, are also cultured. There is a steady growth in shrimp production over the last 10 years as shown in the graph below.



The number of shrimp farms and farming areas has increased steadily over the years due to the active participation of farmers, intensive training and courses provided by the government. Locally developed technology and global access to culture and processing techniques, easy access to credit facilities, government incentives and consistent good market price have also contributed to the steady growth. Under this scenario, it is believed that the potential development of shrimp aquaculture industry in Malaysia is promising in the future.

Major farming areas are located in the states of Sabah, Perak, Johor, Sarawak and Kedah accounting for 42%, 13%, 11%, 10% and also 10% respectively, of the total shrimp farming areas. States that still have vast potential are Sarawak, Sabah, Pahang, Selangor and Johor.

3.2 Development of shrimp hatchery

There are about 94 shrimp hatcheries in Malaysia, where most of them are located in Peninsular Malaysia and Sabah. Hatchery designs vary from simple low budget projects with a shed to house the culture tanks to more sophisticated enclosed buildings with transparent roofs. Most hatcheries are of the latter type. Circular or rectangular tanks made of fiberglass or concrete tanks coated with non-toxic epoxy paint are commonly used by most of the hatcheries for larval and post-larval rearing.

All the hatcheries are dependent on wild broodstock and spawners while a few have their own maturation programmes to supplement wild broodstock supply. Unilateral eyestalk ablation is used to induce ovarian development in female spawner shrimp. Broodstock shrimps are generally transported in oxygenated plastic bags with reinforced bottoms. Some of the hatcheries operate by obtaining nauplii which can be purchased from established hatcheries or spawner suppliers. Initial stocking density is around 50-100 nauplii/litre.

Vibrio is the most common disease organism encountered in shrimp hatcheries. The organism is difficult to control as it is usually present in the culture media thereby causing heavy larval mortalities usually at mysis-1 stage. Normally these losses occur following a bacterial bloom of 70,000 cells/ml or more. Most hatcheries prefer to discard the infected batch as treatment is not economical or worthwhile. Many hatcheries still use antibiotics such as furazolidone or oxytetracycline as a prophylactic measure, though this practice is officially discouraged.

Post-larvae are harvested using harvesting nets and/or basins and an estimate of numbers is made at this stage. Double-layered plastic bags are used for the transport of shrimp seed. For overland transport, the bags are simply transported by truck to their destination, usually at night when the weather is cooler.

3.3 Grow-out

There are two different culture systems, namely semi-intensive and intensive that are widely practiced for *P. monodon* culture. The system commonly practiced in Malaysia is the intensive culture system using stocking density ranging from 25 to 50 pieces per square meter.

Pond preparation involves drying the pond until the surface cracks and then scraping the dried organic matter. Flushing of the pond with water jets, although still practiced by some farmers, is not recommended as it causes environmental pollution. The pond bottom and bunds are limed and some water let into the pond. Tea seed cake is applied to get rid of predatory fish and fertilization carried out to encourage a bloom of phyto- and zooplankton that will serve as natural food for the shrimp. The post-larvae are then stocked in the pond, usually in the early hours of the day when the weather is not too hot.

In semi-intensive and intensive culture, the shrimp are fed with pellet feeds, beginning with the starter feed and followed later by the grower feed. There is a whole range of commercial brands of pellet feeds for shrimps available in the market. Feeding frequency varies from 3-5 times a day. The amount of feed given is adjusted periodically according to the growth rate of the shrimp, which is monitored by means of feedings trays.

Zero water exchange or closed system is also being practiced and to some extent, certain farms use probiotics as bioremediators to improve culture system. As a procedure to sterilize, the water is disinfected from pathogenic microbes using chlorine-based compound such as calcium or sodium hypochlorite.

Fresh, clean and treated seawater is added whenever necessary to compensate loss through evaporation.

Common diseases affecting shrimp during growout are Bacterial Black Spot, vibriosis and viral diseases. Algal blooms can also cause mortality of the stocks and eventually heavy losses to shrimp growers.

The culture period varies according to the culture system used. When lower stocking densities are used, growth rate is faster and the shrimp can reach marketable size within 2.5 months. In semi-intensive and intensive culture, the shrimp are harvested after 3-5 months. Partial harvest is also being carried out in many farms with first harvest usually done in the third month.

Harvest is undertaken using lift nets or bag nets placed at the pond outlet. Lift nets are used, especially for live shrimp (20-25g) for both the local market and Singapore restaurant market. For the export market, larger sizes (30-35g) are preferred. A slightly longer growth period (4.5 months or more) may be needed to acquire such size. Shrimp intended to be processed for the export market must be handled with great care to prevent quality deterioration so as to meet the stringent quality standards of the target countries. The shrimp must thus be iced immediately after harvest and transported to the processing plants under properly cooled conditions. In all the stages of processing within the processing plant, cool and hygienic conditions must continuously be maintained.

4. MAJOR ISSUES OF SHRIMP FARMING IN MALAYSIA

4.1 Diseases

Proper culture management will prevent disease outbreak to occur. Disease can cause mass mortality to the culture stocks at all stages. White Spot disease badly hit shrimp farms throughout Peninsular Malaysia in 1996. White Spot disease causes mass mortalities of shrimps that can wipe out the stocks within 3-10 days after the onset of the signs, especially juvenile shrimps of all ages and sizes. Black Tiger shrimps infected with White Spot Disease or White Spot Syndrome Virus (wssv) have red discoloration and white spots or patches about 0.5-2.0 mm in diameter on the surface inside the carapaces. These white spots are abnormal deposits of calcium salts.

Disease Control and Prevention measures taken include the following:

- The use of shrimp post larvae, which are wssv free and confirmed through Polymerize Chain Reaction (PCR) analysis.
- Encourage the use of Specific Pathogen Free (SPF) bloodstock in hatchery operations.
- Provide bio security measures such as fencing and netting pond are to prevent entry of vectors and carriers into culture ponds.
- Promote environment friendly culture practices such as proper waste/sludge disposal to prevent wssv.

4.2 Environmental Impacts

Shrimp farming in the coastal areas has been developed rapidly over the last 15 years especially along the west coast of Peninsular Malaysia and in Sabah. However, little is known about the impact of such activities on the coastal resources. There is an urgent need to address the impact of all aquaculture activities together with all forms of marine organisms and their ecosystems. The costly collapse of the shrimp aquaculture industry in Taiwan and China, the drop in pond production in the Gulf of Thailand as well as in the south-eastern part of Thailand, the massive destruction of mangrove forests in Philippines and Indonesia and more recently the drop in production in Ecuador would serve as a timely reminder to Malaysia, to act accordingly and learn from this costly lessons in our endeavour to further develop the shrimp farming industry in this country. To reduce the impact of shrimp culture to the environment, farmers and investors are advised to follow the Code of Practice and Farm Certification Scheme guidelines.

4.3 Competitiveness

Cost of production appears to be one of the major factors likely to affect the future expansion of shrimp farming in Malaysia. High cost of local labor and the competitive export market will pose some problem. To remain competitive, more efficient pond management measures must be adopted to reduce production cost and increase productivity. Management measures including proper pond preparation, optimum stocking densities, cost effective feeding regime, and implementing process to control discharges will go a long way to improve productivity leading to a sustainable aquaculture development in Malaysia.

4.4 Conflict of Interests

Land for expansion has become increasingly more expensive and difficult to acquire especially in Peninsular Malaysia partly because of conflict of interest. In an effort to expedite the processing of land for aquaculture purposes, the Department of Fisheries has initiated action to draft the proposal for zoning areas for aquaculture.

5. SHRIMP PROCESSING AND MARKETING IN MALAYSIA

Shrimp harvested from farming operation are marketed either as raw or processed products. The raw products are distributed to wholesale and retail markets with different market price at different states of Peninsular Malaysia, Sabah and Sarawak.

Shrimps for processing are sent to processing plants in Malaysia, particularly Peninsular Malaysia and in eastern States of Sabah and Sarawak. Some processing plants cater specifically for shrimp while others, together with other marine products. In the northern States of Kedah, Penang and Kelantan of Peninsular Malaysia, most of the harvested shrimp are processed at Seberang Prai, Penang.

Shrimps are processed in the processing plants and classified as shown in table below:

- | | |
|-----------------------------|--|
| a) Head-on Shell on | - Frozen fresh shrimp which comes in the original description |
| b) Headless Shell-on | - Frozen fresh shrimp which was not peeled but cut the head |
| c) Peeled Deveined Tail-on | - Frozen fresh shrimp which was peeled and cut the head and deveined |
| d) Peeled Deveined Tail-off | - Frozen fresh shrimp which was peeled, cut the head and tail and deveined |
| e) Peeled Undeveined | - Frozen fresh shrimp which was peeled, cut the head and tail |

Processed shrimp are exported to Japan, Europe, USA, Australia and New Zealand. Headless shell-on or peeled shrimp are preferred by the Japan and American markets while cooked and peeled shrimp are preferred by Australian and New Zealanders.

To comply with international trade and World Trade Organization (WTO) requirement, Hazard Analysis Critical Control Point (HACCP) certificate must be obtained from the Ministry of Health Malaysia.

6. STATUS OF AQUACULTURE OF *P. VANNAMEI* AND OTHER EXOTIC PENAEID SPECIES

There was an official application from a foreign investor in 2000 to introduce *P. vannamei* as alternative to *P. monodon* in Malaysia. The application was thoroughly scrutinized by the Department of Fisheries Malaysia (DoF). Import Risk Assessment studies were done. After thorough considerations, the Department of Fisheries Malaysia has officially rejected the proposal. DoF made a press statement on 17th May 2000 to caution the public.

There hasn't been any approval given even to import specific pathogen free or specific pathogen resistant broodstock from abroad. Since the importation of *P. vannamei* broodstock is not allowed in the country, shrimp hatcheries in Malaysia are not allowed to produce *P. vannamei* post-larvae.

Malaysia implemented an indefinite ban on introduction of *P. vannamei*, operative from 1st June 2003, in an effort to prevent the introduction of TSV and other viruses in Malaysia (The Wave website, 2nd April 2003). The ban, however, was implemented after *P. vannamei* was imported into Peninsular Malaysia from Taiwan Province of China in 2001 and Thailand in 2002, and also in one farm in Sabah (FAO, 2004/10).

There are some pockets of illegal culture operations in remote areas in Peninsular Malaysia and Sabah. However, the state of Sarawak has no *P. vannamei* farms since they have to obtain licenses from the Malaysian government to operate their farms and are concerned that these licenses could be revoked and their ponds be destroyed if they are caught farming *P. vannamei*.

Government effort is being enhanced to ensure registration of all farms with the Department of Fisheries. This is done to monitor culture activity and carry out a risk assessment to ensure that practical, longer-term legislation could be introduced to manage imported alien species and limit disease transmission.

7. OTHER CONCERNS

Availability of *P. vannamei* from the neighboring country tend to flood the local market, offering half the established price for local white shrimp from the capture fisheries or even below. This in turn affects the livelihood of local fisherfolk.

Under the Third National Agriculture Policy (NAP 3) which cover the duration from 1992-2010, aquaculture in Malaysia is designated to play a lead role to supplement the natural fishery resources, which has already reached its maximum sustainable yield. A prospective plan has been drawn up by the Department of Fisheries Malaysia with the aim of gradually increasing shrimp production particularly *P. monodon* production from the present production of about 30,000 mt to 150,000 mt by the year 2010 involving some 30,000 ha of brackish water ponds. Having experienced the wssv problems, development of SPF/SPR shrimp broodstock is the major consideration under NAP 3.

Guidelines to prospective farm operators are being introduced on Good Aquaculture Practices (GAP) to address the discharge of waste matters from shrimp farms. Implementation of Aquaculture Industrial Zone (ZIA), undertaken by the federal government with the cooperation of state/provincial government is a step towards the right direction to ensure that conflict of interest is minimized in such areas.

Environmental Impact Assessment (EIA) is required from all future aquaculture proposals in order to standardize GAP. In addition, an integrated coastal zone management plan involving inter-sector approaches are adopted to ensure the success of the prospective aquaculture plan.

Farm Accreditation schemes are being implemented to award Farming Certificates to shrimp farms that meet the prescribed criteria; thus, assuring the production of quality and safe product. Code of Practice (COP), Aquaculture Guidelines and Standard Sanitary Operating Procedure (SSOP) are emphasized towards responsible and sustainable aquaculture development.

8. CONCLUSION

There is a good potential for the development of the shrimp culture industry in Malaysia provided the available land resources and technical expertise in the country are well utilized. With significant incentives and promotion from the government, promising domestic and export market as well as good financial viability, the shrimp culture industry can be a very promising industry in Malaysia.

Under the current scenario and a prolonged period to overcome WSSV problem, Malaysia is pro-active and committed in developing SPF/SPR broodstock in collaboration with the industry which might take another few years to materialize.

With an ambitious target production of 150,000 mt to be achieved by the year 2010, immediate measures have to be taken to increase shrimp production in the country. The possibility of using local white shrimp (*P. merguensis* and *P. indicus*) is widely explored by the DoF as an alternative to *P. monodon*. Early findings are very encouraging.

Though DoF of Malaysia is not in favor of *P. vannamei* officially, it is still open to views and experiences from the neighboring country. Due consideration would be given if there are established protocols, guidelines and management practices to avoid introduction of TSV and other viral pathogens in the country.

Overview of Existing Shrimp Culture Industry and Development Potential for Culture of *P. vannamei* in Myanmar

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1. OVERVIEW OF SHRIMP CULTURE INDUSTRY

1.1. Historical production figures

Shrimp culture in the form of traditional method commenced in Myanmar in 1970s in the western coastal areas. The culture system was trap and hold method. Natural post-larvae of *Penaeus monodon* were trapped into the ponds during the high tide period. There were no inputs in terms of pond preparation, eradication of predators, water fertilization, feeding, etc. However, 30 to 50 kilograms of large size of shrimps were harvested. As the ponds were usually as large as 50 to 100 hectares, the shrimp production could provide more than enough money for the shrimp farmers. Having no laws concerned with aquaculture, those shrimp ponds existed as illegal ponds. Only in 2000 that the State Level Committee, which is the Shrimp Aquaculture Development Committee was formulated and implemented a three-year project plan of the shrimp aquaculture development in Myanmar.

According to that plan existing shrimp pond area of 26978 hectares was to increase in area of up to 48000 hectares. After the project in 2003, the shrimp pond area became 79984 hectares but it consisted of 2100 hectares of semi-intensive or intensive shrimp ponds. The production figure from shrimp culture was not properly registered. However, the production figure submitted to the State is as follows.

Shrimp production from different culture systems

No	Year	Extensive (mt)	Improved Extensive (mt)	Semi-Intensive (mt)	Total (mt)
1	2000-2001	3629.34	2359.95	1484.61	7473.90
2	2001-2002	4100.59	3366.79	3889.20	11357.08
3	2002-2003	6785.47	6009.55	6325.76	19120.78
4	2003-2004	6878.69	6016.75	6325.76	19221.20
5	2004-2005(January)	3530.37	13147.10	6731.22	23408.60

1.2. Shrimp Export

In 1989, Myanmar Government promulgated a Law Relating to Aquaculture and since then illegal fish-ponds and shrimp ponds have become legal culture ponds under the umbrella of the said law. It is only after the promulgation of this law that the established statistical figures were available. Thus, the shrimp exports of Myanmar in terms of quantity and value including capture and culture appears in Table 1. It is estimated that the shrimp production from aquaculture may be only 25 percent of the total export.

Table 1. Shrimp export of Myanmar (1993-2003)

No	Year	Shrimp Export	
		Quantity (mt)	Value (US\$ Million)
1	1993-1994	6195.00	45.10
2	1994-1995	7940.00	63.20
3	1995-1996	8814.50	72.40
4	1996-1997	12827.80	95.60
5	1997-1998	13467.20	91.90
6	1998-1999	13764.47	96.96
7	1999-2000	15536.01	90.68
8	2000-2001	19477.29	104.23
9	2001-2002	21453.87	94.40
10	2002-2003	22868.11	105.20

1.3. Problems in the industry

1.3.1. Disease out-break

By the time the three-year project plan was implemented, there emerged many private companies that became involved in shrimp aquaculture. Fast development in the shrimp culture resulted in inadequate supply of shrimp seeds as the production of shrimp seeds was very low due to limited number of shrimp hatcheries. So the shrimp farmers imported shrimp seeds and that must have caused the entry of uncertified shrimp seeds. That was the very first time that the semi-intensive and intensive shrimp farming in the country suffered the out-break of white spot viral disease and may have also caused the horizontal transmission of the disease.

1.3.2. Shrimp market price

Through the normal trade, shrimps are exported to many countries. But head-on chilled shrimps are normally exported through the border trade. The price of the shrimp has been very unstable and because of the low price, some farmers stop farming the shrimp using the intensive method. At the same time the cost of fuel for operating paddle wheels has increased tremendously. Sometimes, the selling price of the culture shrimp cannot compensate with the production cost. So the farmers stop farming or some has changed from the intensive system to extensive or improved extensive system of shrimp farming.

2. POLICY ISSUES ON THE IMPORT AND CULTURE OF EXOTIC SHRIMPS

2.1. Existing laws and regulations

There were no specific Fishery Laws until 1989. But the Government of the Union of Myanmar has promulgated four fisheries laws including a Law Relating to Aquaculture. According to the Myanmar Fisheries Laws, the term "Fish" is defined as all aquatic organisms living the whole or a part of their live cycle in the water including eggs, larvae, fry, post-larvae, juveniles etc. Aquatic organisms also include aquatic plants, seedlings and seeds. Under the Law Relating to Aquaculture, section 35 states that prior approval shall be obtained from the Department of Fisheries in terms of import or export of live fishes into and out of the country. To exercise this section, the Government of the Union of Myanmar conferred to the Department of Fisheries as sole the competent agency and the Director-General and Deputy Director-General as the sole competent personnel.

Meanwhile, basic concepts of the section in terms of conservation and preventive measures are also explained to potential importers of live fish in order to facilitate their application. Thus the importer has to comply with this section and the corresponding regulations mandated by the Department.

Apart from section 35 in the Law Relating to Aquaculture, there includes a last section (section 39 A and B) which states that the Minister for the Ministry of Livestock and Fisheries has the right to issue the proceedings with the approval of the Government and the Director-General of the Department of Fisheries also has the right to issue notifications with the approval of the Ministry of Livestock and Fisheries. Up to the present no proceedings and notifications with respect to Invasive Alien Species (IAS) have been issued yet. However, the Department of Fisheries is taking utmost care and commensurate safeguard on the importation of alien fish to Myanmar.

3. STATUS OF IMPLEMENTATION AND ENFORCEMENT

At present the import of exotic or alien shrimp species is strictly prohibited in Myanmar for safeguarding the natural ecosystem. This includes the import the *P. vannamei* and *P. stylirostris*.

4. CULTURE OF *P. VANNAMEI* AND OTHER EXOTIC PENAEID SPECIES

At the beginning of the three-year project plan in 2000, Department of Fisheries has allowed the importation and culture of *P. vannamei*. The DOF as the sole competent authority of fisheries sector, fully understanding that the vannamei has many advantageous factors for culture but it may also cause negative impact to the other shrimp aquaculture industry. Also the Department of Fisheries has been aware that vannamei may carry and outbreak the taura syndrome virus. However, the post larvae of blue shrimp *P. stylirostris* were imported in 2000 and the experimental culture was initiated. Due to very low salinity during raining season the survival was very poor and the species was no longer of interest among the shrimp farmers.

On the other side, the shrimp farmers made several request to DOF to allow the importation and culture of *P. vannamei*. In 2001, one private company was permitted to import 500 parent stocks of *P. vannamei* from Hawaii. Unfortunately or fortunately all the parent-stocks died on the way to the hatchery because of prolonged transport time. At the same time another shrimp farming company was allowed to culture *P. vannamei* in a far isolated area. That company imported one million post-larvae of *P. vannamei*. But it harvested only 4 tons and the company never requests the import of vannamei again.

The Department of Fisheries Myanmar consulted with the scientists from FAO, NACA, SEAFDEC and other agencies whether Myanmar should allow to import and culture *P. vannamei*. Almost all recommended that it was still value early to start vannamei culture. For these reasons, DOF Myanmar has suspended the culture of vannamei. At this moment, the shrimp farmers became fed-up with culturing *P. monodon* because of heavy losses caused by white spot syndrome virus. They are now very much eager to culture *P. vannamei*.

5. LABOR AND EMPLOYMENT GENERATED

Normally the DOF organizes a basic training on hatchery and grow-out culture operation for laborers once or twice a year and they are assigned to the private hatcheries and culture ponds. But for graduates of B. Sc or M. Sc, advanced training course on shrimp hatchery and grow-out culture operation are conducted by DOF once in a year or two years and after the training, some of them are appointed at the DOF and some are recruited by the private sector. The training sessions are mainly concerned with *P. monodon*.

Figure 1. Shrimp production from different culture systems

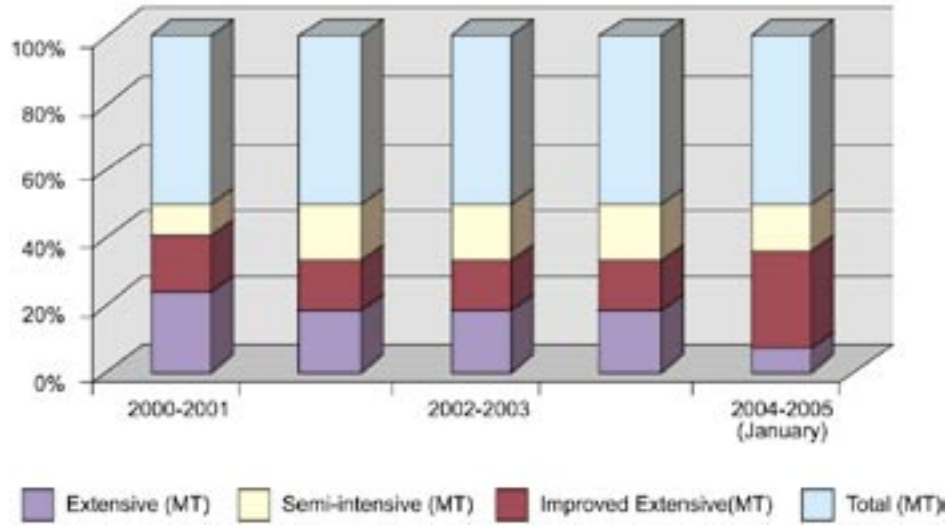
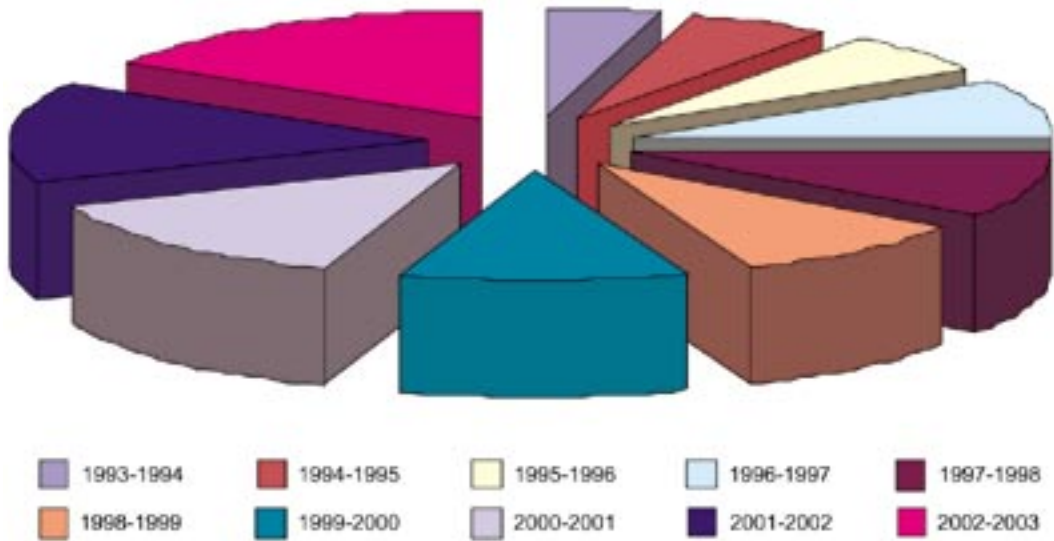


Figure 2. Shrimp Export: Export quality and value



6. R&D ACTIVITIES ON *P. VANNAMEI* AND OTHER EXOTIC SHRIMPS

Introduction of exotic shrimps including *P. vannamei* have not been allowed in Myanmar. Since then there were no activities related to research and development on *P. vannamei* and other exotic shrimps.

6.1 Development of local capability to produce brood stock including SPF and SPR

Local shrimp hatchery operators are operating hatchery management including collection of broodstock from the wild, ablation, broodstock management in the hatcheries, spawning, larval rearing etc. Supposing that *P. vannamei* and other exotic shrimps are introduced, there is a need to educate the operators to enhance their capability, and demonstrate to them the production of SPF or SPR broodstocks. This type of training and demonstration should be collaborated among SEAFDEC scientists and the host country.

6.2 Monitoring coastal areas and fish catch for occurrence of exotics species in the catch

Currently, there is no report on the occurrence of exotic shrimp species in coastal areas and fish catch. However, when exotic shrimp species including *P. vannamei* are introduced, regular monitoring in the coastal areas and fish catch and assessment of the negative impact on native species should be conducted. Principally, the introduction of exotic shrimp species is mainly for the purpose of aquaculture and the escape of those exotic shrimp species should be strictly and carefully prevented.

7. DISEASE OUT-BREAK AND MANAGEMENT

Presently, Myanmar has no source of taura syndrome virus since it has not allowed the introduction of *P. vannamei*. If ever the country would allow the introduction of *P. vannamei*, the best quality of SPF and SPR broodstock shall have to be imported and the newly introduced broodstocks are to be kept in confined and isolated areas.

8. PROPOSED GUIDELINES FOR THE INTRODUCTION AND CULTURE OF EXOTIC SHRIMPS

Despite some characteristics of carrying new virus like taura syndrome, *P. vannamei* is still a suitable species for introduction and culture. It can tolerate to low salinity and also low temperature. It can be cultured at a very high stocking density. Unlike the *P. monodon*, *P. vannamei* needs low profile of protein source in its diet and daily feeds. It can grow fast within 100 days of culture when it attains market size thus resulting in high production.

So the shrimp farmers willingly request DOF to allow the culture of *P. vannamei* in Myanmar. If the Asian and SEAFDEC countries have decisive recommendations on the introduction and culture *P. vannamei*, Myanmar shall also comply with the workshop decision in order to be in line with other Asian countries.

In such situation, the Department of Fisheries is the only competent authority for fisheries development. It should be mainly responsible for the introduction of SPF and SPR broodstocks of *P. vannamei*. In consultation with SEAFDEC/AQD and NACA, Myanmar would get the source of best quality SPF and SPR broodstocks.

Special training and/or workshops concerned with technology on hatchery and grow-out culture operation should be conducted in the host countries prior to the introduction of *P. vannamei* and other exotic shrimps. At the same time, the DOF and other competent fishery authorities should issue some appropriate guidelines to increase pond production and also safeguard the environment in the respective countries.

Status of *P. Vannamei* Aquaculture in the Philippines

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Philippines

1. OVERVIEW OF SHRIMP CULTURE INDUSTRY

Shrimp industry in the Philippines refers only to *P. monodon*, the only penaeid species being exported abroad. It is grown almost all over the country from Northern Luzon to Southernmost part of Mindanao. The culture of tiger prawn locally known as “sugpo” started as a secondary species since only small quantity could be harvested with milkfish. Although growing of this shrimp could be as old as milkfish, it was only in 1951 when it was considered as primary species. Dependent on seed stocks from the natural wild fry, it is on this year when the first propagation of *P. monodon* in brackishwater grow out pond was documented. Its full commercialization, however, was realized in the 1980’s where it had to wait for the hatchery technology in order to meet the national production demand. Below is the development history of the tiger prawn industry in the Philippines.

1.1 Milestones of the Shrimp (*P. monodon*) Industry in the Country

- 1960-1980 - Philippines was one of the pioneers in shrimp farming
 - Extensive method of production was introduced
 - Shrimp farming was fry dependent on the wild
 - Annual production is far below 5,000mt
- 1980-1989 - SEAFDEC AQD promoted breakthroughs on hatchery production
 - Shrimp farming became a significant industry
 - Semi-intensive and intensive farming was introduced
 - Japanese market absorbed 80% produced in Asia
- 1990-1995 - Japanese market collapsed
 - A start up or development period
 - development /import of technology (from Taiwan)
 - Production increased rapidly due to increased number of pond areas
 - rapid growth/attracted more investors
 - Government support and financing no longer a problem
- 1996-1999 - The “boom and bust” period
 - Industry stabilizes to a certain level and then declined to the extent of collapse due to outbreak of diseases
 - Shrimp production continue to decrease
- 2000 to present - verification runs on shrimp culture conducted by SEAFDEC AQD using environment-friendly protocol under different climatic conditions
 - SEAFDEC AQD started to respond to the requests of private sectors for on-farm techno-transfer/demo
 - Philippine shrimp production gradually increases from 34,627 mt in 1999 to 42,390mt in 2001

1.2 Production, Yield and Export/Import

Black tiger shrimp production peaked in the 80’s and started declining in the 90’s (Fig. 1). The main culprit in the collapse of the shrimp industry in the early 90’s was the widespread occurrence of bacterial

diseases such as vibriosis, luminous bacterial (Lumbac) infections, white spot syndrome (wss) which were all attributed to environmental degradations. Because of this, prawn growers lost heavily after several failed runs.

The biggest share in tiger prawn production in aquaculture came from brackishwater fishpond. Minimal contribution was recorded for marine fish cage and marine fish pen (Table 1). The increasing trend from 1998 to 2001 was due mainly to the shifting of milkfish growers to tiger prawn culture because of its rising demand, both at domestic and foreign markets. In 2002, production however registered to a record low of 12.79 % decrease due to poor quality of post larvae resulting to high mortality rate brought about by “Lumbac” coupled with the erratic high salinity of water and hot temperature that slowed down the growth of tiger prawn presumably as an effect of the El Niño.

The top five producing provinces for the lassy rate brought about by “Lumbac” coupled with the erratic high salinity of water and hot temperature that slowed down the growth of tiger prawn presumably as an effect of the El Niño.

The top five producing provinces for the last five years in terms of volume were Pampanga, Zamboanga del Sur/Sibugay, Lanao del Norte, Bataan and Bohol (Table 2 and Fig 2). Meanwhile the combined share of the top five producing provinces to total tiger prawn production was 78.52% in 2002 (Fig 3). From 1998 to 2002, total harvested area of tiger prawn declined from 87,872 to 77,172 ha or by an annual average of 3.2 percent primarily due to high production cost. However, in Pampanga (from 29,297 in 1998 to 30,225 in 2002) and Zamboanga del Sur/Sibugay (from 20,231 in 1998 to 24,417 in 2002), there was an increasing trend (Table 3). The other provinces (Lanao del Norte and Bohol) recorded moderate decreases of 1.03 percent an 4.55 percent, respectively in 2002 Fig 4).

From 1998 to 2001, the annual average yield per hectare of tiger prawn grew from 0.42 MT to 0.51 MT. It decreased by 9.8 percent to 0.46 percent in 2002. Pampanga, Lanao and Bataan showed increasing yields per hectare from 1998 to 2001 but declined slightly in 2002 due to poor quality of post larvae. Bohol had the highest yield of 1.0 MT/ ha from 1998 to 2000 but it decreased to 0.84 and 0.93 MT per ha in 2001 and 2002, respectively. Pampanga, which ranked number one among the top five provinces, remarkably recorded a negative growth rate of 38.57 percent in yield (Table 4 and Fig. 5).

The average farm gate price of tiger prawn at P286.51 per kilogram in 1999 was down by 4.1 percent from the 1998 price. However, farmgate price soared in 2001 and 2002 to P334.17 and P348.14, respectively. On the other hand, retail prices of tiger prawn posted an upward swing from P310.83 per kilogram in 1998 to P360.55 in 2002. The highest growth rates both at farm and retail prices were noted in 2001 at 6.21 percent and 17.12 percent, respectively. Meanwhile, farmgate-retail price margins for the last five years ranged from P12.15 in 1998 to P12.41 per kilogram in 2002. Price margins were higher in 1999 and 2002 at P31.39 to P39.30 per kilogram, respectively.

The volume of shrimps and tiger prawn exported from 1998 to 2002 exhibited an upward movement. Exports rose by about 33 percent in 2002 compared with 2001. An average growth rate of 12.83 percent was registered during the last five years. Japan, whose share to the total export was about 52 percent, reduced their purchase by less than 1.0 percent in 2002. Likewise, exports to the USA went down by about 24 percent. These decreases were more than offset by the combined exportation of shrimps and tiger prawn to Korea, Hong Kong, Guam and other countries which went up by almost 229 percent in 2002 against 2001 resulting in an overall increase of 32.6 percent (Fig. 6). Similarly, the 2002 export value of shrimps and tiger prawn grew by 12.02 percent compared with 2001. Export earnings had an annual growth rate of 2.56 percent.

The country’s importation of shrimps and tiger prawn was less than one percent of its exports in 1998 to 2001. However, the import volume and value of shrimps and tiger prawn abruptly increased in 2002 and the trend is going upward although the ratio of import to export remained low. Importation went up and augmented domestic supply. Lower world price also encouraged importation. China, the number one source of our shrimps and tiger prawn imports in 2002 sold 1,285 MT (in frozen form) to the Philippines. During the year, shrimps and prawns were also sourced from Thailand, Singapore, Taiwan, the USA and other countries. The country imported 144MT from Thailand, 44MT from Singapore, 16 MT from Taiwan and 4 MT from USA. About 85 MT were sourced from other countries.

1.3 Problems in the Industry

1.3.1. The major losses that devastated the shrimp industry were:

- Reduction of culture area from 47,776 has in 1992 to 36,658 has in 1993;
- Reduction in the number of shrimp processors and exporters from 53 in 1992 to 18 in 1995; and
- Our country that produced about 90,000MT to 100,000MT lost the 4th slot in the world producers of shrimp which means billions of pesos.

1.3.2. Other Constraints in the Shrimp Industry

- Many shrimp producers are not yet ready to invest huge amount of capital to adopt the environment-friendly shrimp culture;
- Likewise, most operators are not financially capable to adopt the said technology;
- Poor performance, growth and susceptibility of *P. monodon* diseases;
- The rapid development of *P. vannamei* in the world market makes the operators more aggressive to pressure the government lift the ban on the controversial shrimp. The white leg shrimp head-on is now in global markets and being sold also in Japan, where more than 50% of our black tiger are being exported have worried local shrimp producers;
- Lack of financing program to support the industry;
- The cheaper cost and shorter period of culturing vannamei make the shrimp growers think that it is the best alternative to our high valued monodon;
- The entry of vannamei cannot be effectively controlled for some reasons, making uncertified and uncheck fry enter the country which could be carriers of the dreaded bacterial/virus/diseases;
- Many stakeholders are already dissatisfied for the slow and sluggish recovery of the shrimp industry;
- Illegal entries/importations of vannamei were recorded, documented and apprehended.

2. POLICY ISSUES ON THE IMPORT AND CULTURE OF EXOTIC SHRIMPS

2.1 Existing Laws and Regulations

There are existing policies governing shrimp farming in the Philippines including import and export regulations and related policies to address the major problems and constraints besetting the industry:

1. The Department of Agriculture/BFAR organized the “Oplan Sagip Sugpo” on September 16, 1996 with SEAFDEC AQD Chief, Dr. Rolando R. Platon, as Chair;
2. In the early 2000, BFAR further strengthened its fight against shrimp diseases with the upgrading of its 24 regional fish health laboratories –16 of these were equipped with PCR (Polymerase Chain Reaction) that could detect the dreaded WSS virus;
3. BFAR has acquired the ELISA equipment to detect the presence of banned antibiotic residues such as nitrofurans and chloramphenicol even in minute quantities;
4. BFAR formulated FAO 207 series of 2001 which further strengthened FAO 189 series of 1993 which among others prohibit the importation of exotic shrimps;
5. A Code of Practice for Sustainable Shrimp Farming was prepared by the joint effort of BFAR, SEAFDEC and PCAMRD;
6. Implementation of Surveillance Program – SIMS–Shrimp Importation, Monitoring and Surveillance Team;
7. Organized an inter-agency Task Force – BFAR, ISAFP, BID and PNP; and
8. An ad-hoc team was created as Task Force Vannamei.

2.2 Status of Implementation and Enforcement

1. Even with the strict implementation of the above-mentioned FAO 207 and strict surveillance in airports, traders are finding other ways in bringing the illegal shrimp inside the country without passing through the airports
2. SIMS spearheaded six major confiscations in late 2002 up to 2003
3. Likewise, in August 30 and September 3 of 2003, SIMS Team successfully completed operations on the illegal culture of imported shrimp conducted in two sites in Zambales. Yet there is a report that there are about 700 has farms already operating in Luzon.

3. EXPERIMENTAL CULTURE OF *P. VANNAMEI*

In August 2004, DA-BFAR and Agrifisheries World Inc., a private entity engaged in the culture of various species such as *P. vannamei*, agreed to undertake research and verification studies on the use of Specific Pathogen Free (SPF) and Specific Pathogen Resistant (SPR) *P. vannamei* for hatchery and grow-out purposes at BFAR-NIFTDC, Bonuan Binloc, Dagupan City.

The project promotes partnership between the government and the private sector towards increased shrimp production by introduction of new high-yielding species.

The premise of the agreement are as follows:

1. BFAR recognizes the need to diversify aquaculture commodities such as high value species to improve the economic productivity of available ponds and cages in the Philippines.
2. There is a need to promote competitiveness through broadening the base of the shrimp industry with the promotion of tiger prawn and *P. vannamei* within the requirements for a free market environment.
3. There have been major advances in aquaculture genetics which includes the production of Specific Pathogen free (SPF) and Specific Pathogen Resistant (SPR) strains of *P. vannamei* notable available in Hawaii and other Asian countries.
4. There is a need to ensure that no adverse impact could result in the culture of *P. vannamei* before recommending the use of the species to farmers for nationwide commercial use.
5. There is a need to conduct a comprehensive research to study the issues and problems related to the introduction of *P. vannamei* in the Philippines.

The main objective of the project is to analyze the acceptability and verify the efficiency of SPF and SPR *P. vannamei* as a product for hatchery and grow-out production. Emphasis is given on safety measures to prevent introduction of new shrimp pathogens in the Philippines.

The project has two main components, namely:

Component 1: Pilot hatchery production of *P. vannamei* post larvae at BFAR-NIFTDC, Dagupan City.

Component 2: Pilot grow-out production of *P. vannamei* in NIFTDC earthen ponds and accredited farms in Luzon.

ACTIVITIES UNDERTAKEN

September–December 23, 2004

1. Improvement of facilities

Old finfish hatchery facility was improved to suit the needs of the project. It includes a hatchery building with canvass and concrete tanks.

Electric lines was upgraded, water supply lines were improved, a portion of the hatchery were fenced and covered, and new set of blower was installed.

2. Testing for diseases of *P. vannamei* breeders in the US prior to shipment to the Philippines.

Tissues were sent to Prof. D.V. Lightner of University of Arizona for detection of the White Spot Syndrome Virus (wssv), Hepatopancreatic Parvo-like Virus (HPV), Baculovirus Penaei (BP), Infectious Hypodermal and Hematopoietic Necrosis Virus (IHHNV), Yellow Head Virus (YHV) and Taura Syndrome Virus (TSV). Arrival date in UA was November 29, 2004.

Results of PCR tests conducted by Prof. Lightner of Aquaculture Pathology Office of the University of Arizona, Tucson, USA found the samples free of wssv, HPV, BP, IHHNV, YHV and TSV.

3. Conduct of Workshop prior to arrival of *P. vannamei* breeders

A workshop was conducted on December 1, 2004, on quarantine protocol for *P. vannamei* participated by technical staff of BFAR-NFFTC, BFAR-IFAD and BFAR-NIFTDC. The following references were used:

- Health management and biosecurity maintenance in white shrimp (*Peneaus vannamei*) hatcheries in Latin America. FAO Fisheries Technical Paper 450. Food and Agriculture Organization of the United Nations Rome, 2003
- Manual on Risk Analysis for the safe movement of aquatic animals (FWG/01/2002). Network of Aquaculture Centers in Asia-Pacific

4. Shipment and arrival of *P. vannamei* breeders

1,100 SPR *P. vannamei* breeders (550 males, 550 females) was shipped from Hawaii, USA on December 22, 2004 to BFAR-NIFTDC, Philippines. Arrival date was December 24, 2004.

December 24–February 1, 2005

5. Arrival and maintenance of *P. vannamei* breeders

P. vannamei breeders arrived about 10:00AM at NAIA, Manila and 8:00PM at BFAR-NIFTDC, Dagupan City.

The breeders were acclimatized in two wooden trough before finally stocking them in three 16 ton capacity canvass tanks. Male and female breeders were separated. Salinity was maintained at 22 ppt and temperature between 26-28°C. The breeders were fed with mixed oysters and squid. Cleaning and changing of water was done once a day.

From December 24 to February 1, 2005, the total number of dead breeders was counted at 145 pcs (80 males and 65 females).

January 4–February 22, 2005

6. Health Monitoring

Samples of *P. vannamei* breeders and larvae were submitted to BFAR and SEAFDEC for testing on the following dates:

Date	Samples	
January 4, 2005	6 pcs of breeders (frozen)	BFAR Fish Health Section
January 6, 2005	1 kg breeders (frozen)	BFAR Fish Health Section
February 1, 2005	10 pcs breeders (live)	BFAR Fish Health Section
February 11, 2005	400 pcs PL 8	SEAFDEC
February 17, 2005	5 pairs breeders (live)	SEAFDEC
February 22, 2005	3 pairs breeders (live)	SEAFDEC

Accreditation of *P. vannamei* grow-out operators

1. Implementing Guidelines on Accreditation of *P. vannamei* growers.

A workshop was conducted with SEAFDEC to lay down the guidelines on Accreditation of *P. vannamei* growers.

2. Creation of an Ad-hoc Task Force Vannamei

Fisheries Administrative Order 031 S-2005 was issued by BFAR Director creating an Ad-hoc team named Task Force Vannamei composed of the following:

Team Leader	:	BFAR-NIFTDC Chief
Asst. Team Leader	:	BFAR-IFAD Chief
Members	:	BFAR-NFFTC Chief IRA-TF Team Leader Agrifisheries World Representative BFAR Regional Office Representative SEAFDEC-AQD Representatives

The functions and responsibilities of the Task Force Vannamei are the following:

- a. Preparation of criteria and implementation of guidelines for the accreditation of private and government owned farms who will be recipient of F1 certified SPF *P. vannamei* larvae and broodstocks for the commercial breeding and grow-out farming.
 - b. Monitoring, evaluation and rendering of technical advisory services to all accredited farmers through on the spot visits and consultation/orientation meetings.
 - c. Conduct of regular meetings to review/assess the present conditions and status of *P. vannamei* farming to formulate policy guidelines.
- #### 3. Conducted evaluation of proposed sites of accredited farmers:
- a. Technical considerations:
 - The farm should be accessible to any kind of land transportation.
 - The farm should have strong dikes and gates that are free from leaks.
 - The farm should have clean and sufficient brackishwater supply throughout the year.
 - The farm should have access to electricity.
 - The farm should be free from flooding.
 - The following basic equipment and facilities should be available in the farm:
 - Equipment (refractometer, thermometer)
 - Facilities (water pump, aeration facilities as required, bag net–fine mesh, installation at the drainage canal)
 - b. The applicant should have at least one (1) year experience in shrimp farming
 - c. The applicant should be willing to undergo an orientation seminar on the culture of *P. vannamei*.
 - d. The selected applicant shall sign a MOA with BFAR on the operation of the *P. vannamei* farm.

The proposed sites that were visited are farms located at Western Pangasinan and Zambales. Individual pond areas were measured. Samples of water and soil were collected. Samples of any crustaceans in the sites were gathered and preserved for disease analysis. Pictures of the farm were taken for reference purposes.

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The Culture of *Penaeus vannamei* and Other Exotic Shrimps in Singapore

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ABSTRACT

This paper describes the overview of shrimp culture industry and the historical production of *Penaeus monodon*, *P. merguensis* and the *P. vannamei*. The production of shrimp reduced from 115 metric tonnes in 2002 to 46 metric tonnes in 2004. Imported shrimps to Singapore in year 2003 reached 21,157 metric tonnes and valued at \$129.57 millions. Domestic market alone required 16,359 metric tonnes and valued at \$106.5 millions. Exported shrimps which maintain at 4,913 metric tonnes are mainly the products from the shrimp processing industry and all the raw materials were imported from other countries. Shrimp culture in Singapore suffered significant losses in the 90s due to the Yellowhead Virus (YHV) and the White Spot Syndrome Virus (WSSV) and the reduction of production was also due to urbanisation. Under the Wholesome Meat and Fish Act, the existing laws and regulations are to ensure wholesome food safety. Sampling and testing of all type of fish and seafood products for preservatives as well as contaminants such as heavy metals and drug residues are carried out regularly. All imports of fish products shall comply with prevailing regulations laid down by the Agri-Food & Veterinary Authority of Singapore (AVA). Culture of *P. vannamei* commenced in 2002 and majority of the fry were purchased from Taiwan. The grow-out culture areas calculated at about 3 hectares and only 8 metric tonnes of live *P. vannamei* were produced. The labour and employment generated in shrimp culture are limited by less than 10 persons. R&D activities on *P. vannamei* and other exotic shrimps are not well established, only the monitoring of shrimp production on coastal areas and fishing catch for occurrence of exotic species have been investigated. The field survey of *Penaeus vannamei* culture that was conducted on two shrimp farms (Round concrete pond system and rectangular concrete pond system) showed the stocking biomass at 185 pcs/m³ and 120 pcs/m³, respectively. At the end of the 2-month culture period, the mean body weight of the shrimps reached 10g with the round pond with 60% survival rate and the rectangular pond with 72% survival rate. The biomass of the round pond was at 2.6 kg/m³ while the rectangular pond was 1.2 kg/m³. The results from both systems indicate the potential of *P. vannamei* culture in this region.

INTRODUCTION

The shrimp industry in Singapore began in the 80s and slumped in the 90s due to serious outbreaks of diseases and urbanisation. The dominant species that were cultured then were the black tiger shrimp (*Penaeus monodon*) and the banana shrimp (*P. merguensis*). *P. vannamei* was only introduced to Singapore in 2002. Due to their greater ease of culture, adaptability to the local environment, high growth performance with less protein requirements and better survival rate, production costs were lowered and they became the cheapest shrimps in the market. Experimental introduction of specific pathogen free (SPF) *P. stylirostris*, also known as “supershrimp,” was introduced into Singapore in 2001, however there has been no further development on this species since then.

RESULT & CONCLUSION

Overview of shrimp culture industry in Singapore

Shrimp production in Singapore reached 60 metric tonnes in early 2000 and increased to 114 mt in 2001 and 115 metric tonnes in 2002. The production of shrimp decreased from 115 mt in 2002 to 46 metric tonnes in 2004. The decline is mainly due to urbanization. *P. monodon* and *P. merguensis* were the two major species accounted for over 85% of total shrimp aquaculture production. The production of *P. vannamei* has increased from 6 mt in 2003 to 8 mt in 2004 (Figure 1). The overview of shrimp culture from year 2000 to 2004 and their historical production figures by species (quantity and value) are shown in table 1-4.1

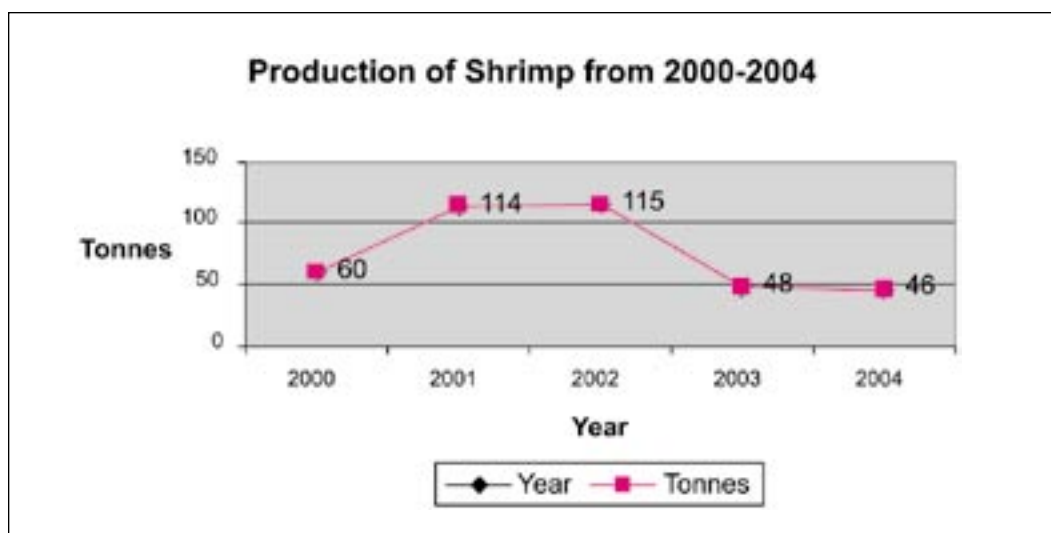


Figure 1: Production of shrimp from 2000-2004

Table 1: Shrimp Production of Singapore from 2000-2004

Year	2000	2001	2002	2003	2004
Tonnes	60	114	115	48	46
Value (\$'000s)	960.0	2050.0	1934.8	926.5	891.2

The historical production figures by species (quantity and value) are shown in Tables 2-4.

Table 2: *Penaeus monodon* Production from 2000-2004

Year	2000	2001	2002	2003	2004
Tonnes	8.0	78.0	11.8	21.0	19.1
Value (\$'000s)	232.0	1412.0	240.8	436.0	400.2

Table 3: *Penaeus merguensis* Production from 2000-2004

Year	2000	2001	2002	2003	2004
Tonnes	52	32	97	21	22
Value (\$'000s)	728.0	566.0	1595.4	391.5	346.0

Table 4: *P. vannamei* and *P. stylirostris* Production from 2000-2004

Year	2000	2001	2002	2003	2004
Tonnes	0	4	6	6	8
Value (\$'000s)	0	72.0	98.6	99.0	145.0

Shrimp export (quantity and value)

The export of shrimp in year 2003 was 4,913 mt valued at \$42.38 millions. Details of the export status are shown in table 5.

Problems in the shrimp culture industry

In the 90s, the shrimp industry in Singapore was perceived to be poor performance with slow growth rate and disease susceptibility of the major indigenous shrimp culture species. *P. monodon* and *P. merguensis* were virtually characterized by serious viral pathogens causing significant losses to the culture industries. In Asia, the native shrimp culture industries suffered heavy losses in 1992 first due to the Yellowhead Virus (YHV) and later in 1994 to White Spot Syndrome Virus (wssv).

Policy issues on the import and culture of exotic shrimps

Existing laws and regulations

An import permit issued by the Agri-Food & Veterinary is required for every consignment of fish products imported. Fish products refer to any of the varieties of marine, brackish water or fresh water fishes, crustacean etc.

Traders may apply for the permit by declaring the import through the TradeNet system. For fish products, documents such as invoices and airway bill would need to be submitted.

Imported fish products are subjected to inspections. Samples may be taken for laboratory analysis.

Status of implementation and enforcement

All imports of fish products shall comply with prevailing regulations laid down by the Agri-Food & Veterinary Authority of Singapore (AVA). Health requirements governing the importation of the high risk items are available on request.

Fish products may be transshipped at or exported from Singapore. The procedures to apply for such approvals are similar to that for import. The approved fee payable for the import, export and transshipment of fish products is \$18 per consignment.

AVA regularly samples and tests all types of fish and seafood products for preservatives as well as contaminants such as heavy metals and drug residues. In addition, AVA has stationed officers at the fishing ports to spot and take action against any illegal activities including the use of preservatives. Under the Wholesome Meat and Fish Act², any person who is convicted of selling or supplying fish or fish products that are adulterated is liable to a fine not exceeding \$50,000 or imprisonment for a term not exceeding 2 years, or both.

Culture of *P. vannamei* and other exotic penaeid species

History of introduction and Source of broodstock

P. stylirostris and *P. vannamei* were introduced into Singapore in years 2001 and 2002 respectively. The *P. stylirostris*, also known as "supershrimp," was introduced into various Asian countries from 2000 while no further developments were made in Singapore after 2001. For *P. stylirostris*, a hatchery was set up in 2001 and the broodstock was brought into the country directly from USA. The hatchery was unsuccessful and the operation was moved to Brunei. For *P. vannamei*, no hatchery was set up and the juveniles were purchased directly from Taiwan.

Grow-out culture and location of ponds and area used for culture

In Singapore, only one farm was used for *P. stylirostris* grow-out culture in 2001 and the farm produced 4 tonnes of shrimps before the operation was terminated. Two farms in Singapore have been actively involved in *P. vannamei* culture since 2002. The pond areas used for culture are about 3 hectares. The total production for the past three years was 18 mt sold to domestic live fish markets with selling prices ranging from \$16 to \$18 per kilogram. The field survey of *Penaeus vannamei* culture that was conducted on two shrimp farms in Singapore from September-December 2004 used a standardized economic questionnaire that included costs, returns and growers' perceptions of constraints.

Economic estimates were developed for representative production systems. Juveniles of *P. vannamei* were reared in two farms using different culture systems. The first farm used a round concrete pond with a water capacity of 700 metric tons while the second farm used a rectangular concrete pond with a water capacity of 2500 metric tons. The stocking biomass of the round tanks system was 185 pcs/m³ while the rectangular tanks system was 120 pcs/m³. At the end of the 2-month culture period, the mean body weight of the shrimps reached 10g with the round pond having a 60% survival rate and the rectangular pond having a 72% survival rate. The biomass of the round pond was at 2.6 kg/m³ while the rectangular pond was 1.2 kg/m³. The results from both systems indicate the potential of *P. vannamei* culture in this region.

Total annual production

The total production of *P. vannamei* in 2003 was 6 mt, valued at \$99,000 and 8 mt value at \$145,000 in 2004 (Table 4).

Domestic market and effect on shrimp volume and prices

Domestic market required 21,157 metric tonnes and valued at 129.57 millions annually (table 5). The price of the domestic market ranging from \$6 to \$12 dollars per kg depending on the sizes and freshness of the shrimp.

Quantity and value of exports

The processing industry will require 5,000 mt annually to support their processing products for export. The export quantity of shrimps and prawns in 2003 was 4,913 mt valued at \$42.38 millions. Details of the import and export are shown in Table 5³ on next page.

Labour and employment generated

So far only ten employments have been generated for culturing the shrimp.

R&D activities on *P. vannamei* and other exotic shrimps

Most of the R&D activities on *P. vannamei* and other exotic shrimps were carried out in early 2000s. As for the *P. monodon* and *P. merguensis*, lots of R&D studies have been carried out in the early 90s. Experimental study on shrimp hatchery also gained strong foothold during early 90s but none of the shrimp hatcheries were able to sustain through 2000.

Disease outbreak and management on *P. vannamei*

So far no major disease outbreaks have been found for the past three years.

Proposed guidelines for the introduction and culture of exotic shrimps

Currently, there is no specific guidelines for the introduction and culture of exotic shrimps. Only a standardized economic questionnaire that included costs, returns and growers' perceptions of constraints was used for the economic estimates and developed for representative production systems.

Table 5. Showing the import and export of shrimps & prawns in 2003

IMPORT & EXPORT OF SHRIMPS & PRAWNS 2003*	Export		Import	
	Tonne	\$'000	Tonne	\$'000
Shrimps & Prawns (Live, Fresh or Chilled)				
China	12	501	5	225
Indonesia	4	168	2,797	9,223
Korea Rep of	14	233		
Malaysia	655	3,694	6,535	39,328
Taiwan	25	248	10	75
Thailand		77	4,890	21,724
Saudi Arabia	21	56		
Vietnam Soc Rep of	8	218		
Others	11	199		
Total	750	5,394	14,303	71,323
Shrimps & Prawns (Frozen)				
Australia	87	1,273	50	1,093
Brunei	13	126		
China	11	50	1,045	6,342
Hong Kong	267	3,106		
India			102	1,157
Indonesia	1,191	8,761	3,207	20,037
Japan	678	9,164	15	257
Korea Rep of	16	213		
Malaysia	945	3,429	345	3,410
Myanmar			1,270	14,148
Norway			39	435
Taiwan	4	72		
Thailand	99	1,093	289	4,703
United States	211	2,859		
Vietnam Soc Rep of	15	77	388	5,844
Others	626	6,761		
Total	4,163	36,984	6,854	58,245
Grand Total of Shrimps & Prawns	4,913	42,378	21,157	129,568

* Source from Singapore Trade Statistic 2003

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1. Quarterly Survey of Coastal and Inland Farming of Singapore 2000-2004 (unpublished results)
2. Wholesome Meat and Fish Act of Singapore
3. Singapore Trade Statistic 2003.

Aquaculture of White Shrimp *Penaeus vannamei* in Thailand

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INTRODUCTION

Aquaculture production in Thailand has been practiced for a long time. Thailand has a huge flood plain, long riverine stretches, natural lakes, reservoirs and brackish-water areas along the coastline. On the Gulf of Thailand and Andaman Sea there are approximately 2,600 kms of shoreline. Marine shrimp farming in Thailand has been part of the culture for the last 80 years (Tookwinas, 1994). However, the technology of intensive shrimp farming has expanded significantly along the coastal province in the last two decades. Presently, Thailand has become the leading country in shrimp production in the world market since 1991 (World Shrimp Farming, 2004) (Table 1) with a total production area of approximately 75,000 ha and 30,800 farmers and production of 330,000 tons in 2003 (Fig.1 and Table 2). Recent statistics show that 37 percent of shrimp farmers are small operators utilizing a farming area less than 0.8 ha, the area between 0.8–1.6 ha of 28%, the area between 1.6–4.8 ha of 24% and the area over 4.8 ha of 11% (National Statistical Office, 2000). The farming species are *Penaeus monodon* and *P. vannamei*. More than 95 percent of marine farming production has been exported frozen, headless and with the shell on. The importing countries are United States, Japan, European Countries, Canada and etc.

1. SUCCESS FACTORS FOR SHRIMP FARMING IN THAILAND

Thailand has been raising marine shrimps for a long time. Traditional or extensive marine shrimp culture has been practiced over the past 80 years. In 1972, the Department of Fisheries was successful in producing marine shrimp, especially the *P. monodon* species (Tookwinas, 1991). Farmers were encouraged to raise additional stocks of shrimp in the traditional pond. This type of culture is called semi-intensive. Intensive marine shrimp farming has just been developed in the last 20 years. The rapid expansion of shrimp culture and increased production has made Thailand the leading country for marine shrimp farming since 1991. Kongkeo (1994) stated the key factors for the success of marine shrimp farming in Thailand. They are:

1.1. Suitable sites

Thailand is located in tropical region and has a long coastal area suitable for shrimp farm construction.

1.2. Availability of wild broodstock

Tiger prawn (*P. monodon*) is locally distributed in the South East Asian Sea making wild broodstocks easily available for hatchery production of shrimp fry in Thailand. The Department of Fisheries has carried out a program of stock recruitment by releasing shrimp fry in coastal waters. Around 500 million fry are released each year. Some farmers, in cooperation with the Department of Fisheries, also join the re-stocking program from a portion of their shrimp production after harvesting in order to maintain or supplement the natural population of tiger prawns.

1.3. Extensive experience in aquaculture

Shrimp farmers have had vast experience in aquaculture and are enthusiastic to learn more and practice advanced technologies. They always have new ideas for development or modification, and eager to run try them. The present success of Thailand in this industry gives testimony to the persistence and ingenuity of Thai people in utilizing applied science to its utmost (C.P. aquaculture, 1994).

1.4. Well-developed infrastructure and supporting industries

Marine shrimp industries require a developed infrastructure and support industries such as transportation, electricity and telephone communications. These infrastructures are needed for the rapid development of shrimp industries in Thailand. Thailand already has enough support and line businesses, such as construction materials, heavy machines, feed mills, shrimp fry hatcheries and food processing plants, which help the development of shrimp industries.

1.5. Small-scale industry

Marine shrimp industry in Thailand is a rather small-scale industry. Most of the culture shrimp areas are small – approximately 0.16–1.6 ha. This is quite convenient for pond construction and operation because the cost of investment is much lower. Thailand originated techniques for backyard hatcheries. Farmers develop their own backyard hatcheries and use simple but sometimes more productive technologies. They account for more than 80% of the national shrimp fry production.

1.6. Less-destructive environment impact

Thailand has a coastline of about 2,600 kms. Marine shrimp farming has been expanding, spreading to all 23 coastal provinces in the country. The effluents from shrimp ponds can be easily dispersed. Previously, mangroves were expropriated for shrimp farm construction due to convenience and accessibility of water supply. However, with understanding that mangroves may destroy not only fish and crustacean nursery grounds, but also natural flood and storm protection barriers (Sakthival, 1985), farmers have found an option – that of rice fields along the coastal areas. These rice fields have clay/silt content that could prevent seepage, which would be suitable for pond construction.

Recent statistics show that only 11.31% of mangrove (conservation and economic zone A) was used for shrimp farming across the country (Research Council of Thailand, 1995). The Department of Fisheries has a strong policy to move all of the farms to suitable areas. The government also has rules for shrimp registration and effluent regulation, in order to prevent the negative effects of shrimp farms on the coastal environment.

In the last 5 years, some farmers in the Inner Gulf of Thailand moved to areas with low water salinity and used the zero water discharge technique in freshwater area in central part of the country. However, this was banned by the Royal Thai Government through the Ministry of Science, Technology and Environment by virtue of the Environment Act BE. 1992. This is due to fear of salinity intrusion in rice fields and other agriculture areas and also that of ground freshwater.

1.7. Research and development program

The research program has been continuously conducted in various aspects of marine shrimp culture development both in government agencies, universities and private sectors. The zero water discharge culture technique was initially developed by the Department of Fisheries research station in Petburi province (Tunsutapanich, *et al*, 1994) in order to avoid contamination of incoming seawater in the water exchange during the culture period. The domestication and genetic improvement of shrimp spawner has been conducted both in universities, private sector and the Department of Fisheries.

The development program on shrimp farm water quality and coastal water quality has been effectively monitored along the shrimp farm and coastal line of the country. The residue in culture shrimp before harvesting is monitored and certificated for both exporting and local consumption.

The code of conduct for responsible marine shrimp farming and related business along FAO guideline and Environmental Management System (EMS) is now on the process for implementation. The progress of activities will be described later.

2. AQUACULTURE OF WHITE SHRIMP

Vannamei White Shrimp was first introduced into Thailand in 1999. The Shrimp fry was illegally brought for culture in Surajthani province, Southern Thailand and was reportedly successful. However, in order to sell the product, it has to be transported to Singapore. This is due to the unavailable product brand of white shrimp in the country at that time. Since 2001, the fry are illegally brought into the country for culture from time to time until 2002 when the Royal Thai Government by the Department of Fisheries (DOF) launched officially the regulation for white shrimp spawner importation. It would be needed for disease free of WWSSV, IHNNV, TSV and YHV certification.

The first imported white shrimps have had some problems of disease outbreak, especially of TSV and IHNNV. The import regulation ended in early 2003. Since then, there had been a shortage of good quality broodstock, hence the DOF allowed the white shrimp spawner importation again in June 2004 under Fisheries Act B.E. 2547. This regulation is required to register the sources of the shrimps, which have to be approved by the DOF prior to the importation.

The origin or hatcheries of shrimp spawner to be imported would have meet the DOF requirements, as follows;

1. Proposed hatcheries would be operated under biosecure system.
2. Imported shrimp spawner would be specific pathogen free (SPF) and/or specific pathogen resistance (SPR).
3. A required certification issued by the government or the private laboratories being accredited by the government authorized agency shall certify that:
 - 3.1 The hatcheries are under monitoring system of at least 2 years and shall not appear to have abnormal mortality during 3 months before exporting.
 - 3.2 Brooders are domesticated by using genetics selection program on farm.
4. The official letters from the farm owners assure their abilities to provide a Health Certificate from the institute states that the importing shrimp in each shipment are Specific Pathogen Free from these following diseases by using PCR technique or the technique recommended by OIE.
 - Wssv (White Spot Syndrome Virus)
 - YHV (Yellow Head Virus)
 - Tsv (Taura Syndrome Virus)
 - IHNNV (Infectious Hypodermal and Hematopoietic Necrosis Virus)

At present, there are 6 certified hatcheries/sources in USA for white shrimp spawner importation to the Kingdom of Thailand. About 30,000 spawners of white shrimp, both male and female, have been imported. It has been estimated that around 100,000 spawners per year are needed for Thai shrimp culture.

The production of white shrimp from aquaculture has rapidly increased since 2002. The production was around 30,000 tons in 2002, 170,000 tons in 2003 and 300,000 tons in 2004 which is around 80% of total marine shrimp production from aquaculture (Table 2 and Fig. 2).

3. CULTURE TECHNIQUES OF WHITE SHRIMP

3.1. Hatchery management

Broodstock manipulation

Since February 2002, the Department of Fisheries has permitted official importation of the White shrimp broodstock from certified worldwide sources. Then, white shrimp seedlings could be produced to support shrimp grow-out farming. Each lot of imported shrimp is possible to maintain a 6-month period and needed for renewable recruitment. The hatchery operators would be registered by the Department of

Fisheries prior to stocking shrimp in their hatcheries and its more required to comply with the standard production process.

Female eye ablation technique is used to induce maturation of the shrimp. Male and female shrimps are stocked at ratio of 1 : 1 fed with live organisms with high concentration of highly unsaturated fatty acid, such as bloodworm, squid, shell etc., are preferred to feeding the broodstock. The periodic check of Virus infection is also recommended throughout the stocking period.

Nursing shrimp fry

To this day, producing shrimp fry can be done in small, medium and large hatcheries. As in the monodon hatchery, one white shrimp spawner releases eggs in a small tank and transferred to nurse in bigger concrete tank. The suitable seawater will be at 27–30 ppt salinity and water temperature at 28–30°C. Diatoms (*Chaetoceros sp.*) and supplements are the primary food in Zoea stage, and would usually take 5 days to develop to Mysis stage. Nauplius of Artemia will be used to feed from Mysis until the Post larvae. At PL stage III - IV, the farmer will begin to reduce the water salinity in order to prepare shrimp fry for culture in the low salinity environment.

3.2. Farm management

Culture techniques

Low salinity culture system Majority of this method is applied in inland farming areas. Shrimp fry (PL13–15) produced in hatchery are stocked in the earthen pond previously used for the *P. monodon* culture. Some farms have often been added highly concentrated seawater (over 100 ppt) to suit to the salinity level in the pond for 3-4 ppt. First, shrimp fry are acclimated in smaller cage (15 m²) setup inside the pond for 3-4 days. After releasing out, young shrimp can survive in the open area. Normally it can be stocked at 70,000–80,000 shrimp per rai (43-50 shrimp per m²). Target size is at 60-80 shrimp per kg within 4 months of culture. Before reaching a period, a part of shrimp product must be harvested to let the remains grow up to the target size in the next 3 weeks. As *P. monodon* culture, aeration is necessary to maintain adequate oxygen concentration in pond water.

Normal salinity culture system. In the early development of shrimp culture, the normal salinity in the culture system is done along the coastal areas especially in the southern part of the country. Like *P. monodon*, culture, salinity in *P. vannamei* culture is kept over 10 ppt. Shrimp fry are stocked in higher densities of more than 120,000 shrimps per rai (75 shrimps/m²). Production is at 2,000 kg per rai (12,000 kg per ha) with 80% survival rate. Table 3 shows some examples in formation of *P. vannamei* culture in Thailand.

However, large operators use the Polyethylene lining pond system. It has been reported that using this system is more productive and can obtain higher size shrimps.

Feeding management

Vannamei shrimps require lower protein such as formulated pellet feed and other supplementary pre-mixes, which are manufactured commercially in the country. Compared to Monodon, White shrimp can feed on the natural food grown in the pond. Feeding can be adjusted to 3-5 times a day depending on the demand. Culture in higher densities (over 60 shrimp/m²) may require more often feeding. Feeding adjustment should be done with more care than Monodon. It is said that management of shrimp culture in higher density is relatively easier than that of low density.

3.3. Disease and Prevention

There are few diseases, which have caused significant damage to Vannamei shrimp culture. They are: White Spot Syndrome Virus (wssv), Infectious Hypodermal and Hematopoietic Virus (IHHNV) and Taura Syndrome Virus (tsv). The Taura Syndrome Virus (tsv) is also found in Thailand since the unofficial stocks imported to the country. Many of farmers prevent the infection of diseases by keeping the farm condition away of risk such as

- Selection of good quality shrimp fry from certified sources, some required the PCR check.
- Maintain the efficiency of feeding control, etc.

4. RESEARCH AND DEVELOPMENT ACTIVITIES ON WHITE SHRIMP AQUACULTURE

White Shrimp aquaculture highly contributed in marine shrimp production, which is approximately 80% of total production or 300,000 tons in 2004. It is expected that the production would be increased up to 350,000 tons in 2005.

The Royal Thai Government by the Department of Fisheries has several plans for Research and Development activities on white shrimp, which are as follow;

- 4.1. Developing capability of producing local SPF and SPR strains of White shrimp broodstock
 - 4.1.1. Establishing a certified and voluntary program for SPF white shrimp hatcheries where private hatcheries can apply.
 - 4.1.2. Permitting private hatcheries to import white shrimp spawners, they should be responsible to keep 10 percent of shrimp fry in their own areas to develop and produce SPF and/or SPR broodstock.
 - 4.1.3. Developing thru DOF own research program on SPF and/or SPR white shrimp broodstock.
- 4.2. Evaluating and Monitoring coastal areas on the habitation of white shrimp in natural waters.

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Table 1. Culture shrimp production of the world (unit: tons)

Countries	2000	2001	2002	2003	2004*
Thailand	290,000	320,000	250,000	350,000	380,000
Indonesia	110,000	90,000	102,000	168,000	180,000
China	200,000	300,000	280,000	400,000	350,000
Ecuador	45,000	45,000	60,000	80,000	80,000
India	85,000	80,000	125,000	100,250	100,000
Vietnam	75,000	95,000	85,000	110,000	160,000
Others	145,000	248,000	278,800	308,000	430,000
Total	950,000	1,178,000	1,180,800	1,516,250	1,680,000

Source: World Shrimp Farming (2004). Remark: * Estimated by Thai Marine Shrimp Culture Association

Table 2. Culture Statistic of Marine Shrimp Production in Thailand

Year	Number of farms	Area (ha)	Total Production (tons)	Product of White Shrimp (tons)
1995	26,145	74,942	259,540	-
1996	23,413	72,664	239,500	-
1997	23,723	73,120	227,560	-
1998	25,977	73,139	252,731	-
1999	28,012	77,579	257,544	-
2000	34,845	79,793	309,794	-
2001	28,000	72,000	280,000	-
2002	27,500	70,400	265,000	30,000
2003	30,800	75,736	330,000	170,000
2004	-	-	380,000	300,000

Source: Fisheries Information Center, Department of Fisheries (2004). * Estimated by Thai Marine Shrimp Culture Association

Table 3. Example of Vannamei shrimp culture Information in Thailand

Pond		1	2	3	4
Pond size	(rai)	5	9	4	5
	(ha)	0.8	1.44	0.64	0.8
Date of released		7 Aug 2004	12 Jul 2004	5 Jul 2004	28 Jul 2004
Cultured period	(days)	91	95	126	110
Released PL	(tails)	700,000	1,200,000	300,000	500,000
Density of Fry	(PL/m ²)	87.5	83.3	46.9	62.5
Harvested size	(ind./kg)	51	58	46	59
Yield	(kg)	13,300	14,800	6,200	10,500
	(kg/rai)	2,660	1,644	1,550	2,100
	(kg/ha)	425.6	263.0	248.0	336.0
Survival rate	(%)	97	72	95	124
FCR		1.35	1.22	1.58	1.14

Source: Shrimp Culture Newsletter, November 2004.

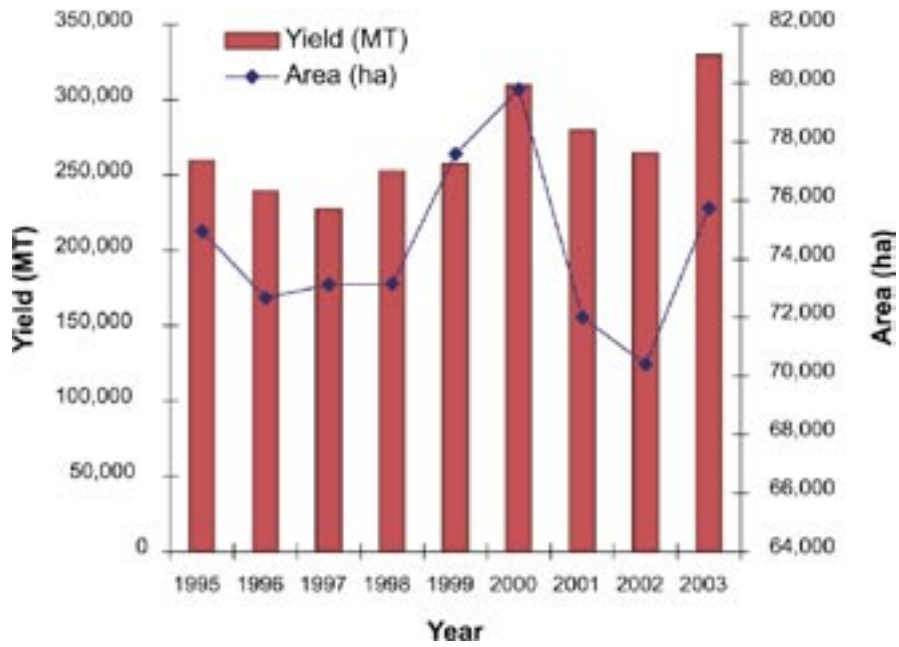


Figure 1. Shrimp production, culture area and total production 1995-2003

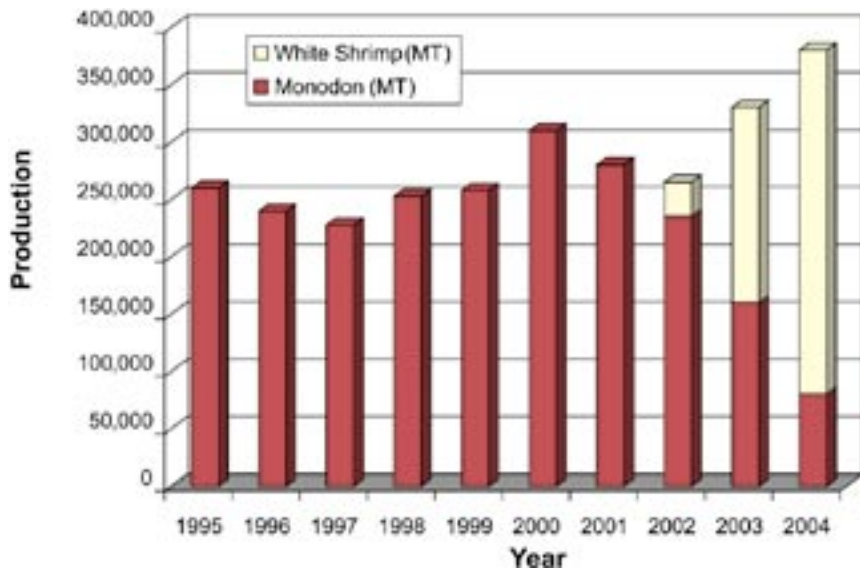


Figure 2. Proportion of Monodon and White shrimp production in Thailand

Shrimp Culture in Vietnam

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1. Overview of Shrimp Culture in Viet Nam

The main farmed shrimp species in Vietnam are *Penaeus monodon*, *P. merguensis* and *Metapenaeus ensis*. The most important species for shrimp culture is *P. monodon*.

In the last decade shrimp culture has rapidly developed as shown in the following figures:

- *The post-larvae (PL) production*: Between 2000 and 2004, the number of hatcheries grew from 2,669 to 5,094; the amount of PL from 10,000 and 25,900 M, respectively.
- *The area for shrimp culture*: The area in 2000 was 224,407 ha and in 2004 the total area was 592,585ha (47,477ha of intensive and semi-intensive culture and 545.108ha of extensive culture, including organic culture).
- *The total production of shrimp*: The total production in 2000 was 104,519 mt and increased to 295,660 mt (290,501 mt for *P. monodon* and *P. merguensis*) in 2004.

2. Policy Issues on the import and culture of exotic shrimp

Vietnam Fisheries Law that has come into force from July 1st, 2004 contains a chapter on aquaculture (Chapter IV). It stipulates aquaculture activities and some articles of the chapter are cited:

Article 23: Masterplan on aquaculture development

1. The masterplan on aquaculture development shall be a part of overall development masterplan of fisheries sector approved by the Government.
2. Ministry of Fisheries shall chair the coordination with relevant Ministries and provincial People's Committees in formulating the masterplan on aquaculture development nationwide and of specific province and city under central level.

Provincial People's Committees, on the basis of the masterplan approved by the Government and in accordance with guidance of Ministry of Fisheries, shall formulate specific masterplan to submit to the People's Council at the same level for passage and to report to the Ministry of Fisheries.

On the basis of approved masterplans and plan regarding the aquaculture development issued by provinces or cities under central level and in accordance with the direction of provincial People's Committees, the People's Committees at lower levels shall prepare specific masterplan on aquaculture site within their jurisdiction to present to the People's Councils at the same levels for adoption and to report to People's Committees at the direct higher level.

3. Any changes and supplement of masterplan on aquaculture development shall be decided by agency dealing with masterplan approval.

Article 24: Aquaculture conditions

1. Organizations and individuals engaged in aquaculture shall meet the following conditions:
 - a. Construction sites for aquaculture facilities shall be placed in accordance with the masterplan.
 - b. Aquaculture facilities shall be complied with technical and conditional requirements; veterinary sanity standards and environmental protection as stated by legislation.
 - c. They shall use feed and veterinary drugs that are up to standards as regulated by legislation regarding veterinary service.

2. Ministry of Fisheries shall issue standards, process and procedures of aquaculture sites; shall chair the coordination with relevant Ministries and ministerial-level agencies, provincial People's Committees to provide guidance, examination and recognition of qualified aquaculture sites conducted by means of semi-intensive and intensive methods that meet the food hygiene and safety standards.

Article 27: Allocation, lease and revocation of aquaculture land

1. The allocation, lease and revocation of aquaculture land shall be done in compliance with Land Law and other relevant legislation.
2. Organizations and individuals to whom aquaculture land is allocated and leased shall comply with rights and obligations as set out by this Law, Land Law and others regulations of relevant legislation.

Article 32: Concentrated aquaculture areas

1. The State shall support to invest in the establishment of infrastructure for concentrated aquaculture areas in accordance with development masterplan and plans of fisheries sector; shall invest in the setting up of monitoring stations for fisheries environment and fish disease control stations.
2. Organizations and individuals conducting aquaculture in concentrated aquaculture areas shall comply with regulations of concentrated aquaculture areas, professional technical requirements on aquaculture construction, aquaculture techniques and farming environmental protection.
3. Ministry of Fisheries shall make regulations relating to water quality standards on aquaculture, specialized technical standards on aquaculture construction; shall issue rules on organization and operation of concentrated aquaculture areas as well as closed-harvest time to ensure food hygiene and safety.
4. Provincial People's Committee shall have responsibility to manage concentrated aquaculture areas.

Article 33: Fish fry

1. The quality of fish fry for aquaculture, rehabilitation and development of fisheries resources shall be ensured in accordance with criteria system of Vietnam.
2. Organizations and individuals who produce and trade fish fry shall meet all trade conditions as regulated by Government, shall ensure the fish fry production to be in accordance with sector's standard requirements.
3. New fish fry and firstly-introduced fish fry used in aquaculture shall be recognized and allowed to be produced by Ministry of Fisheries.
4. The State shall issue policies to promote the research of precious and rare fish fry and the creation of new fish fry; shall invest in establishment of national hatcheries. Ministry of Fisheries shall coordinate with provincial People's Committees to examine the fish fry quality in hatcheries.

Article 34: Import and export of fish fry

1. The imported fish fry shall be subject to quarantine as regulated by legislation regarding veterinary service and plant protection and quarantine legislation.
2. New fish fry imported for the first time shall be approved in writing by Ministry of Fisheries.
3. The transit of fish fry through Vietnam shall be done in accordance with legislation relating to veterinary service, plant protection and quarantine as well as other relevant legislation.
4. Exported fish fry shall be under the list of specialized exportable fishery products except the exchange of fish fry, scientific and technical research cooperation, gifts or other special cases as regulated by Ministry of Fisheries.

Article 36: Prevention and control of fish disease

1. Organizations and individuals engaged in fish fry production and aquaculture shall apply measures to prevent fish disease. Where fish disease occurs, treatment shall be timely applied and local authorities and specialized agencies shall be informed at the same time.

Diseased farmed fish shall be treated in accordance with legislation on veterinary service and plant protection and quarantine.

2. Ministry of Fisheries and People's Committees at all its levels shall be responsible for prevention of fish disease. The proclamation of fish disease and its cancellation, the proclamation of the list on fish disease and epidemic shall be done in accordance with legislation relating to veterinary service.

3. Culture of *L. vannamei* and other exotic penaeid species

The only exotic shrimp species in Vietnam is *L. vannamei*. It was first imported into Bac Lieu province on January 4th, 2001 from Taiwan, while broodstocks and postlarvae were imported from Taiwan, Hawaii and Main Land of China

The total PL production is small coming from provinces of Quang Ninh (150 mln), Phu Yen (71 mln), Ha Tinh (35 mln), Binh Dinh (20 mln), Bac Lieu (8 mln).

The area of vannamei culture is still very limited.

The production is very small. The shrimps are cultured in provinces of Quang Ngai (800 MT), Phu Yen (615 MT), Binh Dinh (167 MT), Quang Tri (150 MT), Thua Thien-Hue (24 MT), Ninh Binh (10 MT), and Quang Ninh, Binh Thuan, Dong Nai.

4. R&D activities on *L. vannamei* and other exotic shrimps

L. vannamei is not yet popular in Vietnam. The Research Institute for Aquaculture No 3 is still researching on the culture of the shrimp.

5. Disease outbreak and management

There is no record of occurrence of Taura syndrome of *L. vannamei* in Vietnam, although other common shrimp diseases appear in other species. The National Fisheries Quality Assurance and Veterinary Directorate (NAFIQAVED) takes all measures to prevent the diseases.

6. Proposed Guidelines for the introduction and culture of the exotic shrimps

- The Ministry of Fisheries is now elaborating technical standards for the white leg shrimp hatchery.
- SEAFDEC to conduct some projects on disease control on shrimp culture in the ASEAN Region.

Status of Aquaculture of *Penaeus vannamei* in China

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I. OVERVIEW OF SHRIMP CULTURE INDUSTRY

Historical Development of Shrimp Culture Industry

China is a country with longest history of aquaculture in the world. Comparatively, shrimp culture is a relatively new industry in China. The earliest national production figure of cultured shrimp was 79 metric tons in 1970. It took more than 10 years for the production to reach 10,000 metric tons. The cultured shrimp production reached 10,093 metric tons in 1981.

In 1981-1988, China experienced the first golden period of shrimp culture industry development after the full maturation of mass production hatchery technique for shrimp (*P. chinensis*). The total production of cultured shrimp unbelievably increased to 199,418 metric tons in 1988 from 10,093 metric tons in 1981. However, the good times did not last long. The peak production maintained for 5 years only, ending in 1992 with production of 206,866 metric tons.

The serious outbreak of shrimp diseases badly hit China along with other shrimp producers in Asia. This resulted to the drop of cultured shrimp production to 87,856 mt in 1993, 40% of the highest production in 1991 (219,571 mt). The production continued to drop to 63,872 metric tons in 1994. The industry started to recover very slowly in the next 3 years, and regained its production of more than 100,000 tons in 1997 (102,923 mt). The slow recovery in cultured shrimp production in 1995-1998 was mainly due to modification in the culture system and techniques. Since 1998, China has been into a new era of fast growth in cultured shrimp production. The production has been keeping a very fast growth, from 143,086 mt in 1998 to 760,430 mt in 2003. The rapid growth of production during the last several years was mainly due to the rapid expansion of culture of *Penaeus vannamei*, an exotic shrimp species. Cultured shrimp production in China during 1984-2003 is shown in Figure 1.

It should be noted that the increase of cultured shrimp production was very abrupt in 2003 in China. It appears unbelievable. Two major reasons could be attributed to it in addition to the expansion of shrimp farming in China in 2003. One is due to the unreported freshwater production of *P. vannamei* before 2003. It was estimated that production of cultured *P. vannamei* in freshwater environment reached 160,000 metric tons in China in 2002. This production was not actually included in the total cultured shrimp production of the year. Secondly, it was only in 2003 when brackish and freshwater production of *P. vannamei* was separately reported.

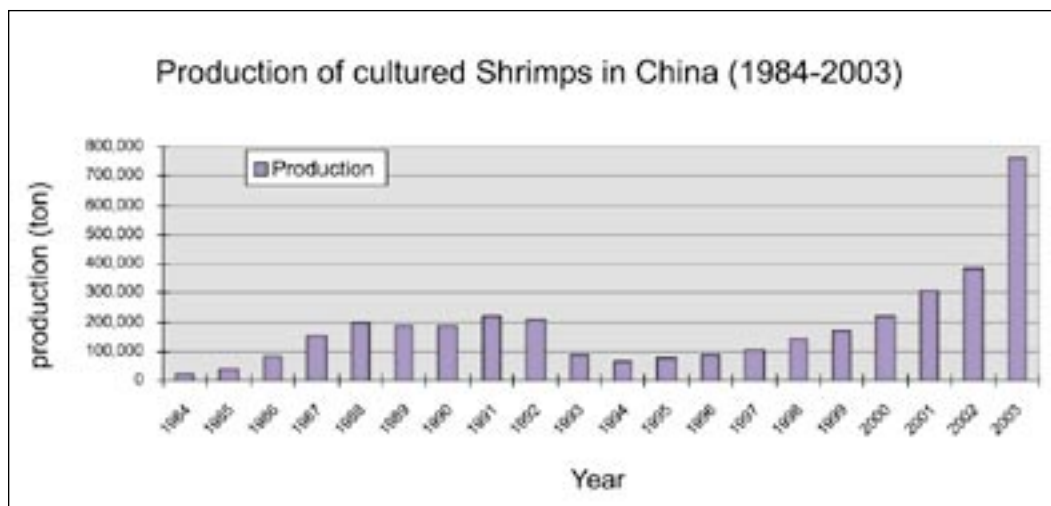


Figure 1. China's cultured shrimp production during 1984-2003

Contribution of Different Shrimp Species to the Total Production

Several species of shrimp species have been cultured in China in the past two decades. Due to the structure of statistic system for aquatic products, production of cultured shrimp species was included in the national statistics by aggregated production of all species until 2003. It was the first time to have separated production figure for four major cultured shrimp species, *P. vannamei*, *P. chinensis*, *P. monodon* and *P. japonicus*. **Figure 2** shows the composition of cultured shrimp production in 2003. It is very clear that *P. vannamei* accounted for nearly 80% in the total production. It dominates the shrimp culture industry in recent years.

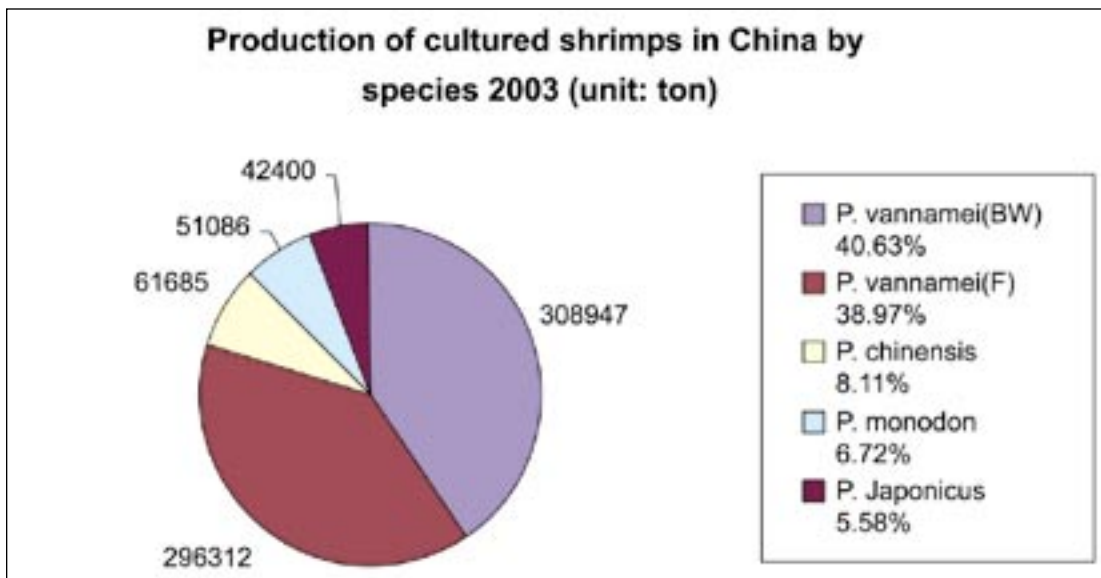


Figure 2. Species contribution to China’s cultured shrimp production in 2003

Value of Cultured Shrimp in China

Shrimps are among the species with highest commercial value in all cultured species in China. Statistic data is only available for the aggregated figure of all cultured shrimp species. Total value of all cultured shrimp species in China during 1984-2002 is shown in **Figure 3**. It should be noted that fluctuation of the total value of cultured shrimps was the result of production change, change in exchange rate of US\$ vs. CY yuan and market price. In 2002, the cultured shrimp production increased by nearly 100% compared with 1988, but the total value only increased by little more than 50%.

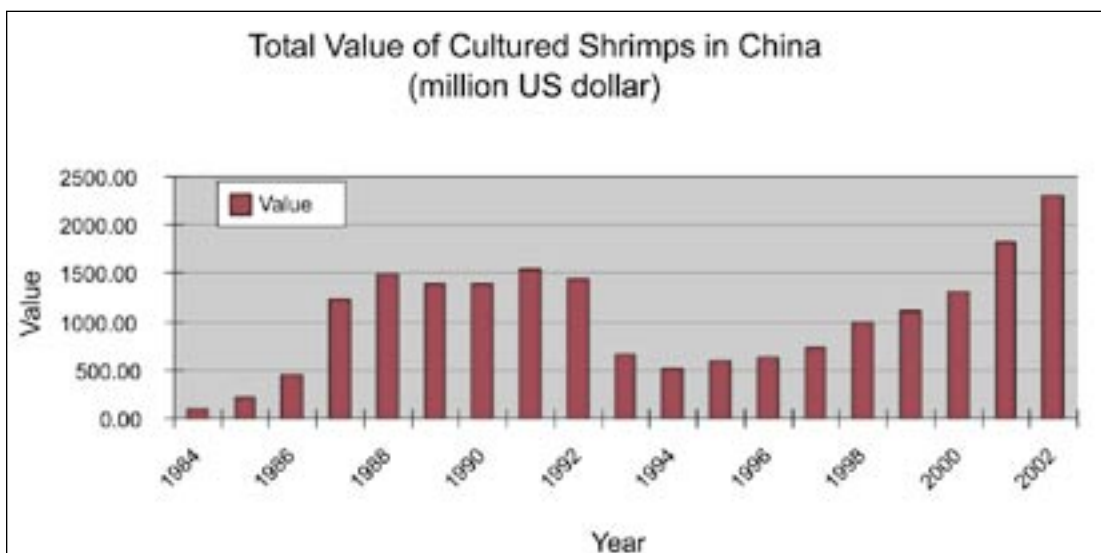


Figure 3. Total value of cultured shrimp in China in 1984-2002

Contribution of Shrimp Culture to Overall Aquaculture Sector

Figure 4 shows the contribution of shrimp culture industry to overall aquaculture sector in China in 1984-2002. In terms of production quantity, the shrimp culture industry takes a very small share in the total aquaculture sector in China. The highest was in 1988 when cultured shrimp production accounted for 2.85 % in the total aquaculture production. When the product value is considered, the role of shrimp culture industry becomes much more important in the whole aquaculture sector. The largest contribution was also in 1988 when cultured shrimp production value accounted for 17.72% of the total aquaculture output value.

Looking at the trend of contribution of shrimp culture industry to whole aquaculture sector in China, it shows that the contribution of shrimp culture Industry in China in 2002 decreased by 60.38% (by volume) and 63.17% (by value) compared with that in 1988 despite of the 92.63% increase in production quantity. Such contrast is mainly due to the expansion of other culture species other than shrimps, which were seriously cumbered by the disease problem. However, the trend in recent years is very promising. It indicates a steady increase, although the question of sustainability remains. What's important is how to sustain such trend.

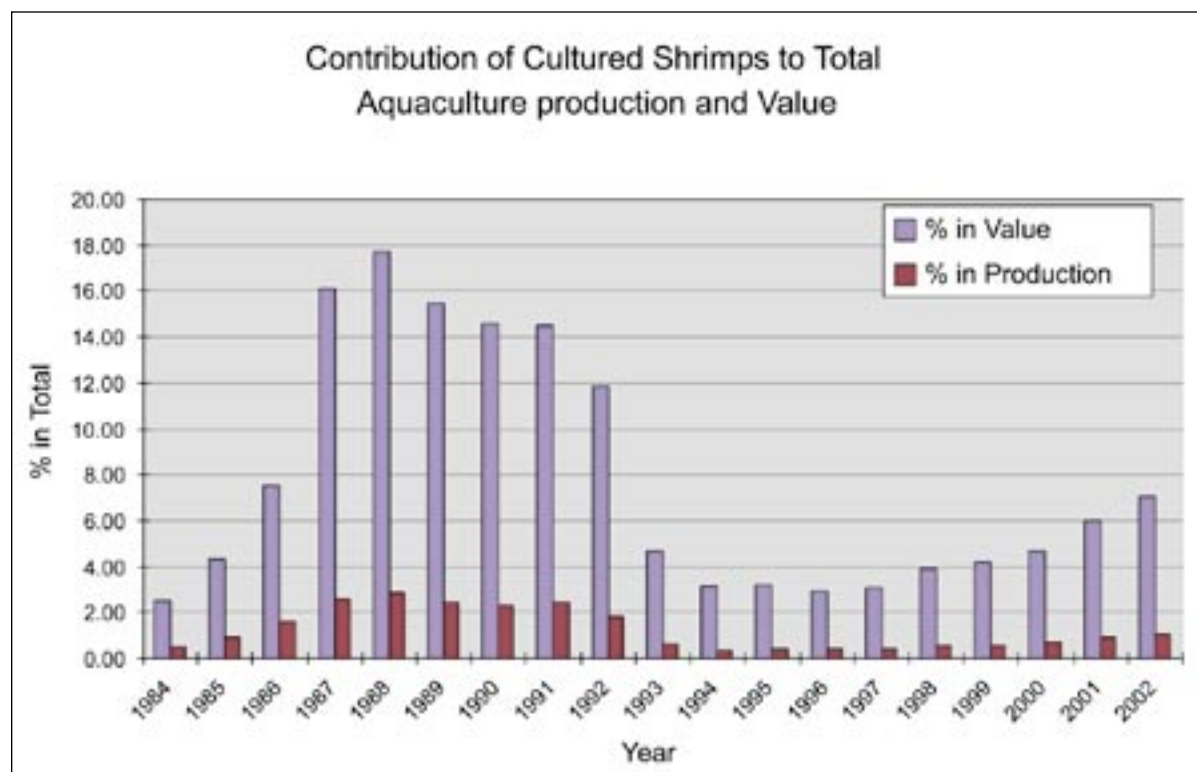


Figure 4. Contribution of shrimp culture to overall aquaculture sector in China

Shrimp Export

Shrimp has been one of the most important export aquatic products in China. However, there is no disaggregated exporting data available for specific commodity from different sources (wild catch vs. aquaculture) due to the structure of national statistic system. The export quantity and value of shrimp from all sources in China during 1984-2003 are shown in **Figure 5** and **Figure 6**.

Considering the contribution of shrimps to the overall aquatic products export from China, it accounted for only 6.45% of the total production in 2002. However, the export value of shrimp accounted for 13.25%. It was the second most important export commodity of aquatic products after river eel in 2002.

Although there is no available statistical data on the composition of exported shrimps, cultured shrimp could take the major share in the shrimp export because the total wild catch of shrimp was only 95,218.mt in 2003. It accounted for about 11 % of the total shrimp production in the same year.

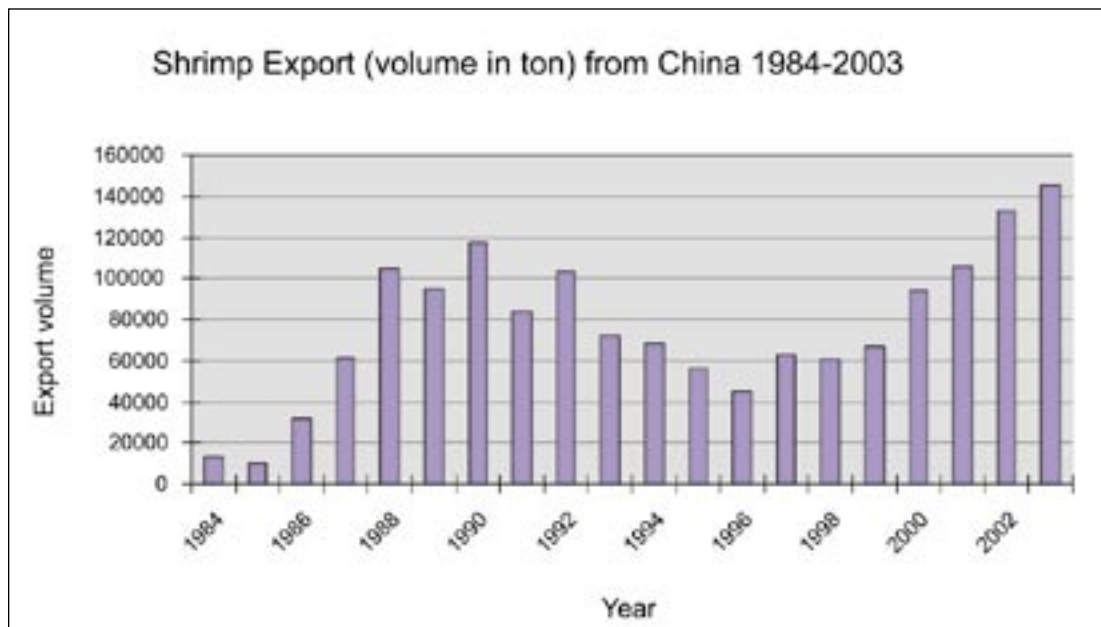


Figure 5. Quantity of exported shrimp from China

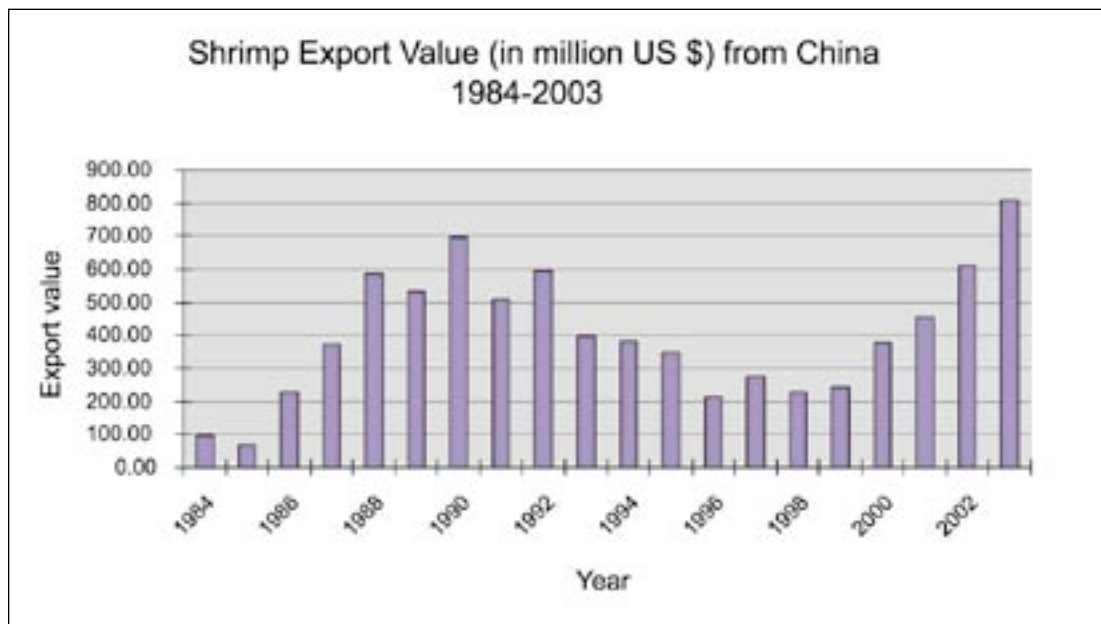


Figure 6. Total value of exported shrimp from China

Problems in the Industry

China is presently facing several major problems existing in the shrimp culture. The first is disease problem, especially White Spot Syndrome Virus disease, which seriously impacted the traditionally cultured species, *P. monodon* and *P. chinensis*. Although tremendous efforts (both financial and human resource inputs) have been invested in tackling the problem in China, there have been no established systematic measures that can effectively prevent and control the outbreak of the disease. The disease associated with *P. vannamei* (especially Taura Virus disease) is also an unpredictable factor determining the suc-

cess or failure of the farmer. *Vibrio* spp is another significant disease in the late period of *P. vannamei* culture.

The quality of shrimp fry is another problem significantly affecting the performance of the industry. Due to the very limited breeding techniques of the hatchery operators and repeated use of broodstock, the deterioration of shrimp fry quality is common. Thus, these result to slow growth rate, prolonged culture period and susceptibility to diseases.

Discharges of untreated effluents from shrimp farming can create serious environmental problems in the near future and could hit back at the shrimp culture industry. Presently, few farmers treat the effluents from their shrimp ponds before discharging to the natural environment. This could be a serious threat to the sustainability of the industry if no effective action is taken soon.

Another problem is market of shrimp products. In the international market, shrimp export industry is facing strong pressure from non-tariff trade barrier (technical barrier) set by an anti-dumping action adopted by importing countries. In domestic market, seasonal market and fast expansion of the production affected the economic returns of the shrimp farmers due to unreasonably low price, sometimes far below US\$ 2.0/kg.

Policy Issue on the Import and Culture of Exotic Shrimps

Since the late 1970s, the Chinese government has been putting high importance to the establishment of the legal system and regulations to regulate various aquaculture related activities. The major laws and regulations concerning with import and culture of exotic shrimp include “Fisheries Law,” “Law on quarantine of imported and exported animal and plant,” “Regulation on management of feed and feed additives,” “Regulation on management of veterinarian drugs,” and “Regulation on management of broodstock and seed for aquaculture.” A “Technical Code for Shrimp Culture to produce healthy food” was issued by the Ministry of Agriculture in 2001. The Chinese government generally encourages introduction of exotic species for aquaculture purpose but stresses high importance to prevent introduction and spreading of new disease pathogens. It is required to conduct ecological risk evaluation before introduction of exotic species. The introduction of exotic species needs to be approved by concerned ministry or provincial authority. The introduction process must strictly follow the officially designated quarantine procedure though authorized government agency.

Traditionally, China used to be ruled by man rather than law, and presently China is now in transitional process from former planned economy to market-oriented economy. The Chinese government is pushing very hard to establish and implement various laws and regulation on various social activities and relationships. However, it takes a long time for the people to change their traditional mind. The implementation and enforcement of aquaculture related laws and regulations are in different status. Some laws and regulations are rather strictly complied while some are not so. For instance, the import of broodstock and seed for aquaculture purpose generally follows the related laws and regulations. However, the cross boundary movement of life aquatic animals (including broodstock and seed) within the country is not always following the concerned laws and regulations. China is currently establishing license system for aquaculture. It will have better control over the aquaculture environment.

II. CULTURE OF *PENAEUS VANNAMEI*

History of Introduction

Penaeus vannamei is the major exotic shrimp species cultured in China now. It was first introduced to China from Hawaii by Oceanography Research Institute of Chinese Academy of Science in 1988. The first successful trial on artificial propagation of the shrimp was conducted in 1992. The first hatchery produced post larvae were obtained in 1994 in small scale. The culture of the species was first conducted in brackish water. The desalinized shrimp fry was introduced to freshwater environment for culture sometime in 2001 due to the serious virus disease outbreak in brackish water. The culture of the species in freshwater started to expand rapidly in China after it was proven to be more successful than in brackish environment.

Source of Broodstock

Despite the rapid expansion in culture area and growth in production, China has not established its capability to produce its own broodstock for the culture of *P. vannamei*. At the moment, broodstock of *P. vannamei* is basically dependent on overseas supply although few hatcheries started to establish their own broodstock. Most hatcheries import broodstock of *P. vannamei* from Taiwan Province, which are believed to be 2nd or 3rd generation from the SPF population introduced from Hawaii. Some hatcheries directly import broodstock from Hawaii.

Number of Hatcheries

China is a vast country and *P. vannamei* culture is fast expanding industry, therefore, it is not possible to have an accurate estimate on the total number of *P. vannamei* hatcheries that are currently operating. The rough estimate is at least more than one thousand. *P. vannamei* hatcheries are more concentrated in Guangdong, Hainan and Fujian Province along the south-east coast of China though *P. vannamei* hatcheries have been established in 14 provinces/autonomous region/ central government directed municipality.

Total Production of Fry

Production of *P. vannamei* fry was not included in the fisheries statistic data until 2003 in China. The total production of *P. vannamei* fry reached 112.634 billion in China 2003. Three provinces along the south-east coast of China (Guangdong, Hainan and Fujian) contributed 69.06% of national *P. vannamei* fry production although 14 provinces/autonomous region/municipality directly under central government reported production figure.

Growout Culture

Within a rather short period, growout culture of *P. vannamei* has spread extensively in China due to its advantages in culture. Basically, *P. vannamei* is now cultured in two different environments, freshwater and brackish water in China. Out of the total 33 provinces/autonomous region/Central government directed municipality in the mainland China, 24 report production of *P. vannamei* from freshwater (inland waters) in 2003, while 11 coastal provinces/autonomous regions/Central government directed municipalities reported production from brackish environment. It was on the first year that production of cultured *P. vannamei* was included in the official statistics data separately.

There is no statistical data available for the pond area used for culture of *P. vannamei*. It can only be estimated from the total production. The rough estimate of the total area of freshwater pond for *P. vannamei* culture may be around 60,000-80,000 ha. and total area of brackish pond used for the same purpose may be around 40,000-60,000 ha.

Marketable size *P. vannamei* used to be 50-80 pieces/kg when the culture first started in China. Recently, there is a significant decline in the growth of cultured shrimp. In order to market the shrimp with more or less the same culture period, the marketable size is much smaller now. It is normally 60-100 pieces/kg now.

The total production of cultured *P. vannamei* reached 605,159 mt. Out of which, 296,312 mt was from freshwater environment and 308,947 tons were from brackish environment. The production distribution of cultured *P. vannamei* is shown in Figures 7 and 8 (next page). It is very obvious that Guangdong province is the largest contributor to the production of cultured *P. vannamei* in China. It contributed about 40% of the cultured *P. vannamei* production in China in 2003. It was followed by Jiangsu province in freshwater culture and by Haina province in brackish water culture.

Contribution to Domestic Shrimp supply and Shrimp Export

It is not possible to exactly evaluate the contribution of cultured *P. vannamei* in domestic market and export. However, a rough estimate can be made according to the total export volume and species composition of the production.

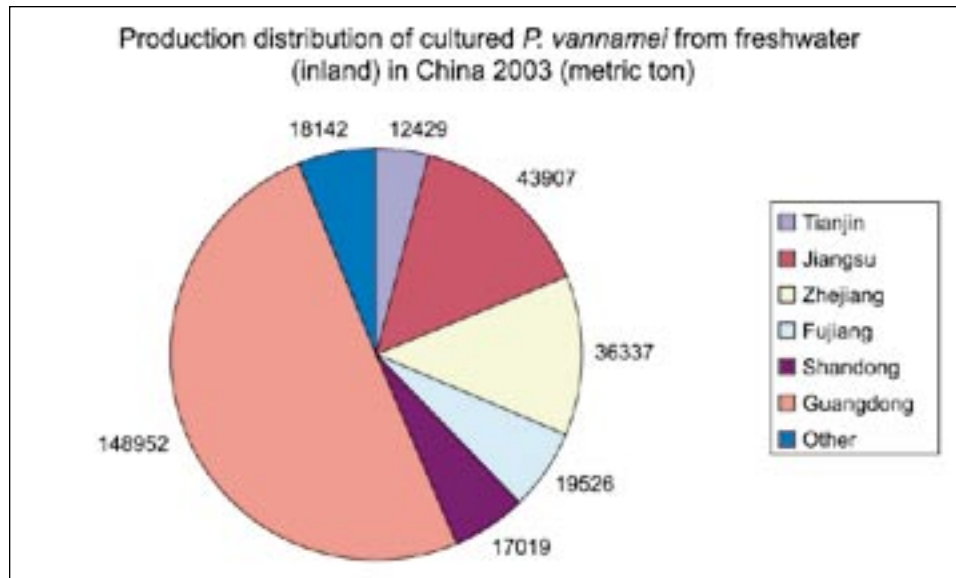


Figure 7. Production distribution of freshwater cultured *P. vannamei* in China

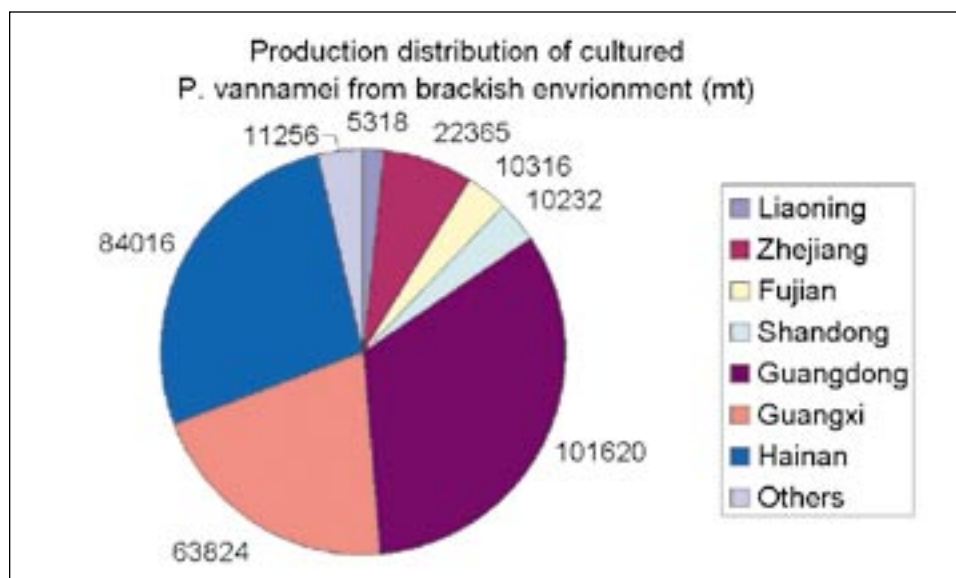


Figure 8. Production distribution of *P. vannamei* cultured in brackish water in China

China exported 145,511.8 mt of shrimp products in 2003. Considering that some of the exported commodities were peeled or processed in many ways, it can be converted into about 20 metric tons of fresh harvest. This accounted for about 23% of the total shrimp production (including wild catch). Therefore, more than three quarters of shrimp production were consumed by domestic market. Considering that *P. vannamei* accounted for about 63% of the total shrimp production in China in 2003, in terms of supply, its contribution to the domestic market is tremendous. It also created a significant impact on the market price. Its market price dropped to US \$ 3-4/kg in 2002 from earlier US\$ 6-7/kg. Such price was maintained more or less the same since then. But, it did not cause much impact on the market price of other shrimp species as the production of those species has been maintained more or less the same.

It is very hard to assess the contribution of cultured *P. vannamei* to the shrimp export either by quantity or value as the exported shrimp only accounted for small proportion of the total shrimp production. The contribution may be very significant, especially cultured *P. vannamei* from brackish environment.

Labor and Employment Generated

In addition to the contribution to domestic shrimp supply and shrimp export, *P. vannamei* culture also brings about significant social benefit in terms of job opportunity. Although there is no such statistical data, it can be estimated that *P. vannamei* culture industry employs about 150,000 labors where about 10,000 are in hatchery operation and about 140,000 in growout culture.

R&D Activities on *Penaeus vannamei*

Large scale culture of *P. vannamei* has been carried out in China for 5-6 years. Therefore, scientific research and technology development activities carried out so far are rather limited. Existing activities are mainly focused on the following aspects:

- Mass production hatchery technique;
- Virus disease fast detecting methods: it is mainly for the purpose to determine whether shrimp post larvae carry virus. Fast detecting kit has already been put into practical use;
- Culture environment manipulation through different agents, such as beneficial microorganism, immune promoting agent such as Chinese herb extracts, vitamin complex and polysaccharide etc;
- Multi cropping and intensive farming system and related management scheme for high yield;

Very limited efforts have been made to improve the quality seed of *P. vannamei*, China has not yet established its own *P. vannamei* SPF or SPR population at the moment.

Disease Outbreak and Management

There was a serious outbreak of diseases in brackish water culture of *P. vannamei* in 2001, which was later identified as Taura virus disease. It caused tremendous loss to the farmers. Since then, there has been no report of serious outbreak of the disease in large area. However, disease problem has been always the number one threat to farmers. Comparatively, disease problem is more serious in brackish water than in freshwater.

At the moment, there is no promising method in preventing and controlling of disease problems. It virtually depends on the quality of shrimp postlarvae. The farmers try to minimize the chance of disease outbreak mainly through improvement of culture condition and applying various disease preventing agents.

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The Southeast Asian Fisheries Development Center (SEAFDEC) is a regional treaty organization established in December 1967 to promote fisheries development in the region. The Member Countries are Brunei Darussalam, Cambodia, Indonesia, Japan, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam. The policy-making body of SEAFDEC is the Council of Directors, made up of representatives of the Member Countries.

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- The Marine Fisheries Research Department (MFRD) in Singapore (1967) for post-harvest technologies
- The Aquaculture Department (AQD) in Tigbauan, Iloilo, Philippines (1973) for aquaculture research and development
- The Marine Fishery Resources Development and Management Department (MFRDMD) in Kuala Terengganu, Malaysia (1992) for the development and management of fishery resources in the exclusive economic zones of SEAFDEC Member Countries

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- Conduct scientific research to generate aquaculture technologies appropriate for Southeast Asia
- Develop managerial, technical, and skilled manpower for the aquaculture sector
- Disseminate and exchange aquaculture information

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