

Aquaculture of White Shrimp *Penaeus vannamei* in Thailand

Siri Tookwinas, Kanit Chiyakum and Sutheewat Somsueb
Department of Fisheries, Bangkok, Thailand, 10900

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.

REFERENCES

- C.P. Aquaculture. 1994. Role and participation of private sector in the promotion of trade and investment in Fisheries in the ASEAN region. Conference on Fisheries Management and Development Strategies for ASEAN Region for the Year 2000, Bangkok, 26-29 July 1994. 6 p.
- C.P. GROUP, 2004. Shrimp Culture News letter, November 2004, 4 pages.
- Fisheries Information Center. 2004. Fisheries Statistic of Thailand, Department of Fisheries, Bangkok.
- Kongkeo H. 1994. How Thailand became the largest producer of culture shrimp in the world, ASEAN-EEC Aquaculture Development and Coordination Program, Bangkok. 28 p.
- Limsuwan Chalor and P. Chanratchatakul, 2004. Shrimp Aquaculture Industry in Thailand. Office of National Research Committee. (in Thai), 206 pages.
- National Statistical Office. 2000. The 2000 Intercensal Survey of Marine Fishery Marine Shrimp Culture. National Statistical Office and the Department of Fisheries, Bangkok, 117 p.
- Research Council of Thailand. 1995. Report on subcommittee on mangrove deterioration identification, Research Council of Thailand, Ministry of Science, Technology and Environment (unpublished).
- Sakthivel M. 1985. Shrimp Farming: a boon or bane to India. ICLARM Newsletter, 8 (3) 9-10.
- Tansutapanit, A., S. Thongrod, T. Sangkornthanakit and C. Omance. 1994. Study on elimination of pollutants in Closed system culture of Giant Tiger Shrimp (*Penaeus monodon*). Petburi Coastal Aquaculture Station, Coastal Aquaculture Division, DOF., Bangkok, 9 p.
- Tookwinas S. and S. Keerativiriyaporn. 2004. Possibility for application of HACCP in aquaculture with emphasizing on Marine shrimp farming industry. Thai Fisheries Gazette, 57(3): 219-223.
- Tookwinas, S. 1991. Standard pattern for intensive marine shrimp culture techniques, Marine Shrimp Culture Development Office, DOF., 8 p.
- World Shrimp Farming. 2004. Shrimp News International. An Annual Report Published by Shrimp News International, San Diego, 284 p.

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.

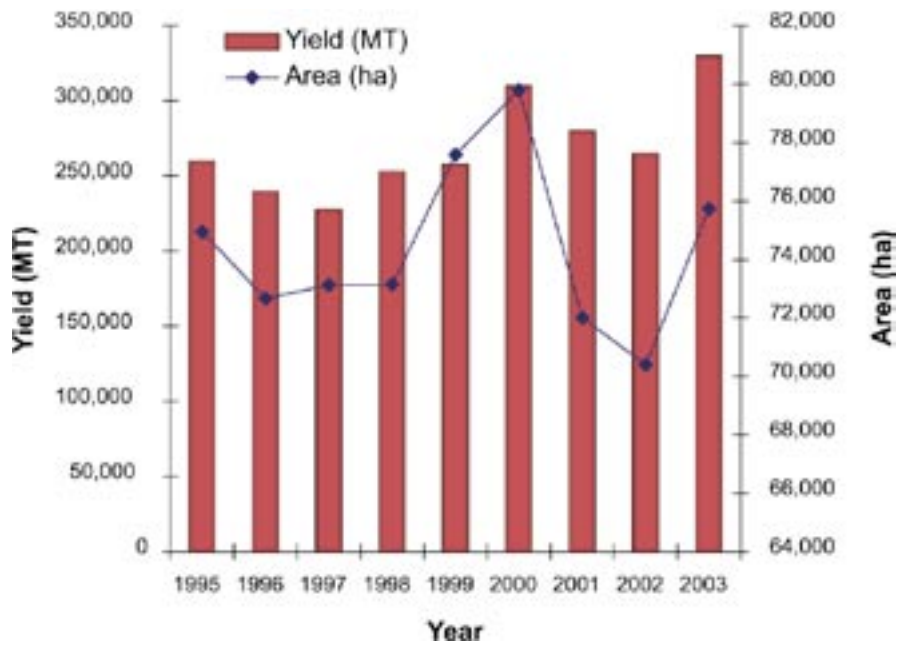


Figure 1. Shrimp production, culture area and total production 1995-2003

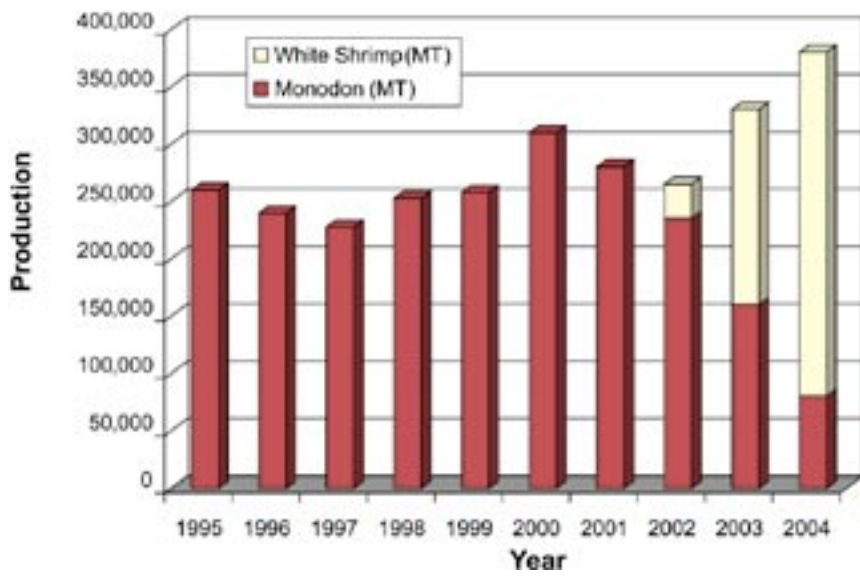


Figure 2. Proportion of Monodon and White shrimp production in Thailand