Chapter 2

LITERATURE REVIEW

1. Prawn distribution

Species of the fresh water prawn genus *Macrobrachium* are distributed throughout the tropical and subtropical zones of the world. They are found in most inland fresh water areas as well as in estuary areas. Most species require brackish water in the initial stages of their life cycle though some complete their cycle in inland saline and fresh water lakes.

There is a wide interspecific variation in maximum size and growth rate, *M.rosenbergii*, *M.americanum* and *M.carcinus* being probably the largest species. *M.rosenbergii* is indigenous in the whole of the South and Southeast Asia areas as well as in the Northern Oceania and in the Western Pacific islands. *M.rosenbergii* is the species most used for commercial farming, and is now farmed in considerable quantity in many countries. (New et al., 1985)

2. Status of prawn production

Freshwater prawn farming constitutes about 5% of the global prawn production. The total global production of *M.rosenbergii* is about 27,000 $t.year^{-1}$. The three main producers are Thailand, Vietnam and Taiwan with 44, 32 and 17 present share of the total output, respectively. (New, 1990)

In different countries or localities, extensive culture system has different characteristics. In the Philippines and Indonesia most farmers utilize ponds originally designed for milkfish culture. (Apud, 1985). In Viet Nam prawn is raised by catching fries prawns from natural habitats and raising them in the pond. In the simple extensive culture, ponds are built on intertidal zones where mangrove forest originally occupied. Total area of this culture system in Mekong Delta was estimated about 160,000 ha by 1992 (Tuan and Phuong, 1993), and spread along the coastal lines of seven provinces: Long An, Tien Giang, Ben Tre, Cuu Long, Hau Giang, Kien Giang, and Minh Hai, but more concentrated in Minh Hai, Kien Giang, Hau Giang, and Ben Tre where wild seeds are more abundant (Hai and Tuan, 1992a). In the improve extensive culture system, which gives relatively high yield, is only suitable for areas which has abundance of wild seeds. (eg. Cai Nuoc, Nam Can

districts in Minh Hai). In contrast, if regions which are poor in wild seeds such as Gia Rai, Hong Dan districts, simple extensive culture alone will give very low yields. To overcome this, farmers intentionally add ponds with collected seeds and/or hatchery seeds (stocking density : 0.5 - 1.m^{-2}). Natural food is still the main food, on-farm feeds are only given irregularly in small amount depending upon their availability. Area of this culture system is estimated about 1,100 ha in the whole Delta (Tuan and Phuong, 1993). Average pond size varies from 1 - 10 ha, mostly 1 - 4 ha. Pond construction is improved with concrete water gate. Canal area ranges from 20 - 40 % of pond area and inversely proportional to the pond size.

Table 1 Status of prawn culture in Viet Nam in 1986

Region	Area(ha)	Production(ton)	Yield($kg.ha^{-1}$)
North	8,500	540	50-60
Central	6,700	600	100
South	107,400	22,660	190-200
Total	124,600	23,800	

Sources: Institute of Marine Products (1988)

During culture period water is exchanged as much as possible to take additional seeds and natural food into the pond. Yield is directly proportional with stocking density

and varies from 200 - 460 kg.ha^{-1}.yr^{-1}. (Hai and Thuong, 1992b). Though this system is more expensive than simple extensive culture, it is less dependent on wild seeds. This may be considered as transitional form between simple extensive and semi-intensive culture. The semi-intensive and intensive culture methods are still limited but expanding gradually. The prawn culture status in 1986 is described in Table 1.

In 1988, the Ministry of Aquaculture and Products estimated the available area for aquaculture to be around 200,000 ha of which about 25 % was used in a mixed-production system, e.g. rice-prawn, rice-giant freshwater prawn, coconut-prawn, salt-prawn and mangrove-prawn. For aquaculture production, Lin and Lee (1992) also reported that the growout system includes intensive monospecies pond culture, and semi-intensive or extensive integrated rice-fresh water prawn or vegetable-fresh water prawn culture. Intensive prawn culture is rare and requires large capital investment for pond construction, high protein feed, large labor and energy inputs, as well as sophisticated farm management skills. The major impediment to large commercial farm development in Viet Nam is the lack of reliable market demand. Although the potential yields of intensive farming are up to 1,500 to 2,000 kg.ha^{-1}.year^{-1}, the risks are also high.

3. The rice-prawn system of the Mekong Delta

3.1. Physiographic description of the Mekong Delta

Mekong river originates in the Himalaya mountains of the central Tibet and flows for about 1600 km in China. It then flows 2400 km through the lower Mekong basin (Lagler, 1976) and drains into an area of 795,000 km², of which 77 % (or 609,000 km²) lies within the four riparian countries of Cambodia, Laos, Thailand and Viet Nam (Mekong Committee, 1992). Below Phnompenh in Cambodia, the river divides into two main tributaries, the Mekong on the East and the Bassac on the West. The Mekong subsequently divides into six main channels: Dai, Tieu, Ham Luong, Ba Lai, Co Chien, and Cung Hau, and the Bassac into three: Dinh An, Tran De, and Bassac (Duc, 1992; Dieu, 1992).

The Mekong Delta covers an area of 4 million ha extending from 8°33′ - 10°55′ North of latitude and 104°30′-106°50′ East of longitude (Dieu, 1992). The Delta covers 9 provinces (Figure 1) and is formed by alluvium brought by the Mekong River. There are three principle types of soil found in Mekong Delta: Alluvium soils are found along the Tien, Hau rivers. They cover an area of 1,110,000 ha. This soil is slightly acidic (pH: 4.5 - 6.5), and suitable for rice cultivation. The acid sulphate soils cover 1,590,000 ha, mainly in Dong Thap Muoi (Long An province) and Long Xuyen quadrangle (An Giang province) and along the coast

line. These soils contain high concentrations of sulphate and low pH values ranging from 2.26 - 3.54, therefore, there are some constraints for rice cultivation. The saline soil cover 808,749 ha along the coastline, from Can Giuoc (Long An province) to Ganh Hao (Minh Hai province). They often associate with acid sulphate soils. Saline soils are caused by sea water intrusion to land in dry season (20-65 km) through the network of rivers and canals. They are permanently or periodically saline. Saline water intruded lands of the Mekong Delta were estimated at 1.6 million ha (Ministry of Agriculture, 1978). During rainy season, flood water from the rivers and rainfall washes salt out and soil becomes suitable for rice cultivation. Such occurrence can be found at Gia Rai, Bac Lieu (Minh Hai province) etc. (Xuan et al., 1986).

The Delta is characterized by complex networks of rivers, canals etc. which are the main ways of transportation, irrigation and aquaculture. The flood season is from June to September, coincides with the rainy season, causes flooding 1.7 million ha (Dieu, 1992).

Mekong Delta has two different tidal regimes: one from the East Sea and the other from the Gulf of Thailand. On the East Sea, tide is irregular semi-diurnal with average daily tidal range is between 0.5 and 0.8 m (Duc, 1992). Due

to the influence of two different tidal regimes and monsoon regime, tide in the southern part of the Delta is complex, for instant in Minh Hai province, the semi-diurnal tide on the east with higher tide range, influenced by monsoon tends to flow to the west coast (diurnal and low amplitude)

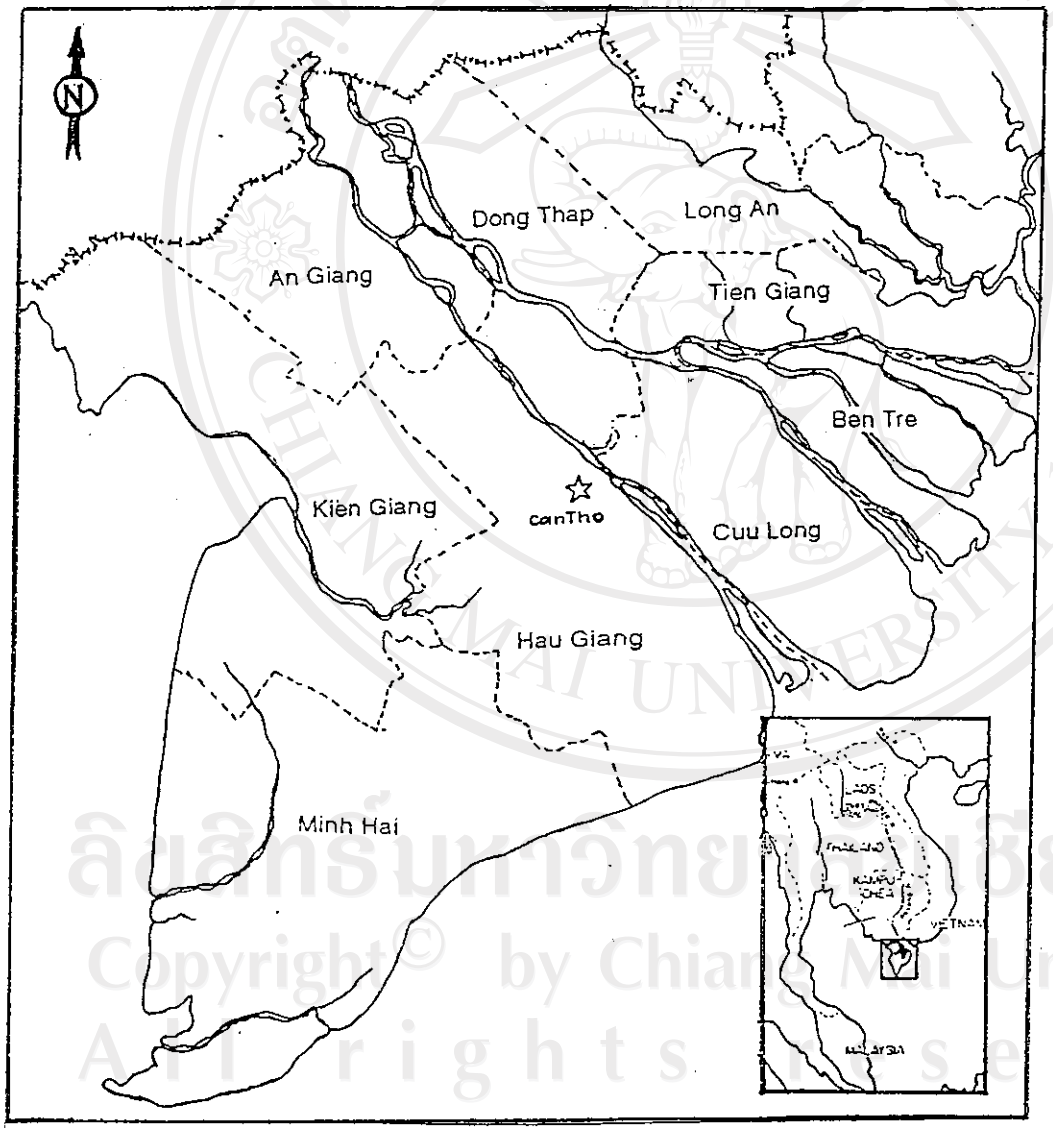

Figure 1. Map of the Mekong Delta of Viet Nam

through a complex network of canals and rivers. This results in a severe erosion in the east coast, and bringing alluvia to the west coast forming accretion, expanding the Delta (Hong, 1992).

Air temperature does not change much all year round averaging 26°C - 28°C. The monsoon rain begins in late May and attains its maximum level in September or October (Duc, 1992), the rest of the year is dry season. Relative humidity remains high throughout the year (Duc, 1992).

3.2. The rice-prawn production system

In the Mekong Delta more than 10,000 ha are used for paddy-prawn culture. Especially, the giant freshwater prawn (*M.rosenbergii*) is the main freshwater prawn species cultivated in the South, with an annual harvest of about 5,000 t. Large flooded areas during rainy season offer considerable potential for this activity (Quynh, 1989). However, at present, the natural fries resources are still not efficiently used. Many methods are used for catching small-size prawn in a big volume but only small portion is used for the culture, and the rest are used directly for food with low value (Chung, 1988).

In recent years, due to the high value of fresh water

prawn, farmers and local leaders in the Mekong Delta are interested in keeping this species in combination with rice culture. Among nine provinces of the Mekong Delta, rice-fresh water prawn culture has been practiced in five provinces. The estimation of growing area and prawn yield is presented in Table 2.

Table 2. Area and average yield of prawn in rice-fresh water prawn system in the Mekong Delta in 1990.

Provinces	Areas (ha)	Yield of prawn ($kg.ha^{-1}.yr^{-1}$)	Percentages of total area
1. Hau Giang	1556	149	79
2. Cuu Long	360	80	14
3. Tien Giang	53	120	3
4. Dong Thap	50	130	2
5. An Giang	48	150	2
Total area	2067		100

Sources: Statistical Data of Provincial Agricultural Services in 1990

The giant fresh water prawn probably occurs in areas along the two main rivers of the Mekong Delta called "Song Tien" and "Song Hau". These areas cover a part of Hau Giang, Cuu Long, Tien Giang, An Giang and Dong Thap provinces. The lowland areas which are suitable for rice-fresh water prawn system require water depth below 0.8 m and

slow drainage water condition. Besides, most of prawns named *Penaeus merquieusis* are found in the brackish and saline water area of Minh Hai, Hau Giang, Cuu Long, Ben Tre, Tien Giang which are bounded by the coast of Eastern sea, the Gulf of Thailand and the estuary areas.

Rice farmers in the Delta have adopted modern high yielding varieties and now have achieved high yields with an average of 4.0 $t.ha^{-1}$ in 1991 (Statistical Data of Viet Nam's Agriculture Forestry and Fishery, 1992). The Delta, with plenty of water and good canal network, has provided suitable conditions for aquaculture, particularly incorporation of freshwater prawn in rice-based farming systems. Therefore rice farmers in the Delta have increasingly adopted rice-prawn system to achieve food security and high and stable incomes.

There are 3 popular rice-prawn farming systems in the Mekong Delta:

a. Rice-saline water prawn system

This practice originated in Gia Rai district, Minh Hai province, then spread to many other places where characterized by fresh water in rainy season and salinization in dry season. During dry season, saline water

intrudes lands, makes it impossible for rice cultivation. The important point should be noticed here is that if farmers let their fields dried, potential acid sulphate soil will become active, and would make it impossible for next year cultivation. Perhaps by trials and errors, farmers learn that by using sea water to fill in the field in dry season, they not only can prevent activity of acid sulphate soil but also help farmers harvest additional products of wild prawn. When the rainy season comes, farmers use rain water to wash salt out and the fields are ready for rice cultivation. This rotation technique offers the farmers the best use of land resources. Cumulative yield of prawn and rice yield can reach up to 690 $kg.ha^{-1}$ and 4 $t.ha^{-1}$, respectively, as reported by Xuan et al. (1986). The main drawback in this system is accumulation of sediments in the field (about 10 $cm.yr^{-1}$) (Tuan et al., 1992b). This process elevates land level, makes it decrease suitability for both rice and prawn cultivation.

Because lacking of mechanical facilities, farmers could not remove the sediments. They just gather them into heaps in the fields. As a results, cultivatable land has decreased quickly. According to the last investigation on this practice in Gia Rai district in 1992, about 30 - 60 % of field area were occupied by soil heaps which could not be used for production purposes (Tuan et al., 1992b).

Therefore, application of mechanical facilities to help the farmers remove these soil heaps are necessary and urgent to save this system from failure.

b. Rice-brackish water prawn system

This system has been practiced in area between the sea water and freshwater. In dry season, farmers impound brackish water which enters freely in rice fields, prawns are caught after 3 to 6 months. Brackish water prawns consist of at least 5 species *Metapenaeus lysianassa*, *M. tenuipes*, *M. indicus*, *Penacus indicus*, and *Sendapocryps landceolatus*. In the dry season, farmers harvest prawn from April to July. In the wet season harvesting lasts from August to January. Average daily yield is 2.5 - 3 $kg.ha^{-1}$ in the dry season and 2 - 2.5 $kg.ha^{-1}$ in the wet season, with a maximum of 4 - 4.5 $kg.ha^{-1}$. Average rice yield is 2.3 $t.ha^{-1}$ in the wet season (Duong et al., 1990b).

c. Rice-giant freshwater prawn-fish system

Under this system prawn culture depends on the occurrence of young prawns caught from natural sources such as rivers and canals. But the amounts of young prawns are unpredictable. There are two main periods of young prawns occurrence in the Mekong Delta: December to February and

July to September. Therefore, there are also two seasons of prawn culture. The first season, wet season starts in June-July and will be harvested in November-December. The second one, dry season begins in November-December and lasts till April-May. Young prawn procurement is easier in the dry season than those in the wet season. However, there are good water quality, abundant natural feeds, easy drainage for harvesting, but not easy to control predators in the wet season (Science Technology Council of Cuu Long, 1988).

A case study on rice-prawn-fish system in the irrigated area showed that *M. rosenbergii* and silver barb (*Puntius gonionotus*) mixcropped with two rice crops a year could provide the average rice yield of 5.7 $t.ha^{-1}$ in the dry season and 5.2 $t.ha^{-1}$ in the wet season, 187 $kg.ha^{-1}$ in prawn yield and 214 kg of $fish.ha^{-1}$ (Duong et al., 1990a).

Another case study on rice-prawn system in the gravitational water area showed that giant freshwater prawn mixcropped with two rice crops a year could provide the average rice yield of 4 $t.ha^{-1}$ in the dry season, 3.9 $t.ha^{-1}$ in the early wet season or 3.5 $t.ha^{-1}$ in the wet season. The average prawn yields was 64 $kg.ha^{-1}$ in rice-prawn system. (Tuyen et al., 1991)

Moreover, farmers can raise fresh water prawn

mixcropped with the main wet season rice in the brackish water areas of Cuu Long, Tien Giang province since freshwater comes annually during the period of flood and rainy season.

Lin and Lee (1992) reported that most freshwater prawn culture systems practiced in the Delta are semi-intensive. The prawns feed on natural food, supplemented with raw farm products, and the yields are usually low at 200 - 500 $kg.ha^{-1}.year^{-1}$. This system is suitable for the present socioeconomic and market situation in Viet Nam but is relatively recent and has potential for improvement. It relies on the availability of juveniles, most of which still come from natural recruitment. The demand for live juveniles has created a large and important sector of freshwater prawn hatchery. Seed supplies from prawn hatcheries are still extremely limited, although a couple of government hatcheries have been recently built in Vung Tau City and Nha Be District, Ho Chi Minh City.

3.3. Management of fresh water prawn in rice-based system

a. Dike and trench in rice-prawn system

In common with the rice-fish culture system, the rice-prawn field is surrounded by high dikes to prevent prawns from escaping during the flood season. Ring trenches

around the inside of the dikes are prepared by excavating earth and depositing them onto the dikes. The dikes which are about 2.5 - 5 meters wide can be used to grow vegetables, field crops, or fruit trees. The trenches are about 2 - 4 meters wide and 1 meter deep. At least two flapgates are installed to regulate the water flow and to insure freshwater supply inside the system. The dry branches of trees are put along the ring trench for hidden place of prawns. The trench area ratio is about 15 - 20 % of the enterprise area (trench+rice area) (Tuyen et al., 1991). Increase in trench area ratio would improve the prawn survival rate, for instance 30 - 51 % of prawn survival with 15 % of trench area ratio (Danh et al., 1989). A case study showed that the trench area ratio of 10 - 18 % is suitable for prawn growth (Ky et al., 1990). In larger fields, diagonal or transverse ditches are also dug to connect the peripheral trenches (Lin and Lee, 1992).

b. Stocking

A case study showed that 20 days after rice sowing or transplanting, the young prawns with average individual weight of 5 g are allowed to move into the rice fields in a population of 0.5 - 2 m^{-2} (Duong et al., 1990a and Tuyen et al., 1991). According to Can (1989), and Lin and Lee (1992), juvenile prawns of 2 - 5 g, caught from natural

waters, are stocked at 1 - 2 prawns.m^{-2} during the first rice crop in the early part of the year, when juveniles are rather abundant. Whereas, most prawns are normally raised for eight months to reach market size, and some are harvested earlier. The major growth takes place during the rainy season from May to October. The survival ratio is high with the population of 0.8.m^{-2}, and this population is acceptable to the farmers (Danh, 1989). Higher stocking rates increase yield but larger prawns with higher value are produced insufficiently in a limited growing season. In Thailand, where the favored size for marketable prawns is about 70 g (head on), and many farms have a growing season limited to about 8 months due to seasonal water supply, a stocking rate of 5 post-larvae.m^{-2} are recommended (New et al., 1985).

c. Feeding

In addition to natural food, rice bran, broken rice, rough rice, coconut meal, cassava roots, crab, snail and dead animal bodies alternately are used as feed to the prawns. Feeding rate is about 2 - 3 % of daily prawn weight in rice field (Science Technology Council of Cuu Long, 1988). However, feeding rate of 3 % of prawn weight is inadequate for population of 1.8.m^{-2} in the field (Danh et al.,1989). Feed meals with protein levels of 19 - 37 % are

used in Viet Nam (Can, 1989).

Feed conversion ratios of 2:1 to 3:1 may be expected for compounded diets. The feed conversion ratio of wet materials, such as trash fish will be much higher perhaps 7:1 to 9:1. Once daily feeding in the late afternoon is recommended (New, et al., 1985). For compound diets, feed conversion ratio of 4.5:1 (Danh et al., 1989) or 6:1 (Can, 1989) could be achieved.

d. Growth

Postlarva prawns could gain an average individual weight of 20 - 50 g and 70 - 100 g after raising for 8 - 9 months and 1 year, respectively (Can, 1989).

The growth rate and survival of a population of prawns depends on many factors, such as density, predation, feed and temperature. In farming practice survival rate of 50 percent would be acceptable (New et al., 1985).

Length growth rate and weight growth rate of prawn raised in the rice field are about 0.97 - 1.76 cm.month^{-1} and 5.56 - 8.72 g.month^{-1}, respectively (Danh et al., 1989).

e. Predation

Predator is perhaps the greatest problem for any aquaculture enterprise, including freshwater prawn farming. Predation occurs mainly through other aquatic species, birds, snakes and humans. The most troublesome predators in Southeast Asia are the snakehead fish (*Ophiocephalus micropites* and *O.striatus*) and the river catfish (*Mystus plariceps*). Crabs can also cause problem, as they bore holes in pond banks. They can be removed by sinking jars (traps) in the pond banks, as shown by Tunsutapanich (New et al., 1985).

f. Water

Dissolved oxygen (DO) level of water should not be below 3 $mg.l^{-1}$ (Can, 1989). Prawn will die at DO level of 0.69 $mg.l^{-1}$, as reported by Xuan (Danh, 1989). Water temperature at 27 - 31°C is suitable for prawn. Prawns are stressed by water temperature above 34°C (Can, 1989). The pH of water at 6 - 8.8 is suitable for prawn (Science and Technology Council of Cuu Long, 1988).

g. Harvesting

The growth rate of individual prawns is extremely

variable, therefore, removal of faster growing individuals permits the slower growing prawns to develop faster. This is the basis for the continuous cull-harvesting technique employed by many farms with year-round water availability. With this technique, large prawns are regularly harvested by seining and the ponds are rarely drained. Batch culture is practiced where water availability is seasonal and continuous culture can not be employed. In batch culture all prawns are harvested when the ponds are drained. Culling is usually practiced to harvest prawns of more than 45 g. Batch culture yields a wide range of prawn sizes and type with different values. Total harvest weight increases with increasing stocking density, to an optimum level, but average size is inversely related. The percentage of the harvest which is marketable is best at low stocking density (New, 1990).

The young prawn size of 4 - 10 g grown in ponds can be harvested with 60 % prawns of marketable size 1 and 2, individual average weight of 30 - 50 g after 3 - 4 months (Science Technology Council of Cuu Long, 1988).

4. Prawn culture impacts on water pollution

Since 1987, prawn culture in Taiwan was hard hit by disease problem and prawn industry almost collapsed (Chen,

1990). The same problems were found in Thailand (Satyarini, 1992; Sataporvanit, 1992). The fundamental causes were poor larval rearing conditions, overstocking, overuse and abuse of drugs, and water pollution (Lin, 1989). Over exploiting carrying capacity caused environmental degradation and destroyed the culture system.

Water pollution may be caused by industrial waste, agricultural and aquacultural activities.

Self pollution is an other problem resulted in high intensive culture operation. In Taiwan because of this problem, there was a 70 % scale down in prawn production in 1988 and the reduction in 1989 was probably even more drastic (Chen, 1990). Viet Nam is in different situation. No intensive culture, no pollution from feed wastes but deforestation has become the main cause of environmental degradation in Mekong Delta (Hong, 1992; Hong and San, 1993; Tuan, Hai and Hien, 1992a).

5. Policies relate to aquaculture

The Institute of Economic and Planning, Ministry of Fisheries has drawn up the fisheries development plan in the Mekong Delta from 1991 - 2000. By the year 2000, it is expected to establish cultivated area of 289,000 ha of which

brackish water prawn culture is 96,000 ha. The production of brackish water prawns and freshwater prawn will reach 48,350 t and 23,660 t, respectively. The fishery service center will be established in the Delta. In addition a joint-venture with foreign investors in different sectors of fisheries will be promoted.

6. Prawn markets

Market is the key factor which directly affects type of development of prawn culture. The world market for prawn around 2.8 million t dominated by Japan, the USA and Western Europe, and accounted for around 85 % of the world trade.

Japan is the largest prawn consumer in the world. In 1991, Japan imported 315.739 t of prawn. However, the import trends of Japan reached a plateau in 1990 and 1991 (Ikeda, 1992).

The US is also a major importer. However, US prefers white prawn in larger sizes, this limits the opportunities for Asian exporters but it is advantageous for South American exporters such as Mexico and Ecuador. Recently Chinese white prawn were accepted increasingly in US market but with price 5 - 10 % lower than of Ecuador (Lee and Wickins, 1992). Since the middle of 1990, prawn consumption

in US market have declined due to the US recession (Filose, 1992).

European market traditionally relies heavily on supplies of cold water prawn. However, the role of warm water prawn in EEC consumption has expanded over the last decade. In 1991, EEC imported 365,000 t prawn mainly from Ecuador, China and Indonesia (Josupeit, 1992). No major change in the prawn consumption patterns are expected after the realization of the common market in 1993.

Since 1989, the economic growth in Asia is now allowing this region a greater share of prawn consumption. Singapore, Hongkong and Malaysia are 3 major importers in this market. Annually, these 3 countries imported some 120,000 t (Ferdouse, 1992).

Prawn culture in Viet Nam so far is mostly extensive. It has just started developing and not to be affected much by saturated world markets. Before 1986, exports had been done exclusively by SEAPRODEX (State company). However, since 1986, provincial factories have the right to export their products directly. The major exported commodity is frozen prawn (80 %), increasing quickly from 3,000 t in 1981 to 45,000 t in 1988 (Singh, 1990). Viet Nam now can export directly its prawn to Japan, Hongkong, Thailand, Singapore

etc. This is significant event to stimulate prawn production in the country compared to the time when US embargo against Viet Nam was so strict.

7. Economic return

A formal survey (Sanh, 1991) of the rice farmers in the study area in the Mekong Delta showed that the farmers also obtained more net return in rice-prawn system than that in rice monoculture. The net return earned from rice-prawn culture is two times higher than those of rice-monoculture $ha^{-1}.year^{-1}$ (Tuyen et al., 1991). Some farmers claimed that prawns and fish ate grass weeds so much that weeding expenses could be reduced by about one-third. So a U S $ 50.ha^{-1} weeding expense decreases to only U S $ 33.40.ha^{-1}. NPK fertilizer application could be reduced by 28 % from 209 to 192 $kg.ha^{-1}$ without reducing rice grain yield (Lightfoot et al., 1990). Even if rice production fell because trenches take up 15 % of the rice area, the high value of prawn at 20,000 VN $dong.kg^{-1}$ (about U S $ 5) compared to rice which sold at 282 VN $dong.kg^{-1}$ still made integration profitable. Net return from rice-prawn culture can be two or three times that of rice-monoculture. Moreover, integration of agriculture and aquaculture could play a significant role in sustainable farming. (Lightfoot et al., 1990). The prawn production ranges from 200 to 400 kg.ha-

.year^{-1} with a gross return of U S $ 600 - 1,200.ha^{-1}, which far exceeds the income from the rice crops generated from a shared rice field in an integrated rice-prawn culture (Lin and Lee, 1992).

The integrated rice-prawn farming has large potential for development in the Mekong Delta, because of the existence of vast irrigated areas suitable for prawn culture. The rapid increase in the popularity of rice-prawn farming in certain areas of the delta suggests that farmers have accepted the concept and are confident of the economic viability of the system. One major concern to rice-prawn farmers has been the use of pesticides such as Endrin, Parathion and Monitor. Freshwater prawn farming is a relatively new activity in Viet Nam and research on pond management is needed to improve the production and economic return of the farmers (Lin and Lee, 1992).