CHAPTER 5

SHRIMP AQUACULTURAL SYSTEMS AND RELATED ISSUES

This chapter is devoted to describing shrimp aquacultural systems, activities of shrimp aquacultural farms, and the problems relating to shrimp aquaculture in the research site.

5.1 Existing shrimp aquacultural systems in Phu Vang

As mentioned earlier, there has been no official definition of the shrimp aquacultural systems in Phu Vang, therefore a clear-cut definition of shrimp aquacultural systems must be defined for the study. Through interviewing the head of Phu Vang Department of Agriculture and Statistics and examining real situations of shrimp aquaculture, the following main criteria were set up and used to divide the shrimp aquacultural system into four sub-systems: Seed resource, feed resource, pond location/characteristics, stocking density, source of water supply, investment level, and management level.

The detailed definitions of the four shrimp aquacultural systems are as follows:

Traditional extensive shrimp aquacultural systems (TESAS): TESAS use wild seed and are totally based on wild or natural feed. Ponds are formed using nets and are located in lagoons. The stocking density is about 1 post larva per square meter. The water source is tidal and TESAS are characterized by very low investment and management requirements.

Improved extensive shrimp aquacultural systems (IESAS): IESAS use wild seed and artificial seed supplement. Feed for shrimp is both natural and self-made (self-made feed can be fish, small shrimp, meat etc.). Ponds are also formed using nets and located in lagoons. The stocking density is less than or equal to 3 post larvae

per square meter. The water source is tidal and IESAS are characterized by low investment and management requirements.

Semi-intensive shrimp aquacultural systems (SSAS): SSAS use artificial seed. The feed used is mainly processed feed. Unlike TESAS and IESAS, ponds in SSAS are located on land (earthen ponds) and the water used is a pumped water source. The stocking density is less than 15 post larvae per square meter. SSAS are characterized by moderate investment and management requirements.

Intensive shrimp aquacultural systems (ISAS): ISAS use only artificial seed and processed feed for shrimp. Ponds are located on land (earthen ponds) and the water used for the system is a pumped water source. The stocking density is more than 15 post larvae per square meter. ISAS are characterized by high investment and management requirements.

Of seven criteria used to define the various shrimp aquacultural systems, the last two criteria look into investment and management and focus on the qualitative than the quantitative aspects of these areas. It is easy to determine the required investment level. However, when defined, this benchmark or standard level will change over time because of changes in currency value. Based on the second and the third criteria, pond location and stocking density, it is observable that the first two shrimp aquacultural systems, TESAS and IESAS, perhaps do not need water pumps and aerators; while the two latter systems, SSAS and ISAS, do. Farms, which have both water pumps and aerators belong to the ISAS, since the investment in aerators is so high; whilst those farms that have only water pumps should belong to the SSAS. Pumps are more essential than aerators in both SSAS and ISAS, since in these two systems, shrimps are reared in earthen ponds and water must be pumped into these ponds. Moreover, stocking density of the SSAS is lower than in the ISAS thus aerators are even less important in the SSAS than in the ISAS. If both pumps and aerators are bought, investment is high. Therefore, farms that have both pumps and aerators would be considered to belong to the ISAS.

Furthermore, the required management level is a qualitative measurement. However, it is clear that in the TESAS and IESAS, due to the low investment level, farmers may not pay as much attention to taking care of shrimp, feeding them at exact feeding times and frequencies, observing and testing the water quality regularly, or applying disease prevention, etc. On the contrary, in the SSAS and ISAS where investment is high, these tasks will be carried out more precisely as financial losses or gains will be more pronounced. The management level in SSAS and ISAS is clearly higher than that in TESAS and IESAS.

5.2 Activities of shrimp farms

5.2.1 Cropping calendar

The following is the cropping calendar of shrimp aquaculture, which is produced by the Department of Agriculture and Statistics of Phu Vang district.

Regions of the district	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
A. Region I - Communes which have earliest appropriate salinity Thuan An, Phu Thuan, Phu Hai		Crop 1				Crop 2						
B. Region II - Communes which have later appropriate salinity Phu Dien, Vinh Xuan, Vinh Thanh, Phu My, Phu Da		Crop 1				Crop 2						
C. Region III - Communes which have very late appropriate salinity Vinh An, Vinh Phu, Vinh Ha					1 crop							

Source: Department of Agriculture and Statistics of Phu Vang, 2001.

Figure 5.1 Cropping calendar of shrimp aquaculture in Phu Vang

In shrimp aquaculture, salinity is important. If salinity does not reach the appropriate range, shrimp aquaculture cannot be conducted. Since the salinity is

affected by time and region, the district is divided into three regional areas. The salinity cycle in the lagoon water is different in each of these regional areas.

Region I is the region, which achieves the appropriate salinity earliest in the year. This region consists of three communes Thuan An, Phu Thuan and Phu Hai. Since the appropriate salinity starts early in the year, these communes can culture two crops per year. The first crop can be started at the beginning of February and completed at the end of May. The second crop can be started immediately after the first crop and completed at the end of September.

Region II achieves appropriate salinity slightly later than region I. This region consists of Phu Dien, Phu My, Phu Da, Vinh Xuan and Vinh Thanh communes. As appropriate salinity achieves later, the shrimp crops are started later than in region I; however, this region can also culture two crops per year. The start and finish of each crop is about a half month later than in region I.

Region III achieves appropriate salinity later than both regions I and II, so it can only culture one crop per year. This crop starts at the beginning of May and can last until mid-October. There are three communes in this region namely Vinh An, Vinh Phu and Vinh Ha.

This is the suggested seasonal calendar of the district. However, in reality, based on experience, aquaculturists in each region can check and measure the salinity in the lagoon water and they are free to decide when to begin each crop.

5.2.2 Shrimp pond preparation

In Phu Vang, SSAS and ISAS shrimp ponds can be built by farmers themselves, or by the People's Committee of the commune. Where ponds are built by the People's Committee of the commune, they will be sold or auctioned to farmers for a 10-year duration.

According to Yen (2001) small ponds are easy to manage; however, the cost of building and operation is high. In most cases, pond sizes from 0.5 ha to 1.0 ha are suitable and efficient for intensive shrimp aquaculture and 1.0 to 2.0 ha for semi-intensive shrimp aquaculture. In Phu Vang, ISAS pond sizes are more uniform (10 sao or 5,000m^2) than in the SSAS. In both systems, the smallest pond size is 3 sao (1,500 m^2) and the largest pond size is 15 sao (7,500m^2). The most common pond shape is rectangular.

Pond preparation includes a number of activities that must be carried out before the pond can be used for the first time and before each subsequent crop. The main objectives of pond preparation are to provide the shrimp with a clean pond bottom and appropriate, stable water quality. Like any shrimp aquacultural regions, shrimp aquaculture in Phu Vang follows these pond preparation activities.

Cleaning: The amount and organic content of the sediment that accumulates in the pond during the production cycle depends on the culture system. This sediment must be removed or broken down to sustain production and prevent accumulation of organic materials. If the sediment is not removed from high yield production ponds, production will rapidly deteriorate with each successive cycle.

The dry method is widely applied in Phu Vang to remove sediment from pond bottom. The procedure consists of draining, liming, ploughing and drying the bottom of the pond for 3 to 5 days. The objective of drying the pond is to allow oxygen to penetrate the pond bottom and the accumulated waste. This oxygenation can also increase the acid production from potential acid sulphate soils. Ploughing, while increasing the oxygenation and exposure of the pond sediments, has the disadvantage that it increases suspended solids once the pond is refilled. It also increases the porosity of the soil and makes the pond bottom uneven. Ploughing should be combined with compaction to avoid these problems. In Phu Vang, the dry method is carried out using machines, buffaloes or laborers.

Liming: After cleaning, the pond should be filled briefly to flush out any remaining fine debris and to check the pH of the water. This water should be left in the pond overnight and then removed. This process may be repeated until the pH of water is above 7.

The need to use lime after the final flushing varies from pond to pond. In most ponds in Phu Vang, dolomite ($CaMg(CO_3)_2$) or agricultural lime ($CaCO_3$) is applied. Lime application helps produce optimum pH and alkalinity. Lime application is not only applied in this period, it is applied during the crop as well when the pH of the pond falls below the optimum range.

Water preparation: Ponds are filled, fertilized and the water treated to encourage a healthy plankton bloom and to prevent other species entering the pond.

After the initial liming has been completed the pond is filled to cultural depth. Water from a reservoir or main channel will be pumped into the pond through a fine mesh to stop the waste entering cultural ponds.

It is essential to avoid introducing other animals when the water is pumped into the pond. These animals may include crustaceans, finfish, and other invertebrates. These species will either compete for food or actually kill and eat the shrimp. In addition they may introduce pathogens into the ponds, including serious viral conditions such as White Spot. That is why water needs to be treated to remove such animals either in the reservoir or supply canal, or once the pond has been filled.

Coloring or plankton culture: In Phu Vang, the way plankton is cultured in the shrimp ponds is different at each farm. Based on water state and soil type of cultural ponds, farmers have to culture plankton appropriately. Materials used to culture plankton are inorganic fertilizers (urea, N-P-K, ammonium phosphate or super phosphate), organic fertilizers (sun dried chicken manure) or rice bran, fish sauce, etc.

Inorganic fertilizer should be dissolved in water and spread over the surface of the pond. If it is not dissolved, it will preferentially enrich the pond bottom,

encouraging the growth of benthic or filamentous algae. Organic fertilizer is first soaked overnight in water and the resulting mixture is spread over the pond surface. If the manure is not soaked it may be blown to the edge of the pond.

After a few days a plankton bloom should develop, turning the water slightly green. This color shows that the plankton is in good condition for shrimp development.

5.2.3 Preventing diseases, feeding and harvesting

The objective of disease prevention is to help shrimp have good health, thus resisting disease and tolerating stress, when the environment is not suitable with shrimp. With that objective, the materials used for disease prevention are nutritious foods, antibiotics, or vitamins, etc. In the market, there are hundreds of shrimp nutritious foods and vitamins. Therefore, it is difficult for farmers to decide the most suitable materials for their shrimp. Consequently, materials used for disease prevention are not uniform. Hence, there should be official guidelines on shrimp disease prevention to help farmers select the appropriate disease prevention materials, and the appropriate level and frequency of application.

Feed management is one of the most important aspects of successful shrimp production, since feed is one of the main inputs in the system. The objective should be to produce shrimp in a sustainable manner with the largest margin of profit. In Phu Vang, according to the survey, feed cost accounted for 53% and 46% in total production cost of the SSAS and ISAS, respectively (Table 6.4).

For the first 7 to 10 days, aquaculturists in Phu Vang often use the yolk of boiled chicken eggs or fresh food, usually small fish, to feed shrimp. The purpose of adding these fresh feeds is to encourage the post larvae to start feeding. It is also possible that the fresh feeds may have some effects as organic fertilizers. It is, however, possible to introduce disease with fresh food, especially if it contains any crustaceans or fish. That is why some farms do not want to feed shrimp with these fresh foods.

It has been found in the survey that farmers adjust the feed and feeding frequency for shrimp based on the feeding nets. In addition, in the first month, shrimp are fed 5 or 6 times a day and in the later months they are fed 4 or 5 times a day. The relative feeding rate decreases during the production cycle since shrimp eat less as they grow, that is, they consume a smaller proportion of their body weight per day.

The objective of successful harvesting is to get shrimp out of the pond in good condition, within a short time and, if possible, when the price is high. Shrimp must not be physically damaged or excessively contaminated with mud from the pond bottom. If they are harvested rapidly, they will be in better condition and will be fresher when they reach the processors. Buyers in many areas are already paying a premium for good quality shrimp and this is likely to become more and more common.

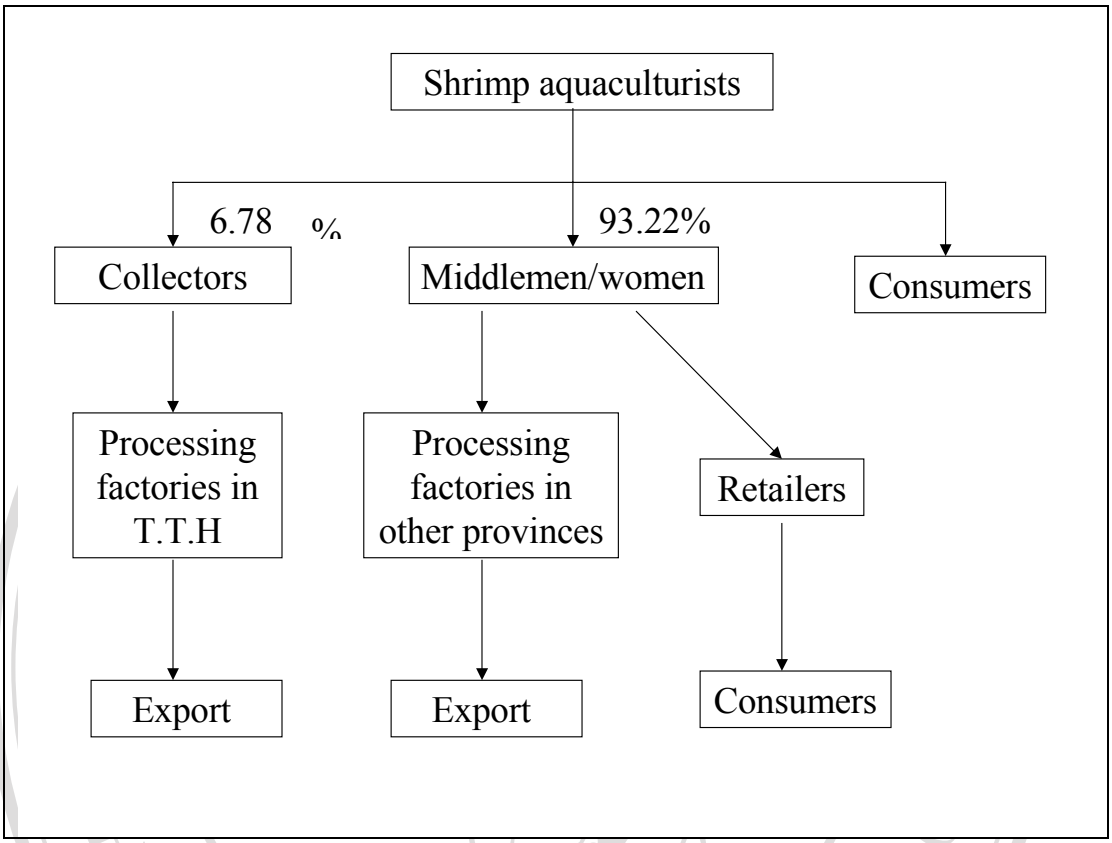
The timing of the harvest is influenced by the market price; however, it is mostly dependent on the condition of the shrimp and the pond. In the worst case, if there are increasing mortalities in the pond, it may be necessary to perform an emergency harvest, regardless of the size or value of shrimp.

In Phu Vang the most popular method of shrimp harvesting is to drain the pond to the level of water of 40 to 50 centimeters deep, then use a harvest net with a direct current electricity tool, namely “siết” or “xiết”. This method helps keep shrimp clean, fresh and undamaged.

5.2.4 Shrimp marketing

Marketing channels of Thua Thien Hue in general and Phu Vang in particular are depicted in Figure 5.2.

After harvesting, shrimps are sold to one of three main channels: collectors of processing factories in Thua Thien Hue, middle women/men or directly to final consumers.



Source: Survey, 2002.
Note: T.T.H is short for Thua Thien Hue province.

Figure 5.2 Marketing channels for shrimp in Phu Vang

The third marketing channel, final consumers, is made up of predominantly aquacultural farmers and their friends and families. As a percentage of the whole harvest, the amount consumed by them is insignificant and has therefore not been included in these calculations.

Within the first marketing channel, shrimps are collected by collectors from aquatic processing factories in Thua Thien Hue province. According to Tam (2000), it is important to consider the role of Song Huong freezing factory, the biggest aquatic products processing factory in the province, which has a monopoly on buying aquatic products for processing and export. The distribution of shrimp (second crop of 2002) by the sample farms through various marketing channels is presented in Table 5.1.

Table 5.1 Distribution of shrimp through the marketing channels

Item	Channel 1			Channel 2		
	Semi-intensive	Intensive	Total	Semi-intensive	Intensive	Total
Farm	5	3	8	63	47	110
%	6.00	7.40	6.78	92.65	94.00	93.22

Source: Survey, 2002.

The results from the survey showed that only 6.78% of shrimp aquacultural farms of the two shrimp aquacultural systems in Phu Vang sold their shrimps through the first channel, the processing factories in Thua Thien Hue. Specifically, 6% and 7.4% of the SSAS and ISAS farms, respectively sold their shrimps via marketing channel 1.

The second marketing channel is the main channel which consumes the shrimps from the farms. 93.22% of farms (92.65% of the SSAS and 94% of the ISAS, correspondingly) sold their shrimps to middlemen. According to farmers, the reasons why they want to sell their shrimps to the middlemen are that the term of payment, mode of payment, term of buying and so forth of the middlemen are better than those of the aquatic processing factories in Thua Thien Hue. Furthermore, the middlemen have a simple way of buying. Farmers reported that their shrimps take a long time to ready and having paid much care and attention to them, they are concerned that they should be treated humanely. When shrimps are harvested and sold, farmers would like them to be handled with care. They do not want their shrimps to suffer from the long process of selection and categorization. Therefore, farmers accept a slightly lower price in exchange for the quick and simple buying procedures used by middlemen.

The middlemen in Phu Vang can be categorized into two types: those who live in the district and those who come from outside the district.

Of the two types of middlemen, shrimp aquacultural farmers sell their products to the locals more than to the outsiders. In the development process of aquaculture, a group of people called "*chủ nậu*" in Vietnamese have established themselves as successful local middlemen. *Chủ nậu* are appeared with the advent of aquaculture. They have important economic roles (Binh, 1999). They help solve the difficulties of the aquacultural inputs and outputs. In addition, they help solve the problems in demand and supply for the community. They can control the market price, not only in aquatic products but also in other commodities, since they have roles as shrimp materials sellers, shrimp buyers or loaners. As previous established, shrimp aquaculture often needs a lot of investment, especially in feed costs. Towards the end of the crop, shrimp eat a lot more than at previous times. Some poor farmers do not have enough money to pay the shrimp feed sellers immediately. Knowing this, *chủ nậu* can sell shrimp feed to aquaculturists on credit or lend them money to buy shrimp feed. Additionally, when shrimp aquaculturists have financial problems in any aspects of their lives, *chủ nậu* can lend them money immediately. When shrimps are harvested, aquaculturists will sell their shrimps to *chủ nậu*. The selling price can be a little bit lower than the market price, however, farmers are willing to sell to *chủ nậu* as wish to keep a good relationship with the peoples who help them when their families are in need. Moreover, these shrimp aquacultural farms hope to foster relationships with *chủ nậu* for the successful sale of future shrimp crops.

Aquaculturists who have enough capital or are able to get a loan from the banks to raise shrimp, do not owe the *chủ nậu* any favors, thus they are free from the obligation. There is no barrier to prevent these farmers from choosing the best buyers. Therefore, these aquaculturists can sell their shrimps to whomever they choose. In this case, their selection is usually the middlemen from outside the district with whom the price is often a little higher than that achieved through other channels.

5.3 Current problems in shrimp aquaculture

Aquaculture is one of the main strategies in the economic development of Phu Vang. Moreover, geographic and environmental conditions are favorable for

enclosing lagoon areas and for constructing aquacultural ponds. However, the rapid aquacultural development has had impacts on the environment and resources, an issue that requires more research and discussion.

5.3.1 Environmental and social problems

Phu Vang lagoon belongs to Tam Giang lagoon and its environmental status can be deduced from the environmental status of Tam Giang lagoon, Thua Thien Hue province.

According to Wilson *et al.* (2001) over-fishing, pollution, and aquacultural development threaten one of the Asia's largest lagoons, a 22,000 hectare body of water on which 300,000 poor people depend for their rural livelihoods.

In the richest fishery grounds of the lagoon, near the main opening to the sea, aquaculture has developed far beyond the lagoon's capacity. "Aquaculture began in 1978 with the opening of a research station focused on seaweed culture. Shrimp aquaculture began in 1987 and it significantly increased in late 1990s (Mien *et al*., 2000). Since then, "all the fishers who turned to aquaculture have clearly become richer. Now they have houses, televisions, and so on". But "while the aquaculturists were getting rich, the traditional fishers were getting poorer" (Phap, 1996 cited by Meunier, 1999).

According to (Phap, 1996 cited by Meunier, 1999), local fishermen and women have lost some of their fishing areas, while aquaculture has taken over most of the prime spots in the lagoon. The large increase in the number of nets and aquacultural ponds has also made an impact on the ecosystem by polluting the water and destroying natural nursery grounds, which normally offer shelter for juvenile fish, shrimp, and crab.

According to Tuyen and Brzeski (2000) problems are now emerging as the number of fishers increases and as aquaculture develops in the lagoon. The conflicts have been observed as follows.

5.3.1.1 Conflicts between agriculture and aquaculture

Farming has been sustained for many generations on the thin stretch of sandy, saline-intruded, draught-prone land. As the population increased, however, agricultural yields, from some marginal lands (with poor sandy soils) and during some extreme climatic years, have not met family requirements. In recent years, as income from farming has decreased and the price and demand of aquatic products have increased, a large number of farmers have resorted to fishing with simple, mobile gears thereby increasing the pressure on lagoon resources (during slack farming seasons). In addition, farmers then began converting their land to aquaculture. This change from crop and animal production to aquaculture has improved economic returns however it is not without problems (Mien *et al*., 2000).

The conversion of agricultural land into aquacultural area and the construction of pond required the destruction of the primary dikes preventing saline intrusion from the lagoon. Though adjacent rice fields were thought to be protected by the highway, acting as a dyke, saline intrusion has affected these fields. Though aquaculture might be an appropriate direction for the development of saline-intruded sandy lands, its impacts on society, environment, agriculture and lagoon resources should not be ignored.

5.3.1.2 Conflicts between aquaculture and fishery

The privatization of the water area for aquaculture (ponds and net enclosures) has reduced the public area available for fishing. This has caused some serious conflicts, some of which have led to the damage of aquacultural structures. First, mobile fishers versus fixed fishers. In general, water area is considered public for all fishers. However, fixed gear fishers have the right to their own fishing grounds. Mobile gear fishers have very limited rights to fish in those grounds. As a result of resource depletion, fixed gear fishers are expanding or enclosing their fishing grounds and the overall numbers of fishers and gear are increasing, causing stress to resources and to fishers. Unequal access to fishing grounds leads to unequal benefits between

fishing groups, which results in conflicts. Other conflicts occur among fishers because of the use of destructive fishing gear by certain groups. Small conflicts result in quarrels or fighting. Serious conflicts must be solved by the authorities. However, traditional mobile fishers, though poor, have been fishing for many generations and understand the informal rules in fishing. They try to preserve good relations with fixed gear fishers in exchanging for help when it is needed. Second, conflicts sometimes arise between farming groups and fishing groups. Different groups living around the lagoon have access to different natural resources. The farmers want to fish but in return, refuse to share their land with the fishers who want to practice farming. The fishers want to have access to land and, as well, compete to gain a higher share of fishing grounds. Farmers are reputed to use destructive fishing gear such as lamps at night, dynamite and poison oblivious to the destruction of aquatic environment. They are accused of stealing fish from the cod end of fish corrals.

5.3.1.3 Conflicts between aquaculture and aquaculture

There exist conflicts among the four shrimp aquacultural systems in general and between the net enclosures pond shrimp aquacultural systems (TESAS and IESAS) and the earthen pond shrimp aquacultural systems (SSAS and ISAS) in Phu Vang.

There are many net enclosure ponds used in the first two systems. Nets used for shrimp ponds must have small cells and high net cell the density. Due to these design features, water in the lagoon, especially water near the offshore, cannot be exchanged entirely with the seawater by the tide. In addition, the water pumped into the channels for the latter two shrimp systems is from the lagoon. As a result of the workings of the TESAS and IESAS, the water environment used for the SSAS and ISAS is substandard and dirty. According to the farmers, the years which have large floods bring the good harvests for the following season crops. This is because with a large flood, the waste and turbidity in the lagoon are removed entirely and thus water quality is much improved, they added. Their ideas prove that the inappropriate aquacultural practices of the TESAS and IESAS might have prevented the success of the SSAS and ISAS.

Within a shrimp aquacultural system, the conflict can be as follows. Intensive shrimp production occurs in a relatively small area. Crowding of farms in these areas results from inadequate planning and regulation. There are no comprehensive plans, which take in to account the relationship between the total area in shrimp ponds at a particular site and the carrying capacity of supplying or receiving water bodies at that site. It is common for the water discharged to the lagoon by one farm to be subsequently utilized by a neighboring farm. It is found from the 118 farms of the survey, only some farms belonging to aquacultural cooperative in Phu My commune treated waste water before draining it to the lagoon; most of the farms did not.

Currently, aquaculturists are interested in maximizing short-term profit, consequently sacrificing environmental sustainability. In this pursuit, the majority of the aquaculturists dispose untreated waste water from culturing ponds into natural waterways and coastal areas. This practice has had an adverse impact on Thua Thien Hue coast and Thua Thien Hue lagoon, beaches, and marine ecosystems.

5.3.2 Shrimp disease

A disease can be any abnormality in the structure of the function of the animal. This means that diseases are not just infections but also include environmental or nutritional problems which lead to reduced production. Disease problems have resulted in massive financial losses in the shrimp farming industry.

Most, if not all, shrimp diseases occur as a result of a combination of factors. It has been widely accepted that disease in aquatic animals usually results from a combination of a susceptible host in a harmful environment, together with potentially harmful organisms (pathogens). Most diseases in shrimp are a combination of poor environmental conditions, resulting in either damage to the shrimp or a reduction in its capacity to fight diseases. In many cases there will be organisms in the pond that can take advantage of this situation to infect the susceptible shrimp. Since shrimp diseases have complex causes it is essential that consideration be given to the shrimp, pathogen and the environment in order to prevent and treat disease problems

(Chanratchakool *et al*., 1998). In addition, the high stocking and feeding rate used in intensive shrimp production increase the dissolved organic matter from metabolites and decomposed uneaten feed in the pond.

Common diseases occurring at the research site were external fouling, externally invasive conditions, vibriosis, hepatopancreatic viruses, yellow head disease, and white spot disease. Of these, white spot disease is the most serious. The best solution to the problem of white spot disease is to immediately harvest the shrimp assuming they are large enough. However, in some cases it may not be worth conducting an emergency harvest, for example, if the shrimp are too small or if most have already died. In such a case, the water should be treated in the pond, prior to discharge. Every effort should be made to avoid the water from the affected pond coming into contact with the inlet water for the affected farm or any neighboring farms.

Culturing activities in Phu Vang are also facing and being threatened by serious diseases. The results of the survey are presented in Table 5.2.

Table 5.2 Shrimp disease status of the SSAS and ISAS in 2001 and 2002

Shrimp system	Statistics	2001		2002	
		Number of crops	% farm-crop infected by diseases	Number of crops	% farm-crop infected by diseases
Semi-intensive	Mean	1.76	16.00	1.94	54.41
	Std. Dev.	0.63	44.40	0.24	55.81
Intensive	Mean	1.34	42.00	1.68	74.00
	Std. Dev.	0.82	67.30	0.51	69.43
Total	Mean	1.58	27.00	1.83	62.71
	Std. Dev.	0.74	56.50	0.40	62.43

Source: Survey 2002.

In 2001, the SSAS aquacultured 1.8 crops and 16% of farm-crop were infected with shrimp diseases, while the number of aquacultural crops from the ISAS was lower (1.3 crops) but the percentage of the farm-crop with shrimp disease infection was higher (42%). This state was also the same in 2002 with the figures of 1.9 crops, 54.41%, 1.7 crops, and 51.27%, in that order.

It is obvious that the disease problems in the ISAS were more severe than in the SSAS for years 2001 and 2002. Within each system, the level and frequency of disease occurrence in 2002 were also higher than in 2001. For instance, within the SSAS, in 2001 only 16% of farm-crop were infected with diseases while in 2002 the rate of infection was much higher at 54.41%. The ISAS figures show a similar increase. The farm-crop infected with diseases in 2001 was 42%; however, in 2002 this figure was 74%.

It is evident that the inappropriate management of shrimp farms not only causes environmental problems, but also affects the shrimp production of the farms themselves. Farmers should be aware of this situation and change their practices accordingly.

In brief, aquaculture is one of the main strategies in economic development in Thua Thien Hue in general, and Phu Vang in particular. Shrimp aquaculture is an important source of household income, employment, foreign exchange earnings, as well as food of course. However, rapid expansion in shrimp production is responsible for major social, economic and environmental problems. For shrimp aquaculture to be sustainable, it must provide an adequate farm income, generate export earnings and protect the long-term productivity of natural resources and the environment. These should be the main objectives of the leaders and shrimp aquaculturists.