Challenges to Shrimp Production in the Bentre Province, Vietnam

By

Pham Van Khang

Master thesis in International Fisheries Management

(30 credits)

Department of Social Science and Marketing

Norwegian College of Fishery Science

University of Tromsø

May 2008

ACKNOWLEDGEMENTS

First, I would like to express my deep gratitude to my supervisor professor Bjørn Hersoug, who from the beginning to the end, showed his concerns regarding my progress. His straightforwardness aided in the focus of this thesis.

Secondly, I would like to thank the NORAD program for their financial support and all other teachers or visiting lecturers, program coordinators and colleagues of the Norwegian College of Fisheries Sciences.

I also would like to thank RIA.1 where I worked. DoFi Bentre staffs and participants from three districts Binhdai, Thanhphu, Batri who help me during my field work.

For my family and friends, thank you for all of your love, encouragement and friendship during my studying in Tromsø.

Tromsø, May 2008

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

ABBREVIATIONS

BMP	Better Management Practice in Aquaculture
CDI	Center for Development and Integration Vietnam
CoC	Code of Conduct
DANIDA	Danish Development Agency
DARD	Ministry of Agriculture and Rural Development
DoFi	Department of Fisheries
FAO	Food Agriculture Organization of the United Nations
FSPS	Fisheries Sectors Programme Support
GAP	Good Aquaculture Practices
Ha	Hectare
IUCN	International Union for the Conservation of Nature
LFA	Logical Framework Analysis
MOFI	Ministry of Fisheries
NACA	Network of Aquaculture Centres in Asia-Pacific
NAFEC	National Fisheries Extension Center
NAFIQAVED	National Fisheries quality Assurance and Veterinary Directorate
NGO	Non- Governmental Organization
NORAD	Norwegian Agency for Development Co-operation
RIA	Research Institute for Aquaculture
SPSS	Statistical Package for Social Scientists
SUMA	Support to Brackish Water and Marine Aquaculture Development
UNEP	United Nations Environment Programme
US$	American Dollar
USA	United States of American
VIFEP	Viet Nam Institute of Fisheries Economics and Planning
VND	Vietnamese currency Unit (Dong)
WB	World Bank

ABSTRACT:

Shrimp world production in the last few years has shows very high growth rates. In Vietnam in general and Bentre in particular, shrimp farming has rapidly developed recently and become an important economic sector, creating employment, increasing farmers' income and earning foreign currency for the country. However, shrimp farming in Bentre is facing a number of challenges that hinder the sustainable development of the sector. The development has been through unplanned expansion of the number of farms, households, farming area, and recently farming intensification. The shrimp farming is small-scale in nature, based mainly on individual households. The fast growth of the shrimp farming has led to negative environmental impacts in both the short term and long term with mangrove degradation, ecological imbalance, pollution and outbreak of diseases. Management of the industry is facing many obstacles regarding planning, seed supply, irrigation development, capital mobilization and environmental protection. Although shortcomings have been pointed out by the Vietnamese Government for many years, they still remain.

To be sustainable, careful consideration should be given to appropriately understand and address these issues. Therefore, this study will provide an analytical overview of shrimp farming industry in Bentre. Additionally, the relevant aspects of shrimp aquaculture development, major problems faced by the industry and a synthesis of the environmental and socio-economic impacts of shrimp farming will be highlighted. Finally, shrimp trade as well as infrastructure, management and policy issues of the sector will be analyzed and discussed in order to provide the implications for sustainable shrimp farming development in Bentre.

Key words: Challenges in shrimp production, Vietnam, Bentre, black tiger shrimp and sustainable aquaculture development.

1. INTRODUCTION

World aquaculture continues to grow more rapidly than all other animal food-producing sector, with an average growth rate of 8.8 percent per year since 1970, compared with only 1.2 percent for capture fisheries and 2.8 percent for terrestrial farmed meet production systems (FAO, 2006).

Shrimp farming has become a major aquaculture activity and source of investment over the past two to three decades. Since the late 1980s, farmed shrimp has become a major contributor to overall shrimp supplies in the world, making up for the declining wild catch and meeting the steadily increasing demand. It is now a major factor in world markets. The average annual percentage grow rate for 2002-2004 is 28.7 %, and in 2004 the total production of shrimp was 2,476,023 tonnes (FAO, 2006).

Several elements have driven the rapid expansion of shrimp culture. They include potentially high profits, buoyant demand for high value seafood products, increasing demand for farmed shrimp due to limitations and fluctuations from capture fisheries, and the industry's capacity to generate foreign exchange and employment in poor coastal areas. Benefits of shrimp farming to poor coastal communities thereby reduce poverty.

Although it has brought significant benefits to some areas, it has also been associated with environmental degradation, social conflict and negative impact to economies. Many have questioned the sustainability of the shrimp industry. Widespread disease incidences have also raised questions relating to its sustainability in purely practical terms. The large areas of land required for extensive and semi-intensive farming have led to significant natural habitat loss through conversion of wetlands into ponds. In recent years, several major crop failures have occurred. The conversion of many ponds to other forms of aquaculture, such as marine fish, followed, and in some cases ponds were abandoned. Problems have been experienced by China, which lost a large part of production due to disease outbreaks in the early 1990s, while India had a major crop failure in 1995. Other major producers such as Indonesia, Vietnam and Bangladesh have also suffered crop failures in shrimp production, mainly due to diseases. Consequently, the unpredictability of supply, resulting partly from disease over the past few years, has introduced some uncertainty

into the market, with significant local and short-term price fluctuations (Nhuong et al, 2006).

Vietnam has a long coastline with 3,260 km and large number of closed bays, lagoons, straits, and numerous river systems. These natural features give Vietnam a great potential for developing aquaculture in land water bodies, coastal brackish water and marine water areas. In economic terms it contributes 1.56 million new jobs, mainly for young people in rural communities, increased fish consumption up to 20.7 kg per capita (in 2006), and increased export value from 986,000 USD in 1999 to 3.32 billion USD in 2006 corresponding to 3.86 % of GDP in 2006 (Dan, 2007).

In brackish water, shrimp farming has become a major part in coastal economic development. This fact, together with the attractions of high profits, high market demand for shrimp products, and supportive policies from the government, led to the rapid development of the shrimp farming sector and its establishment as an important economic sector that created employment, increased farmers' incomes, and earned foreign currency for the country. Shrimp farming in Vietnam, however, is facing a number of challenges that hinder the sustainable development of the sector. The negative environmental impacts from shrimp disease outbreaks, natural resource degradation, user conflicts, food safety problems, and most recently, tariff barriers, are major concerns for the shrimp farming sector. To ensure the sustainability of the industry, careful consideration should be given to understanding these issues and addressing them appropriately. In this thesis, the relevant aspects of shrimp aquaculture development, including the socioeconomic, technical, and environmental aspects as well as infrastructure, management, and policy issues of the sector are analyzed and discussed to understand their implications for the sustainable development of shrimp farming in Vietnam.

The study focuses on environmental, social, economic issues, policies and markets which are challenges to shrimp production, and suggests solutions to sustainable shrimp development. The study also aims to characterize shrimp production, the aquaculture activity of small-scale shrimp farmers that is the largest group of aquaculture farmers, and a major contributor. Farmer organizations in shrimp production are also mentioned.

The Mekong river delta covers 70 % of the aquaculture area of the country and contributes 80 % of total shrimp culture products in Vietnam (Dan, 2007). Bentre is a coastal province located in the eastern part of the Mekong delta. Bentre covers an area of 2,287 km^2 with 65 km coastline and a dense network of rivers and canals. The province has diverse wetlands and rich aquatic resources (Statiscal Office, 2005). Bentre province developed the shrimp industry later than other provinces in Mekong river delta so there is a good chance that Bentre learned about shrimp production from other provinces. The area of shrimp farming in the province 32,253 ha, (5.23 % of the total shrimp farm area of Vietnam) and contributed an export value of 134 millions USD (5.34% of the total export value of shrimps in Vietnam) (Thao, 2006). With the high potential for shrimp production, shrimp culture in Bentre has been developing rapidly and has become a major economic sector of the province and major province contributing to the shrimp production in Vietnam. Together with the rapid development of the shrimp industry, it has faced several severe risks during the last five years: the spread of shrimp disease, shrimp price fluctuations and other factors which has made shrimp farmers lose enthusiasm to cultivate shrimp.

Figure 1: Map of Vietnam showing the position of Mekong River Delta

This study also focuses on the aquaculture activity of small scale shrimp farmers. This is the largest group of aquaculture farmers, and a major contributor to production with over 80 % production (Sena De Silva, 2007). These farmers have limited land or water areas, often with limited access to technical, financial, and market services. There is a large number of farmers, but they are difficult to regulate. The study also concerns policies, that is, the policies in the shrimp farming which are influenced by different institutions. Often these policies do not fully include the

stakeholders, and they are not directed towards solving the societal problems as perceived by the farmers.

There are several major challenges confronting shrimp aquaculture: the production should be environmentally friendly, socially responsible, contribute to sustainable economic development, and comply with international standard (meet food safety requirements) and still remain profitable. An effective response to these challenges requires the coherent interplay of numerous stakeholders. Shrimp farming is one of the main activities possible in the coastal zone, but making it sustainable is a great challenge.

2. METHODOLOGY

2.1 Site selection

The main shrimp aquaculture producing areas in Vietnam are Kiengiang, Camau, Baclieu, Soctrang, Travinh and Bentre provinces, all provinces located in the Mekong river delta. In this study, the selected shrimp aquaculture areas are in the Bentre province. There are three coastal districts (Binhdai, Batri, Thachphu) in Bentre, and they were chosen for the study based on their geography and current shrimp production. The selected areas of studies are presented in Figure 2.

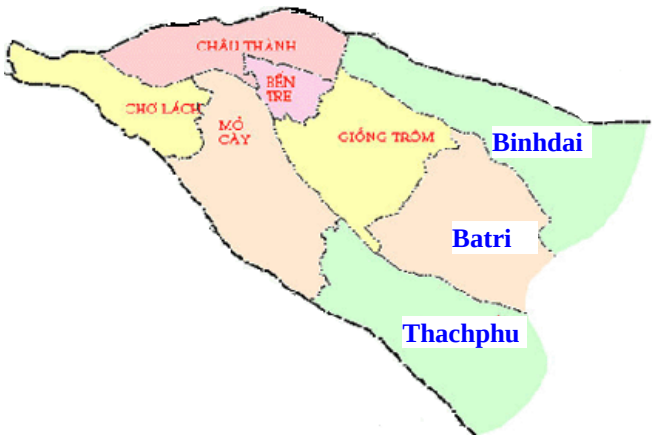


Figure 2: Map of the Bentre province showing the position of the three districts

2.2 Questionnaire

The questions in the questionnaire were based on aquaculture management and aquaculture sustainable development theory. Information was obtained from questions concerning the economies, environment, and society, and other subjects related to sustainable development in shrimp aquaculture.

2.3 Farm selection

The survey investigated small-scale shrimp farms that use large land/water surface areas and are main contributors to aquaculture production.

2.4 Data collection

The data and information consists of primary and secondary data collected through a survey from June 2007 to August 2007. The aims of the survey were to study the activities and address the challenges in shrimp aquaculture activities, from the

production, plans, policies, distribution and marketing in the areas of study. The data also relates to farmer organizations and producer organizations.

2.4.1 Primary data (interview)

The primary data was obtained from interviews with the different actors involved in the selection of shrimp production. Interviews with 87 small-scale shrimp farmers in three districts (30 in Binhdai, 30 in Batri, and 27 in Thanhphu) and some local fishery officials were conducted. Officials in the Bentre Department of Fisheries (DoFi) were also interviewed. The data was supplemented by secondary data.

2.4.2 Secondary data

Secondary data was collected from archives, the Fisheries Department of Bentre (central, provincial, and district levels) and documents published by the Ministry of Fisheries. Data was obtained from literature, including public documents, journals, articles, statistical agency, and keynote speeches. Addition information was collected from newspapers, some of them published on the internet.

2.5 Research framework

The Logical Framework Analysis (LFA), developed by different development agencies, was used to analyze and address the problems/challenges in shrimp production, different stakeholders who are involved in shrimp farming activities, and the different factors that have induced and shaped the shrimp activity patterns. The LFA used in this study is described in *The Logical Framework Analysis* by NORAD in 1999, 4th Edition (NORAD, 1999).

2.6 Data analysis

Microsoft Office Excel and SPSS 11.5 for Windows (Statistical Package for Social Scientists) were used in data analysis.

2.7 Limitation

There are some limitations in the study due to the short period of the survey. The study only focused on small-scale shrimp farming. For further studies on challenges, study should investigate suppliers, buyers and processing and other objects in order to obtain a comprehensive view of the Bentre's shrimp production.

In this study only the first part of the LFA, the problem analysis and objective analysis were employed to identify problems and future solutions of the problems. This is due to the limited scope and objectives of this study, based on the research questions on challenges to shrimp production.

3. THEORETICAL FRAMEWORK

Shrimp farming is one of the livelihoods of poor and often landless people in coastal areas even though profits may decrease in the future. With expectations for aquaculture to continue contributing to food security and poverty reduction, it is necessary to ensure that aquaculture develops sustainability.

Sustainable farming is a critical issue and has become a major concern of the aquaculture industry (Shang, 1998) and (Srinath, 2000). The fisheries and aquaculture systems are diverse, complex, and dynamic creating concern and challenges for the stakeholders involved in both fisheries and aquaculture. Diversity means that the systems are various and multi-faceted in terms of the stakeholders involved, characteristics of the area, and the social and cultural conditions. Complexity means that the relationship between the system and environment features could be complicated. Dynamic refers to the fluctuations and changes within a system and between systems that is unpredictable and irreversible (Kooiman, 2005b) and (Jentoft, 2007).

Sustainable development and sustainability are complex issues that are difficult to define and apply to aquaculture (Michael Phillips, 2001). The term of sustainability has been defined in various ways, but perhaps most widely accepted definitions of sustainability is "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland report [1]). An even more succinct definition from the International Union for the Conservation of Nature (IUCN) says that "sustainable development improves people's quality of life within the context of the Earth's carrying capacity".

Sustainable development has been defined by Food Agriculture Organization of the United Nations (FAO) in relation to agriculture and fisheries in the following way: "Sustainable development is the management and conservation of the natural resource base and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations". This definition recognizes that institutions are important and highlights the need for education and training, effective institutional arrangements and a legal and policy framework. (FAO, 1997a).

[1] Source: http://worldbank.org/depweb/english/sd.html (Read 27-01-2008)

Sustainability in agriculture and aquaculture is commonly split into three separate components: social sustainability, economic sustainability, and environmental sustainability. It also integrates three main goals: environmental stewardship, farm profitability, and prosperous farming communities

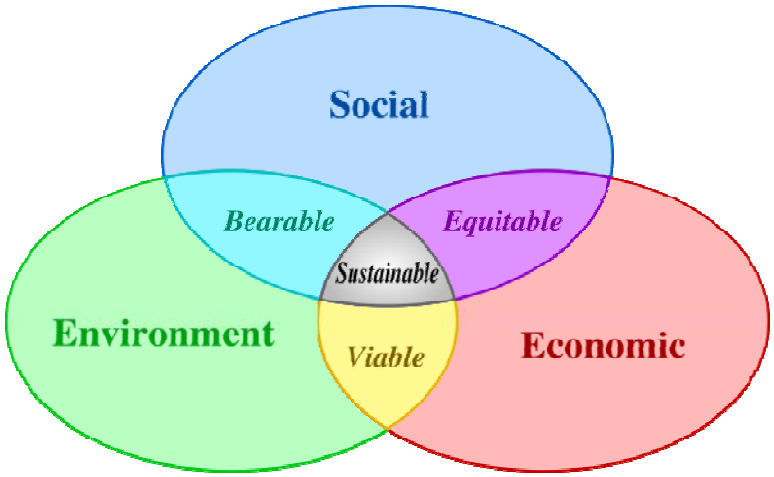


Figure 3: Scheme of sustainable development: at the confluence of three preoccupations [2]

There are general guidelines available on the different issues to consider. The Code of Conduct on Responsible Fisheries adopted by the FAO Conference in 1995 (FAO, 1995). The Code sets out principle and international standards of behaviour for responsible practices to ensure effective conservation and management and development of living aquatic resources. At the same time, the Code recognizes the nutritional, economic, social, environmental and cultural importance of fisheries and aquaculture, and the interest of all those involved in these sectors. Fundamentally, the Code recognizes the importance of activities that support the development of aquaculture at different levers: the producer level; the local level, such as the farm and its integration into local area management and rural development schemes; the national institutional and policy environment; and international and trans-boundary issue. The Code identifies many key principles in the development of management strategies based on an understanding of aquaculture.

[2] Source: http://en.wikipedia.org/wiki/Sustainable_development (Read: 26-01-2008)

3.1 Management at the farm level

There is a lot of information on aquaculture farming systems and various definitions are available, such as the level of intensity of management, output, and degree of integration with other on farm activities. However, there are diverse culture species, culture facilities, and management practices in use and thus a very wide range of farming systems.

Key factors to be understood in the functioning of a farming system are the technologies of production and the social, economic and environmental aspects. The technology level includes: feeds, seed quality, fertilizers, water quality and availability of chemicals, disposal of wastes impact on environment, and food safety of aquaculture products (Michael Phillips, 2001).

A wide range of aquaculture management systems are already employed with varying degrees of success. Aquaculture systems range from small-scale with low conditions for subsistence to large-scale with commercial units for trade purposes. For success in aquaculture managements, it is important to understand information on site selection, farm construction and design features, aquatic animal health management, brood-stock and seed production, production techniques, appropriate feeds use, water and sediment management, and others concerns (FAO/NACA, 1995) and (Chanratchakool, 1998).

The challenge is to optimize dissemination and use of such information and experience.

3.2 Management at local level

There are many and various interactions between an aquaculture farm and the external environment including environmental resources and local communities. Furthermore, there can be significant cumulative effects where there are large numbers of farms crowded in small areas (Michael Phillips, 2001).

Environmental interactions with aquaculture arise from a wide range of inter-related factors including: availability, amount and quality of resources, type of species cultured, size of the farm, culture systems management, and environmental characteristics of the farm location (Michael Phillips, 2001).

At the local level, social and institutional interactions are also important and need to be better understood, for example: participation of and benefits to rural communities, institutional support through extension services, access to information, etc (Michael Phillips, 2001).

Another concern in aquaculture management is integration of aquaculture into rural development and special area management plans with the promotion of aquaculture for poverty alleviation and people's livelihoods.

3.3 Management at the national level

At the national level, government policy, and institutional and human capacity are most important in providing a strong foundation for aquaculture to develop in sustainability (Michael Phillips, 2001).

It is widely recognized that most community and farm activities are influenced by national-level policy, legislation and institutional support. In addition the international level clearly has an impact on aquaculture development at a local level through trade and consumer preferences (Michael Phillips, 2001).

3.4 Small-scale farmer research

Promotion of sustainable development through small-scale integrated aquaculture is attractive to many projects and scientists. Most scientists focus on the technical aspects of aquaculture, resulting in the impression that the major constraint facing aquaculture development is a shortage of technical knowledge, overshadowing the developmental and educational constraints (Edwards, 1998). The most important constraint to aquaculture development is dissemination of existing knowledge.

The small-scale operator often lacks the ability to take on responsibility in productions because of a poor economic situation and/or lack of technical knowledge. Small operators therefore tend to focus on short-term survival of their own operation at the expense of the environment (World Bank, 1998). Smaller and poorer farmers generally choose sites on the basis of available rather than suitability. Therefore, good planning is required to prevent development in unsuitable areas and/or to facilitate development in suitable areas. The limited capacity of developing-country institutions in education, research and development compounds this fundamental failing (Edwards, 1998).

The role of institutions in promoting the development of aquaculture, alongside the resource-base of the farm and the farmers' perceptions of their needs, can also be analysed when reviewing management.

Pillay (1997) lists a number of factors required to ensure long-term for sustainable aquaculture development:

• Adequate planning of farming enterprises and responsible siting of farms

• Sufficient involvement of local communities

• Effective environmental impacts

• Effective design of farms, including irrigation and drainage systems

• The pursuit of increased yields over time, rather than the largest possible returns in the short term

• Adoption of appropriate technologies for production and waste disposal

• Measured use of chemicals and therapeutic agents (only when and in the amounts actually needed) (Pillay, 1997).

3.5 Codes of Practice

The technical methods, management systems and practices needed for minimizing impacts are being increasingly incorporated into the more formal "Codes of Practice", notably in more commercially oriented and salmon and intensive shrimp farming. Several aquaculture organizations, for example, the Irish Salmon Growers Associations, the Australian Prawn Producers, the Global Aquaculture Alliance Association, the Marine Shrimp Culture Association of Thailand, and others have taken the FAO Code of Conduct a step further and formulated Codes of Practice (COP). These COP contain principles for preventing or mitigating negative environmental and social impacts through the use of "best management practices" (BMP). They are currently for voluntary adoption and consist of documented guidelines available to farmers. Furthermore, the extent to which COP will be fully adopted by farmers under self-regulation and the environmental consequences of their adoption remain to be determined. Implementation is a very important issue, particularly for small-scale farmers.

Concerning shrimp production, there are several international organizations involved, for example: Food Agriculture Organization of the United Nations (FAO), Network of Aquaculture Centres in Asia-Pacific (NACA), United Nations Environment Programme (UNEP), World Bank (WB) and World Wildlife Fund (WWF). They deal with different aspects of shrimp farming such as: (i) Technical consultation on policies for sustainable shrimp culture, Bangkok 1998. (ii) Shrimp farming and the environment, World Bank 1998. (iii) Basic principles for management and development of aquaculture toward improving the responsibility of shrimp farming, Norway 2003. (iv) International principles for responsible shrimp farming, FAO/NACA/UNEP/WB/WWF 2006.

In Vietnam, government and Ministry of Fisheries co-operate with international organizations to build and implement principles for aquaculture. Examples include: the Euro Retailer Produce Working Group (EUREP) cooperating with the National Fisheries Quality Assurance and Veterinary Directorate (NAFIQAVED) to promulgate Viet-GAP in 2007 for Tra and Basa fish in Vietnam; in 2002 when the Food and Drug Administration (FDA) of United States co-operated with NAFIQAVED to promulgate Good Aquaculture Practices (GAP), and in 2004

when NACA/SUMA promulgated Better Management Practices (BMP) for shrimp farming implemented in Vietnam.

BMP for shrimp farming

Promoting responsible shrimp farming, the Government of Vietnam initiated several projects to translate the International Principles for Responsible Shrimp Farming into practices that targeted better production, product quality, and environmental and socio-economic sustainability. Assistance was given to the promotion of responsible shrimp farming at all levels and for all links in the production chain. Simple and practical BMPs were developed for brood-stock and seed quality, hatcheries, farmers, addressing particularly the needs of less resourced small-scale farmers.

BMPs can support producers to:
- Increase efficiency and productivity by reducing the risk of shrimp health problems
- Reduce or mitigate the impacts of farming on the environment
- Improve food safety and quality of the shrimp farm product
- Improve the social benefits from shrimp farming and its social acceptability and sustainability (NACA/SUMA, 2005).

There are differences between BMP and other extension messages commonly disseminated to shrimp farmers. Extension messages are often focused in ways to increase products and quality of the product. BMPs can help producers to farm shrimp in a more sustainable way developing also environmental and socio-economical.

BMP's generally refer to the better management practices. The term in BMPs can be used in several ways. It has been used to refer to the best-known way to undertake any activity at a given time. Practices were also used in regards to increasing the efficiency and productivity and/or reduce or mitigate impacts. Better practices are often required by government or others to encourage a minimally acceptable level of performance (and eliminate bad practices) with regard to a specific activity (NACA).

BMPs were undertaken under a cooperative project between NACA, SUMA and the Ministry of Fisheries, Vietnam. Experiences from this project were incorporated into NAFIQAVED efforts towards sustainable shrimp farming and now

contribute to the development of national standards for sustainable shrimp production. It is a process of relative improvement in efficiency, and it continues developing as the shrimp aquaculture industry develops.

GAP for shrimp farming

GAP was set up to require shrimp product safety for consumers. Fresh, hygienic, and clean shrimp production without therapeutic agents and chemicals must be emphasized according to GAP (NAFIQAVED, 2006).

According to GAP, shrimp farms must start from internal farm management such as appropriate area use, buildings and structure, water quality for shrimp culture and good conditions for product protection. In addition the internal farm management and culture plan is important to know the culture method, schedule crop, feed quantity, water transfer, capital cost and harvest plan.

The GAP certification procedure includes the ability to trace products, required by many of the import countries. It is now generally agreed that good management practices can make shrimp farming highly sustainable and that procedures and methodologies for sustainable shrimp farming have been practiced success in some countries. These might include: effective and holistic farm management practices, requirement for production of hatchery and disease resistant shrimp seed, domestication of brood stock, diversification, regulatory framework, community involvement, education and training, etc.

4. SHRIMP AQUACULTURE IN VIETNAM AND BENTRE

Vietnam has a great potential for developing aquaculture in inland water bodies, coastal brackish water and marine water areas. With a long coastline and large number of closed bays, lagoons, and estuaries, Vietnam has the potential for brackish water shrimp farming development. This fact, together with the attractions of high profits, high market demand for shrimp products, and supportive policies from the government, led to the rapid development of the shrimp farming sector and its establishment as an important economic sector that created employment, increased farmers' incomes, and earned foreign currency for the country. Shrimp farming in Vietnam, however, is facing a number of challenges that hinder the sustainable development of the sector. The negative environmental impacts from shrimp disease outbreaks, natural resource degradation, user conflicts, food safety problems, and tariff barriers are major concerns for the shrimp farming sector. To ensure the sustainability of the industry, careful consideration should be given to understanding these issues and addressing them appropriately. In this thesis, the relevant aspects of shrimp aquaculture development, including the socio-economic, technical, and environmental aspects as well as infrastructure, management, and policy issues of the sector are analyzed and discussed to understand their implications for the sustainable development of shrimp farming in the Bentre province.

4.1 The status of shrimp farming development in Vietnam

Most of shrimp culture area in Vietnam is concentrated in the Mekong delta, along estuaries and canals, in the central coastal regions, and in the Red River and Thai Binh rivers delta in the North.

Together with expanding the culture area, shrimp production increased dramatically from 1990s, especially after the year 2000 when Vietnam became one of the top five shrimp production countries in the world (Nhuong et al, 2006). Main shrimp species for cultures in Vietnam are Black tiger shrimp (*Penaeus Monodon*), Pacific white shrimp, White leg shrimp (*Penaeus Vannamei)*. Black tiger shrimp is the most important one, contributing the largest production.

During the past 8 years, Vietnam witnessed an outstanding, over four-fold, increase in fish production, going from 336,000 tons in 1999 to 1148,000 tons in 2006 (see figure 4.1), while figure 4.2 shows the over six-fold increase in culture shrimp production going from 57,500 tons in 1999 to 354,600 tons in 2006 (Dan, 2007).

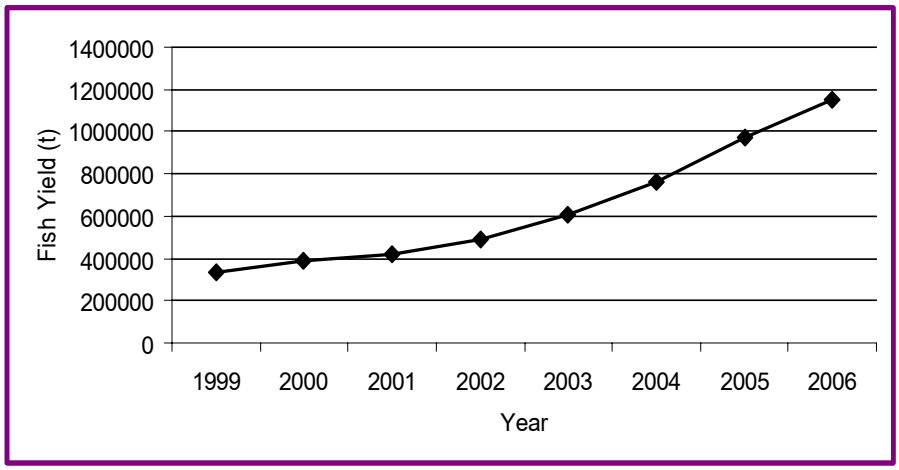


Figure 4.1: Total fish yield culture (1999-2006)

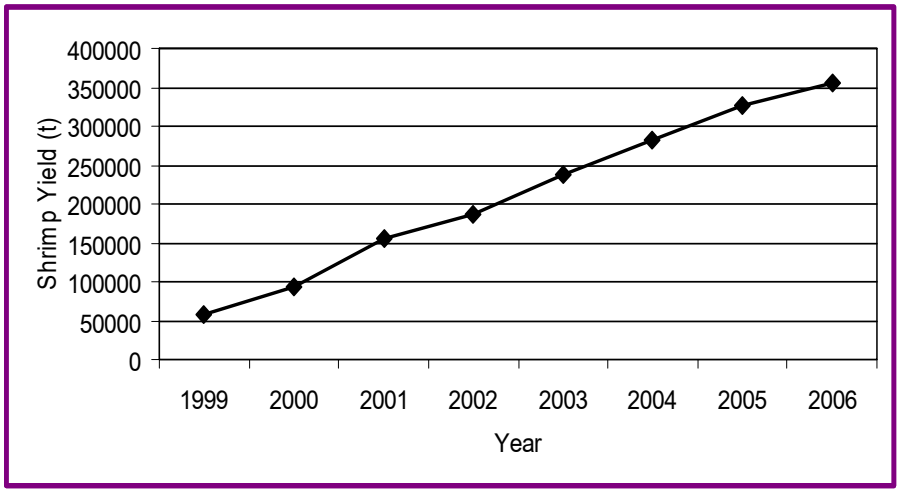


Figure 4.2: Total shrimp yield culture (1999-2006).

The Southern provinces (provinces in Mekong river delta) are the main contributors of shrimp products in Vietnam, responsible for 82 %, while the Red River delta is responsible for 3 %, and the remaining areas are responsible for 15 % (see figure 4.3) (Dan, 2007).

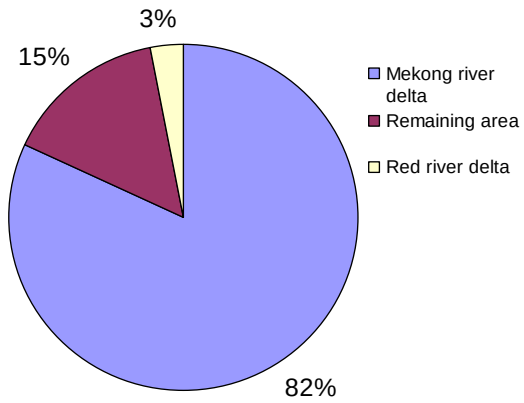


Figure 4.3: Shrimp production contribution (2006)

Under the impacts of Resolution 09/NQ-CP in year 2000, the land conversion to shrimp farming has been conducted all over the country, but most concentrated and expanded in the Mekong river delta, producing the largest shrimp volume in Vietnam. This movement led to a rapid increase in the shrimp farming area. According to MOFI's statistics, the area for shrimp culture increased from 250,000 ha in 2000 to 478,000 ha in 2001. By the end of 2005, there had been 604,480 ha of land used for shrimp culture (MOFI, 2006). This area included shrimp and rice farming in rotation and about 26,000 ha out of 136,000 ha of mangrove forest, which were used for shrimp culture as a combination of shrimp production and forestry. This has made Vietnam one of the countries with the largest area for shrimp culture in the world (Nhuong et al, 2006). The coastal provinces south of Vietnam are producing most of the shrimp using 87 % of the total area followed by 8 % in the Northern provinces and 5 % in central Vietnam (Thao, 2006) (see figure 4.4).

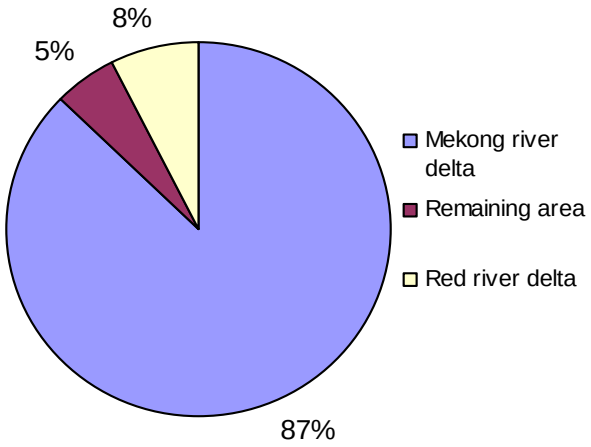


Figure 4.4: Shrimp area distribution (2005)

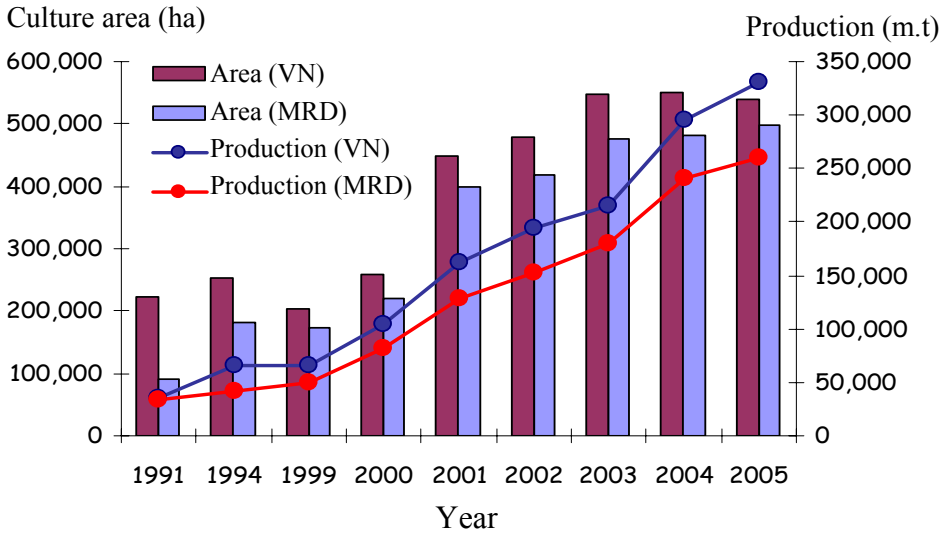


Figure 4.5: Culture area and production of shrimp farming in Vietnam and the Mekong river delta

Source: (Huynh Thi Tu, et al August 2007)

Improved extensive farming and semi-intensive farming are the most common cultivation methods. Aquaculture productivity based on extensive farming is on average 300 kg/ha and the productivity based on semi-intensive farming 1,500-2,000 kg/ha. At present the area used for intensive and semi-intensive farming accounts for 10 % of the aquaculture area. In some provinces, the productivity of intensive shrimp farming has reached 5-7 ton/ha/crop. In Northern Vietnam there is usually only one crop per year that can be harvested while in the South there are generally two crops per year. The enormous increase of the brackish-water aquaculture has some negative impacts, as the silting of the inland areas reach up to 10 km inland and in addition there is an important reduction of the mangrove area (FAO, 2005).

Shrimp aquaculture can be conducted by using shrimp monoculture or poly-culture with tilapia and seaweed. The increase of shrimp aquaculture production can be done through intensification and by opening new land for aquaculture. The development of shrimp aquaculture tends to be different from one area to another, depending on characteristic of environment, and the availability of production facilities. For example, it depends on the production facilities (shrimp fry, feed, fertilizer, medical remedies, machinery, oil and fuel); infrastructure (transportation, canal system); human resources; investment and financing.

4.1.1 Technical aspects

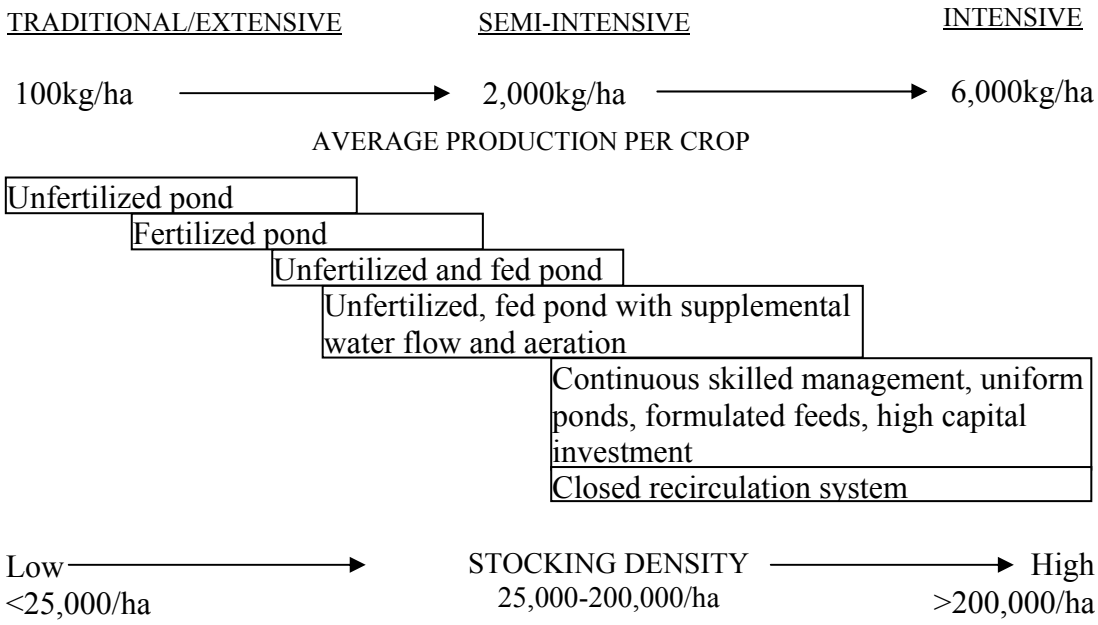
The technology for shrimp culture in Vietnam has been developed significantly over the last ten years towards more intensive farming. The traditional extensive farming areas with natural shrimp seed have been reduced and replaced with the improved extensive farming systems, which have been supplemented with the artificial seed and food. This system has become the dominant aquaculture form. The semi-intensive and intensive farming systems have been introduced. However, nowadays the expansion of those systems is considered carefully, regarding the environmental and natural resource impacts.

Artificial breeding techniques are available for production of Black tiger shrimps and Pacific white shrimps. The number of shrimp hatcheries has increased rapidly in the last ten years, from 2,086 farms, producing about 6.6 million of 15-day shrimp post larvae (PL15) in 1998 to 5,094 farms producing about 26 billion of PL15

by 2004 (MOFI, 2005). Those hatcheries, which supply seed for the entire country, are located mainly in the central part of Vietnam and is now being spread to the southern coastal areas. The production of shrimp seed in the North was weak and only met 14 % of the need of this region (MOFI, 2001); the rest had to be imported from the Central provinces or from Southern China. Currently, the Northern provinces are trying to produce shrimp seeds by themselves to meet the local demands in order to minimize the risks of spreading epidemic diseases as well as enhance efficiency (Nhuong et al, 2006).

4.1.2 Shrimp farming systems and intensity

Shrimp farming production systems in Vietnam are technically diverse. They are commonly classified as traditional, extensive, semi- intensive, intensive, and super-intensive. Various other designations such as “improved extensive”, “mangrove-shrimp culture” are also used. In practice, these terms are ill-defined, reflecting a broad and continually changing spectrum of systems that vary according to how intensively they use different resources (capital, labour, skills, land, water, seed, feed, fuel, and equipment).



Source: Clay 1996

Figure 4.6: Continuum of different shrimp farm production systems

Traditional/ extensive systems

Traditional/extensive shrimp farming is still conducted in many parts of Vietnam, often in conjunction with crab and fish. Pond size ranges from a few hectacres to hundres hectacres. When local waters are known have high densities of shrimp seed, the farmer opens the gates, keeps the wild shrimp, and then grows them until they reach market size. The shrimp along with crabs and fish feed mainly on natural food in the pond, where natural food also arrives each time the water is changed. Stocking density depends on the abundance of wild seed. Production is commonly from continuous harvest or semi-continuous harvesting. The farmers may also use limited fertilization and supplementary feeding. The tides provide water exchange, dependent on the height of the intertidal zone tidal regime. Construction and operating cost are low. Cast-nets and bamboo traps are used to produce the harvests (VIFEP, 2002) and (Thuy, 2004)

Ponds may be used for rice production during the wet season, and for shrimp production in the dry season. Such alternating use of the ponds has certain advantages,

increasing the farmer's sufficiency and overall production. In addition, poly-culture reduces the financial rick involved in shrimp farming. However, it is only feasible in very specific climatic and hydrological regimes.

Semi-intensive systems

Semi-intensive farming usually involves carefully laid-out pond, feeding and power of pumping. Due to high density, there is more competition for the natural feed in the pond, so the farmers augment production with shrimp feed (commercially formulated compound feed, trash fish, or locally collected molluscs). Juveniles are sometime stocked at high densities in nursery ponds until they are large enough to be stocked at lower densities in grow-out ponds. The farmer harvests by draining the pond through a net or by using a harvest pump. Farmers usually renovate their ponds once a year (Ha Xuan Thong, 2003).

Intensive system

Intensive shrimp farming usually involves small ponds, high stocking density, careful management, intensive feeding, waste removal, and mechanical aeration. Water exchange rates for such systems used to be very high, but in recent years (stimulated mainly by the fear of introducing diseases through the water supply) many farmers have begun to use low water exchange systems. In some cases, water may be recycled through a storage reservoir, allowing for the development of completely closed water systems, so that water is required only to make up for water lost to seepage and evaporation.

4.1.3 Social-economic aspects

According to the MOFI's statistics, shrimp farming is more profitable than normal agriculture production forms such as rice and salt production in the coastal areas. In Kiengiang province in the South, the profits gained per one hectare of shrimp culture is estimated to from three to eleven times higher than rice production cultivated in the same coastal land. This shrimp profit is from five to six times higher than rice production in Thaibinh province in the North (MOFI, 2006). However, shrimp pond farming also requires higher investment in comparison with the other mentioned production forms. This is a barrier for the poor or medium sized farmers to enter the

shrimp farming industry without the credit supports from the bank or government. For example, in the Camau province, the improved extensive shrimp farming system requires the production cost of VND 23 millions per hectare, equivalent to US$ 1,533/hectare, which is considered to be a fortune for the poor or medium sized farmers. However, this system produces the average profit from VND 25 to 30 million per hectare, equivalent to US$ 1,666 to 1,999/hectare, nine times higher than rice culture. Similarly with the intensive shrimp farming, this system produced the profit from VND 70 to 110 million/hectare, equivalent to US$ 4,375 to 6,875/hectare (MOFI, 2006).

As there are high capital requirements for entering the shrimp farming industry in Vietnam, the majority of shrimp investors are people who have the ability to access credit from the bank or other capital sources. According to Nhuong and et al. (2006), there are about one million fishermen who used to earn their living by inshore fishing, who have gradually shifted to shrimp or other kinds of aquaculture, due to the reduced fisheries resources and inefficient exploitation. In addition, a number of people who used to earn their living by agricultural farming or low-productivity salt production have turned their interests into shrimp farming. There are also some private companies and cooperatives investing in shrimp farming. Poor farmers may benefit indirectly from shrimp industry through the employment opportunities that this sector creates for the local community, such as the part-time jobs during the production cycle or the seed and feed supply service.

4.1.4 Markets

The marketing of shrimp and other fisheries products in Vietnam is complex. There are various product forms, marketing channels and markets. Shrimp products may be marketed live by farmers or sold to middlemen who sell products in retail markets or assemble and sell to processing plants for export. Shrimp products are exported mainly in frozen form and accounts for about 50 % to the total export value. In 2003, the total fisheries export value was US$ 2.2 billion, shrimp contributed US$ 1.14 billion (52 %) (World Bank, 2004). In 2005, export values reached US$ 2.65 billion and the aquaculture sector (including shrimp farming) contributed US$ 1.63 billion (MOFI, 2006).

Important export markets of Vietnam's shrimp are Japan, America and the European Union. Before 2001, Japan was the number-one market for Vietnamese fisheries export but lately, this market has lost its first position to the American market. Fisheries exports to America climbed up dramatically after the signing of Vietnam-US Bilateral Trade Agreement. Vietnam's frozen shrimp export to America is ranked 2nd behind Thailand (Nhuong et al, 2006). However, the US shrimp anti-dumping tariffs imposed for China and five other countries in addition to Vietnam have reduced the volume of exported frozen shrimp products. At the end of 2004, the Department of Commerce (DOC) imposed extra tariffs of 4.13 % - 25.76 % upon the Vietnam frozen shrimp exported to the American markets (VnExpress, 2004). The impact of this would be significant in the short-term, but many exporters look on shrimp as a commodity, and expect the markets to even out such pricing issues quite quickly (World Bank, 2004). However, according to the WB (2004) the shrimp farming sector in Vietnam is being influenced by several macro-level market-related trends, such as increasingly stringent food safety and quality standards, certification and traceability, importing country awareness of social and environmental issues in shrimp farming, vertical integration in the shrimp industry to control costs and risks and trends towards lower farm gate prices. All those issues need to be addressed and responded to in a proper manner in order to ensure the sustainable marketing of shrimp products.

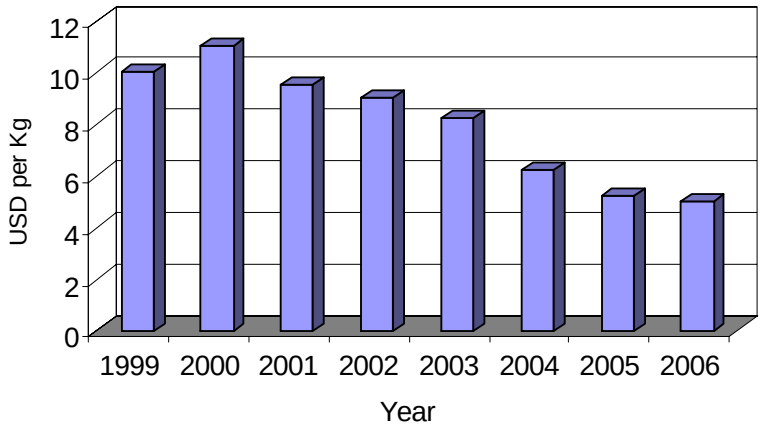


Figure 4.7: Farm gate price offered to shrimp farmers

In addition to the goal of export, cultured shrimps are also consumed in domestic markets, mainly in big cities like Hanoi, Hochiminh, Haiphong, Danang, Hue...etc., but in small volumes. The majority of shrimp products in the domestic market are fresh and boiled shrimp (Nhuong et al, 2006).

Although shrimp price showed a steadily decreasing trend (see figure 4.7), shrimp farming continues to be attractive to local farmers, investors and the local government because of its high profit, and the high market demand (Nhuong et al, 2006).

4.1.5 Disease and environmental issues

Shrimp aquaculture farmers in Vietnam have experienced serious disease outbreaks, which were concluded to be related to environmental factors (Nhuong et al, 2006). More intensity in shrimp farming development always goes together with using higher amount of shrimp feed, drugs, and other products. This creates serious problems when redundant shrimp feed and wastes that have not been treated are thrown directly into the environment, polluting rivers and coastal inhabitations and reducing biodiversity. In addition, the risk of disease contamination is always threatening the economic efficiency of the production. In the years of 1994-1995, the epidemic spread rapidly in the southern provinces, influencing 84,858 hectacres of shrimp area and causing a loss of VND 249 billion, or equivalent of 15.66 million US$ (MOFI 1999). In 2001 and 2002, the shrimp diseases continued to threaten and cause great damages to farmers in the Mekong delta. Therefore, diseases and environmental pollution are the main threats to the success and sustainability of the shrimp industry in Vietmam. Limitations to the expansion of shrimp culture areas include:

Picture 4.1: Unplanned shrimp ponds
Source: (Dan, 2007)

- Unplanned development and poor design of pond systems in shrimp culture areas. Some areas for growing shrimp in Vietnam are being developed without planning, and pond and irrigation systems within the culture areas are not being designed in accordance with technical standards. In these cases, the aquaculture area has only one water channel for both water supply and discharge. Thus, wastewater from

one pond may be taken into another pond nearby, and disease pathogens may become epidemic within a region (Cao Le Quyen, 2006).

- Excessive use of chemicals and pharmaceuticals in shrimp ponds. Regulation and management of the chemical and pharmaceutical industry for aquaculture in general, and for shrimp, in particular, is inadequate in many areas. Some poor quality chemicals and medicines as well as those supported by false claims are still marketed to and used by farmers. In some aquaculture areas, farmers apply chemicals and pharmaceuticals to their ponds in excessive amounts (Cao Le Quyen, 2006).
- Organic wastes that accumulate at the bottom of shrimp ponds also create problems for cultured species, especially when they decompose under anaerobic conditions in bottom sediments (Cao Le Quyen, 2006).

This challenges beg the question: What are the solutions to address the environment issues emerging from shrimp farming? In the year of 2002, where shrimp disease was the most severe and causing big losses for farmers, MOFI issued the Environment Management Regulations for concentrated shrimp farming zones (released with the Decision no. 04/2002/QD-BTS by the Minister of the MOFI) in order to solve the problem of shrimp disease outbreaks. This regulation has been applied for the concentrated shrimp-farming zone with an area of over 30 ha and intensive or semi-intensive technologies. It covered a range of environmental issues in shrimp farming areas from site selection, water source use, infrastructure items required, sedimentation and treatment ponds for grow-out ponds, shrimp seed quality, disease prevention and contamination avoidance, chemical and medicine use and waste water discharge.

4.1.6 Food supply

The pellet food market for shrimp in Vietnam is strongly competitive among the many private companies from China and Taiwan, Thailand, the United States, and Vietnam. All of these companies supply both the pellet shrimp diets for aquaculture and feed for the cattle and poultry industries. Nevertheless, the price of shrimp feed is still high, and this has a direct impact on production costs and returns and the financial sustainability of the shrimp farming industry.

4.1.7 Infrastructure

The physical infrastructure for shrimp pond culture includes irrigation systems, electricity, roads, etc. Irrigation is the most important factor affecting the success of the crop. Irrigation systems in shrimp culture areas, however, are still poorly developed throughout the country. Almost all of the areas used for shrimp aquaculture use existing forms of irrigation intended for agriculture; therefore, they do not meet the technical requirements of most aquaculture systems. Infrastructure development for shrimp and other kinds of aquaculture is still open for investment and is encouraged by MOFI and the Government. The credit program for physical infrastructure investment in aquaculture follows the instructions of the Decision No. 132/2001/QD-TTg, on infrastructure investment for rural handicraft villages, rural transportation and aquaculture infrastructure. Under this program, few investment projects have been implemented to build up irrigation systems for shrimp industrial zones. However, there are still some conflicts in water supply and discharge between agriculture and aquaculture systems. The conflicts are rising as the water shortage become more severe in many agriculture areas (during the dry season) and threaten the sustainability of the coastal shrimp farming systems.

4.2 Aquaculture in the Bentre province

The Bentre province is located at the end of the Mekong River basin, enjoying many advantages for aquaculture development, such as a wide natural area of 231,351 ha, a 65 km long coast line with four crossing rivers of Cochien, Hamluong, Balai and Tien, and dense canals.

There are favourable natural conditions in all three zones of environment (fresh water, salt- and brackish-water). Fishing and aquaculture in Bentre have expanded significantly and accounted for 21.5 % of the GDP in 2005.

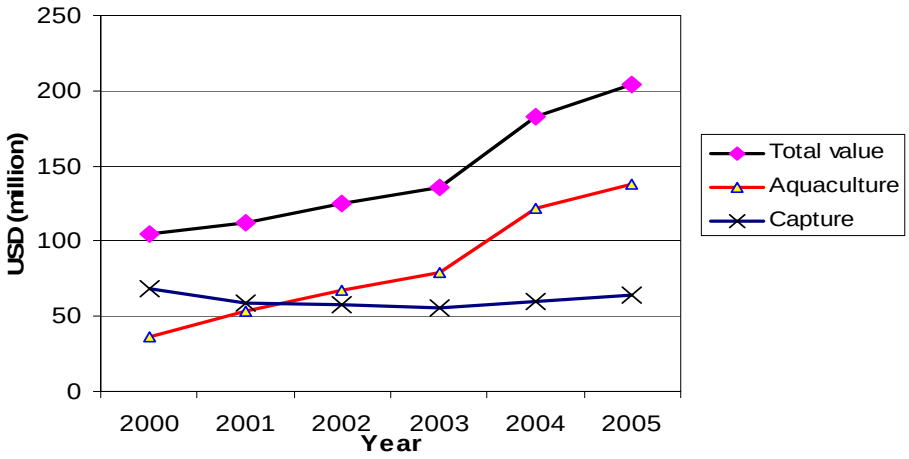


Figure 4.8: Gross output of fishery in Bentre

The gross production value of the fishery in 1999 accounted for 16.9 % of the GDP. Its average growth rates were estimated at 5.5 % annually between 1990 and 1995, and this shot up to more than the double during 1996 and 2000, at 11.6 % per year. In 2000, the fishery produced a gross value of US$ 104.5 million to reach US$ 204 million in 2005 (see figure 4.8), standing second in contribution to the GDP of the province (Statiscal Office, 2005).

Fishery activities have been encouraged to develop toward offshore fishing as one of the many measures taken by the province's government to boost the industry's output. In 2002, for example, the total number of fishing boats was reduced by more than 14 % compared to 2001, down from 1,959 boats to 1,670 boats, whereas the number of offshore fishing boats increased by 11.5 %, from 459 to 528 boats. Similarly, the total product increased 6.6% and total boat's power pushed up 11.1%.

In aquaculture, the total area of water surface (or cultured ponds) has been rapidly extended, from 12,470 ha in 1990 to 33,028 ha in 2000. In 2002, the figure was 34,392 ha, up 6.6 % compared to 2001. The same year, production volume increased by 50 % compared to 2001, in which shrimp increased by 23.9 % and clam

Picture 4.2: Convert rice farm to shrimp farm in Bentre **(***Photo by: Khang)*

increased by 63 %. Exceptionally, the shrimp breeding business during the same time increase by 116.5 %. Shrimp farming in rice fields in the seawater intrusion zone has recently received government permission to expand in the Mekong Delta through a new decree, Decision 09/NQ-CP, issued on 15th June 2000. In the same year, the rice-shrimp farming areas were rapidly increased in Bentre. The shrimp component of this system appears to be lucrative while the rice component faces a lot of problems. Therefore, there is a tendency to shift the system into mainly shrimp farming. This may lead to an unsafe development due to the high-risk connected with shrimp culture and reduction of system diversity. Proper planning for the expansion and development of sustainable farming systems is thus a critical requirement (Do Quang Tien Vuong, 2001).

Potentials and advantages for aquaculture development especially tiger prawn farming are available in Bentre. Besides the tidal flats, canals and integrated aquaculture with agriculture and forestry cultivation areas, the province consists of over 50,000 ha of aquaculture with a concentration on shrimp farming in the coastal districts of Binhdai, Thanhphu and Batri.

In 2005 the area of shrimp farming was 32,253 ha, holding 5.23 % of the total area used for shrimp farming in Vietnam, contributing a value of US$ 134 millions or 5.34 % of the total value of aquaculture products in Vietnam (Thao, 2006). The total area of aquaculture in Bentre in 2006 was 40,829 ha, (down 4.5 % compared with 2005), and there are 31,419 ha for shrimp culture. Total shrimp products were 20,160 tonnes, a decrease of 19.4 % compared to 2005 (see in figure 4.9) (DoFi Bentre 2006).

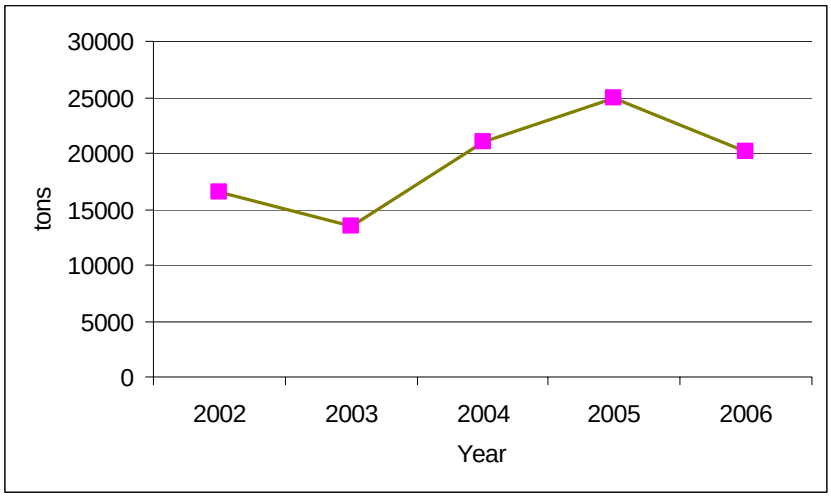


Figure 4.9: Bentre province raised shrimp volume

Despite many years of development based on favour natural conditions for aquaculture, shrimp farming in Bentre has recently become the economic spearhead. There is a continuous increase of farmed shrimp area and volume.

Shrimp breeding contributes not only an important part of the provincial GDP and economic growth rate but also creates employment, settlement and income generation for thousands of labours, and reduces rural employment pressure. In many coastal rural areas of Bentre, the model is of much interest thanks to its economic effectiveness. Through shrimp breeding, many households escaped from poverty. In Bentre in 2003, 15,186 workers were involved in shrimp farming and 17,480 people in 2005. Moreover, hundreds of others are service suppliers of feed, breed and other materials or hired by shrimp pond owners. Shrimp feeding related workers are mainly located in the coastal districts of the province, such as Binhdai, Batri and Thanhphu district (CDI, 2006).

Management and applied technology

Shrimp in Bentre is characterized by small enterprises and local ownership. The small-scale shrimp farmers have limited capital to develop the business, simple facilities and low level of management. Generally speaking, small-scale and medium scale shrimp farmers use traditional (extensive) and semi-intensive technology. Larger scale or industrial farmers have high-tech facilities in the controlled management, and use intensive technology with high stock density of shrimp fry, resulting in high productivity. There are only a few private businesses operating large scale shrimp farming, and generally they are integrated shrimp farming industries. To manage environmental problems and diseases in the shrimp farming region, Bentre government and DoFi Bentre promulgated Decision 4024/2002/QD-UB in 2002 to set up the management board for each concentration of producers in the shrimp region. This management board is responsible for solving problems and reporting about the situation to higher levels (local authority or DOFI), while distributing information from the higher level to the farmers. The members of the management board are farmers who have good knowledge and experience in shrimp culture and credibility.

In June of 2007, DoFI Bentre and VIFEP worked together to survey and select pilot areas to set up a co-management model in shrimp aquaculture.

The technology of shrimp aquaculture varies from location to location, depending on the level of technology applied. In general shrimp farmers in Bentre apply the different technologies of shrimp aquaculture, that is, traditional/extensive, semi-intensive and intensive. The technologies depend on the size of cultivation area, the volume of fertilization used, the aeration system, the feeding mechanism and the level of stoking density and management system such as management of water exchange, monitoring biomass and water quality, environment warning and disease monitoring.

Traditional/extensive shrimp farming uses little or no fertilization and supplementary feeding, with the low production cost. Traditional/extensive shrimp farmer use fertilizer to grow plankton as source of shrimp feed, and sometimes they use supplementary feeds. Stock density depends on the abundance of wild seed, sometimes they can stock more with artificial seed when shrimp density is too low. Normally, density is lower than 5 shrimps/m^2.

Semi-intensive farming more regularly uses inputs with higher densities, between 10-25 shrimps/m^2. In production they use commercially formulated compound feed, trash fish, or locally-collected molluscs. To add water, farmers salvage tidal water or use pumping.

Intensive shrimp farming implies high stocking density (30-60 shrimps/m^2). In intensive farming they have to manage closely and use intensive feeding, pellet-feed and aeration. Generally, they use medical treatment during the culture cycle, and costs are high (US$ 2.5-4 /kg live shrimp), with the high variable cost mainly for feed and water quality maintenance. The most effective ponds use the intensive technology with small area, and the high density and production can be up to 9 ton/ha (Nga, 2006).

Shrimp species in Bentre

Shrimp species in Bentre that are cultivated are still limited compared with other value shrimp species that have been cultivated in some countries included others parts in Vietnam. Black tiger shrimp is the main species in brackish water culture in the

Mekong river delta and in Bentre, while leg shrimp is not a native species from Vietnam (White leg shrimp is still not allowed for culture in the Mekong river delta). The government introduced this species in 2001. This species can be cultured in the north and central provinces of Vietnam.

Market channel

Normally, shrimp products are sold to local agents and local markets. Local agents have been playing the role as suppliers of shrimp to processing plants, market and larger collectors. The role of the trader is not only as a buyer, but also as financer, and market interaction are not based solely on supply and demand, but rather on individual links that can be seen as exploitative or symbiotic depending on one's perspective. One of the consequences is that there is no transparent pricing mechanism. The exporters and the traders determine the price, while the shrimp farmers only have a little margin and low profit (Charles, 2001) and (DoFi Bentre, 2007a).

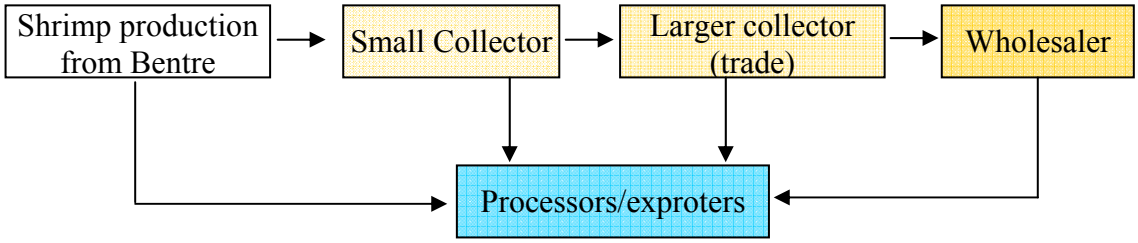


Figure 4.10: Shrimp market channel in Bentre

Production model

In 1999, a co-operative in shrimp aquaculture was set up, and the number of cooperatives increased to 163 in 2004. However in 2005, 25 cooperatives were dissolved due to losses, and of the remaining 138, 53 co-operatives were unprofitable. In production, the co-operatives have many limitations in their organizational structure and management.

In 2006, a new model was established, called Sustainable Shrimp Production Union. There are various members (supplier, farmer, seafood plant, bank and DOFI) involved in this union. Currently, this model has not started.

5. CHALLENGES IN SHRIMP PRODUCTION IN BENTRE PROVINCE

5.1 Shrimp farming system

5.1.1 Seed produce and hatcheries

Most shrimp farmers still rely on wild shrimp for the production of seed. They either capture wild juveniles that are stocked directly in grown-out ponds (extensive shrimp farming), or they spawn wild females in a hatchery. In Bentre most brood-stock of the black tiger shrimp are caught in the wild by offshore trawlers specially equipped to hold live shrimp. These are then transported to hatcheries, where they are held and conditioned using high-quality feeds. Some brood-stocks are now sourced from extensive ponds.

Most hatcheries in Bentre are small-scale hatcheries, and they are usually operated by a family group. Their chief advantages are low construction and operating costs and their ability to open and close quickly in response to the seasonal demand for seed and the supply of brood-stock. They work with small tanks, and usually concentrate on just one phase of production, such as nauplii or post-larvae. Disease and water quality problems often wipe out production, but it is a relatively simple matter to disinfect and restart operations. Survival rates of the developing larvae in small-scale hatcheries ranges from nearly 0% all the way to 90 %, depending on a wide range of variables, such as water quality, stocking densities, temperature, and the experience of the hatchery operator.

The quantity and quality of the seed product still is one of weaknesses in shrimp production in Bentre. Almost all shrimp seeds are imported from central provinces while local hatcheries provide only about 10 % of the seed required (DoFi Bentre, 2007b). This is a constraint for management. Seed quality is a big challenge for shrimp production not only in Bentre but also in Vietnam in general.

The number of hatcheries increases every year. In 2002 Bentre had 5 hatcheries while in 2006 there were 55 hatcheries. High demand for shrimp seed encouraged individuals and organizations to develop shrimp seed, but the shrimp seed

production encounters difficulties such as water quality and salinity (Sy, 2007), which affect the seed quality, and hence productivity.

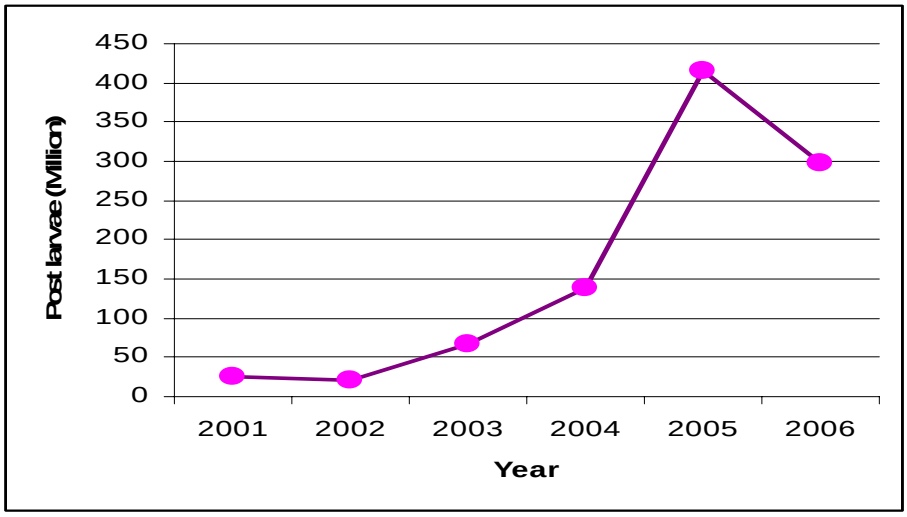


Figure 5.1: Shrimp post larvae product in Bentre

Figure 5.1 shows the production of shrimp seed. The interviews with the aquaculture farmers show that 85% considered the seed quality as normal while 15 % considered it as bad, and no one agreed that the seed quality was good.

Seed testing is one major step before seeds are stocked. Seed will be tested when local hatcheries sell seed or seed import from other provinces. Test results are normally lower than planned, for example in 2005 only 70 % of the seed was tested even though the plan called for 100 % of seeds to be tested (DoFi Bentre, 2005a).

5.1.2 Models of shrimp farms and scale

Most areas for shrimp production in Bentre are based on an extensive or alternative model, and the trend to higher intensity is shown in figure 5.2. The extensive shrimp area is reduced over time: in 2000 extensive shrimp farms held 28,199 ha (99 % of the shrimp farm area), while in 2006 this area was 25,960 ha (83.3 %). Semi-intensive and intensive areas, on the other hand, increased from 244 ha in 2000 to 6,466 ha in 2005.

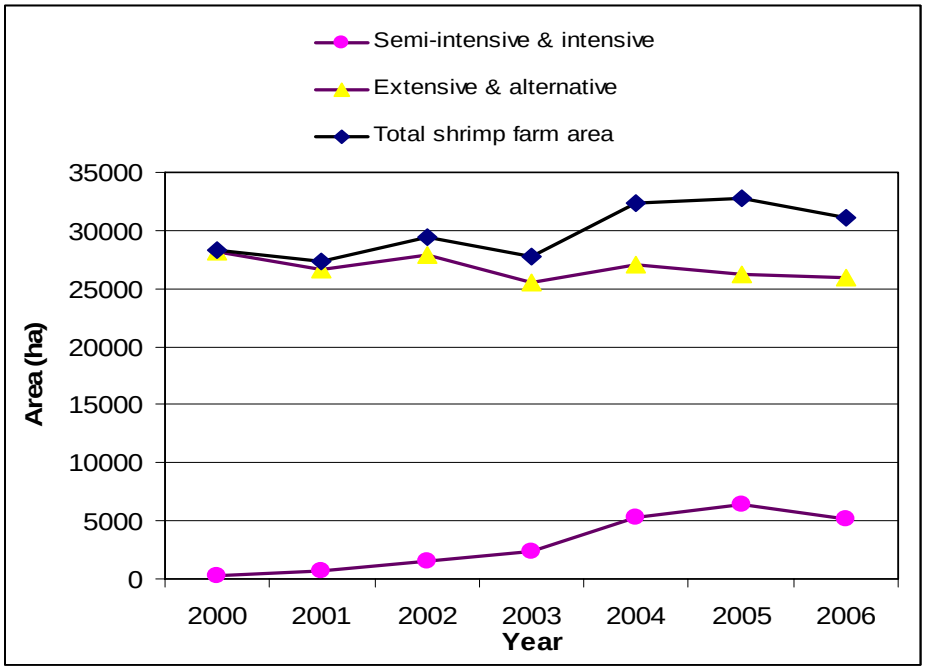


Figure 5.2: Models of shrimp farms distributed by area

The Resolution 09/NQ-CP of the Government allows farmers to convert low productive rice fields, uncultivated areas, and salt pans into ponds for aquaculture. The area for shrimp culture increased as most of them are based on the semi-intensive shrimp model. However, for the year 2006 the area for shrimp farming decreased to 5,189 ha in both models. The shrimp farm areas decreased because of a shrimp disease in 2005, during which the owners lost their crop and did not have the ability to operate a new crop. Others did not have water systems appropriate for shrimp culture when they converted from one form to another (DoFi Bentre, 2007b). The question is: how large an area is critical for sustainable shrimp industry development in the Bentre Province?

Shrimp farms vary enormously in scale, in terms of both area used and production. Small farms in Bentre have an area of half a hectare or less, most of these were converted from other forms. Of the 87 farm owners who were interviewed 76 % had a farm area less than half a hectare. Small-scale operations are characterized by low investments and exchanges with other operators.

Smaller and poorer farmers generally choose sites on the basis of availability rather than suitability. Therefore there is a need to restrain development in unsuitable

areas and/or to facilitate development in suitable areas. For instance, when farms were sited in what was previous mangrove, soil acidity was reported as a significant problem (Pornlerd chanratchakool, 2004). Small-scale operations vary in terms of shrimp culture methods, diseases, and how they treat the environment. There is a high risk if one farm unsuccessfully treats a disease, as it will contaminate a number of contiguous small farms. The cumulative impact of a large number of contiguous farms in close proximity can be environmentally damaging; therefore, it is important to take into account the density of development, especially in relation to the carrying capacity. The danger involved in such operations is that the small-scale operator often lacks the ability to take on the responsibility for following regulations or the technical standards because of a poor economic situation or lack of knowledge or both. The result of interviews shows that 18.4 % do not completely follow regulations and technical standard, explaining that following all the steps of technology standards and regulations is over their capacity or that following all steps is complex or both.

Normally, small operators tend to focus on short-term survival of their own operations at the expense of the environment, even when they understand that they are facing a serious problem. Thus, such operations tend to be detrimental to the environment, and particularly to the sustainability of shrimp farming.

5.2 Environmental issues

The rapid development of Bentre's shrimp farming has already been causing imperative environment problems in the short-term and long-term such as the degradation of mangrove forests, ecological imbalances, threats of environmental pollution and the spread of epidemic diseases.

5.2.1 Destruction of natural habitat and reduction of mangrove forests

Extensive shrimp farming takes place in the intertidal zone, commonly in or contiguous to estuarine systems. Semi-intensive and intensive shrimp farming usually takes place in the upper intertidal zone or just behind or above the intertidal zone, often in adjacent wetlands. Some shrimp farming now takes place in inland areas. Most tropical estuarine systems are dominated by mangrove, an intertidal ecosystem

of tree and shrub species specially adapted to saline habitats that supports a wide range of other organisms.

The estuarine provides offshore fisheries, including shrimp, fishes and crab. These areas assimilate and use organic matter, turning some of it into sediments. The mangrove probably enhances these functions and in addition produces a range of wood and other forest products, protects the shoreline against flooding and inundation in storms, increases sedimentation and accretion, and reduces erosion. When shrimp ponds are built in this area, these functions will be lost

Mangroves are under high pressure from a suite of development activities, including overexploitation for firewood and charcoal production, conversion to agriculture, salt farming, and coastal aquaculture. The relative contribution of these different activities to mangrove destruction varies widely according to purpose and there is no doubt that shrimp farming has been a significant cause of destruction.

One of the most serious environmental problems is the pressure of expanding shrimp farming on the coastal environmental resources, particularly the mangrove forests. The majority of the coastal farming area after 2000 resulted from transferring low productivity rice fields, while a minority of them originated from mangrove forest. Thus, the destruction of mangrove forest for shrimp ponds in Bentre took place in the 1990s. After 2000, the deforestation slowed down because the Government took strict management measures and the people also acknowledged that the zones of sediment in mangrove forests were not suitable for developing shrimp farming (Nhuong et al, 2006). Although mangroves are now widely recognized as being unsuitable for shrimp aquaculture development, primary or secondary mangrove forests are still converted to shrimp ponds. The disadvantages of mangrove forest destruction have been clearly shown, such as the reduction of biodiversity, coastal erosion, salinization of agricultural land, all threatening the sustainable development of shrimp farming.

In addition, coastal resources, and in particular mangrove and estuarine systems, have been under intense pressure from increased population and development demands for many years. Significant areas have also been converted to shrimp farms. It is precisely because these resources are often on public-access property that settlers have been able to do this.

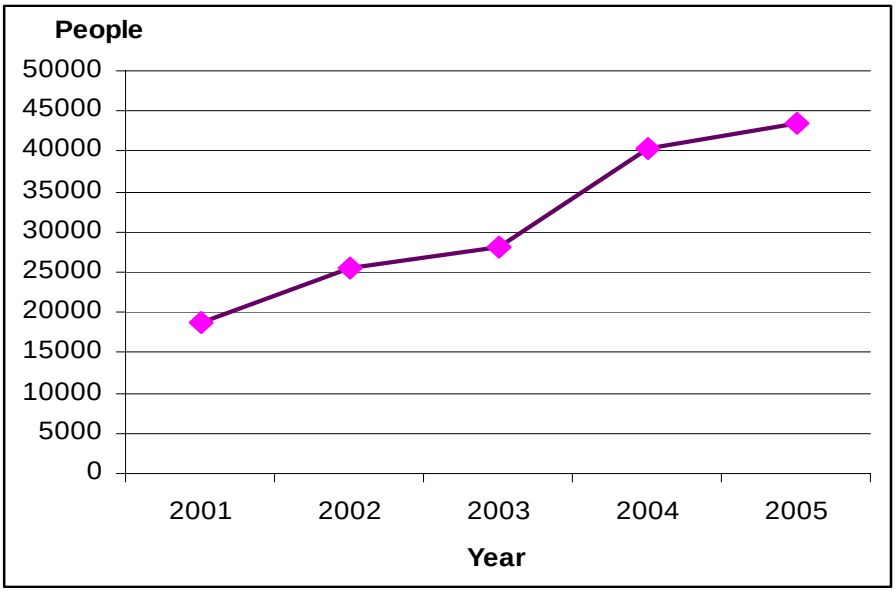


Figure 5.3 Labour force working in fisheries in Bentre

Figure 5.3 shows the rapid increase of labour working in the fisheries. In 2001 18,632 labourers worked in fisheries, while the numbers increased to 43,570 in 2005, most of them participate in shrimp farming (Statistical Office, 2005). The destruction of mangrove forest are not only due to shrimp farming, it also includes the cutting of trees for wood, fuel and other products, agriculture, and salt farms. These have led to significant degradation of the mangrove and estuarine resources in Bentre. Thus, protecting the mangrove forest for sustainable shrimp culture is important. Simply controlling shrimp farm development will not save the mangroves. A much broader policy, planning, and regulatory framework will be required to stem the degradation of coastal resources.

5.2.2 Using fresh water in shrimp farming

Water use in shrimp farming is extremely variable, ranging from little more than make up water to compensate for evaporation and seepage to very high rates of exchange. For the semi-intensive and extensive shrimp farm models, fresh water is normally used to mix with seawater in order to make up for evaporation in ponds and produce the optimum salinity, especially in the dry season in Bentre.

Many farmers said that they lack fresh water in the dry season, especially in farms converted from rice fields or salt fields. The freshwater source depends on irrigation of agriculture. The result of the survey shows that 80.5 % (70 farm owners) lack freshwater in the dry season, and some of them pump freshwater from groundwater. Using freshwater from groundwater allows saltwater intrusion into groundwater reservoirs and the loss of water supplies for agriculture and domestic purposes.

Expanding the shrimp farms into interior fields runs the risk of damaging agriculture and hence reduces food security. Seepage through pond bottoms, discharge of pond water into freshwater areas, and seepage of salt from sediment disposal sites can salinize freshwater reservoirs, canals, and adjacent rice field. For example, in the Camau province (one of provinces in Mekong river delta), there are many shrimp farms converted from rice fields. After several shrimp crops, the shrimp farms start to be polluted, diseases occurred frequently, and the owners lose the harvest. They prefer to reconvert the areas to rice farms, but are usually unsuccessful.

The severity and significance of the salt's impact to others is also recognized. Shrimp farming may represent the best economic option at present in Bentre. However, for a long-term shrimp production the potential social, environmental, and land-capability impacts must be thoroughly researched and assessed, and adequately planned for, if implementation is to be sustainable.

5.2.3 Organic matter and nutrient pollution

Together with the degradation of mangroves forest, negative impacts to fresh water and agriculture and signals of environmental pollution appeared in many zones of shrimp farming. The development of intensive farming always goes together with farmers using more and more shrimp feed, drugs, products and chemicals. Redundant shrimp feed and wastes without being treated are thrown directly into the environment, polluting rivers and coastal inhabitations, destroying ecologies, and reducing the biodiversity. The risk of spreading epidemic diseases, which damages farmers economically, is significant along with the degradation of water quality and the environment.

The water in shrimp ponds is high in nutrients and organic matter, especially towards the end of the production cycle. These nutrients are derived mainly from waste food and metabolic products and poor feeding practices, especially the over-use of feed. This pollutes the ponds and significantly increases the cost of operation. When pond water containing high concentrations of nutrients and organic matter from a large number of shrimp farms is discharged, the effects can be negative. These impacts may be detrimental to the farm itself, to neighbouring farms, and to the wider environment. Even the training content and other extension materials show the necessity of a reservoir and sediment pond in shrimp farm systems, especially for semi-intensive and intensive models (a sediment pond is used to treat waste water before being drained to outside shrimp farm systems). However, the result of the survey shows that there are 13.8 % who do not have reservoirs and none of the respondents (100%) have a sediment pond. According to Sy (2007), there are only large-scale or private companies with intensive shrimp farm models that have sediment ponds.

The significance of the impact of organic matter and nutrients from shrimp culture depends on management practices. Good management practices can radically reduce the export of nutrients to the environment. Where farms are well dispersed, or the carrying capacity is high, effects are likely to be minimal. All of the farmers who were interviewed (100%) recognized that the water quality worsened every year, and this affects directly the shrimp products.

The quantity of waste nutrients and organic matter produced in a shrimp farming system is directly related to the feed conversion efficiency, and this in turn depends on feed quality and feeding practice. High-quality feed, and feeding the right amounts at the right time, can reduce nutrients and organic matter wastes, while at the same time it also reduce costs. Shrimp in brackish water systems are fed pellet diets supplied by various fish food processing companies. In Vietnam, it is a strongly competitive feed market, with the main pellet-feed imports coming from China, Thailand, India, and some other countries, as well as feed companies in Vietnam. There are many different trademarks and varying qualities.

Poor water quality affects not only the shrimp in the concerned ponds but also those in neighbouring ponds, as well as other ponds relative to the water system. The

eruption and spread of diseases often occurs in connection with poor water quality and disastrous outbreaks can affect entire regions.

5.2.4 Using chemicals in shrimp culture

Shrimp farmers now use a wide range of chemicals and drugs in shrimp production and to facilitate harvesting and transportation.

The most commonly use of chemicals in shrimp culture is for disinfecting ponds, for pond soil disinfection, for pond water management and various antibiotics for disease treatment and prevention. In aquaculture, the use of chemicals and other drugs is common, and there are a great number of kinds, which are used in large volumes. According NAFIQAVED, as of May 2007 there were 190 products which contained chemicals or drugs allowed for use in aquaculture, and most of them were used in shrimp production. In addition there were 351 domestic products and 211 import products that were waiting to be authorized (NAFIQAVED, 2007). The use of some of these chemicals raises a variety of environmental concerns. Perhaps the greatest is the indiscriminate use of antibiotics to control or prevent disease outbreaks, and in particular the use of antibiotics that affect human health, such as chloramphenicol. Several bacterial and viral diseases have affected the shrimp farming industry in recent years, and large quantities of antibiotics and other drugs have been used to reduce shrimp mortality and treat the diseases. Some of the medicine will flow to the environment and damage other organisms. In fact, 40% of the farm owners interviewed used chemicals, antibiotics, vitamins and supplement products for the shrimp ponds when diseases occurred and 100 % of the farm owners had used chemicals, supplement products and other drugs for water treatment in the period of growing shrimp.

The result of indiscriminate use of antibiotics proliferates antibiotic-resistant (and thus more dangerous) pathogens, makes diseases more serious and as a consequence causes more crop failures.

According to Sy (2007) there are numerous chemicals and drugs used in shrimp production in Bentre without certificates, where agents often sell products at low prices with special offers and a high percentage commission for sellers (Sy, 2007). Drugs and other chemicals are commonly overused, due to the fact that the

cost of possible losses from disease are very high compared with the costs of treatment. Furthermore, even when instructions specify a certain dosage, operators sometimes believe that using a higher dosage will get a better effect, so they use more than the recommended dosage.

Excessive or indiscriminate use of drugs and other chemicals have a serious impact on the environment and are detrimental to the shrimp industry itself. Food safety authorities are alarmed, and there are several batches of goods exported that have been destroyed because banned chemicals and drugs residues are found in the products.

5.2.5 Diseases

Since 1994-1995, the epidemic widely spread in Bentre and the southern provinces, influencing 84,858 hectares of shrimp area and causing a loss of US$ 16 million (MOFI, 1996). In 2001 and 2002, the shrimp diseases continued to threaten and cause great damages to farmers in the Mekong delta. Some of the diseases that troubled the shrimp farming industry are directly caused by environmental problems, while a number of other diseases are triggered or spread more rapidly due to environmental problems. Another cause of the diseases was that the sources of shrimp seed lacked a thorough quality control. It was estimated that only 10 % of shrimp seed in the Central region met the quality standards; therefore, low quality shrimp seed was attributed to mass of shrimp deaths in the Bentre. In addition, farmers' shortages of technical knowledge and failure to comply to the technical regulations was an indirect reason the disease spread.

In recent years, shrimp farming has been afflicted with outbreaks of viral diseases that have greatly undermined profitability and sustainability of operations. The White Spot Virus Disease is the most common and serious shrimp disease affecting shrimp farms. In Vietnam, attempts to eradicate the disease have so far failed. The White Spot Disease was probably responsible for the major shrimp farming disasters in Bentre and all shrimp areas in Vietnam. In 2005 the disease outbreak had spread to 1,190 ha of shrimp farms in Bentre, while the area affected by the disease had increased to 1,259 ha in 2006 (DoFi Bentre, 2007b).

Based on a detailed survey, 100 % of the farm owners have been afflicted by shrimp diseases sometime in their history. According to officials of DoFi Bentre, the first shrimp crop in 2007 is a bumper year for shrimp, but in spite of the success of the crop, 31% of the farms still failed. This is a warning of the high risk involved in shrimp culture.

As mentioned above, in spite of the numerous chemicals and drugs used in disease treatment, the result of the treatment was low, only 3.7 % successful, 33.3 % passable and 63 % unsuccessful. The cause of most diseases was water quality, while the remaining diseases were due to the seed quality. According to farmers, shrimp diseases have increased during the last five years, and they have become more "sophisticated".

Outbreaks and spread of shrimp diseases cause a number of serious environmental and other problems, such as an increased risk of infections in wild shrimp and other crustaceans. The wild host carrying pathogens will return to shrimp farms through the exchange of water. That can in turn harm the wild populations, and in the end, human health. As a consequence, degradation of the pond environment increases health problems, which triggers crop losses and the increased use of chemicals. A large number of treatments have been used by farmers, and some of these substances have been banned by importing countries for the prospects of food safety.

In addition, many reports have recognized areas where shrimp farmers have abandoned some of the most important producer districts. Usually, the diseases have made production unprofitable in these locations, so the farmers have been forced to quit.

5.3 Social and economic issues

Shrimp development in Bentre has brought about great social and economic benefits as well as generating jobs, creating income for coastal communities, improving local infrastructure and earning foreign currency for the province. Shrimp farming results in direct benefits to the coastal regions where the people do not have much choice over their livelihood. Under the government's policies, many people who produced salt and

rice inefficiently have moved to shrimp farming, creating a diversification in livelihood, enhancing people's living standard, and preventing an exploitation of natural resources. Shrimp farming also brings about growth of services such as seed and feed supply, creating new jobs and increasing income of the people. It is clear that the development of coastal shrimp farming has made important contributions to the goal of hunger elimination and poverty alleviation. However, shrimp production also faces a number of challenges relative to the socio-economic situation.

Shrimp aquaculture is undertaken in coastal areas that are used for a variety of other activities. Therefore, shrimp farming affects not only by those who are directly involved in it but also others who live and work in the area. Shrimp is thus a big business in Bentre, with large corporations involved in the investment, development and operations of the shrimp farms. In such circumstances a relatively small part of the benefits of shrimp farming are shared by the local population, while a number of problems arising from shrimp farming may affect everybody.

As has been seen in many areas, the social structure of a local community may change when aquaculture is developed. Many poor farmers become rich, a number of farmers become poorer, large fortunes are made in some cases, and political and financial relationship and relative power shift. However, if such changes are very rapid and substantial, the local community may have difficulty in adapting, and in extreme cases, social disorder may result. Disorder most likely take place when land becomes concentrated in a few hands, especially if the landowners are non-local people. According to Sy (2007) most of the rich owners come from other places (big cities, neighbour provinces), and they have come to Bentre to invest in shrimp farming.

5.3.1 Population and use resource

According to figures from the Bentre statistical office (2005), the average rate of increase in the labour force working in fisheries is 24.7 % (most of them participate in shrimp farming). The problems of high population density, rapid population growth, low educational levels of the people, underdeveloped infrastructures, and scarcity of opportunity for economic development have led to unemployment and labour excess in coastal areas. Besides, numerous fishermen earning their living through inshore

fishing have gradually shifted to aquaculture due to the reduction of fishery resources and inefficient exploitation. In addition, a number of people who used to earn their living through agricultural farming and low-productivity salt production, have turned their interests into aquaculture.

Demand for expanding shrimp areas has also put pressure on land and water resources. According to our survey, 71.3 % expected to expand their shrimp farm area. In many cases, shrimp farming has been able to develop in mangrove and other coastal areas where the government have issued permits. In other cases, previously common access land has simply been appropriated and developed illegally by farmers. In either case, the extent of common access resources has been reduced, often to the detriment of the poorest sectors of society.

In many localities with areas suitable for shrimp farming, the land values have been increasing. This seems like a good opportunity to encourage poor farmers to sell their land to invest in other activities. While this may bring short-term benefits and financial relief in the absence of alternative employment opportunities, it ultimately leads to increased poverty and inequity. According to Sy (2007) many local farmers sell land to rich people from other provinces who come to Bentre to invest in shrimp farming.

Expanding shrimp areas may have some negative impact on agriculture. Conflicts may relate to competition for water or salinization of water. Conflicts can arise from saline discharge into irrigation canals, although contamination with chemicals is also possible. Are the shrimp farmers getting richer and the fishermen and agricultural producers getting poorer? According to a report from Oxfam, research in Travinh Province (part of the Mekong delta) shows that the hamlets taking part in aquaculture have become richer while others involved in fishing and agricultural production have become poorer. During the distribution of land, some households sold the land as they thought aquaculture was not profitable. Now, they have lost their chances because the land for aquaculture has been used fully. They are also unable to buy lands from other people since the land prices have surged (Oxfam Great Britain, 2003).

5.3.2 Employment

Most shrimp farming in Bentre is small-scale, based on the labour source from members in the family. According to the World Bank, shrimp farm operations require far fewer workers than, for example, rice farming, which is an alternative to shrimp farming. The report shows that rice farming requires ten times as many workers as shrimp farming (World Bank 1998). However, the average rate of increase (24.7 % per year) to participate in aquaculture is too high, and in Bentre a large part of the labour force has become redundant. The difficulties appear because the redundant labours have a low education level and a lack of other skills. According to the survey, most farm owners work exclusively with aquaculture (74.7 %) while 21.8 % also include agriculture. The opportunity to obtain other jobs is low. As a consequence, high density of population is synonymous with reduced income.

5.3.3 Scale, intensity and suitability of shrimp culture for poverty elimination

In Bentre, small-scale shrimp farmers are the dominant sector of the shrimp industry, in terms of numbers and production. However, more intensive forms of shrimp farming are often not easily accessible to the poor, who may also be at a disadvantage in product quality and marketing.

Normally, during the first few years of production when the environment and water quality is good, most shrimp farming based on extensive or semi-intensive methods enjoys good results. However, after several bumper crops, most farmers decide to stock with higher densities, and problems arise, leading in some cases to complete failure. Failure is mainly caused by a lack of technical knowledge, particularly in preventing and controlling disease outbreaks, which are most likely in intensive shrimp farming. Intensive shrimp farming is normally relative to high-risk, high-reward activity and requires significant investments as well as access to credit for most farmers who have limit budgets. However, the danger with making credit available to people who have little experience in managing credit is that they can easily fall into the trap of spending available money during grace periods and thus fail to meet payment deadlines. According to Tam, who works in a credit-bank, 24% of farmers fail to meet the payment deadlines (Tam, 2007). Due to the high percentage of shrimp farmers who do not meet the payment deadline, access to credit becomes

more difficult. The survey's result also showed that 70.1 % of the farmers had difficulties in accessing credit from bank while for 28.7 % it is impossible.

It is very difficult for the poor farmers to use shrimp farming to get rid of hunger and poverty at the time of industrialization and intensification. The first reason is the full exploitation of shrimp farming land and the high land price. The second reason is that intensive and semi-intensive farming are very complicated, high risk works requiring a large investment capital that the poor cannot afford. In order to raise the intensification, most of the households have to borrow capital while the possibility of success is far from assured. According to VIFEP (2001) estimates, even in the years with bumper harvests, about 20 % of farming households suffer from losses. The possibility of the poor suffering losses would be higher due to the restraint of skills, resources and other limitations. The failures in shrimp farming may force the households to sell land and other properties to pay off debts. Reports of non-governmental organizations have shown an increasing rate of people who have no land in the Mekong Delta. As a result, this threatens to widen the gap between the rich and the poor in rural areas and causes social conflicts among people who are exploiting the coastal resources. Apart from obvious advantages, shrimp farming has also had some bad impacts on economic and social aspects. These issues have been reported by some non-governmental organizations (EJF, 2002).

5.4 Infrastructure

The infrastructure includes irrigation systems, electricity, roads, etc. In those, the most important factor affecting the success of the crop is irrigation. Irrigation systems are still poorly developed throughout the province. Almost all the areas used for shrimp aquaculture use existing forms of irrigation intended for agriculture, therefore they do not meet the technical requirements of most aquaculture systems. Have few investment projects have been implemented to build up irrigation systems for shrimp in the industrial zones. However, there are still some conflicts in water supply and discharging between agriculture and aquaculture systems. The conflicts threaten the sustainability of the coastal shrimp farming systems. According to a report of the DoFi Bentre, some areas have invested and are preparing for intensive shrimp culture methods, but in 2007 farmers did not stock or they moved to extensive methods. The

report shows that four communes in Binhdai district were affected by polluted water because of Balai sluice-gate, while in the Binhthang commune 650 ha were affected by polluted water because the water systems did not meet the requirements (DoFi Bentre, 2007c). The integrated management approach for water resource use and exploitation should be applied in order to improve the situation.

5.5 Financial ricks associated with shrimp farming

In the policies to develop aquaculture in the Bentre province, shrimp culture tend to move to higher intensity, from extensive production to semi-intensive and intensive (Bentre people's committee, 2003). In general, financial risks increase with increasing intensity. In more intensive systems, the probability of loss and the cost of such losses if they do occur are likely to be higher. Although average returns may be higher, they are subject to larger fluctuations in response to factor prices, market prices, and losses from diseases or environmental factors. However, the relationship is neither simple nor universal. Well-planned, designed, and managed intensive systems will be less vulnerable to diseases than poorly planned, designed, and managed extensive systems. Diseases have not been limited to semi-intensive and intensive systems, for it has also become widespread in extensive systems in the Mekong delta in recent years. The financial risks also differ substantially with the size and organization of the farm, and the financial status of the operator.

5.5.1 Input and output factors

The availability of raw materials and the costs of procuring them can vary according to location and time of the year. The raw material for a shrimp farm will include items such as supply of seed, feed, labour, fuel, and transportation.

Increase of fuel prices relative to other input cost and the currency inflation in Vietnam have magnified the increased costs for the farmers. For input factors, shrimp feed is the most important for the shrimp farmers. The pellet food market for shrimp is strongly competitive with many private companies from Mainland China and Taiwan, Thailand, the United States, and Vietnam. All of these companies supply both the pellet shrimp diets for aquaculture and feed for the cattle and poultry

industries. Nevertheless, the price of shrimp feed is still high, and this has a direct impact on production costs and returns and the financial sustainability of the shrimp farming system. Normally the costs of shrimp feed are 40-60 % of the total production costs. Rising feed cost can undermine the long-term viability of shrimp culture. This is particularly the case given the long-term tendency for the price of shrimp to fall as production increases or as a result of competition with other (shrimp) species.

Feed quality, disease prevention measures, hygiene water quality, and general management practices are factors affecting the productivity of the farms. Seed quality is also an important factor.

Different kinds of farmers operating at different scales and intensity have very different exposure to financial risks. Small-scale shrimp farmers with other sources of income can become poor when the shrimp crops fail, but they engage in other activities, which give them an alternative source of income. Furthermore, they may be able to convert their land back to other uses. For small-scale shrimp farmers with no alternative sources of income, a failed crop can lead them directly into a poverty situation. In the survey results, in terms of assessment of income in a period of the last 5 years the figures show that most the farmers have alternative income, and their income has increased.

Using Chi-Square tests of independent in SPSS give results in table 5.1

Table 5.1 Association between main income and change in total income of shrimp farmers during last 5 years in 3 categories i.e. increase, no change and decrease

Main income	**Total income (farm owner)**			
	Increase	No change	Decrease	Total
Aquaculture				
Count	38	20	7	65
Expected Count	41.8	17.2	6.0	65.0
Residual	- 3.8	2.8	1.0	
Aquaculture and agriculture				
Count	15	3	1	19
Expected Count	12.2	5.0	1.7	19.0
Residual	2.8	- 2.0	- 0.7	
Cattle-breeding				
Count	3	0	0	3
Expected Count	1.9	0.8	0.3	3.0
Residual	1.1	- 0.8	- 0.3	
Total				
Count	56	23	8	87
Expected Count	56.0	23.0	8.0	87.0

Preliminary observation indicates the different values between the observed value and expected values (that is, main income and total income in this sample are dependent). Notice that the measure has an association between main income and total income. The result is supported with a high Chi-square value (4.411) (a lager Chi-square value large, suggesting a significant difference between observed and expected value).

However, the sample size is not big enough (with a large sample size the two values: Chi- square (4.411) and Likelihood ratio (5.528) will be close to equal) and Phi (Φ) value (0.225) represents a weak association between main income and total income.

Shrimp price

One of the most important factors influencing the economic performance of shrimp farming is the farm-gate price of the shrimp. Shrimp prices fluctuate greatly, especially in the beginning and the end of a production cycle. The price normally declines during the harvest season. During the boom years of shrimp development in Vietnam, it was estimated that shrimp farming was responsible for a 40 % drop in prices in the period 1999-2006, especially when China's cultured shrimp came on the market in great quantities. Whereas the price of input factors increases rapidly, it means that the shrimp farmers are facing big challenges in the present and in the future. It is reasonable to assume that farmed shrimp will have an increasing effect on market prices. In addition, the commercial barriers from import countries have been reducing shrimp export volume, therefore shrimp gate prices have been reduced also.

5.5.2 In competition with others species in market

Shrimp still have high sales prices compared to most other farmed species. However, Vietnam's black tiger shrimp now has a very strong competitor, White leg shrimp. (White leg shrimp is a popular shrimp in Central America. It is now imported and grown in Taiwan, China, and Thailand). At several international trade fairs, importers cancelled the orders on importing Vietnam's black tiger shrimp to purchase white leg shrimp from Thailand and China (Vietnamnet, 2007b). The traditional markets for Vietnam's shrimp like Japan and the US now also consume white shrimp, while this kind of shrimp has also become the first choice of many restaurants.

According to Associate Prof Dr Nguyen Huu Dung, Deputy Chairman of the Vietnam Association of Seafood Exporters and Producers (VASEP), black tiger shrimp once dominated the world's market because the Asian white shrimp at that time had low output and unstable supply. However, the situation has become quite different: the quality of white leg shrimp now is the same as black tiger shrimp, while the price is lower. As a result, Vietnam's black tiger shrimp is in danger of being excluded from import contracts.

In the US, importers do not note the difference between black tiger shrimp or white leg shrimp; they pay in accordance to shrimp size with a higher price for bigger shrimp. Meanwhile, there is no considerable gap between the price of black tiger shrimp and white leg shrimp of the same sizes. It is clear that it is more profitable to hatch white leg shrimp than black tiger shrimp. For example in 2006, Thailand exported 400,000 tonnes of white leg shrimp, 98 % of the total output. Thailand now can control the process of shrimp culture. Farmers have been successful in raising large-size white leg shrimp, even bigger than black tiger shrimp, which has helped them gain a larger market with competitive prices, 10-15 % cheaper than the black tiger shrimp. Besides, white leg shrimp can bring higher outputs, 25-30 tonnes/ha, which allows 2-3 times the profit of a black tiger shrimp farm (Vietnamnet, 2007b).

The former Ministry of Fisheries of Vietnam in 2003 banned the white leg shrimp seed production, and the white leg shrimp stock together with black tiger shrimp. In 2006, the ministry prohibited white leg shrimp stock in Mekong River Delta provinces, but allowed farmers to raise this kind of shrimp in the provinces in the north and central of Vietnam. The ministry initiated the ban for fear of transferring the Taura disease from white leg shrimp to black tiger shrimp. (Taura disease is a serious disease in white leg shrimp).

5.6 The policy for shrimp farming development

In general, the government's guidelines and policies for aquaculture have taken into account the harmonization of social and economic development targets and environment protection in order to maintain a sustainable and high growth rate. However, the deployment of these policies has produced many drawbacks. The

planning, seed, capital, environmental management and epidemic disease control have not yet met the demands of a sector with a very high growth rate. The policy goals have been lowered (Nhuong et al, 2006). Local authorities and farmers usually implement policies and guidelines of government in a "selective way". The goals of policies resulting in benefits in the short term are usually followed while the goals of protecting the environment and maintaining the sustainability are ignored. For example, many projects of industrial shrimp farming do not have components relating to the environmental treatment such as sediment reservoirs, rubbish grounds and buffer belts of mangrove forests. Even in some places, sediment reservoirs are leased to farmers just to raise a bit more money for the budget. Additionally, the policy of the government is inconsistent and changeable in a short time. The policy planning for aquaculture development is also quite passive, short-term, and has the characteristics of unscheduled and ad-hoc policies. This badly affects investment efficiency. Dr. Ha Xuan Thong (2003) remarked that "the enforcement of policies for aquaculture development in last time was inclined to focus on economic growth and social stability without concerning fully about the sustainability".

Lack of enforcement instruments and personnel makes it impossible for authorities to control the problems occur.

6. SOLUTIONS FOR SHRIMP FARMING MANAGEMENT

The promotion of sustainable shrimp farming in Vietnam is clearly defined in all of the local government (included Bentre government) and MOFI's development strategies and policies. In order to achieve that development goal, it is very important to recognize and identify the potential challenges ahead. Therefore, the following constraints need to be overcome and addressed during the development process of the shrimp-farming sector.

6.1 Environmental sustainable management

The problems caused by shrimp farming and by other sectors located near aquaculture areas have not been resolved in all aquaculture areas. Solving these difficult problems requires *an integrated management approach* as well as a high level of cooperation and coordination among several relevant sectors.

6.1.1 Protect mangrove forest

As mentioned above, mangrove forests have important roles in shrimp development. Therefore it is necessary to protect mangrove forests, to mitigate negative impacts to mangrove forests from shrimp farms that can be constructed away from mangrove areas altogether, or constructed on the landward fringe of the mangrove forests, and to ensure that any future increase in production comes from the same or a smaller area of land, so that no further destruction of mangrove is allowed.

6.1.2 Reduce organic pollution in shrimp pond

The quantity of waste nutrients and organic matters produced in shrimp farming is directly related to the feed conversion efficiency. The organic pollution is dependent on feed quality and feeding practices. If the feed is high quality, feeding the right amounts at the right time will reduce the organic pollution in the shrimp ponds. Stock with high density (semi-intensive and intensive) need adequate equipment. Aeration is

necessary, and heavy aeration can help break down organic matter and minimize the quantity of anaerobic sediments that can accumulate at the bottom of the shrimp ponds.

6.1.3 Right use of chemicals

To mitigate the effects of chemicals one should apply two basic rules: minimal use and correct use. Correct use depends upon effective information dissemination and communication. Limiting chemicals and drugs used in shrimp aquaculture is difficult because there are many sources and types, not only for use in aquaculture but also for veterinary use or even for human use. Hence, there is a need for responsibility among the farmers together with well-planned dissemination of information.

Most foreign shrimp importers have imposed very strict regulations and standards for the antibiotic and chemical residuals in shrimp products as well as strict measures to examine and to punish any violations of these rules. Responding to this matter, a number of management policies have been promulgated in order to take control of the chemicals and medicine used in shrimp farming as well as the food safety and quality issues. This includes MOFI's specific policies that respond to the EU market requirements over the strict ban of ten chemicals in exported seafood (including shrimp products): Decision No 01/2002/QD-BTS, Decision 18/2002/QĐ-BTS and Decision 15/2002/QĐ-BTS. These policies list chemicals and antibiotics that were banned in aquaculture and processing use in order to guide the aquaculture farmers and processing enterprises to examine their production activities. Currently, increasing strict requirements from foreign importers of Vietnamese exported sea food products (including shrimp products) have expanded the list of banned or limited-used chemicals and antibiotics in fisheries production and trading. In this regards, the list of ten chemicals in Decision No 01/2002/QD-BTS in 2002 has been expanded to 17 completly banned chemicals and antibiotics and 34 limited used chemicals and antibiotics in the Decision No 07/2005/QD-BTS in 2005. In addition to that list of chemicals, Decision No 26/2005/QD-BTS regarding the United States and North American markets also banned the use of 11 Fluoroquinoloness antibiotics in fisheries products exported to those markets. In order to implement those policies effectively in reality, especially the Decision No 07/2005/QD-BTS, the MOFI has

issued supportive documents to instruct its professional agencies and local responsible agencies to implement those policies in their own management fields. The Instruction No 03/2005/CT-BTS dated 07/03/2005 is released to fulfil this task. This instruction required PPCs, provincial DoFIs and Provincial DARDs to deploy the Decision No 07/2005/QD-BTS (Cao Le Quyen, 2006). Additionally, it promoted the monitoring and managing of the use of chemicals and antibiotics in all stages of fisheries and aquaculture production and examination of the chemical residuals in fisheries products, especially the banned and limited used chemicals and antibiotics. This instruction also required NAFIQAVED, National Fisheries Extension Center (NAFEC) and Department of Science & Technology to cooperate with each other to enhance the work of inspections over the production activities of aquaculture farmers including: chemical, antibiotics, food and seed production and trading as well as the production and trading of processing enterprises and exporters. Special atttention is paid to sea products exported to the EU, Canada, Switzerland, and the United States, with the application of treacibility in finding the root of the chemical and antibiotic problems in exported sea food.

6.1.4 Disease prevention and management

Diseases have made shrimp farming unsustainable. Thus far, Bentre's DoFi has had the ability to diagnose serious diseases with two laboratories, based on the best equipment. However, prevention and treatment of diseases only from the authorities is not enough. It needs to be coupled with efforts to promote improved management practices on the individual farms. If shrimp farming is to become more sustainable, there is a need for a more strategic and integrated approach; a need for a comprehensive approach to deal with diseases prevention and improved management strategies. Achievements in prevention and management of diseases are also influenced by how the shrimp farm development is planned.

A good system for disease prevention and treatment of diseases depends on strong efforts on different levels. The DoFi staff needs a basic understanding of pathogens and improved disease epidemiology. The farmers need to follow all steps of disease management as noted in the extension material, for example: stock with high quality or free disease seed, high quality feed supply, measure waster quality and

optimal grow-out conditions. Farmers need competence in the rapid identification and correct treatment of disease outbreaks.

Achievement in shrimp management is affected by site selection. It is of great importance, not only for appropriate soil and water regimes for the farm, but also because of broader issues such as the proximity of other farms and the carrying capacity of the environment. Beside that, good design of shrimp ponds, water supply and discharge system help to improve environmental and disease management.

The achievements will also depend on the skills of managers, staff and access to information. Most analysis will agree that shrimp disease is the single most important risk factor.

6.2 Mitigation negative impact of social economic

6.2.1 Employment

High population concentrations of shrimp culture has lead to a number of problems related to socio-economic issues. It is necessary to provide employment to surplus labour or to redistribute the labour force, although it is difficult and solving this challenge will take a long time. Effective resource use planning and ideally integrated coastal management are also important elements in order to tackle these issues.

6.2.2 Access to credit

The brackish water shrimp aquaculture requires high levels of investment in comparison with other types of production. This will continue to limit the number of farmers in the sector, especially the poor farmers. They will definitely need proper credit programs and technology training if the poor farmers are the target group. The lack of available credit to the shrimp sector in Bentre is also a major constraint. However, giving farmers easy access to credit without adequate training or practices will only leave the farmers in debt, so credit should not be extended lightly. For example, when there was a boom year in shrimp production, credit was easily available to promote small-scale shrimp aquaculture which in turn resulted in rapid intensification, expansion of shrimp farms, people moving from other productions to

culture shrimp and in some cases environmental degradation, disease, financial collapse, and indebtedness.

In terms of reducing the costs in shrimp production, feed cost is an important factor. The price of shrimp feed is still high, and this has a direct impact on production costs and returns and the financial sustainability of the shrimp farming system. In the longer term, research and development should focus on the protein ingredients in shrimp food in order to find the way to replace the fishmeal protein ingredient with vegetable protein ingredient to reduce the price of shrimp feed.

To solve the socio-economic problems the authorities cannot try to deal with the farmers on a case-by-case basis. What is required is a well integrated strategy. This needs to reduce the negative externalities of resource appropriation and environmental degradation while increasing participation of the poor in various shrimp activities and distributing the benefits more widely. To achieve all these goals will require effective land resource use planning and require local government intervention in the form of grant aid and credit. The risks associated with shrimp culture must be taken fully into account when considering or promoting shrimp farming development.

6.3 Reducing financial risks

In general, financial risks increase with increased intensity. Managing and avoiding the risks requires improved siting, design, technology, and management. The relationship between intensity, returns, risks, and access to credit and skills requirements should be given careful consideration in the planning and design of shrimp culture programs. The most important safeguard against financial risk is a proper and well-documented feasibility study and other studies related to markets, the supply of raw materials, and also the probability and costs of diseases. In order to reduce the financial risk associated with shrimp diseases, crop diversification or single crop per year should be considered. For instance, in areas where diseases occur, farmers should stock one crop for shrimp and in the remaining time the ponds should be kept fallow or stocked with tilapia or sea bass.

6.4 Planning

Although the Vietnamese government and local governments have planning systems that have been applied to aquaculture, they have usually been unable to apply procedures thoroughly and consistently due to pressure from the rapidly developing shrimp culture industry. Thus, the inputs for a Master Plan for the development of shrimp aquaculture, as well as detailed plans for each area are necessary. Sector plans should be linked with other sectors and a set of appropriate incentives. The planning and regulatory framework is needed to address social, economic, and environmental issues in a comprehensive manner. It will need to include all elements of integrated coastal management and should be pursued as a long-term objective.

Most shrimp farm sites are chosen on the basis of availability rather than suitability, and government intervention in the form of land use policy and planning may therefore be required to address this issue. The plans have to develop combined legislation and planning procedures applicable to aquaculture development, including coastal planning and environmental assessment procedures. The plan should consider restoration very carefully when ponds have been developed on land previously used for rice because restoration may be more difficult.

6.5 Legal issues and policy

The implementation of the legal and policy framework for aquaculture development and management needs strong power and legal backing. Support and management policies that include disease control, quarantine management, seed and product quality management, etc., need to be more strictly enforced.

According the World Bank report (1998), sustainable development of shrimp aquaculture is most likely where the following preconditions are present:

- A legal, regulatory, and enforcement framework specifically designed or adapted for coastal aquaculture development
- The existence of, and compliance with, an aquaculture development and management plan, or an integrated coastal management plan for the area

- Proper law enforcement instruments, supported by the resources necessary for enforcement

6.6 Diverse species culture

Facing a situation of losing the competition of black tiger shrimp in the international market, the Vietnamese government needs to do comprehensive research on how to diversify shrimp species, especially regarding the white leg shrimp, which is the main competitor in the market. The white leg shrimp is a species that has dominated in many of the large shrimp producers in the world, such as China, Thailand, the Philippines and others.

6.7 Putting principles into practice: GAP/CoC/BMP

The Vietnamese government promptly recognized the need for sustainable development. With support from the United States in 2004, NAFIQAVED, the government institution responsible for aquatic animal disease control and safety, initiated a pilot project to assess the effects of Good Aquaculture Practices (GAP) and its implementation in shrimp farms including its application in 134 ha in Binhdai and Thachphu district of the Bentre province. GAP included the application of better health management and food safety practices, reduced application of chemicals, decreased environmental impact, and quality assessment of pond inputs.

Three years after implementing GAP, preliminary results indicate that most farmers implemented GAP and obtained a good quality product. The project achieved the essential targets of GAP: (1) Reducing shrimp diseases, there was a significant decrease of shrimp diseases compared with before and compared with ponds outside the pilot project; (2) Reducing water pollution, environmental degradation inside and outside the shrimp farms; (3) Guaranteeing 100 % food safety of the products from the project; (4) improving shrimp productivity (NAFIQAVED, 2006).

Bentre has also received support from FSPS.II. The second phase of the Danida supported Fisheries Sector Programme targets activities towards the poorest parts of the rural population to enable them to benefit from the dramatic growth in the

fisheries sector. The second phase of the Fisheries Sector Programme (FSPS.II) started in Bentre from 2006 and runs to 2010. Environmental protection measures are included in all components of FSPS.II and support is given to address environmental concerns. In the first phase (FSPS.I) started in 2004, NACA, in collaboration with FSPS.I and the Vietnamese government, has also been implementing and disseminating Better Management Practices (BMP) in small-scale semi-intensive shrimp farming systems. GAP and BMP are very similar and address similar shrimp health, food safety and environmental protection issues, although BMP has a stronger disease control focus and attention is also given to establishing farmer groups to ease BMP implementation. In the pilots applying BMPs, the production of this species was rather stable since farming household had strictly followed the technical procedures such as stocking at low densities, better management of water supply and environment, which resulted in no disease outbreaks and higher productivity. Applying BMP is flexible and following BMP guidelines is largely dependent on the shrimp farmers.

GAP/CoC/BMPs are guiding aquaculture documents to reduce diseases, assure food safety and environmental sustainability. Several countries have applied GAP/CoC such as Thailand: GAP (1994), CoC (2000), India: GAP (2000), Vietnam: GAP (2004), and Bangladesh: GAP (2004).

The principles of GAP/CoC/BMPs are:

- Recognize hazards of disease, food safety and environmental impacts
- Prevent hazards from occurring or under permitted limits

Targets of GAP/CoC/BMP:

The main purpose of GAP: (1) assuring that 100% of food products are safe; (2) minimizing diseases; (3) decreasing negative impacts to the environment (4) increasing profits due to higher price; (5) preventing diseases

The main purpose of CoC: (1) assuring that 100% of food products are safe; (2) being friendly to the environment; (3) assuring legal rights for work forces and creating good community relations; (4) increasing profits due to higher price.

BMP: The main contents of BMPs are implementation of CoC at a higher level; details, guiding documents, technical standards and stakeholder's responsibilities.

The Principles provide the basis upon which stakeholders can collaborate for more sustainable development of shrimp farming. For the government, they provide a basis for policy, administration and legal framework. It can be renewed, adjusted, funded and implemented to address the specific characteristics and needs of the sector in order to protect and enhance the industry, the environment, other resource users and consumers. They also provide the basis for development of standards and certification system.

Many import countries require traceability certification for aquaculture products (supply chain management and traceability pass liability back to producers). Traceability certification is a challenge for small-scale farmers. According NAFIQAVED, a GAP certificate is becoming a safe conduct for shrimp product export to high price markets.

So far, environmental monitoring and disease warning system of aquaculture in general and of shrimp farming have been set up. This system is being run by Research Institute for Aquaculture No 2 (RIA 2), responsible for Mekong delta. However, the achievements are still minimal.

6.8 Production and management models

6.8.1 Co-operative shrimp production

In production, the co-operatives have show many limitations in their organizational structure and management. These limitations have led to a decrease in the number of co-operatives. During the first few years of co-operative shrimp farming, characterized by extensive or semi-intensive methods, results were generally good. However, with more intensity year after year and as more intensive methods of farming were adopted, problems arose, and in some cases the co-operatives were complete failures. The problems were mainly caused by a lack of proper technical knowledge, particularly in preventing and controlling disease outbreaks, which are most likely in intensive shrimp farming. Heterogeneous technical knowledge, and the

limited financial capacity of farmers in the co-operatives also contributed to the bad results.

Another factor is that the farmers contributed the entire budget for the co-operative running of farms. The budget was not stable and large enough for running the farms, especially when abnormal situations occurred. When members were really poor they were not able to contribute at all. Thus, one of the key elements for success in co-operative shrimp farming seems to be access to credit in order to give all members in the co-operative the chance to meet their requirements. However, the danger with making credit available to people who have little experience in managing credit is that they can easily fall into the trap of failing to meet payment deadlines. In addition, training and extension expertise are important factors to keep co-operatives alive. Extension work can be set up in the community. With extension experts assisting, the farmers can adjust their operations to various conditions and behave responsibly in their co-operatives.

6.8.2 Union production

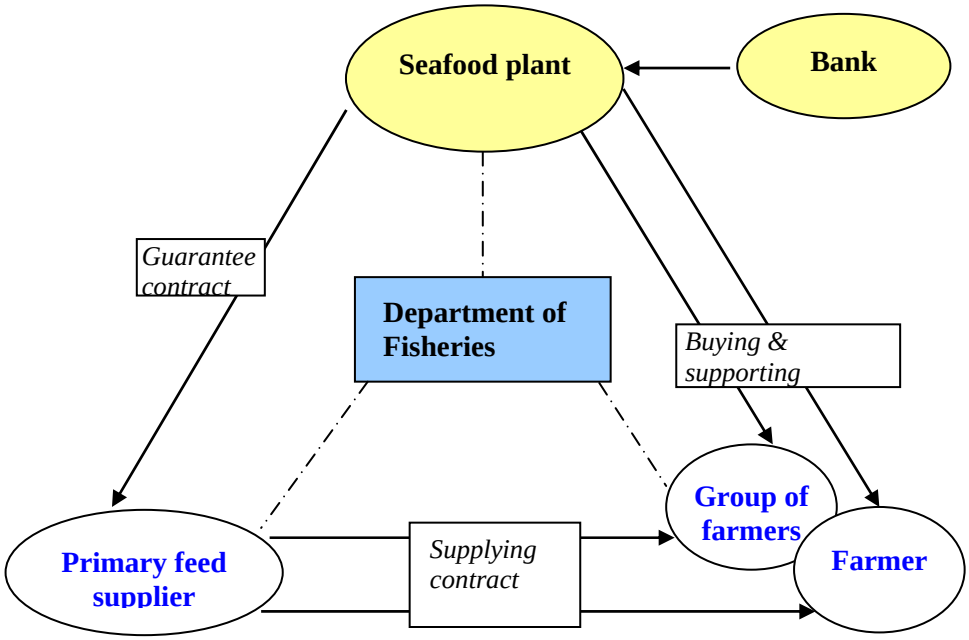


Figure 6.1: Union shrimp production model

Figure 6.1 shows the web of Union shrimp production that has been set up in the Bentre province. At the time of survey, the Union had not started yet, but it will face a

number of difficulties: (1) currently, banks have limited investments in aquaculture, so the government needs a program to support farmers' access to credit; (2) according to the DoFi Bentre report, the capacity of processing plants still low; (3) most suppliers are small suppliers so they will have difficulties when they take part in the Union. However, with encouragement and support of the government, DoFi, and other participants it is seems like a good production model.

6.8.3 Co-management

Currently in the main shrimp areas, DoFi and local governments have established management boards, but these have not have the desired effects. The reasons may be limitations such as: the management competences of members on the management board are weak; weak regulation enforcement; lack of budget; the information flow is limited, etc.

Under support of FSPS.II in 2007, DoFi Bentre co-ordinated with VIFEP to carry out surveys and select pilots to set up co-management in the shrimp farm area. Recent experiences with co-management pilot schemes in many countries in the region have shown that it can be successful. In the current situations of costal communities and shrimp farm areas in Bentre, co-management could be a solution for shrimp production management. Co-management is the sharing of decision-making and responsibility for the management between the community (local shrimp farmers) and the government (centralized management). When farmers participate in co-management, the quality of the regulations will improve while legitimacy and democracy of co-management will increase too. Co-management involves the partnership of government at all levels so it can be a comprehensive tool to solve conflicts more effectively. The idea is that co-management is cheaper, better, and more responsible.

A pleasant fact is that 100 % of the shrimp farmers who were interviewed recognized the need for co-management and organizations in shrimp production like co-operatives and Unions.

6.9 Stakeholders

Stakeholder was defined as primary and secondary stakeholders in terms of the direct relevance to the interest (Mikalsen 2001). Primary stakeholders are the individuals or groups who are needed and essential for survival, such as: investors, employees, customers and suppliers. Secondary stakeholders are anyone who effect or are affected by the cooperation, but they are not engaged and not essential for its survival.

According to Mikalsen et al. (2001) there are three attributes of stakeholders: (1) legitimacy groups that have a legal, moral or presumed claim on the firm; (2) power groups that are in a position to influence the firm's decision; and (3) urgency groups whose claims demand immediate attention from managers.

Stakeholders in Vietnam fishery and aquaculture include:

- Fishers, fish farmers and relevant groups of society whose livelihood relies on fishing or aquaculture; NGOs; fishery industries; and relevant industries that support fishery and aquaculture activities (feed, seed, drugs, chemicals, etc.)
- Other industries that directly or indirectly utilize the territory.
- Research and educational institutions; government or authority parties that facilitate fisheries management and enforce regulations.

The involvement of stakeholders has come to be seen as an essential part in management and production systems. Stakeholder participation in the decision-making can improve the situation. To understand stakeholders involvement is important in bringing them into the system, using their competencies and capacities and ensuring they are heard and have influence.

7. DISCUSSION AND CONCLUSIONS

7.1 Discussion

With favourable weather conditions, great potentials of area and the government's open policies as well as a high demand for shrimp in international markets, Vietnam in general and the Bentre province in particular, has made impressive achievements in shrimp farming. In regards to area, employment, and foreign currency, shrimp farming is one of the most developed activities in Vietnam (EJF, 2002). Bentre is an agricultural province with a young population and a high density of population. Moreover, the area for agricultural in general land has been used nearly completely (Nhuong et al, 2006). Development of industries cannot keep pace with the increasing demand for jobs in rural regions. Accelerating coastal aquaculture is the inevitable trend that supplies more job opportunities for coastal people and makes great contributions to the development of the province. The reality shows that development of coastal aquaculture has considerably changed the face of the coastal communities. During the process of development, shrimp production has met many difficulties as the sustainability has not been properly addressed. The main challenges that shrimp production in Bentre is facing will be discussed below:

The first challenge relates to shrimp aquaculture planning. Bentre government delegates power to DoFi's managers and orients the development of aquaculture through preparing and enforcing development plans for every stage. However, the plans still have many deficiencies. Much of the coastal shrimp farming development in Bentre took place unplanned and without control of the governments (DoFi Bentre, 2005b). Lack of planning has led to many risks in coastal aquaculture. The planning lacks a practical, scientific base and only points out general guidelines based on development practice without orientating farmers or highlighting what methods work best for sustainable development in a particular area. Because of a lack of careful planning, there are dangers of environmental pollution, mangrove forest destruction, and regular outbreak of disease that causes damage to production. Current planning tends to enlarge the area, develop infrastructure without paying much attention to possible solutions or issues of livelihood and sustainable development. Planning only focuses on developing projects, especially intensive ones while the imperative aim of planning should be to provide orientations and to manage all aquaculture operations

(Nhuong et al, 2006). On the other hand, most of plans were launched by the higher authorities without the involvement of local people in order to achieve the top-down targets of social and economic development. Therefore, resources were not mobilized to carry out these plans. Since the national budget is not ensured, the plans usually go bankrupt. Another reason is that planning is not popularized, lacking a sustainable orientation, and this planning only focuses on a management aim with a limited scope (Ha Xuan Thong, 2003). Another problem, which makes planning more difficult, is the management of land for aquaculture. The status of most aquaculture land is unclear and managed by the government. The government authorizes lower authorities for land management and the lower authorities then delegate the land management responsibilities to the People's Committees at district and commune level. This management mechanism creates a favourable condition for the local authority and farmers to develop aquaculture in a disorderly fashion. In reality, the land for aquaculture has been assigned and hired in different ways.

The second problem for shrimp production is that the policy targets and sustainable development orientation of the government is hindered by the inability of capital mobilization. At the macro-level the local budget is not enough to carry out policies aimed to accelerate the aquaculture sector. The government's capital invested in projects is usually widely spread, and in practice, investments are often trimmed, changing the original targets and ability to fulfill them. At micro-level almost all farmers have low capital and a high demand for borrowing money from financial organizations. However, channels providing capitals for aquaculture are usually limited, and lending mechanisms are very strict because banks consider the aquaculture as a high risk sector. Therefore, the shortage of investment capital and infrastructure for aquaculture, and the use of low quality inputs have caused high risks of spreading diseases, environmental contamination, and incurring severe losses.

The third issue of shrimp production relates to problems with seed and input services. When the current hatcheries inside the province just meet 10 % of the demand for seed, most farmers buy seed from the central provinces. In fact, the seed quality is very unstable, and reserves of brood-stock shrimp fall when most of the habitats for wild shrimp like mangrove forests, tidal zones and lagoons are completely exploited. Because of the scarcity of brood- stock shrimps, many hatcheries had to buy low quality brood- stock shrimps from the outside to breed. This led to a

reduction in the quality of shrimp seeds. This is an important element that has a powerful effect on the sustainability of shrimp farming. Because most farmers depend on seeds with unclear origins which are sold freely in the market, the productivity is unstable. Therefore Vietnam has recently introduced a strategy for developing national hatcheries.

The fourth issue concerns development and the application of science and technology. Most people involved in shrimp farming rely on their own experiences without careful technical instructions. The application of scientific advances in production in order to assure the sustainability of aquaculture is facing many obstacles because many farmers are illiterate or have a low educational level. According to the survey, 77 % of the shrimp farmers are only educated at a primary school level.

The fifth challenge of shrimp production is irrigation for shrimp farming. Together with seed services, irrigation systems play a meaningful and significant role in the farming. A suitable and complete irrigation system helps farmers minimize the risks in farming. However, the irrigation for aquaculture is under the management of two different organizations: the Ministry of Agriculture and Rural Development manages and constructs irrigation system outside of the farming areas (like sea-dikes) and the Ministry of Fisheries supervises the irrigation construction in the internal areas of shrimp farming zones. Therefore there is generally disagreement on how to manage and regulate the water systems. Because the farming area is growing too fast, the irrigation is unable to meet requirements of development, resulting in shortage of freshwater, which results in the mass death of shrimp in the dry season.

The sixth problem relates to the management and production organization. Shrimp farming is a complicated sector, closely linked with environmental and natural resources. Therefore, it is necessary to have a strict administration from the government in the development of shrimp farming. Currently however, the functional and administrative system for managing and guiding aquaculture development, fisheries extension and veterinary quarantine in aquaculture, and quality control of input materials, particularly at local level, are still weak and unable to satisfy the administrative requirements of the sector.

In aquaculture the household-based economy is the main production form. However, the scale of household size in Bentre and Vietnam in general is too small,

fragmented, and unequal, which hinders the orientation for sustainable development. The regulations and laws are not detailed enough to regulate the relations among households, and individuals use the resources in small zones and in specific contexts. In this situation, it is an essential task for Bentre's sustainable shrimp farming development to enhance competitiveness and harmonize volunteer relations by encouraging co-operation and linking separate households to build up self-governed shrimp farming groups as well as unions, co-management, and cooperatives that take part in aquaculture.

The seventh challenge is environmental. Environmental problems of shrimp farming come from unplanned development and users who are irresponsible or lack essential knowledge. Each project is required to comply with environmental impact assessments and make a list of the environmental impacts. However, almost no legal regulations of the government have succeeded in managing environmental problems and assessing the impacts on the coastal shrimp farming environment. Many farmers developed shrimp farms under the form of small- scale operations based on a solution to diversify income without establishing projects. As a consequence of the degradation of the environment and water quality, diseases frequently occurred. The epidemic diseases are a big threat for aquaculture in general and shrimp farming in particular, especially when the transformation takes place too quickly, when sources of capital for investment are limited, and when planning cannot catch up with the development.

The eighth issue for shrimp production is social. The extensive production form has not met the demands of coastal communities with high population density. The transition to intensive farming requires a large amount of capital and sophisticated technology that makes it nearly impossible for the poor to get involved. At the same time, aquaculture development also leads to a reduction in coastal resources such as estuaries, alluvial grounds, and mangrove forests, which the poor used for earning their living before (natural fisheries, small business). Benefits from aquaculture are probably distributed more unevenly to the parties in the coastal communities. Most of the benefits accrue to the households taking part in the shrimp aquaculture, which partly widens the gap between the rich and the poor in the region, threatens poor farmer's livelihood and creates the risk of unsustainable development. Thus, when encouraging aquaculture and particularly when promoting intensive

shrimp farming with the involvement of outsiders, social and economic issues in coastal zones have become more pressing, especially the conflicts between the outsiders and the local people, employment for the poor and reservation of natural resources which serves their livelihoods. The aims of hunger elimination and poverty alleviation in developing shrimp farming can be realized through phasing in the government's policies. For instance, the government must do well in carrying out policies to make the shrimp farming profitable and ensure steady growth. In addition, the government should reasonably levy taxes such as environmental tax, land tax, taxes on corporate or on shrimp farms and extract some of this money to alleviate poverty, eliminate hunger as well as improve the public infrastructures in order to enhance the lives of the people. However, at present, most of the government's policies for aquaculture are focused on growth rather than on regulating and managing social issues concerning the development of shrimp farming.

The market for products is the final issue in shrimp production. The sustainability of shrimp farming depends much on the market demand. Currently, shrimp products are mostly exported to three main markets: America, Japan and European Union. World markets for shrimp products tend to be fully matured, while in some countries the areas for shrimp farming are continually increasing based on a more diverse shrimp species culture. Therefore, the world shrimp sector is suffering the pressure of increasing competition. Consumers in developed countries are more and more concerned about the quality of products and social and environment issues caused by shrimp farming. Barriers like quality and technological standards, origins, traceability of products are being established. This will cause many difficulties for Vietnam's shrimp industry in general, as the sector consists of mainly small-scale producers in which the condition of the channels of purchasing and marketing products are not good. To deal with these problems, many experts support the solution of developing centralized zones for shrimp farming industrially and intensively in order to control the quality of products in the production process (Nhuong et al, 2006). However, development of intensive industrial shrimp farming zones probably will not support the control for quality of products. The majority of farmers use industrial feeds, medicines, and chemicals in intensive farming. The government set up programs of research and fisheries extension in order to gradually apply GAP/BMP. It is

dangerous for the small-scale producers if the markets demand very strict standards that they cannot meet. In this case, only big businesses and large-scale farm owners with efficient performance have a chance of survival. One option for small scale producers is establishing self-governed teams, unions, cooperatives, co-management in order to enhance performance, protect the environment, prevent diseases, and create high quality products.

Vietnam's shrimp sector which is developed by coastal communities without a concentration of large-scale investors has avoided social conflicts among local resource beneficiaries and shrimp farmers, and therefore has enhanced the social sustainability. However, the small- scale production has made the shrimp farming in Vietnam less efficient and production cost higher than those in other countries (Nhuong et al, 2006). In addition, the application of practical regulations and experiences as well as the control of product origins will become more difficult over time. The current trend of development shows encouragement from the government for intensive farming with the involvement of outside investors; this is a solution that industrializes the shrimp sector. Together with encouraging investors and stimulating the farm economy, the government should take into account the environmental management measures and adjust the social relations by means of policies, taxes, and fees that are imposed on the coastal shrimp farmers.

7.2 Conclusions

It has been difficult to manage the development of brackish water shrimp farming in a sustainable way. Comprehensive research on the real situation, challenges and concerning problems of shrimp farming industry will support the sustainable shrimp development trend in Bentre.

The shrimp farming in Bentre is a relatively new activity that can be extremely profitable. Therefor, it has tended to develop very rapidly, without adequate planning or regulation. This development is at low level, mainly under the form of extensive and improved extensive, or at higher level as in semi-intensive farming systems. Hence, the productivity of most shrimp farms is low. In addition, the major production model is the household-based economy, which is very tattered and simple.

This has negative effects on the product quality, particularly hygienic standards of the food, and leads to a decrease in product competitiveness in the market while creating management difficulties as well.

Since it is significant source of foreign currency earnings, the government is interested in promoting rather than restraining the shrimp expansion (thus promoting environmental conservation) by offering generous tax incentives and other inducements. Many salt-infected rice fields, salt fields, and coastal alluvial grounds have been transformed to aquaculture, especially shrimp farming. Although it creates opportunities for employment and income in coastal communities, the management of the shrimp sector faces many obstacles, such as planning, irrigation, seed, lack of capital and environmental protection. The fast growth of shrimp farming in Bentre creates urgent environmental issues in both the short-term and long-term, such as mangrove degradation, ecological imbalance, pollution, and the outbreak of diseases. Disease is so far the greatest threat to the sustainability of the shrimp farming industry. The use of chemicals associated with disease prevention and treatment are also major problems in the industry, related partly to the unplanned and unregulated development already noted. Although some shortcomings in management, planning, seed production have been pointed out for many years, they still remain unsolved because of a weak management mechanism, limited ability of staff, and the low-educational standard of the majority of farmers. The potentials of the export markets are great but many challenges remain ahead because of the increasingly sophisticated requirements of quality, food hygiene and the erection of “technological and trade barriers”.

Shrimp aquaculture generally requires high investments in both land and water for more extensive systems, or inputs for more intensive systems. The need for investment funds makes the activity less accessible to the poor farmers, and it may therefore generate risks in this sector. Careful access to credit for shrimp farmers is necessary.

It is clear that more sustainable shrimp farming will be difficult to achieve without a comprehensive and integrated set of interventions and initiatives by the government, development agencies, planners, extension agents, farmers, NGOs, processors/traders, and researchers. All these parties should be involved and become stakeholders in shrimp production. Together they should promote or facilitate a more

rational and appropriate use of land and water, work to better protect the environment, and improve monitoring and regulation related to disease incidences, water management, and wastewater disposal. To implement these requirements the national and local governments are important in shrimp production. The roles should be co-ordinated and promote appropriate interventions that will be crucial to the future sustainability of the shrimp culture.

At present, the shrimp sector is developing towards a reasonable structure of improved extensive farming, semi-intensive farming and intensive farming. At the same time, the government also encourages establishing centralized shrimp farming zones for export. Goals such as community involvement, enhancing quality, increasing the output of shrimp products, sustainable development, and environmental protection are faced with many difficulties and will be challenges in forthcoming years. Therefore, in Vietnam in general and in Bentre in particular, the policies for the shrimp industry must be adjusted and complemented to improve the quality of the development so that the shrimp farming can develop sustainably.

REFERENCE:

Bentre People's Committee. (2003): Policies for aquaculture development in Bentre province (in Vietnamese). Bentre, Vietnam.

Cao Le Quyen, T. P. L. (2006): Policy Research and Development for shrimp farming in Camau, Vietnam. Vietnam Case Study in the International project: Trade liberalization, Rural Poverty, and Environment. WWF reports.

Center for Development and Integration Vietnam (CDI). (2006): Trade liberalization and shrimp farming of the poor in Bentre province. Hanoi, Vietnam**:** 17.

Chanratchakool, P., Turnbull, J.F., Funge-Smith, S., MacRae, Ian H. and Limsuwan, C. (1998): Health management in shrimp ponds (3rd edition). Aquatic Animal Health Research Institute, Bangkok.

Charles, A. T. (2001): Sustainable fishery systems (Fish and aquatic resources series 5) Oxford: Blackwell Science.

Dan, N. C. (2007): Recent aquaculture development in Vietnam and future trends. World Aquaculture Society Conference, Hanoi, Vietnam.

Do Quang Tien Vuong, C. K. L. (2001): Rice-Shrimp Farming in the Seawater Intrusion Zone of Mekong delta, Vietnam. ITCZM Monograph No. 6.

DoFi Bentre. (2005a): Annual report of fisheries production in 2005 and action plan for the year 2006 (in Vietnamese). Bentre, Vietnam.

DoFi Bentre. (2005b): Fisheries production report in five years (2001-2005) and action plan for period 2006-2010 (in Vietnamese). Bentre, Vietnam.

DoFi Bentre. (2006): Annual report of fisheries production in 2006 (in Vietnamese). Bentre, Vietnam.

DoFi Bentre. (2007a): Meeting on established fishery co-manangent in Bentre (in Vietnamese) (Record at 29.06.2007). Bentre, Vietnam.

DoFi Bentre. (2007b): Annual report of fisheries production in 2006 and action plan for the year 2007 (in Vietnamese). Bentre, Vietnam.

DoFi Bentre. (2007c): Report of fisheries activities in first 6 months of the year 2007 and action plans 6 months remain (in Vietnamese). Bentre, Vietnam.

Edwards, P. (1998): A systems approach for the promotion of integrated aquaculture. Aquacult. Econ. Manage. 2: 1-12.

EJF. (2002): Risky Business: Vietnamese Shrimp Aquaculture – Impacts and Improvements. Environmental Justice Foundation. London, UK.

FAO. (1995): Code of Conduct for Respoonsible Fisheries. FAO, Rome.

FAO. (1997): FAO Technical Guidelines for Responsible Fisheries : Aquaculture Development. FAO. N. 5. Rome

FAO. (2005): Vietnam's Fisheries Country Profile

FAO. (2006): The state of world fisheries and aquaculture:

FAO/NACA. (1995): Regional study and workshop on the environmental assessment and management of aquaculture development (TCP/RAS/2253). NACA Environ. Aquacult. Develop No. 1.

Ha Xuan Thong, H. C. H., Nguyen Hai Duong. (2003): Actual situations of shrimp farming in mangrove ecological system and number of development orientations (in Vietnames). Hanoi.

Huynh Thi Tu. et al. (2007): Acetylcholinesterase activity as a biomarker to assess the stress level of *Penaeus monodon*. World Aquaculture Society Conference, Hanoi, Vietnam.

Jentoft, S. (2007): Limits of Governability: Institutional Implications for Fisheries and Coastal Governance Marine Policy 31 (4): 360-370.

Kooiman, J., Chuenpagdee, R. (2005b): Governance and Governability. Fish for Life. Interactive Governance for Fisheries. J. Kooiman, Bavinck, M., Jentoft, S., and Pullin, R. MARE publication series No.3: 325-349.

Michael Phillips, C. B., Peter Edwards. (2001): Systems Approach to Aquaculture Management. Aquaculture in The Third Millennium. P. B. B. Rohana P. Subasinghe , Michael J. Phillips, Courtney Hough, Sharon E. McGladdery, J. Richard Arthur. Bangkok, Thailand**:** 239-247.

Mikalsen, K. H., Jentoft. S. (2001): From user-group to stakeholders? The public interestin fiesheries management. Marine Policy 25 (2001)**:** 281-292.

MOFI. (1996): Annual Report of Fisheries Production in 1995 and Action Plan for the year 1996 (in Vietnamese). Hanoi, Vietnam.

MOFI. (1999): Aquaculture Development Program for period of 1999 – 2010. (in Vietnamese). Hanoi, Vietnam**:** 20.

MOFI. (2001): Annual Report of Fisheries Production in 2000 and Action Plan for the Year 2001. (in Vietnamese). Hanoi, Vietnam**:** 21.

MOFI. (2005): Annual Report of Aquaculture Production in 2004 and Action Plan for the year 2005 (in Vietnamese). Hanoi, Vietnam**:** 25.

MOFI (2006): The review report on the Implementation of the Aquaculture Development Program period of 2000-2005 and solutions for the next period of to 2010 (in Vietnamese) Ministry of Fisheries, Ha Noi, Viet Nam**:** 33.

NACA. Better Management Practices http://www.enaca.org/modules/tinyd12/index.php?id=3." Retrieved 31 jan, 2008.

NACA/SUMA. (2005): Reducing the Risk of Aquatic Animal Disease Outbreaks and Improving Environmental Management of Coastal Aquaculture in Vietnam.

NAFIQAVED. (2006): Project completion report "Implementation of good aquaculture practice (GAP) to ensure food safety for fishery material originated from 23 ha, 37 ha culturing sites of Binh Dai district and K22 culturing site of Thanh Phu district, Ben Tre province." (in Vietnamese)**:** 3-6.

NAFIQAVED. (2007): List of Chemicals, drugs and other products for water treament use in Aquaculture till 15th of May, 2007 (in Vietnamese). Hanoi, Vietnam.

Nga, T. T. T. (2006): Co-management in shrimp production in Bentre province (in Vietnamese). Sustainable Shrimp Development Conference. Hanoi, Vietnam.

Nhuong. T. V., et al. (2006): The shrimp industry in Viet Nam: Status, Oppurtunities and Challenges (Chapter 12), 20 pp in the Book of Shrimp Farming and Industry: Sustainability, Trade and Livelihoods. The University Press Limited, 2006. ISBN 984 05 1643 4 (Bangladesh Centre for Advanced Studies).

NORAD. (1999): The Logical Framework Analysis: Handbook for objectives-oriented planning. 4th Edition.

Oxfam Great Britain. (2003): A Participatory Poverty Assessment. Duyen Hai and Chau Thanh Districts, Tra Vinh Province, Vietnam. Oxfam GB. Hanoi, Vietnam.

Pillay, T. V. R. (1997): Aquaculture development and the concept of sustainability International Conference on Aquaculture, Kuala Lumpur 25-27 Sept. 1996.

Pornlerd chanratchakool, F. c., et al. (2004): Extension material for shrimp culture in Vietnam.

Sena S De Silva, M. J. P., C.V. Mohan. (2007): Meeting the Demands and Challenges of Globalization of Trade in Aquaculture: The Role of a Regional Inter-Governmental Body. World Aquaculture Society Conference, Hanoi, Vietnam.

Shang, Y. C., Leung. P, and Bith-Hong Ling. (1998): Comparative economic of Shrimp farming in Asia. Aquaculture. **164:** 183-200.

Srinath, K., Sridhar , M., Kartha, P.N.R., and Mohana, A.N. (2000): Group farming for sustainable aquaculture. Central & Coastal Management **43:** 557-571.

Statistical Office. (2005): Statisttical Yearbook 2005 (in Vietnamese) Ben Tre Statiscal Office 2006.

Sy, N. V. (2007): Interview on shrimp production in Bentre (Record on 05.07.2007). Bentre, Vietnam

Tam, H. V. (2007): Meeting on established fishery co-manangent in Thachphuoc commune (in Vietnamese) (Record on 28.06.2007). Thachphuoc, BinhDai, Bentre, Vietnam

Thao, N. V. (2006): The elements effected to industrial shrimp production in Bentre province (in Vietnamese). Hochiminh, University of Economics.

Thuy, P. X. (2004): Build up intensive shrimp farming model in Khanhhoa province (in Vietnamese). Nhatrang, Fisheries of University. Doctor of science.

Vietnamnet. (2007): Vietnam's black tiger shrimp meets redoubtable rival (in Vietnamese) http://vietnamnet.vn/kinhte/2007/11/757197/." Retrieved 28 Nov, 2007.

VIFEP. (2002): Current status of potential aquaculture in coastal area and environmental factors affected to Vietnam's coastal aquaculture (in Vietnamese). Hanoi.

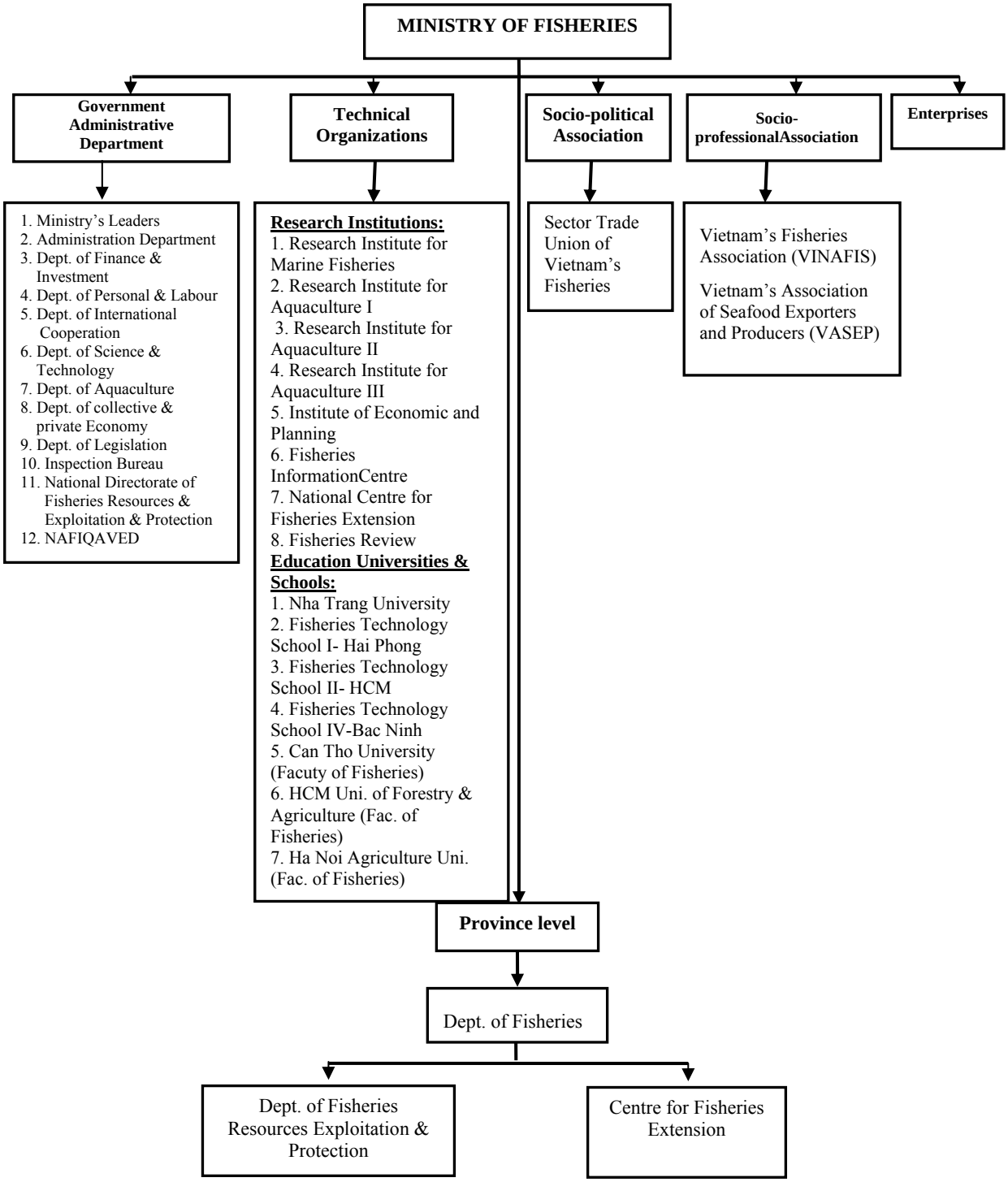
VnExpress. (2004): DOC final decision for Vietnam' Shrimp (in Vietnamese): http://www.vnexpress.net/Vietnam/Kinh-doanh/2004/12/3B9D91AF/. Retrieved 21, February 2008.

World Bank. (1998): A discussion paper designed to assist in the development of sustainable shrimp aquaculture- Shrimp Farming and the Environment

World Bank (2004). Research Report on Vietnam Fisheries and Aquaculture.

APPENDICES

Appendix 1: Organization structure of Fisheries sector (update July, 2007)



Appendix 2: The examples of questioners

1. Total shrimp pond(s) area?
2. Stock density?
3. Where did you buy seed? How is seed quality?
4. Does your pond system have separate supply canal and drainage canal?
5. Does your pond system have a reservoir? And have a sediment pond?
6. Do you treat waste water before drain off away from culture pond?
7. Did you use chemicals/drugs to kill fish in ponds before stocking?
8. Do you use antibiotics /drugs in treating diseases and pond management?
9. How were the results of your treatment?
10. What is your opinion about diseases in shrimp culture over the last 5 years?
11. Does it lack fresh water during the dry season?
12. How do you think about water quality during the last 5 years?
13. After you started with aquaculture, how is your family income?
14. Do you have plans to extend your shrimp area?
15. Do you find conflicts in shrimp production?
16. How is your ability to loan money from the bank?
17. Assess your economy during the last 5 years with shrimp culture
18. Who buys your shrimp product (% total product)?
19. How is cost of producing shrimp the last 5 years?
20. How is result of last crop?
21. Do you meet any conflict between people inside and outside your organization
22. Do you follow all requirements stated in the regulations?
23. Do you think it is necessary to develop assistance community management in aquaculture

Appendix 3: List of farm farmers was interviewed

NAME	District	NAME	District
Nguyen Van Dung	Binhdai	Lam Van Hoa	Batri
Ngo Van Bo	Binhdai	Tran Van Dua	Batri
Nguyen Van Ri	Binhdai	Vo Van Ton	Batri
Nguyen Thanh Cong	Binhdai	Le Hong Hanh	Batri
Tran Van Duc	Binhdai	Le Van Thong	Batri
Trinh Văn Quan	Binhdai	Nguyen Van Tu	Batri
Ngo Xuan Hong	Binhdai	Pham Van An	Batri
Luong Van Thu	Binhdai	Nguyen Van Men	Batri
Pham Van Tang	Binhdai	Nguyen Van Chien	Batri
Nguyen Tan Vu	Binhdai	Nguyen Van Ham	Batri
Pham Van Tien	Binhdai	Nguyen Van Rong	Batri
Nguyen Van Phong	Binhdai	Nguyen Van Chin	Batri
Ha Van Lien	Binhdai	Vo Van To	Batri
Nguyen Van Thao	Binhdai	Nguyen Van Sang	Batri
Vo Van Long	Binhdai	Nguyen Van Be	Batri
Nguyen Van Bi	Binhdai	Le Van Duc	Batri
Le Van Tinh	Binhdai	Dang Thi Khai	ThachPhu
Tran Van Hai	Binhdai	Tran Van O	ThachPhu
Tran Van That	Binhdai	Phan Van Truong	ThachPhu
Bui Van Ghe	Binhdai	Nguyen Van Choc	ThachPhu
Nguyen Thi Diep	Binhdai	Nguyen Van Xieu	ThachPhu
Pham Van Het	Binhdai	Le Thi Chiem	ThachPhu
Nguyen Thi Tham	Binhdai	Nguyen Van Nhan	ThachPhu
Nguyen Van Quan	Binhdai	Pham Van Ngan	ThachPhu
Pham Thi No	Binhdai	Le Van Cung	ThachPhu
Duong Thi Tham	Binhdai	Le Van Them	ThachPhu
Do Van Manh	Binhdai	Ho Van Cai	ThachPhu
Nguyen Van Hiep	Binhdai	Mai Van Cach	ThachPhu
Bui Van Minh	Binhdai	Mai van Ngoan	ThachPhu
Phan Van Chau	Binhdai	Tran Van Tri	ThachPhu
Nguyen Van Tong	Batri	Le Van Hien	ThachPhu
Nguyen Van Doi	Batri	Mai Thi Trieu	ThachPhu
Le Huu Lai	Batri	Truong Thi Yen	ThachPhu
Nguyen Van Cut	Batri	Vo Van Chan	ThachPhu
Tran Van Thanh	Batri	Nguyen Van Vi	ThachPhu
Ho Van Chi	Batri	Le Van Tho	ThachPhu
Dao Van Khan	Batri	Nguyen Van Khon	ThachPhu
Ho Van Toi	Batri	Huynh Duy Hung	ThachPhu
Tran Van Thien	Batri	Vo Van Sa	ThachPhu
Nguyen Van Chang	Batri	Pham Van Ga	ThachPhu
Pham Thanh Phuc	Batri	Tran Van Lo	ThachPhu
Nguyen Van Tho	Batri	Dang thi Kha	ThachPhu
Thai Van Den	Batri	Ho Van Lao	ThachPhu
Thai Van Thoi	Batri		

Appendix 4: Illustration pictures of shrimp production in Bentre *(Photo by: Pham Van Khang)*

Management board meeting in Thachphuoc commune

Semi-intensive shrimp farm in Bentre

Rice field converted to shrimp farm

Panel with needed information in shrimp production