OPPORTUNITIES AND CHALLENGES IN LOBSTER MARINE AQUACULTURE IN VIET NAM: THE CASE OF NHA TRANG BAY

Nguyen Thi Kieu Thao

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The Norwegian College of Fishery Science

University of Tromso, Norway

&

Nha Trang University, Vietnam

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Nha Trang city, May 15th, 2012

Nguyen Thi Kieu Thao

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ABSTRACT

Well-known for high value in economics, art and nutrition, nowadays, lobsters are exported for high income, and are popularly cultured in open ecosystem of the central provinces of Vietnam, including Khanh Hoa province. Developing from 1990s, lobster farming generates super profit and high internal rate of return in investment. As a small lobster culture region of Khanh Hoa province, lobster farming career in Nha Trang bay used to create a number of jobs for not only farmers, but also for fishers and other locals related to this farming. In recent years, after the disease outbreak occurred in 2007-2008 and the typhoon happened in 2009, there is a phenomenon that farmers in Nha Trang bay limit their cages for lobster culturing and transform gradually to culture marine finfish. Additionally, a new regulation of the Government was introduced from 2010 in the bay. Threats from disease outbreaks and natural disaster, pressures from costs increase and devaluation from middlemen are unbearable to farmers. Still they do overcome these obstacles and continue their farming in the changing economic conditions nowadays.

This paper estimated nitrogen loadings and profitability under these circumstances to find out what factors influence on this career in Nha Trang bay. In order to explain, a model was built, and results were derived based on 60 observations of lobster farms in Nha Trang bay within March 2012. By a simple econometrics model, the role of parameters such as environment, stocking density, culture time, number of cages, costs related to operation such as seed cost, feed cost, antibiotics and vitamin use, capital source, species composition was descriptive in this profit estimation. Moreover, opportunities and challenges are defined in this career to farmers.

One of the results found, is that the new regulation introduced was well received. Profitability of farms was found with an average of benefit cost ratio of 30.1% and an average of 30% in internal rate of return. For suggestion to farmers in near future, farmers should reduce stocking density as well as concentrate on feeding the two most valuable species such as spiny lobster and green lobster without caring about red lobster in Nha Trang bay.

KEY WORDS: *Nha Trang bay, Marine cage lobster aquaculture, opportunities, challenges, nitrogen loading, new regulations, internal rate of return, profitability estimation.*

1.CHAPTER 1: INTRODUCTION

1.1. OVERVIEW OF AQUACULTURE IN VIET NAM

The world’s ever-growing population is consuming more and more fish while our oceans cannot produce enough wild fish for our human being (NACA, 2010). Aquaculture is nowadays considered the only viable alternative for meeting the increasing need for fish and seafood products in the future (NACA, 2010). The fisheries and aquaculture sectors are important contributors to the GDP of many Asian countries (De Silva, 2009). Nevertheless, while aquaculture provided economic and nutrient benefits to millions, its development has directly contributed to the loss of significant ecosystem properties through land and seascape transformation, and also more indirectly through pollution into sea (NACA, 2010). There are also concerns in fluctuation of markets and resources as well as climate change. Sea level rise, changes in temperature and salinity may have undesirable impacts on the resilience of social-ecological systems in almost countries which economies related to marine aquaculture. Vietnam, similarly, is not excluded from these countries. Advantages and disadvantages in marine cage farming in this change need to be considered.

Being one of the nations along the East Sea, Vietnam’s coast line is relatively shallow and has strong surface and bottom currents but less wave height, except in the seasonal severe typhoons. Because of such good natural conditions, marine aquaculture has developed in Vietnam since 1989. Up to now, it has played an important role as income for households in many provinces of Northern and Central regions such as Hai Phong, Binh Dinh, Phu Yen, Khanh Hoa, etc. Therefore, the Ministry of Agriculture and Rural Development has very high growth expectation for marine fish cage farming, due to the high prices received from the products produced such as lobster, orange spotted grouper, tiger grouper, green or greasy, glass-eyed perch, sea bream, cobia, red snapper, sea bass, pompano, red drum, etc. For the year 2005, fish production is estimated at 5,000 tones and for lobster at 1,795 tones (FAO, 2007).

In year 2005, there were more than 45,000 lobster cages in Viet Nam, which mainly farmed lobster in Khanh Hoa(over 25,000 lobster cages) and Phu Yen (about 19,000 lobster cages) (Nha,

2006) (figure 1). Many households in Central coast of Vietnam became rich from this marine farming (Khanh Hoa Association of Fisheries, 28 Jan 2010).

Figure 1: Khanh Hoa map *(Source: Google search)*

Lobster production was estimated to be 1900 tons in 2006 with a value at more than US$65 million. In 2007, there was a significant decline in production to about 1400 tones (Hung & Tuan, 2008) because of milky disease, and the production continued to fall in the following years (table 1).

Table 1: The development of marine lobster culture in Khanh Hoa, Phu Yen and Ninh Thuan in period from 2000 – 2009

Unit: cages/tons

Province	Items	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Khanh Hoa	Number of cages	***9,380***	***11,500***	***14,980***	***16,647***	***23,420***	***25,418***	***29,206***	***27,100***	***27,000***	***20,829***
	Volume	***561***	***550***	***765***	***985***	***1,655***	***1,100***	***1,142***	***863***	***712***	***600***
Phu Yen	Number of cages	8,065	8,335	8,885	15,529	19,020	18,220	18,400	22,505	19,414	17,427
	Volume	102	161	177	424	647	764	750	461	388	235
Ninh Thuan	Number of cages	200	290	450	410	555	350	130	120	130	150
	Volume	20	30	40	45	50	45	25	16	18	27
Total in 3 provinces	Number of cages	**17,645**	**20,125**	**24,315**	**32,586**	**42,995**	**43,988**	**47,736**	**49,725**	**46,544**	**38,406**
	Volume	**683**	**741**	**982**	**1,454**	**2,352**	**1,909**	**1,917**	**1,340**	**1,118**	**862**

Source: An, 2011.

The need of consumers in main export markets namely Hong Kong, Taiwan of China and Japan is a strong driving force for the development in aquaculture of Vietnam. Due to Vietnam's advantage in geographical position to such areas, live and chilled fish are mainly traded by boats in convenience in comparison to other ASEAN countries (Association of Southeast Asia Nations). Also, there is a growing demand of fresh fish from domestic market due to substantially improved personal income over the years (Hung, 2007).

However, mariculture in Vietnam is often still small scale, mainly because it is restricted to the inshore areas (De Siva, 2007). In addition, there are still some limitations including a need to develop markets, hatchery and nursing technologies, finding feed alternatives to trash fish, and problems with diseases control and health management. Associated with its fast development, Vietnam's aquaculture has already encountered significant challenges in recent years, including disease outspread, food safety issues with products for local consumption and export, negative environmental impacts on habitats and water quality (MOFI, 2005a). Environmental problems are particularly serious within sea water exchange. Uncontrolled development in farming cages has lead to self- pollution of aquaculture farms resulting in continued disease outbreaks and heavy economic loss for farmers. With this kind of farming in environmental "open – access" culture conditions, it is necessary to plan careful site selection and adopt improved management in order to minimize these losses. The question for authorities then is how to balance the negative and positive consequences from an environmental integrity perspective.

1.2. PROBLEM STATEMENT AND RESEARCH OBJECTIVES

1.2.1. Problem statement

In Central of Vietnam commonly and in Nha Trang specially, lobsters used to be opportunities for life change of numerous farmers with high returns. Taking account for about 73 percent of total marine aquaculture surface water in Nha Trang bay, as a valuable export species, lobsters generate the highest value in comparison to other cultured species in the same region (Department of Khanh Hoa's Fisheries, 2007). From the infant period in 1990s, the rapid development in number of cages was out of control of the authority. From a socio- economic view, cage farming, has over the two last decades created numerous careers for local labors, not only for farmers and fishers, but also for labor related to building and operations of hatcheries in the area.

Normally, farmers stock lobsters in all months of the year, but mainly from November to April in the next year. According to the experience of farmers, this is the time period when seed resource exploited is most abundant, have the best quality and the highest survival rate. In order to reduce seed cost, this industry relies completely on the capture of wild swimming pueruli or settled juveniles by local fishers and merchants. Nevertheless, facing seasonal disease and natural disaster, recently, the farmers have encountered strong forces from other challenges such as rise in costs related farming activity, lack of capital and farm gate price variation. From the fact that milky disease outspread led to lobster's death in most of cages in Central of Viet Nam in year 2007, lobster farmers fall in disadvantages in their farming continuously. From year 2009, price of many goods has varied strongly due to inflation, which has varied from 7% (2009) to 18.6% (2011) (CIA World Fact Book). It is difficult to keep high production with high profit each crop as previous years. Even though, with high volume harvested in crop, the farmers might worry about loss of income because of falls of farm gate price at the time of harvest. Nowadays, instead of using 100% number cages for lobster as in last decades, farmers has reduced the number of cages used for lobster gradually by nearly 50 percent, using the other proportion to culture marine finfish.

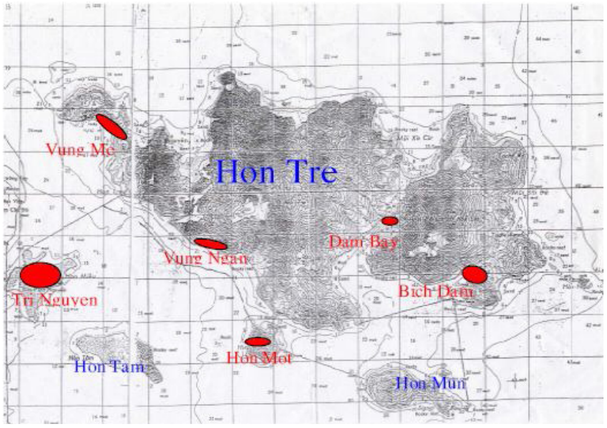

Figure 2: Distribution of five cultured areas in Nha Trang bay *(Soure: Yen et. al, 2002)*

As a wonderful tourism destination, Nha Trang bay is considered as one of the most beautiful bays in the world. Aquaculture farming and tourism in the same bay are the challenging for both industries although in this case farms are in small scale. In order to establish the rights and duties of farmers as well as ensuring sustainable development, in 2007, the Government had set a Master plan of marine aquaculture farming in surface seawater of Nha Trang bay and Cam Ranh bay from 2007 to 2015. Based on this project of regulations, many surveys were carried out to formulate environment controlling data as well as built details in map of aquaculture areas mainly. From December of 2010, the Government in Khanh Hoa province introduced regulations restricting the number of cages, the position of the cages, the distance between farms and the total area in which aquaculture is allowed. Table 5 shows the development in number of households involved in farming of lobster, the number of cages and area used for the years 2005, 2010 and 2011.

Table 2: The development in number of households involved in farming of lobster, the number of cages and area used in Nha Trang bay from 2005 to 2011

Area	Year 2011			Year 2010			Year 2005		
	No. of HH (HHs)	No. of cages (cages)	Culture area (ha)	No. of HH (HHs)	No. of cages (cages)	Culture area (ha)	No. of HH (HHs)	No. of cages (cages)	Culture area (ha)
Vung Ngan	79	2,576	3.7600	82	2,622	-	50	1,191	2.050
Dam Bay	47	1,648	2.6006	68	3,027	-	52	1,073	2.700
Tri Nguyen	55	1,176	1.8090	82	1,100	-	59	486	1.350
Hon Mot	22	732	1.0512	30	859	-	27	491	0.930
Bich Dam	54	687	0.9749	58	762	-	51	502	0.800
Total	**257**	**6,819**	**10.1957**	**302**	**8,470**	**13.800**	**239**	**3,743**	**7.830**

(Source: Department of Economics of Khanh Hoa Committee, 2012)

Note: Households denoted by HH, “-“: lack of data.

Five lobster culture areas, Tri Nguyen, Hon Mot, Vung Ngan, Bich Dam and Dam Bay in Nha Trang Bay, are subjects to the regulations. The total culture area of surface water was reduced by 3.6 ha, accounting for 26 % of the region, from 13.8 ha in 2010 to 10.2 ha in 2011 (table 2). Accordingly, households who had empty or unreported cages in previous years or inefficient farms had to cut down these numbers. Distance between the farms was adjusted in order to make room for free for water flows and movement of resident’s boats. All farms were arranged in lines and areas like a “town” in the sea surface. Manta anchors and artificial reefs were set up on seabed in order to stabilize farms as planned positions. All farms were positioned by Geographic position system (GPS) and provided with identified numbers in East sea specific position. From now on, the regulation in this area has set up.

Table 3: The development of Lobster cultured in Nha Trang bay in period from 2001 - 2011

Item/Year	2001	2005	2006	2007	2008	2009	2010	2011
No. of lobster cages (cages)	1,579	3,743	-	-	-	-	8,470	6,819
Cultured area (ha)	71	20	20	20	13.8	13.8	13.8	10.2
Volume of lobster (tones)	-	300	223	113	220	200	200	208

(Source: Department of Economics of Khanh Hoa's Committee, 2012)

Comparing to year 2001, the number of cages in 2010 is over 5 times higher although the area used is reduced by approximately 80%. Moreover, disease outbreaks have occurred to threat farmers from year 2006, with total volume in 2007 reduced by 49% from 223 tones (in 2006) down to 113 tones. The main reason for the decrease outbreak is said to be environmental degradation and pollution from marine farming in the sea water (Department of Fisheries Aquaculture, 2012). Interestingly, productivity of lobster in these farms has increased after the treatment regimen on lobster applied.

1.2.2. Research objectives

The general objective of the study is to estimate opportunities in marine lobster aquaculture as well as possible economic impacts of changing environmental conditions on this farming in Nha Trang bay. In this paper, we discuss opportunities in new regulation and analyze which factors affect profitability in this farming industry in the area. Variables included in the analysis are an environmental indicator (nitrogen loading), stocking density, culture time, number of cages, experience of farmers, seed cost, antibiotics and vitamin cost, species composition, location and capital source. Data from 60 farms in these 5 aquaculture areas of the bay was collected and used in the analysis. In addition, benefit-cost ratio, net present value and internal rate of return of this career are also calculated.

The paper is structured as follows:

In the first section, we characterize the economics of lobster aquaculture at the local level, and highlight the industry's key problems**.** Section 2 provides a short literature review and methodology.

Section 3 presents the results of the analysis, while in the last section we describe a range of alternatives and solutions, and present recommendations to the Government and farmers of Nha Trang bay. We propose some solutions or recommendations on how to develop a more efficient and sustainable lobster aquaculture in the near future of the bay.

1.3. STUDY SITE

1.3.1. Role of lobster aquaculture in Khanh Hoa province

The coastal region of Khanh Hoa province is a potential location for developing marine aquaculture, especially seed nursing and marine aquaculture. In the past decade, farming of marine fish, initially in cages located in sheltered coastal waters developed mainly by small enterprises, has started to grow significantly. The businesses are typically single household investments, with small scale from 5 to 50 cages depending on wealth and credit worthiness.

Nowadays, Khanh Hoa is well-known as main location for supplying many species such as tiger shrimp, white leg shrimp, snails, crab as well as some valuable fishes like grouper, red snappers, cobia and sea bass. Fisheries seed hatcheries have mainly crowded in coastal districts namely Ninh Hoa district, Van Ninh district, Nha Trang city and Cam Ranh city.

In recent years, although some lager farms have developed with foreign investment originating from Norway, Taiwan, France and Australia, the small-scale farmers still dominate this sector with a large fraction of the total number of cages. The main marine fish species cultured are lobster and red drum. There are 23 lobster culturing areas belonging to the four main regions with total area 4,112 ha (appendix 1).

In 1993, several dozens of households farmed lobsters and groupers in several hundred cages (Master planning of mariculture in Nha Trang bay up to the year 2015, 2010). This number has increased quickly in throughout the 1990s (table 4).

Table 4: The development of lobster cages cultured in Khanh Hoa province in period time from 1994 - 1999

Year	1994	1995	1996	1997	1998	1999
No. of lobster cages (cages)	580	1,400	1,500	1,500	2,000	2,438
Volume (tons)	80.6	108	160	160	160	203

(Source: Dau, 2002)

Nevertheless, the strong and rapid growth in lobster cages farming, lack of management in this sector contributed to loss for farmers in addition to the disease outspreads normally happened (Khanh Hoa associate of fisheries, 28 Jan 2010). Due to the milky disease outbreaks occurring in the end of year 2006 and the first 10 months of year 2007, most farmers in Khanh Hoa and Phu Yen lost their crop. As a result, in Khanh Hoa, there was a drop in volume from 1200 tons in 2008 to 400 tons in 2007. Table 5 illustrates the development in marine lobster farming in the period from 2007 to 2011.

Table 5: Lobster cultured in Khanh Hoa province in period time from 2007 - 2011

Item	2007	2008	2009	2010	2011
No. of lobster cages (cages)	29,800	28,000	26,958	21,320	19,191
Volume of lobster (tones)	1,200	400	952	1,150	985
The no. of seed (individual)	2,384,000	2,240,000	2,156,640	1,705,600	1,535,280

(Source: Department of Fisheries Aquaculture, 2012)

Thus, at that time, the Government tried to find out alternatives to solve this problem by limiting pollutions from marine aquaculture as well as strengthen lobster in order to adapt the prevailing environment in these areas. The scientists and the Government had researched this disease from the end of year 2007. As a result, treatment regimen on lobster had found out. It has applied from 2008 and is well greeted by farmers here.

1.3.2. Cultured species

Of the many kinds of lobsters found in Vietnam ocean, five species are suitable for aquaculture; green lobster or the scalloped spiny lobster (*Panulirus Homarus (A)),* red lobster or longlegged spiny lobster *(Panulirus longipes (B)),* spiny lobster *or* the ornate spiny lobster *(Panulirus ornatus (C)),* rocky lobster *Panulirus stimpsoni (D),* bamboo lobster *(Panulirus polyphagus (E))* (figure 3).

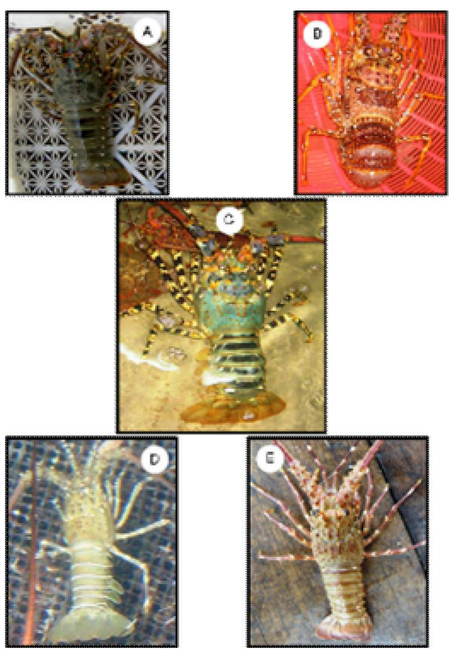

Figure 3: Several lobsters species culture in the Central Part of Viet Nam.

P. homarus (A), P. longipes (B), P. ornatus (C), P. stimpsoni (D), P. polyphagus (E).

(Source: Nha, 2006)

Spiny lobster and green lobster are most cultured because of their high value and environmental adaptive ability in many culture regions. In Khanh Hoa province, red lobster still is farmed besides these two species. The industry relies on wild caught puerulus by fishermen. About 30-40% of the seed originates from local area of the province, the remaining seed is supplied from other near provinces, or imported from other countries (Department of Fisheries Aquaculture, 2012). The lobsters are reared in small cages in until their weight up to approximately 30 g, when they are moved to a different type of cage where they are grew out to commercial size (Williams, 2004). The aquaculture technology of this industry is still to be developed (Williams, 2007).

1.3.3. Life cycle of lobster

Juvenile lobster can be caught from the wild nature or bred by human beings. According to Phillips (2006), the life cycle of the lobster is divided into 5 main stages, each associated with specific ecological conditions, and thus reveals distinct species adaptation (figure 4). Lobster mother spawn fertilized eggs, which become larvae and are drifted to the sea, where they develop until the end of puerulus stage. It takes about 9-11 months for the larvae to grow and become lobster juvenile.

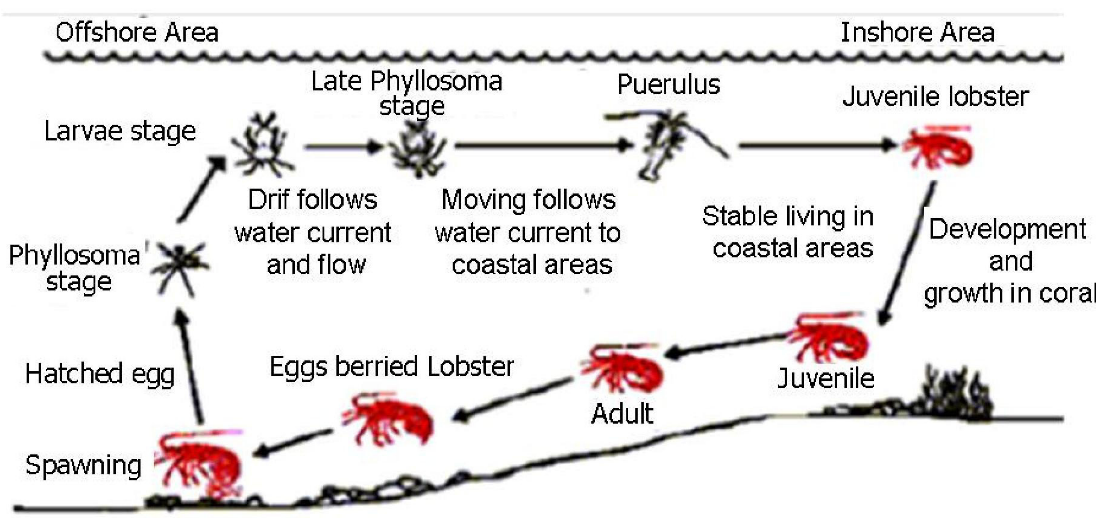

Figure 4: Life cycle of lobsters *(source: Phillip B.F. – CSIRO).*

Phyllosoma stage

Larvae float on the surface water in the oceans and seas and move into the inshore direction via waves, wind, and ocean flows. They have a very fragile transparent body, which is about 1.5 to 2.0 mm in length.

Puerulus stage

Phyllosoma larvae turn into Puerulus larval stage and live in the sea floor after 12-15 times of molting and metamorphosis. The puerulus larvae still have fully transparent bodies, swim freely, move into shallow areas with favorable ecological conditions such as sheltering in areas with complex terrain or covered with numerous seaweeds. The larvae are harvested mostly in the early week of new moon of month.

Juvenile stage

After about 4 times of molting and metamorphosis, Puerulus become young lobsters. They have clearly colors. First, they live in seaweed beach, on edge of the luxuriant branches of advanced sea vegetation or in caves and small interstitial gaps of reefs next to the shore. After reaching the size of 15-20 mm carapace length, they move out to find the small caves covered with rock and seaweeds, where they can find prey and avoid predators.

Adult stage

In this stage, lobsters move to the deeper coastal reefs, from depths of 500-100 m depending on the species. The environmental conditions such as temperature, salinity, sediment composition, light cycle, flow of the tide affect the lobsters' processes of allocating, molting, coupling, fertilizing and laying eggs during this period.

1.3.4. Value chain in aquaculture lobsters

Although cultured by farmers in the last 20 years in Viet Nam, lobster is still a wild species from the ocean. Therefore, the value chain is impacted by many stages. Input refers to cages system, equipment, seed source, feed source, antibiotics, etc. In order to get high output production, culture technology is the core of farming chain. However, in output stage, middlemen play a significant role in trading lobsters and function as a link between output and consumer chains. These chains are connected tightly and the input part is described in more detail the following parts. Figure 5 shows a simplified version of the elements in this value chain:

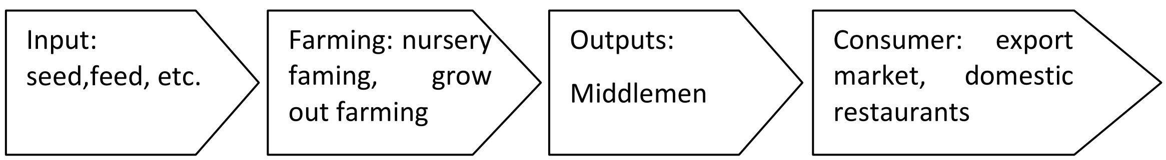

Figure 5: Value chain in lobster aquaculture.

1.3.5. Cage farming

1.3.5.1. Site selection

Site selection is an important part in the culturing or nursing of lobster. Lobster cages are mostly located in bays, gulfs or channels where farms can avoid wave, wind and typhoon, freshwater from rivers in the rain season and polluted water. Bottom under cultured area is sandy or muddy – sandy mixed with hag-horn corals. Minimum water depth (measured at the lowest tide) of cages is 4 m for fixed cages, 4 – 8 m for iron cage type and more than 8 m for floating cages. Speed of water flow and bottom water current is from 1 – 2 cm/s.

1.3.5.2. Cages structure

In practice, small-scale lobster farms usually use the cages of 16 - 20 m^2 (surface area). The main components are cage frame, cage net, floating buoyant and anchor system. Cage frame is made of materials such as iron (submerged cages), durable cylindrical wooden chunks (fixed and floating cages); rectangular parallelepiped in shape. Cage net is variable in mesh size based on the size of lobster and the net installed outside the net cage for protection. Floating buoyant make the farm float and makes it safe to walk on the cage raft. The number of floating buoyant is about 6 -8 pieces per cage squared meter. Anchor system made by iron fixes the cage at a place.

1.3.5.3. Equipments and tools for lobster farm

Culturing in farms under the surface of sea water, each farm needs some essential equipments and tools to support production activities related to diving and living. There are main equipments and machines such as boats, electricity generator, diving equipment, net washing equipment. Boats are used for transporting feed and moving in the sea between the main land and the cages or raft. Electricity generator is used for supplying electricity power for living activities and production. Net washing equipment is used for cleaning net and cages. Diving equipment is used for supplying oxygen for diver under the seawater when checking lobster performance. Tools such as scissors, knife, or cutting machine are used for cutting feed (fresh fish) into pieces of different sizes. Heat-insulating boxes, medicine boxes, buckets, net rackets of different sizes are used to collect lobsters for checking and harvesting. Others are nets, lifebuoy, rope and life-jackets.

1.3.5.4. Types of lobster cage

There are 3 kinds of cages commonly used in Khanh Hoa province. However, floating cages are more popular in Nha Trang bay due to they are moved easily from aquaculture to in-shore during the unstable weather or from polluted water and disease area to the cleaner or without disease area. In addition, feeding and cleaning cages are easier than others. By contrast, the next 2 types of cage are not common in Nha Trang bay.

Floating cages

Although high cost at using durable materials for floating buoy, rope, wooden frame and using fiberboard/canvas to cover the cage to protect lobster from heat of sunlight, these cages are more advantages in moving to better water quality area. Number of wood chunk depends on the scale of raft, normally about 6 – 8 pieces per cage square and connected with each other by stainless steel screws. Common dimension (width x length x depth) of cage is (4 x 4 x 7) m. There are 6 – 8 plastic barrels or cans/ cage square used as floating buoy. Anchors are hung at the four corners of the cage to keep it securely. Rope strands with 2 – 4 cm in diameter connect cage to cage together in the same raft. Distance between two strands is 1 m at least to eliminate the impact of strong wave, especially in storm season. This kind of cages is popular in Nha Trang bay of Khanh Hoa province (Tuan, 2007).

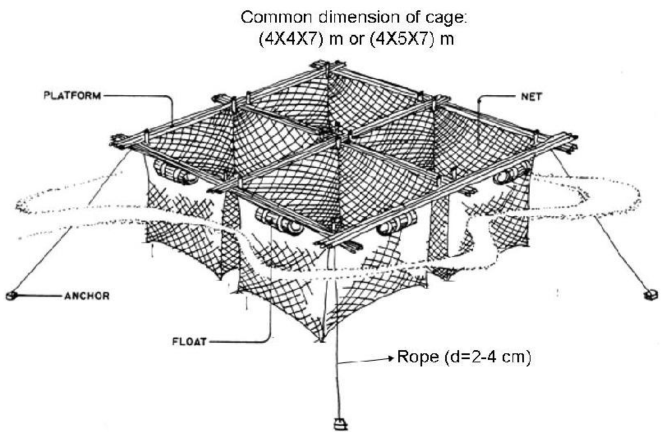

Figure 6: Dimension of floating cage *(Source: Hoang, 2011)*

Submerged cages

The frame is made of iron wire with 8 -12 mm diameter. All iron wires are covered with rust – resistant paint layer inside, layer of tar and nylon outside to increase the lifetime of cage. These cages have a feeding pipe and are common for nursing juveniles in Nha Phu lagoon (Ninh Hoa district) and for growing out in Cam Ranh bay in Khanh Hoa province.

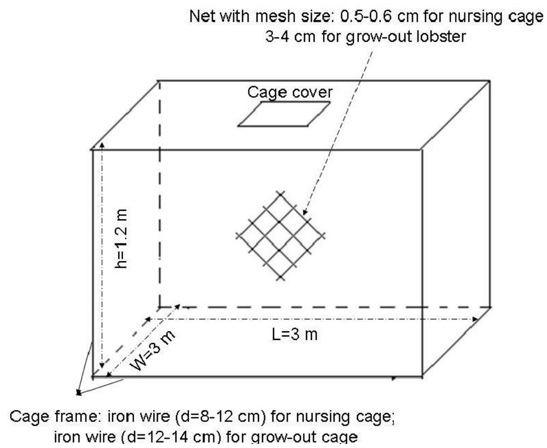

Figure 7: Dimension of submerged cage *(Source: Hoang, 2011)*

Fixed cages

The frame is made of salt-resistant wood. With a 10-15 cm diameter and 4-5 m length, wooden stakes are combined every 2 m in order to make a rectangular or square shape frame. The bottom area of a farm is normally 20-40 square meters, or varies up to 200-400 square meters. The cage may be on bottom or off bottom from 0.5m above the seabed. This kind is common in Van Phong bay in Khanh Hoa province because Van Phong is a sheltered bay.

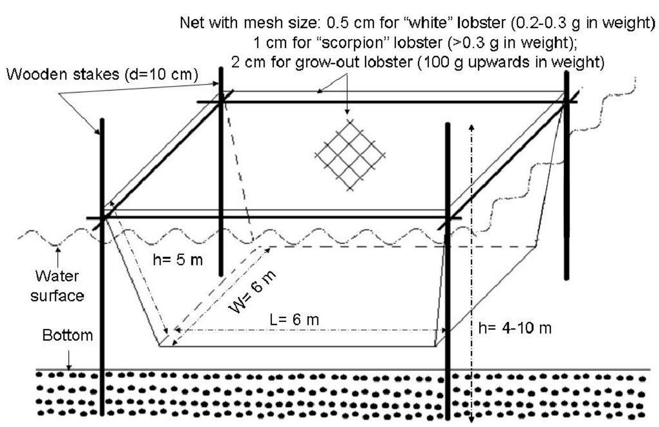

Figure 8: Dimension of fixed cage *(Source: Hoang, 2011)*

1.3.5.5. Seed

Seed collection

When buying seed from fishermen and merchant, farmers must observe carefully the seed via some good performances of lobsters. For examples, swimming activity of lobsters is quickly. Lobster peel is brightly shining, not adhere with seaweed. There is no signal of disease such as red body, milky muscle and black gill. Lobsters are observed to have all antennae, legs and other appendages. At 'white' lobster stage, it is not easy to differentiate between different lobster species, hence, using different signal to discriminate between the spiny lobster with other ones.. Lobsters are uniform in size, same species, have carapace length of 7 – 9 mm, body weight of 0.3 – 0.4 g/individual. In addition, especially, farmers care to prevent environment shock from transportation and stress for lobster.

"white" lobster (1) "scorpion" lobster' (2) nursed lobster seed (3)

Figure 9: Size of lobster fingerlings. *(Source: Hoang, 2011)*

Seed transportation

Newly caught lobsters are very sensitive under impact of the new environment. Therefore, it is important to hold and transport them in spongy boxes by some specific ways so that maintain high quality and survival rate. Temperature is maintained at 21 - 22^{o}C and 23-25^{o}C if transporting duration is about 5 -15 hours or 3 – 5 hours, respectively.

Stocking methods

In the stage of stocking to the culture cage, seed boxes /bags are kept for one hour to balance the temperature inside and outside. After that, pouring seawater in the cage site gradually into the box and discharge the water in the box slowly, so that the lobsters are familiar to the new environmental water. Weighting and measuring a group of 15 – 20 individuals to define initial size. Then, farmer release all the lobster fingerlings to the prepared cage. Density of releasing is dependent on the development stages of lobster. For example, nursery density depends on the initial size of spiny lobster:

- ‘White’ lobster: 30 - 40 ind./m2
- Lobster stage at 1.5 - 4.0 g/ind.: 25 - 30 ind./m2
- Lobster stage at 4 - 10 g/ind.: 15 - 20 ind./m2
- Lobster stage at 10 - 50 g/ind.: 10 - 15 ind./m2
- Lobster stage at 50 - 200 g/ind.: 7 - 10 ind./m2
- Lobster stage more than 200 g/ind.: 3 - 5 ind./m2

1.3.5.6. Feed

Fresh and live fish is popularly used in lobster farming. There are crustacean (shrimp, swimming crab, other crab, etc.), mollusk (mussels, snail, etc.), trash fish (cardinal, mullet, flying fish, etc.) bought from fishermen are mainly used. In reality, combining these types of feed at certain ratios based on the development stages of lobster is the way to save money in term of nutritional value. Vitamin supplements (B, C, etc.) and squid oil are adding to feed for lobster

Figure 10: Feed types for lobster *(Source: An, 2011)*

Combining feeds in lobster farming

Nutritional requirement of lobster is varied depending on the growth stages. In nursery time, crustacean, mollusk or trash fish may be used to feed to the fingerlings. In practice, lobsters fed with crustacean and mollusk at a ratio of 3:1 have high growth rate.

In grow-out, mixture of 25% crustacean (small shrimp, crab, etc.), 25% mollusk (oyster, mussel, etc.) and 50% trash fish (such as cardinal, mullet, etc.) is effective in feeding lobster.

1.3.5.7. Checking cage and water

In the initial days in nursery period, the hard parts and gut of feed are removed and feed chopped into small pieces. In first 2 months, lobster seed is fed with an amount of 30-40% body weight twice/day in the early morning and late afternoon. The cages are cleaned out of all the remaining feed and molted lobster shells. After 15 cultured days, lobsters are checked, determined by body weight and length and survival rate. The four-month-old lobsters are moved into grow-out cages.

In grow out period, feed is cut into pieces and adjust to around 15-17% body weight depend on kind of feed.

Every day, the farmer checks the cage by diving into cages to observe as suitable lobsters health, behavior and feed utilization in order to adjust feed as well as clean the cages and take out remained feed, remained shell.

1.3.6. Some environmental factors influenced lobster development

1.3.6.1. Temperature

In the Central of Viet Nam, water temperature in the natural distribution of juvenile of spiny lobster ranges from 24-31^{o}C, of adult varies between 26-29^{o}C in summer and about 22-27^{o}C in winter. An sudden increase in temperature of from 3-5^{o}C, will cause most juveniles of different species to die, while a decrease of 5^{o}C lead to slow growth and stop lobster molting phases completely.

1.3.6.2. Salinity

Salinity impacts on feeding activity, prolonged molting, or even death in the lobsters. While salinity in the area, which juvenile lobsters were found, ranges from 33-34 ppt, salinity ranging from 30-35 ppt is suitable for lives of for feeding adult lobster. Sudden changes in salinity from 5-15 ppt create a decrease on feeding activity from 30-90%. If the salinity drops down to 20-25ppt in 3-5 days, the juvenile lobsters is dead slowly and the mature lobster cannot eat.

2. CHAPTER 2:
RESEARCH METHODOLOGY AND RELATED LITERATURE

2.1. RESEARCH METHODOLOGY

In this section, the methodology used to analyze the profitability of lobster farming is a combination between calculations of the indicators from Break even analysis, Benefit cost ratio (BCR), Net present value (NPV) and Internal rate of return (IRR) with estimation of profit equation.

The profitability of lobster farming depends on many factors. Some of them can be controlled by the farmers; others are externally given variables which the farmers must adapt their production. Therefore, the farmers must make many choices and considerations when planning the production. The speed of current, salinity and temperature are examples of variables that are externally given for specific location. The nitrogen loading to the surrounding environment, type and number of cages, quantity of medication and vitamins used, stocking density are examples of variables that the farmer, at least partially, can control.

2.1.1. Nitrogen loading estimation

In marine farming, besides phosphorous, nitrogen releases directly into sea water through uneaten feed and faecal production. Nitrogen is an important nutrient in fish feed, it is used to build proteins, the main component in muscle tissue. Nitrogen releases in the water is not harmful before it reaches a certain level where there is can increase risk for eutrophication and following anoxic conditions. Therefore, it is considered a significant source of pollution from aquaculture. However, it has not been possible to get data on nitrogen content in the water. I have therefore chosen to calculate the nitrogen loading from lobster farming based on the nitrogen content of the feed and physiological factors of lobster. Two different methods are used and compared before the results are used as input in further analysis.

Beveridge (1996) showed that amount of wastes, particularly total nitrogen (N), released into environment is estimated from equation as following:

$$N_{Feed} = N_{Retetion} + N_{Waste} \quad \text{or} \quad N_{Waste} = N_{Retetion} - N_{Feed} \quad (Eq.1)$$

Where:

N_{Feed} : nitrogen content in feed

$N_{Retetion}$: the net gain of nitrogen content in lobster

N_{Waste}: nitrogen loading into sea environment

From that equation, the research of An and Tuan (2012) estimated nitrogen loading into environment based on crude protein content in lobster and feed after chemical analysis. Nitrogen was calculated from crude Protein:

$$\text{Nitrogen} = 6.25\% \text{ Crude Protein} \quad (Eq.2)$$

If we know weight of feed and lobster, we can calculate nitrogen loading by this method:

$$N_Q = N_F - N_L \quad (Eq.3)$$

From eq.2, transforming eq. 3 into:

$$N_Q = [(P_F - P_L) \times 6,25]/100 \quad (Eq.4)$$

Where:

N_Q: nitrogen loading into sea environment (kg)

N_F: nitrogen quantity in feed in lobster farming (kg)

$N_{L:}$ Nitrogen quantity in lobster (kg)

P_F: Protein weight in feed of lobster farming (kg)

P_L: Protein weight in lobster meat (kg)

On the research of Thai (2007), another way to calculate the waste Nitrogen loading from lobster cage based on the Mass Balance Equation, Wallin & Hankanson (1991) if we define food conversion ratio (FCR) as following:

$$L = P \text{ x } (F_c \text{ x } C_{feed} - C_{fish}) \quad (Eq.5)$$

Where:

L: amount of nitrogen wastes into marine environment (kg/m2)

P: the total amount of lobster production (kg/m2)

F_c: the food conversion ratio (different in households)

C_{feed}: nitrogen level in feed (%)

C_{fish}: nitrogen level in lobster (%)

2.1.2. Break even analysis

A firm breaks even if total cost equals total revenue. This is illustrated in figure 11. According to Jolly & Clonts (1993), it is hard to calculate the price of aquatic products if a producer cannot define production costs.

Fixed costs are constant regardless of the output produced and they are presented by the horizontal line. Variable costs at each output level are calculated by the distance between total cost and fixed costs. The total revenue curve indicates the price multiplies the quantity of production for the farm's product, and the profit is shown by the distance between the total revenue curve and the total cost curve.

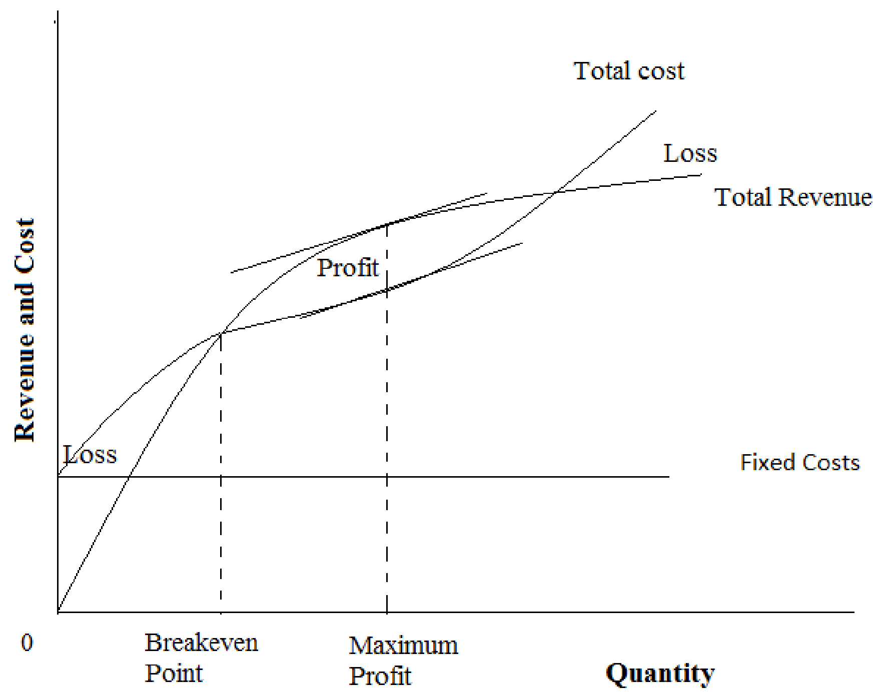

Figure 11: Break even quantity, price, profit, and loss in production.

(Source: Jolly and Clonts, 1993)

In addition, in business, break-even point illustrated in figure 11 is usually popular to apply. In the figure, the breakeven price is easily identified. To calculate breakeven price, we apply the formula:

Break-even price to cover total cost (per unit of production) = $\frac{\cos t}{yield}$ (*Eq.6*)

Break –even cost, which is called break-even price, per weight (unit of weight) means that all fish produced must be sold for a minimum at break even cost per weight unit to cover all costs.

The amount attributed to variable cost may be calculated in this way:

Break-even price to cover variable expense (per unit of weight) = $\frac{operating \cos t}{yield}$ (*Eq.7)*

To cover only variable costs, all the fish produced on the cultured area have to be sold for Break-even price to cover variable expense per unit of weight.

The same way to calculate break- even to cover fixed cost:

Break -even price to cover fixed cost = $\frac{fixed \cos t}{yield}$ (*Eq.8*)

In aquaculture operation, high input costs are considered carefully whether it is profitable or not to produce in a given year.

In short run, operating costs must be covered. In long run, revenue received might pay for total cost in order to reproduce in the next cycle of production. Therefore, in aquaculture production, it is important to find out in which levels of the production alls cost are covered.

2.1.3. Benefit-cost ratio and Internal rate of return

The benefit-cost ratio (BCR) and Internal rate of return (IRR) are used to decide whether a propose lobster farming should go ahead or not.

Cost-benefit analysis (CBA) is carried out to evaluate the costs of planning with a project against the benefits that would generate from it. Therefore, an efficient farming is undertaken by average costs and average revenue of household lobster culturing. Then, in order to use Cost benefit Analysis (CBA), we calculate the Net Present Value (NPV):

$$\text{NPV} = \sum_{i=1}^{n} \frac{(TR - TC)_i}{(1+r)^i} \qquad (Eq.9)$$

Where:

TR = gross revenue (unit of monetary), receiving from selling lobster (per year).

TC = total cost (unit of monetary), including costs of fixed costs (initial investment) and variable costs (annual operation cost or cost of production for per year).

r = discount rate (banking interest rate or working capital rate)

If the NPV > 0, the farm gets a net benefit. We then proceed by finding the IRR of farming. This is done by replacing r with IRR in Eq. 9 and solving the equation:

$$\text{NPV} = 0 \qquad (Eq.10)$$

for IRR.

If IRR $\geq$ r, this farming should go ahead. If not, this farming should close.

2.1.4. Profitability estimation by econometrics model

Lobster aquaculture farming is thought to be influenced by environment factors, technical factors, labor, capital, species composition and location. Therefore, we estimate the affect of these variables on profit per cage using the model following:

$$PROFIT_i = \alpha_0 + \alpha_1 NIT_i + \alpha_2 SD_i + \alpha_3 CT_i + \alpha_4 NC_i + \alpha_5 FEC_i + \alpha_6 SEC_i + \alpha_7 ANT_i + \alpha_8 EX_i + \alpha_9 EDU_i + \alpha_{10} CAP_i + \alpha_{11} SC1_i + \alpha_{12} SC2_i + \alpha_{13} SC3_i + \alpha_{14} LOC1_i + \alpha_{15} LOC2_i + \alpha_{16} LOC3_i + \alpha_{17} LOC4_i \qquad (Eq.11)$$

Where:

i= 1,..,n - observations in the survey.

$PROFIT_i$: the profit per cage of lobster farmer i (1000 VND/cage per year). Because in Nha Trang bay, farmers use same size of cages, profit of each farm can base on profit of each cage.

NIT_i : the nitrogen wasted of feeding of each farm per cage (kg/cage). This indicator is calculated by result from nitrogen loading estimation.

SD_i: the stocking density per cage (number of seed or individual/cage). This means that the stocking density in number of juveniles per cage (number of seed/cage) at the last stage – commercial culture time which is reported by the household i.

CT_i: the cultured time per crop (month). That is the number of months described by farmers in cultured time per crop (month).

FEC_i: the feed cost per cage (1000 VND/cage) which household i spends on feed for his farm cages.

SEC_i: the seed cost per cage (1000 VND/cage) which household i spend on seed for his farm cages.

ANT_i: the amount of money is spending on antibiotic and vitamins use per year (1000 VND/cage). Because of different kind of antibiotics and vitamins used in the farming, we value all these kinds into the same monetary unit.

NC_i: Number of cage (each farm).

EXi: the experience of each farmer (year), which explained in experience year of farmers in his business. We expect that the longer experience in farming of farmer lead to the higher profit himself.

EDU_i: the farmer's education level of farmer (level) from level 1 to 12 from primary school to secondary school, high school.

CAP_i: source of capital, from own household or from other sources. We denote 0 = capital from own household, 1= other sources.

SC_i : species composition between 3 cultured species, which depends the choice of farmers, such as (spiny, green, red); (spiny, green); (spiny, red); (green, red), (only spiny), (only green), (only red) lobsters. So, we denoted by variables:

$SC1_i$: spiny lobster in species composition, 1= culture species, 0= no culture.

$SC2_i$: green lobster in species composition , 1= culture species, 0= no culture.

$SC3_i$: red lobster in species composition, 1= culture species, 0= no culture.

LOC_i : dummy variable of location for farm from 5 cultured areas in Nha Trang bay. The parameter, which is defined as dummy variables whether there is different profit due to geographical position and water currents under sea among the areas, denoted following:

$$LOC1=\begin{cases} 1 \text{ if property is in Tri Nguyen area} \\ 0 \text{ if property is not in Tri Nguyen area} \end{cases}$$

$$LOC2=\begin{cases} 1 \text{ if property is in Hon Mot area} \\ 0 \text{ if property is not in Hon Mot area} \end{cases}$$

$$LOC3=\begin{cases} 1 \text{ if property is in Vung Ngan area} \\ 0 \text{ if property is not in Vung Ngan area} \end{cases}$$

$$LOC4=\begin{cases} 1 \text{ if property is in Bich Dam area} \\ 0 \text{ if property is not in Bich Dam area} \end{cases}$$

Lobster farms in Dam Bay area function as base case.

With the consideration of lobster profit depends on several variables explained above, we will estimate profit regression of lobster cage in each area in Nha Trang bay as following:

In Tri Nguyen:

$$PROFIT_i = (\alpha_0 + \alpha_{14}) + \alpha_1 NIT_i + \alpha_2 SD_i + \alpha_3 CT_i + \alpha_4 NC_i + \alpha_5 FEC_i + \alpha_6 SEC_i + \alpha_7 ANT_i + \alpha_8 EX_i + \alpha_9 EDU_i + \alpha_{10} CAP_i + \alpha_{11} SC1_i + \alpha_{12} SC2_i + \alpha_{13} SC3_i \qquad (Eq.12)$$

In Hon Mot:

$$PROFIT\ i = (\alpha_0 + \alpha_{15}) + \alpha_1 NIT_i + \alpha_2 SD_i + \alpha_3 CT_i + \alpha_4 NC_i + \alpha_5 FEC_i + \alpha_6 SEC_i + \alpha_7 ANT_i + \alpha_8 EX_i + \alpha_9 EDU_i + \alpha_{10} CAP_i + \alpha_{11} SC1_i + \alpha_{12} SC2_i + \alpha_{13} SC3_i \qquad (Eq.13)$$

In Vung Ngan:

$$PROFIT\ i = (\alpha_0 + \alpha_{16}) + \alpha_1 NIT_i + \alpha_2 SD_i + \alpha_3 CT_i + \alpha_4 NC_i + \alpha_5 FEC_i + \alpha_6 SEC_i + \alpha_7 ANT_i + \alpha_8 EX_i + \alpha_9 EDU_i + \alpha_{10} CAP_i + \alpha_{11} SC1_i + \alpha_{12} SC2_i + \alpha_{13} SC3_i \qquad (Eq.14)$$

In Bich Dam:

$$PROFIT\ i = (\alpha_0 + \alpha_{17}) + \alpha_1 NIT_i + \alpha_2 SD_i + \alpha_3 CT_i + \alpha_4 NC_i + \alpha_5 FEC_i + \alpha_6 SEC_i + \alpha_7 ANT_i + \alpha_8 EX_i + \alpha_9 EDU_i + \alpha_{10} CAP_i + \alpha_{11} SC1_i + \alpha_{12} SC2_i + \alpha_{13} SC3_i \qquad (Eq.15)$$

In Dam Bay:

$$PROFIT\ i = \alpha_0 + \alpha_1 NIT_i + \alpha_2 SD_i + \alpha_3 CT_i + \alpha_4 NC_i + \alpha_5 FEC_i + \alpha_6 SEC_i + \alpha_7 ANT_i + \alpha_8 EX_i + \alpha_9 EDU_i + \alpha_{10} CAP_i + \alpha_{11} SC1_i + \alpha_{12} SC2_i + \alpha_{13} SC3_i \qquad (Eq.16)$$

It is common test that whether this profit depends on other variables have not mentioned in the model as well as the difference in lobster profit generated by the difference in variables mentioned in the model.

2.2. LITERATURE RELATED

There are some materials and papers related to the study as following:

In Nha (2006), it is difficult to prevent disease in lobster due to marine lobster cage farming is an open ecosystem. Moreover, during culture process, lobster influenced by many stages in farming such as grading, cleaning, change or replace mesh and frame of cage. Simultaneously, stocking from crop to crop in the same farming system, the mesh of net in cages becomes a source for containing pathogens. The purchase, seed transportation or movement of cage from one location to another, on the other hand, are the main factors contributing to the transmission of pathogens. Therefore, disease prevention plays important role in the culture process. Nevertheless, the disease only occurs when three factors namely the pathogen (bacteria, viruses, fungi, etc), the host's weak resistance and bad environmental conditions compound together. By contrast, the disease will not occur.

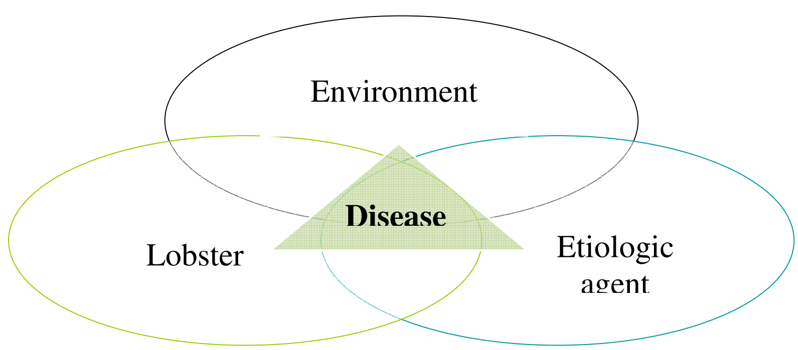

Figure 12: Interaction among 3 factors of owner – etiologic agent – environment and direction for inhibiting of disease development. *(Source: Nha, 2006)*

In De Silva (2009), the author said that lobster aquaculture discharges nitrogen into sea and may lead to serious environmental impacts. Especially, intensive cage culture operations can lead to over carrying capacity of the sea water, and result in fish kills, not only farmed stocks but also wild stocks. Moreover, accumulation of excessive amounts of nutrients from uneaten feed and excreta of cultured fish impacts the culture environment, tending to generate the levels of ammonia, even toxic hydrogen sulphide. These can threat the stock so that easy fall in disease or death. In avoiding the rise of the phenomenon, farmers have high needs to use veterinary drugs and chemicals for their prevention and treatment. These may lead to many problems associated with food safety and environment.

Petersen & Phuong (2010), showed that the lobster farming industry in Khanh Hoa and Phu Yen provinces is a high-risk high-return industry. In this paper, a benefit - cost ratio (BCR) of 1.44 is an attractive figure in the area with an average net revenue of 262 million of VND /year (or just under US$15000/ year – US exchange rate in 2009). This BCR is rather than other seafood farming in the same region (for example, figures including 1.36 of mud crab and 1.09 of tilapia farming in the region (Petersen 2009)), and in other small-scale aquaculture enterprises internationally (e.g, the BCRs are 1.2-1.3 of silver perch farming in Australia (Guy, Johnston & Cacho 2009), approximately 1.2 of pearl farming in India (Rao & Kumar 2008)). However, a huge cost for these farms from feed and seed take account for 83% (61% of costs in feed and in seed 22%). Conversely, all other costs contribute 7 %. Additionally, it is said in this paper that the main problems in the development of lobster operations are related to water quality and temperature issues, insufficient access to credit, good-quality affordable feed and accurate information about technology improvements in lobster farming.

2.3. DATA COLLECTIONS

2.3.1. Primary data

Primary data was collected by personal interviews of 60 farmers culturing lobsters in 5 areas of Nha Trang bay including Tri Nguyen, Hon Mot, Vung Ngan, Dam Bay and Bich Dam. Firstly, a draft of questionnaires was designed. Then it was applied to trial in interviewing 2 households in

Tri Nguyen and Hon Mot culture area for testing some questions whether they are suitable or not to farmers. After correcting the questionnaires in order to appropriate and familiar with lobster farmers in Nha Trang bay, the questionnaire was used in collecting essential information from farmers. The questionnaire used in the interviews is included in appendix 2. The such preparing for survey limited mistakes during survey. Therefore, the data collected from 60 households can adapt the requirement of the research as first intention.

2.3.2. Secondary data

Secondary data was collected from previous papers, theses, available reports of the local management agencies. Some data was also supplied by Department of Economics, Department of Aquaculture, Department of Environment and Natural Resources, Department of Agriculture and Rural, Research institute of Aquaculture no. 3 in Khanh Hoa. Local management agencies such as Vinh Nguyen People's committee helped and updated documents related to lobster farming information.

2.3.3. Sampling

First of all, the research intended to interview 12 respondents per each cultured sites. However, there is different number of cages in lobster farms in the 5 culturing areas. So, there are different numbers of respondents from the different areas.

In field trips, small boat rent to move from farm to farm in the 5 areas of Nha Trang bay. According to direction of the boat's pilot, random households who had lobster farm were interviewed. Even though, in Vung Ngan region, in order save time, meeting with households in the boat get information from farmers and after that the boat picked up them from Vung Ngan to the in-shore. In Tri Nguyen, another way, meeting occurred at farmer's home when they were preparing to go back their farms in the afternoon.

3. CHAPTER 3: RESULTS

3.1. CHARACTERISTIC OF SAMPLES

Of the 257 households who are farming in Nha Trang bay, there were a total of 60 respondents in surveyed areas. The geographical distribution of the respondents and the number of cages used in these areas are shown in table 6.

Table 6: Sampling of household in the Nha Trang bay in year 2012.

	Area	Number of households (households)			Number of cages (cages)		
		Samples	Total	% samples/total	Samples	Total	% samples/total
1	**Vung Ngan**	10	55	18.2%	382	1,176	32.5%
2	**Dam Bay**	10	22	45.5%	369	732	50.4%
3	**Tri Nguyen**	16	79	20.3%	612	2,576	23.8%
4	**Hon Mot**	9	54	16.7%	243	687	35.4%
5	**Bich Dam**	15	47	31.9%	639	1,648	38.8%
	Total	**60**	**257**	**23.3%**	**2,245**	**6,819**	**32.9%**

The size of households range from 3 to 9 persons and the average is 4.75 persons. This is similar to the findings of Ly's survey of Central coast's farmers in Binh Dinh, Phu Yen, Khanh Hoa provinces (2009). Farmers are mostly in labor age and have experience in farming. Their average age is 45.18 years old, with 67 and 28 years as the highest and lowest observations, respectively. In 2010-2012, the average revenue was 1.274 billion of VND (USD$61,238) per crop. The highest revenue level is 6.108 billion of VND (USD$293,634), and the lowest as 0.178 billion of

VND (USD$8,562) (Exchange rate between USD and VND in 31/3/2012 is 20,800). Table 7 shows a summary of lobster farmers' characteristic in Nha Trang bay.

Table 7: Characteristic of farms in Nha Trang bay in 2012

Items	Max	Average	Min
Size of household (members)	9	4.75	3
Age (years old)	67	45.18	28
Experience (years)	22	11.18	3
Education (level 1-12)	12	7.85	2
Size of farm (number of cage)	140	37.4	7
Revenue of each farm (USD)	293,634	61,238	8,562

(Source: *Own survey)*

In order to get an overview of farmer's knowledge, the respondents were asked about education level and experience. Presenting ability in receiving and adopting technologies, education level affects indirectly lobster productivity and profitability. Within the respondents, most lobster farmers educated at primary, secondary and high school. In further, higher experience in lobster farming helps them save feed, seed, costs and limit the losses of risks from external environment during crops as well as choose the time for culturing and harvesting in order to get high returns. While the longest experience of farmer among respondents is 22 years, average level is 11.18 years, which is higher than that of the lobster farmers in Central coast (Ly, 2009). About technical support during farming, 100% farmers reckon that they rely on the experience shared between farmers normally. They put more trust in the experience shared from farmers who applied a given technology with good results compared to other sources. From that experience, they adjust feeding regime as well as adding antibiotics and vitamins for farming so that lobsters increase their resistance.

The authority has contributed with conferences about methods to help the farmers improve their productivity, including the use of antibiotics and vitamins and prevent diseases as well as information of natural conditions, natural disasters and diseases outbreak. The farmers refer to this information as other activities.

Simultaneously, the question related to the knowledge about environmental pollution shows that almost all farmers understand consequence of water pollution and waste from high density of cages. The questionnaire also included a question related to new government regulation. This is used to assess how content the farmers are with the authority after setting up this regulation. 100% of them responded they are content. Before year 2010, local farmers were free to culture and move their cages around in the bay without informing the government. In addition, farmers were not subject to any entrance fees or to other fees related to environment. By other hand, farming in the area for a long time since 1990s, they are illegal in their rights and duties without regulation. Without certificate for using water surface means that the Government did not recognize their right in their own farms. From 2010 on, for the first time, the government introduced some new regulation; every farm has an address number and must keep number of their cages and fix the position of their farm and clean the surroundings of the culture farm. This is the first step in order to control farming in the bay and creating right and duty of farmer with respect to the authority.

Stocking density and culturing period

In general, after buying the post larva, lobster seeds were nursing about 2-3 months in the nursery cages, which are divided from large cages with the stocking density of 400 - 800 specimens/cage. When lobsters weigh 100-150g they have a survival rate range of 50% -90%. Farmers then change the stocking density to between 50 and 300 specimens per cage until harvested. Average stocking density is 122.5 individuals/cage including spiny lobster, green lobster and red lobster. After growing out, spiny lobster weigh about 0.8 kg and it is harvested after 16-18 months. Green lobster is harvested when they reach the weight of 0.2 kg after 12-15 months. Red lobster gain 0.15kg per individual and is harvested after 14-16 months. Survival rate depends on the seed resource. The seed from fishermen is higher than from middlemen (form own discussion with farmer). The data shows that survival rate are 71% in spiny lobster, 73% in green lobster, 51% in red lobster in average (from own interviews). Table 8 summarizes the culturing time of the different species.

Table 8: Difference in time between three culture species per crop (months)

	Max	Average	Min
Spiny lobster	18	17.24	16
Green lobster	16	13.53	12
Red lobster	16	14.52	14
Average	17	15.14	13

(*Source:* Own survey)

Species composition

Tending to shorten time in culture and shorten loss from diseases, natural disasters, basing on characteristic of each lobster species, some farmers choose combining three of species of lobsters in the same farm. 82%, 92% and 45% of the number of interviewed respondents choose spiny lobster, green lobster and red lobster respectively for culture farming (own survey). The main reason for most farmers to choose green lobster is their medium value and high resistant ability. Instead of 100% farmers cultured spiny lobster (Ly, 2009), this figure reduces to 82% because of their low resistance. However, this figure is still high due to their higher value and higher weight than others. The red take account for nearly 50% due to their cheap price in seed. This is suitable to poor farmers.

Number of cages

According to the samples, while the numbers of available cages of each household are 37.42 cages in average, 140 cages in maximum and 7 cages in minimum, the numbers of cages actually being used are 25.58 cages, with 96 cages and 5 cages as maximum and minimum respectively.

Interpreting these different figures, there are some reasons related to investment cost, diseases and unstable farm gate price of lobster in recent years. If they culture lobster in most of cages as before, they have insufficient capital to operate their farms due to higher cost. In addition, risky from diseases outspread threats their farm. Being pressured from middlemen, the farm gate price is not stable. The farmers realize that the more production is, the lower farm gate price is. Therefore, in recent years, they tend to culture finfish for daily instant needs of local people instead of using almost cages. This indicates that lower risk, lower cost and shorter cycle of capital are more preferable.

In reality, number of cages in lobster cultured is used lower than that which the farmers have had. All cages have the same surface area, 4 x 4 (length x width), but they differ in the height with ranges from 4m to 8m depending on the depth of aquaculture seabed.

Seed source

According to Department of Fisheries Aquaculture in Khanh Hoa (2012), 30-40% seed resource is supplied from harvesting within local seas such as My Giang, Nha Phu lagoon (Ninh Hoa district), Mon lagoon (Van Ninh district), Nha Trang bay and Cam Ranh bay and the remaining is bought from neighbor provinces namely Phu Yen, Ninh Thuan, Quang Ngai, Quang Nam and imported from Indonesia, Philippine and Sri Lanka. Similarly, in Nha Trang bay, seed source bought takes account for 38.3% from local fishermen, and 61.7% from merchants (own survey).

Feeding

Because of my concern was about total cost of feed, I did not try to go deeply in the feeding regime of all stages in lobster culture technology.

Trash fish called "nhom nhua" (slang word) including small crabs, shrimps, fish, squid and other shells is used mainly for lobster in these areas. The composition of the diet differs throughout the phases in culture time. At the nursery time period, shrimps, crabs and shells are preferable feed, generating good growth and high survival rate. By the time, this kind of feed is replaced gradually by increasing trash fish components. Due to the increase in the price of shells and crabs in recent years, farmers often decide on a feeding regime consisting of 25 days with trash fish and 5 days of others in order to add essential nutrition for lobsters (a discussion with a farmer). In experience of farmers, by diving observation in cages every day, farmers can adjust by increase or decrease feeding quantity based on the remaining feed after feeding.

In general, the price of trash fish varies between farm locations. For example, in Tri Nguyen which is nearest place from land, most of the farmers are residents on this island, and they choose feed from fishermen. Every day a small boat will carry feed directly to each farm in this area. Hence, the price of feed is cheapest. Meanwhile, on other islands which are further away from land, farmers who are not resident in these places, buy trash fish from middlemen in the market. They go to their farms and come back to the land in the same day. So the price they pay for their feed is higher.

Antibiotics and vitamins use

The survey tried to name some antibiotics and vitamins which are used by farmers in this region. However, there is a variety kinds of different antibiotics and vitamins used. It is hard to define the exact quantity used. Therefore, I have chosen to use the spending on antibiotics and vitamins in general as a variable.

3.2. NITROGEN LOADING FROM THE LOBSTER CAGES

In this study, the first intention of this paper is to study environmental variables of water quality such as nitrogen loading, salinity and temperature in each farm. Nevertheless, none of the farmers answer that they check these parameters. In addition, it is hard to calculate the quantity of nitrogen polluted the area due to different water depth, current flows and water exchange. However, nitrogen is considered an important parameter representing marine water quality. Hence, based on previous papers, this research estimated nitrogen waste in Nha Trang lobster farms.

First of all, the information related to the nitrogen content in trash fish and in commercial lobster must be determined to estimate the waste of nitrogen. Based on parameters of Chien (2005), average nitrogen content in trash fish feed is 1.337% and measured nitrogen content in harvested lobster is 3.580%. In addition, according to An (2011), average fish conversion ratio (FCR) ranges from 27 to 30 in Viet Nam lobster farming. FCR is chosen as 27 as his paper implied (An, 2011).

Table 9 show the results from applying the formula of Wallin & Hankanson (1991) (Eq. 5) to estimate the total nitrogen loading in Nha Trang bay for the 2 years 2010 and 2011:

Table 9: Nitrogen loading in Nha Trang bay from period time 2010-2011 applying Eq.5.

Item/Year	2010	2011
Volume of lobster (tones)	200	208
FCR	27	27
%N content in trash fish	1.337	1.337
%N content in lobster	3.58	3.58
Nitrogen loading per year (tones)	**65.038**	**67.640**

With an FCR = 31.8 in average for the 3 provinces Binh Dinh, Khanh Hoa and Phu Yen Ly (2009) get the result of 389 kg nitrogen loading from 1 ton of lobster, whereas an FCR = 27 gives a nitrogen load of 325 kg per ton of lobster. It means that if we increase FCR, this loading will be higher.

However, in the latest result from the paper of An and Tuan (2012) (See Eq. 4), nitrogen loading into environment of Khanh Hoa lobster cage farming in the year 2010 is 257.49 g per 1kg commercial lobster meat. It means that to produce 1 kg lobster meat, nitrogen wastes to water is 0.25749 kg. Similarly, to produce 1 ton of lobster, nitrogen loading from feed for lobster culture is 257.49 kg. This figure is lower in comparison to Ly (2009) and Chien (2005). Because there are the similarity in feeding regime and natural condition, this number is suitable to Nha Trang bay belonging to Khanh Hoa province. Hence, the research trusted this method to estimate nitrogen loading in Nha Trang bay. Total nitrogen wasted into the marine environment from trash fish feed marine lobster cage aquaculture in Nha Trang bay in year 2010 and 2011 was calculated and is shown in table 10:

Table 10: Nitrogen loading in Nha Trang bay from period time 2010-2011 applying Eq. 4.

Item/Year	2010	2011
Volume of lobster (tones)	200	208
Nitrogen loading per 1kg lobster (kg)	0.25749	0.25749
Nitrogen loading per year (tones)	**51.498**	**53.558**

All calculations in this research are based on the latter way in order to measure nitrogen loading of each household for next estimation.

3.3. PROFITABILITY OF LOBSTER FARMING

3.3.1.Revenue

The survey was carried out within March 2012, which was in time farmers was waiting for harvesting and selling their lobsters. However, while some farmers have sold their lobster, others are waiting the price is higher than that at the time this survey happened. In March, the price went down in comparison to previous months from the end of 2011. Those delaying their harvest are trying to feed their lobsters in their cages in order catch an acceptable price. When interviewing, some farmer informed the revenue, others gave the weight of lobster they had in their farm. Therefore, for the households which were delaying their harvest, an estimate of revenues from coming sales based on lobsters weight and the price at the given time was made.

The average lobster production per cage was 46.37 kg, including 122.5 lobsters of different species. Spiny lobster are classified by 3 lobster classes (class 1: over 1 kg/ individual, class 2: over 700g up to 1kg/individual, class3: from 500g up to 700g) for sale, meanwhile, green lobster and red lobster are sold without classification in weight of each commercial individual. The average weight of one spiny lobster is 0.80 kg while that of green lobster is 0.20 kg and 0.15kg in red lobster. The average prices, which are surveyed, are 1,552,717 VND/kg (class 1: 1700,000 VND/kg, class 2: 1,535,319 VND/kg, class 3: 1,422,833 VND/kg) of spiny lobster, 807,722 VND/kg of green lobster and 460,000 VND/kg of red lobster. Total average revenue is calculated and shown in table 11.

The survey reveals that 100% of the farmers sell their lobsters to a middleman with the price given by middlemen at one time point. The price is settled after agreement between farmers and middlemen. Usually, middleman come and weight lobster at the farm. Lobsters are transferred to shore and then exported to China.

In some cases, the middlemen have functioned as a lending institution for the farmers when they have insufficient cash to cover the feeding cost. Some middlemen then supplied feed in exchange for a lower price at the time of harvest.

The farm gate price of lobster depends on the importer from China. Additionally, because market information and lobster price is updated by the middlemen without intervention or regulations by the government, price of lobster depends on export market, especially in harvested crop. The domestic consumption accounts for small proportion supplied to local restaurants.

3.3.2.Cost of production

Fixed cost

A large of amount of money is spent on initial investment which includes cages system, boats and other essential equipment. They have different time to replace and the depreciated period is over 1 year. Therefore, fixed cost is calculated from depreciation of them in straight line method.

The cage system is the most expensive item for the farm. In Nha Trang bay, all floating cages are 16 m^2 and the average cost is 4.355 millions of VND. It takes around 7 years to be replaced the new one. To save money, in the nursery time period, farmers divide the cage into 2 or 4 small squares with nets with smaller mesh size to nurse juveniles before commercial stage.

Besides cages system, all farmers have some guarding cottages, depending on number of cages, each farms had one or more cottages, small or big. Machines, equipments, tools and other things related to farm operations, as well as individual tools for living, are in side these cottages. Labors can stay there to guard lobster for the whole day. The average cost per household for building these cottages is 27.467 millions of VND and it has an average of 5-years-used period.

In order to move from the farm to the shore (or mainland), normally, the farmers use an engine powered boat. Alternatively they use a boat with circular shape and paddle. This is cheaper and more convenient for short distances, such as from farm to farm and around the farm during diving time. The cost of an engine powered boat is about 15 millions of VND. The cost of the second boat is 0.9 millions of VND. The average investment for boats is 8.374 millions of VND. In general, the depreciation time for these boats is 12 years. However, in Vung Ngan, most of farmers do not have boats with engines because of the owner is not resident in that area. Every day, they move from inland to the farm via public boat and spend money on fee of ticket. They bring food and feed to the farm. In the afternoon they come back home and let all things to the hired labors to guard the farm.

Electric power plays a core role in operating diving equipment and daily light for the whole farm. Normally, each farm has an electricity generator because the electricity network can not cover from inland to the farming area due to far distance, except for Tri Nguyen area. The farmers living in this area use electricity power from their home without the generators.

In further, diving equipment is a useful tool to support diver into bottom of cages for checking lobsters, feeding and removing feed waste. Generally, one diving tool costs about 3.922 millions of VND and has a 5 years-used period.

Variable cost

Variable cost are production costs including cost of seed, feed, antibiotics and vitamins use, fuel, labor cost, loan's interest, and miscellaneous cost which includes food related to labors, small repaired costs related to tools, machine, equipments and cages, etc. Because of the characteristic of this career, the owner of the farm must pay for whole living cost of their labors besides labor salary. Hence, all costs related to labor is called labor cost. In many cases, the owner goes direct to work in his farm. So when labor cost is computed, the cost for the owner is included. For example, if in the farm there are 3 labors including 1 owner, labor costs is calculated for 3 persons. Average variable costs are shown in the table 11.

3.3.3. Calculations of net returns, break- even price and benefit cost ratio

To get an estimate of the profitability of lobster farming in Nha Trang bay, an average for all items for all 60 respondents was calculated. Accordingly, for a household with 25.6 cages and a 1,232 kg harvest of lobster, the total revenue per year was 967 millions of VND in average. Total variable cost per year is 692.8 millions of VND. Income above variable cost per year is 274.205 millions of VND. Fixed cost is 33.93 millions of VND. With total cost 726.728 millions of VND, net return above total cost is 240.276 millions of VND. In each cage, while net return above variable cost is 10.718 millions of VND, net return above total cost is 9.392 millions of VND. The break - even prices of lobster are 562.399 thousands of VND to cover variable cost and 589.943 thousands of VND to cover total cost.

Table 11: Estimated average costs and returns per household each year in Nha Trang bay for the period 2011-2012.

1USD = 20,800 VND

	ITEMS	VALUE	%
1	**TOTAL REVENUE (TR) /year (VND)**	967,003,463	
1.1	Average cages (cages)	25.6	
1.2	Average production (kg)	1,231.9	
2	**VARIABLE COST /year (VND)**	279,412,036	**95.3**
2.1	Seed/year	279,412,036	40.3
2.2	Feed/year	299,451,474	43.2
2.3	Antibiotics, vitamin/year	8,289,353	1.2
2.4	Labor cost/year	87,320,000	12.6
2.5	Energy (electricity power, fuel)/year	5,658,720	0.8
2.6	Loan interest/year	2,702,000	0.4
2.7	Other/year	9,964,000	1.4
	Total variable cost (VC) /year	**692,797,583**	*100*
3	**INCOME ABOVE VARIABLE COST/YEAR (VND)**	274,205,880	
4	**FIXED COST (VND)**		**4.7**
4.1	Depreciation cost/year for Guarding cottage	5,493,333	
4.2	Depreciation cost/year for Cages system	23,195,238	
4.3	Depreciation cost/year for Boats	697,847	
4.4	Depreciation cost/year for Diving equipment	1,263,889	
4.5	Depreciation cost/year for Diving cloths	945,000	
4.6	Depreciation cost/year for Electricity generator	762,619	
4.7	Depreciation cost/year for Net washing equipment	786,667	
4.8	Depreciation other cost/year	785,500	
	Fixed cost (FC) /year	33,930,093	
5	**TOTAL COST/YEAR (VND) TC = VC + FC**	726,727,676	**100**
6	**NET RETURNS ABOVE TOTAL COST/YEAR (VND)**	240,275,787	
7	**NET RETURNS PER CAGE**		
7.1	Above variable costs	10,718,145	
7.2	Above total costs	9,391,887	
8	**BREAKEVEN PRICE**		
8.1	To cover variable cost	**562,399**	
8.2	To cover total cost	**589,943**	
9	**BENEFIT-COST RATIO (BCR)** BCR= REVENUE/TOTAL COST	**31.1%**	

3.3.4.Net present value and internal rate of return

In order to calculate internal rate of return (IRR), based on available data, the paper computed in average of 60 households about the number of cages, production quantity, average revenue per year, average investment per year, average variable cost (annual investment). Assuming that the cycle of farming is 12 years in order end the longest depreciation time of boat among other equipments and estate. Banking interest rate is 12% per year presently instead of that was 14% at the time the paper began 5 months ago. Assuming the rate will not vary and stay at 12%, the paper still assumes all cash flows arise at the end of each year.

According to above figures, net present value for 12 years as well as internal rate of return are calculated according to equations 9 and 10. The results are reported in table 12.

Table 12: Net present value (NPV) and Internal rate of return (IRR)

	ITEMS	VALUE
1	AVERAGE NUMBER OF CAGES PER HOUSEHOLD (CAGES)	25,58
2	AVERAGE PRODUCTION OF LOSTER PER HOUSEHOLD (KG)	1,232
3	AVERAGE REVENUE PER YEAR (VND)	967,003,463
4	AVERAGE INITIAL INVESTMENT PER YEAR (VND)	220,067,519
5	AVERAGE VARIABLE COST PER YEAR (VND)	692,797,583
6	INTEREST RATE OF BANK (r) (%)	12%
7	CYCLE OF FARMING (YEARS)	12
8	NET PRESENT VALUE - NPV (VND)	**963,492,618**
9	INTERNAL RATE OF RETURN - IRR (%)	**30%**

According to the results from table 12, the total net present value for 12 years farming is 963,492,618 VND using an average of 25.58 cages per household in Nha Trang bay. This means that lobster farming is profitable. The internal rate of return is 30%, which is 2.5 times higher than the working capital rate 12% and benefit cost ratio is 31.1%. However, these figures are lower than the benefit cost ratio of 44 % found by Petersen (2009) and the IRR of 43% reported by Ly (2009) for Vietnam lobster.

3.3.5.Estimating profitability of lobster farming

In this part, the paper is going to determine the contribution of different factors affecting on lobster profitability including of the environment variable.

At the beginning, the model was set up in expressing the lobster profitability depending on the feed cost, seed cost, stocking density, culture time, farmer's experience, farmer's education, anti-biotic use, capital source, species composition and environmental parameter as in equation 9. After eliminating correlated variable, choosing suitable variables, regression equation was estimated. The results from the regression of equation 11 are listed in table 13:

Table 13: Profit Estimation with dummy variables of location by Eview 7

Dependent Variable: PROFIT
Method: Least Squares
Sample: 1 60
Included observations: 60

Variable	Description	Coefficient	Std. Error	t-Statistic	Prob.
C	Constant	-21662.39	12351.5	-1.753827	0.0864
NIT	Nitrogen loading quantity	2516.174	299.3015	8.406821	0.0000
SD	Stocking density per cage	-60.64485	16.1617	-3.75238	0.0005
CT	Culture time	1371.117	742.106	1.847602	0.0714
NC	Number of cage	103.7262	24.28765	4.270738	0.0001
SEC	Seed cost	-0.586467	0.147554	-3.974598	0.0003
ANT	Antibiotics and vitamin use cost	-5.519565	1.828342	-3.018891	0.0042
EX	Experience	-0.533152	101.8895	-0.005233	0.9958
CAP	Capital source	-1527.994	875.7191	-1.744845	0.088
SC1	Species composition 1	473.5037	3335.091	0.141976	0.8877
SC2	Species composition 2	-301.0693	2208.241	-0.136339	0.8922
SC3	Species composition 3	-2636.199	1029.288	-2.561187	0.0139
LOC1	Dummy variable of location 1	1018.287	3213.298	0.316898	0.7528
LOC2	Dummy variable of location 2	-1907.987	1630.263	-1.170355	0.2482
LOC3	Dummy variable of location 3	-683.28	1450.075	-0.471202	0.6398
LOC4	Dummy variable of location 4	-1828.466	1483.957	-1.232155	0.2244

R-squared	0.835464	Mean dependent var	7684.076
Adjusted R-squared	0.779372	S.D. dependent var	6291.489
S.E. of regression	2955.182	Akaike info criterion	19.04369
Sum squared resid	3.84E+08	Schwarz criterion	19.60218
Log likelihood	-555.3106	Hannan-Quinn criter.	19.26214
F-statistic	14.89453	Durbin-Watson stat	1.896187
Prob(F-statistic)	0		

There is no heterokedascity in the regression equation estimated. The equation with R^2 = 83.54 %, that means 83,54 % of the proportion of the variation in lobster profit is explained by the regression model.

In general, according to the table above, this model had 8 variables of 12 variables with significance under 10%. In particular, while capital source CAP and culture time CT variables are significant at 10%, nitrogen loading NỈT, number of cages NC, stocking density SD, seed cost SEC, antibiotics and vitamins cost ANT are at 1%. Species composition 3 (red lobster) variable is significant at 5%.

In contrast, p values of the 4 remaining variables such as EX, SC1, SC2 and dummy variables of location are not significant at the 10% level**.** This means that there is poor statistical support for claiming that these variables are important for explaining any of the variance in profit per cage.

The redundant variables test was carried out but the result was not better. For instance, regression test for profit estimation without dummy variables of location by Eview7 excluded these variables. The null hypothesis H_0 is coefficients of dummy variables are all zero. The p-value of this test was 63.34%, which means that the chance of observing is an F-value of 0.6449 when H_0 is true with 63.34 % in chance. The estimated Ho has p-value 63.34 % so it is statistically different form zero. Therefore, H_o is rejected. A smaller R^2 (82.5 %) of new equation and bad p-value of the test showed that it were not better in comparison to the first model.

Therefore, we accept the former model. The result is described as the following table as the profit regression for Nha Trang bay:

$$\mathbf{PROFIT_i = -21{,}662.39 + 2{,}516.17{*}NIT_i - 60.64{*}SD_i + 1{,}371.12{*}CT_i + 103.73{*}NC_i - 0.59{*}SEC - 5.52{*}ANT_i - 0.53{*}EX_i - 1{,}527.99{*}CAP_i + 473.50{*}SC1_i - 301.07{*}SC2_i - 2{,}636.20{*}SC3_i + 1{,}018.29{*}LOC1_i - 1{,}907.99{*}LOC2_i - 683.28{*}LOC3_i - 1{,}828.47{*}LOC4_i} \quad \text{(Eq.17)}$$

With coefficients of variables, the model shows that there is a positive relationship between lobster profit per cage and culture time, number of cages and nitrogen loading. This means that when lasting 1 month culture time, profit per cage goes up as **1,371.12** thousand of VND. Similarly, the profit of farmer will be rise by **103.73** thousands of VND if the farmer adds 1 more cage. Unexpectedly, coefficient of nitrogen loading factor had the positive sign. The first idea is to test seawater quality including salinity, temperature and nitrogen loading in 5 culture areas. However, it was not possible to get data on salinity and temperature on a geographical scale that match the other data. Both temperature and salinity of seawater depends on season and depth of water as well as on water exchange. They are the same nature because the areas are connected by open sea. Therefore, nitrogen loading from each cage per year is the only environmental parameter included in the analysis, and it was expected to have a negative impact on lobster profitability. The reason for this result might be found in the dual role of nitrogen. The waste of feed and fecal products from lobster is released into sea water, mixed others elements in seawater and transported away from the farm by sea currents and water exchange. At the same time nitrogen is an important nutrient. There is a positive correlation between nitrogen loading and feed quantity, nitrogen loading increase is familiar to feed quantity increase. Looking at equation 4 which was used to estimate the nitrogen loading from lobster farming, we see that if nitrogen loading increases, so must the amount of feed since the amount of nitrogen in feed and lobster are treated as constants. More feed may result in better growth and for that reason, 1kg increase per cage of nitrogen loading, which equalizes 104.86 kg in feed quantity increase (FCR =27), will lead to **2,516.17** thousand of VND in profit per cage.

On the other hand, seed cost, stock density, antibiotic and vitamins use, capital source and red lobster composition impacts on profitability negatively. An increase in any of these variables will lead to the decrease in the profit. In detail, if seed cost increase by 1000 VND per cage each year initially, profit per cage per year drop by **590** VND. In addition, if stock density increases by 1 individual/cage with size $16m^2$, the profit goes down by **60,640** VND. Accordingly, a drop of profit per cage is **5,520** VND is expected if the farmer adds 1000 VND in using antibiotics and vitamins for lobster every cage - year . If the farmer borrows money for investing in lobster farm (CAP = 1) rather than using household savings, the profit will reduce by **1,527.99** thousands of VND. In other words, if the farmers have their own money, they will earn by this amount of money. Interestingly, the appearance of red lobster (SC3=1) in species composition will lead a decrease of **2,636.20** thousands of VND in the profit per cage of red lobster in comparison to other species. In fact, with the lowest price of red lobster (400,000 – 500,000 VND/kg) and the average harvested size of 150g-250g per individual, the revenue from this species is low compared to the other species.

4. CHAPTER 4: DISCUSION AND CONCLUSION

4.1. Discussion

Nitrogen loading

Following previous papers, two different methods of computing nitrogen loading was used. The method of Wallin & Hankanson (1991) gave the higher results than that of An & Tuan (2012) for lobster farming in Nha Trang bay. The findings based on the figures calculated by the latter method, was that the production of 1 ton of lobster, will result in a nitrogen loading of 257.49 kg into Nha Trang bay's environment.

The total nitrogen load from lobster farming was estimated to about 51.498 tons in year 2010 and 53.558 tons in 2011. Although nitrogen loading was quantified, no evidence was found of a negative nitrogen impact on lobster profitability in Nha Trang bay. This result differs from that of Ly (2009) on lobster productivity in the Central coast. But feed waste, which is a main source of nitrogen loading, can potentially have some significant consequences on sea environment. Surprisingly, nitrogen loading was found to have a positive effect on profitability. The reason for this could be that if nitrogen loading into the sea goes up, it so must be the quantity of feed supplied into this farming. And more feed would normally imply more growth although the growth curve could be concave. Since nitrogen loading into sea is positively correlated with growth, the effect on profit is positive. In other words, the nitrogen loading releasing via lobster culture activity has not reached over environment capacity in Nha Trang bay.

So far farmers has developed cages and increased stocking density without caring about common sea environment of the bay. In fact, how to control nitrogen loading and other environment factors from this farming is a challenge for the authority in Nha Trang bay from now on.

Profitability of lobster farming cage

The second aim of this study is to estimate factors affecting profit per cage by a simple econometric model. In this model, all variables explained over 83 % the variation of profit. The number of observations used in the analysis was collected from 60 farms from five areas, accounting for 23.3 % of the total number of households and 32.9 % of the number of cages in Nha Trang bay. Seed cost, stocking density, culture time, number of cages, money spending on antibiotics, capital resource and species composition variable per household was found to have significant impacts on profit. In addition, the representative environmental variable, which is nitrogen loading, in Nha Trang bay generates the positive impact on lobster profitability. In contrast, dummy variables representing location were not significant.

The number of cages in the area, also impacts on profit positively. This indicates that farmers need to use more cages instead of limiting them as in the present. Simultaneously, stocking rate should be also reduced to get higher profit. At the same time, both using more cages and increasing frequency of changing cages to reduce stocking density during culture phases is a solution for higher profit. This seemed a converse with the result found in Ly (2009), showing the negative relation between lobster productivity and cage density, but this solution means that the farmer need using more cages to reach efficient profitability level.

Accounting for about 80% in average cost each farm, feed cost and seed cost rise will lead to a decrease in profit. Seed cost and feed cost vary strongly due to variation of fuel price, especially in seasonal time. The paper only concerns about the cost in order to valuate increase affects on profit. Unfortunately, only seed cost has a meaning in the statistical estimation.

In recently, the red's appearance in farming causes a reduction in return of farmer. Red lobster obtains lower price per kg and a lower harvest weight. Experience over many crops, farmers calculate how to combine different species as well as choose the time point for seeding at the reasonable seed's price, and how to manage this cost at the beginning of a crop in order to get higher benefit.

Different kinds of antibiotics and vitamins are used and the use is mainly based on the experience shared between farmers. However, in monetary terms, the result above showed that an increase in cost of this using will lead to a decrease in profit, although this accounts for only 1.2% of the variable cost. Interestingly, contributing to only 1.2% in variable cost, the impact of antibiotics has a nearly 10 times stronger effect on profit in comparison to seed cost, which accounts for 40.3 % of the variable cost. Therefore, that is really a worry about the environment due to affect of antibiotics use in long run.

Comparing the results to those reported in papers related to larger regions such as the Central of Viet Nam including Nha Trang bay, the lobster aquaculture was found to be slightly less profitable. Nha Trang bay is one of four lobster culture regions in Khanh Hoa province, which is a place with the longest experienced farmer in 3 provinces of Central coast (Ly, 2009). An IRR of 43% was reported in Ly (2009) and an BCR of 44% was reported in Petersen (2010), while in this study, the IRR was found to be 30% and BCR with 30.1% in the crop 2010 – 2012. Accordingly, the results in the study are smaller 13% in IRR and 13.9% in BCR than that of Ly (2009) and Petersen (2010). In qualitative aspect, a reason why explained that there is a change in economics condition of Viet Nam these recent years in commonly. Nevertheless, even with the current rate of inflation, an IRR of 30% and BCR of 30.1%, are in indication of a profitable industry and that lobster farming can be a considered a good opportunity.

Accounting for 95.3%, variable costs has a high ratio in the total cost. Additionally, feed cost is still high proportions in variable cost (43.2%). In circumstances when farmers are delaying harvest in hope of receiving a good farm gate price, farmers should care about feed cost and time lasting since feed is such an important component of the total costs. The profit added from waiting must cover the increased feed cost. This is a risky game when prices are fluctuating. Therefore, need more research about the price fluctuations is needed. Good predictions on farm gate price data would be valuable support to farmers in their process of choosing harvest. The paper found that the breakeven price in average for different species was 562,399 VND to cover variable cost, and 589,943 VND to cover total cost. These are the minimum prices required to survive with this career of lobster farming.

The regulation

Although the regulation had set up completely from December 2010 to May 2011, from the published result of authority, it is calculated that the productivity in year 2011 is higher than in year 2010. Calculations are presented in table 14 below.

Table 14: Production and calculations related to productivity in Nha Trang bay in the period from 2010-2011

	Item	Year 2010	Year 2011	2011-2010	% 2011/2010
	(1)	*(2)*	*(3)*	*(3)-(2)*	*(3)/(2)*
1	Number of cages (cages)	8,470	6,819	-1,651	80.5%
2	Square of cultured area (ha)	13.8	10.2	-3.6	73.9%
3	Production quantity (tons)	200	208	8	104.0%
4	Productivity per number of cage (tons/cage)	0.023613	0.030503	0.006890	129.2%
5	Productivity per cultured area (tons/ha)	14.49275	20.39216	5.90	140.7%
6	Nitrogen loading (tons)	51.498	53.558	2.06	104.0%

Source: own calculations

The figures represented in the table 14 clearly show that both productivity measures above increased after the regulations set up, even if the regulation was in effect only the 7 last months of 2011. Although in year 2011 the number of cages was cut downed by 19.5% or 1,651 cages, the production increased 4% or 8 tons in comparison to year 2010. Accordingly, production increased with 29.2% per number of cages or 6.89 kg/cage and 40.7% per unit of cultured area or 5.9 tons/ha respectively.

According to archived results of the survey, in the last crop, there are 36.74 kg in harvest per lobster cage per year. Meanwhile, this number in whole bay is 30.5 kg in average productivity in year 2011. The figures are not much difference each other. However, the difference can explained by the fact that the survey included in the production in whole crop from the end of year 2010 – the beginning of year 2012, meanwhile above figures calculated in table 14 reflected the production harvested within year 2011.

It is hard to define exactly how much of the change is due to the regulation setting and how much which is caused by other factors. However, it might be interpreted as sign of the regulation having a positive effect on the production in the bay. In the regulations about distances between cages and farms, cages rearrangement led to improve environment of aquaculture area. It is thought that the regulation setting had useful affect on the environmental quality in the sea certainly. In other words, environmental quality and productivity have improved after introduction of the regulation.

The survey revealed that 55% of households borrow money with high interest from individuals or agencies in order to cover annual investment cost. This rate varies 1.16% to 6% per month, which is higher than banking interest rate of about 0.16 % to 5% per month. After the new regulation, all households had their own identified address number corresponding to their farms and they will have a certificate ensuring the right to use the water surface. Therefore, this is an opportunity for Nha Trang bay's farmers in continuing to invest their business because it will make it is easier to get access to credit at low interest rates. Similarly, rights and duties of farmer in the bay are defined. Farmers can borrow money from banks or legal credit agencies with lower interest via mortgage on their farm and according to their business plan.

4.2 Conclusion and suggestion

The new regulation in Nha Trang bay is really an opportunity for marine lobster cages farming in Nha Trang bay. Following this regulation, natural sea environment is more concerned by all stakeholders. From that, farmers believed in their farming and felt being encouraged from local authority in order to strengthen facing with the challenges.

Results indicated that this farming still generates profitability and high internal rate of return. The profit estimation illustrated that in conditions of market change, a change in nitrogen loading and culture time has the strongest positive effect on profitability. The next are stocking density and number of cage with different signs. Seed cost, which accounts for 40% of the variable costs, has a smaller impact than the cost of antibiotics and vitamins which account for only 1.2 % of the variable cost. Conversely, location variables, which the paper expected, do not play a significant influence in the profitability in Nha Trang bay.

With the limited in time, budget, and data, the limit of this paper is not enough samples in each region to compute all influenced affects clearly and exactly.

The nitrogen loading representative parameter is the sole parameter used in this paper for marine water pollution measure due to lack of reliable data related on other kinds of wastes. Hence, further researches on these parameters are needed too to archive the accurate result.

In order protect sea environment of Nha Trang bay, Government should be concerned about the marine environment and how to manage this environment, taking the interests of various stakeholder groups into account. Based on the results from the analysis, suggestions to some problems related to 4 areas are made:

Management and Environment

From the regulations set in Nha Trang bay, the authority should:

- Educating farmers to understand the benefit of protect sea environment. A guideline for environment protection in Nha Trang bay should be made and applied as soon as possible. This guideline should also cover all small actions which may impact on environment of each resident in the bay. For example, educating farmers to classify different kinds of waste from farms in the bay in order prevent non - decomposed waste releasing into sea and improve sea water quality.
- Imposing the environment standard of sea water quality, checking these parameters and imposing environment fee for using natural resource annually in order to make farmers have responsibilities to environment.
- Setting a fine in responding to bad actions, for instance, discharge of waste into marine environment should be considered.

Aquaculture science

- Funding yearly to built and collect panel data about farming activities for whole bay.

- Because culturing red lobster species with other valuable lobster species is not effective, it is needed to funding more experiments of polyculture with other species in order to balance environment and economic benefit.

Society

- From the survey, experience from other farmers is most trusted. Hence, building a co-management organization for lobster farmers in the bay is essential in order to connect all farmers together. Through this organization, market information and experience are shared and supported. Additionally, the government use this organisation in communication with farmers such as using experienced farmer to take a experiment as an example for farmers.

Economic

From impact of above variables on profitability, more research should be carried out in value chains. The government could do scientific and rational plan in managing value chains to manage aquaculture farming as well as support the farmers. In which, the authority should play an important role to adjust the relationship between farmers and other stakeholders.

In the first chain, checking sources, quality, quantity and technical standard from all inputs which are feed, seed, antibiotics and vitamins use before adding to marine environment is necessary. For instance, managing quality of feed and total allowed catch of trash fish; improving quality seed and recording seed sources.

In the next chain, standardizing farming technology, measuring environment technical parameters in each farm annually and recording correct data of feeding regime and treatment regime are for further research in order to improve farming.

Finally, the Government should support market information for local farmers and try to manage trade between middlemen and China importer so that shorten loss from lobster devaluation at the time of harvest.

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APPENDICES

APPENDIX 1 : Natural characteristics of 23 cultured areas of Khanh Hoa province

	Area/Region	Total square (ha)	Average depth (m)	Minimum distance from inshore in reality (m)	Characteristics of seabed
I	**Van Ninh district**				
1	Dam Mon	1,200	10	-	Sand and coral
2	Ninh Dao	300	12	200	Sand and coral
3	Khai Luong	36	14	150	Sand, mud and coral
4	Diep Son	35	12	100	Sand, mud and coral
5	Xuan Tu	200	6.2	500	Sand, mud and coral
6	Ninh Tan	30	15	200	Sand, small stone and coral
7	Xuan Vinh	90	6	1,000	Sand, mud
8	Ha Gia	50	6,8	1,500	Sand, stone and coral
II	**Ninh Hoa district**				
9-10	Vung Tau- Hon Lang	>100	5-10	-	Mud sand
III	**Cam Ranh city**				
11	Cam Phuc Bac	40	6	100	Mud sand
12	Cam Phuc Nam	70	6.5	300	Mud sand
13	Cam Phu	40	8	300	Mud sand
14	Cam Thuan	35	9	100	Mud sand
15	Cam Linh	47	11	1,000	Mud sand and coral sand
16	Cam Lap	20	10	150	Sand, mud sand
17	Binh Ba	1,200	10	-	Mud sand
18	Binh Hung	40	8	-	Mud sand and rock
IV	**Nha Trang city**				
19	Tri Nguyen	0.7	12	60	Mud sand
20	Hon Mot	0.65	12	50	Mud sand, small stone sand
21	Vung Ngan	4.4	15	50	Mud sand, small stone sand
22	Dam Bay	7.5	15	50	Mud sand, small stone sand
23	Bich Dam	8	15	50	Mud sand, small stone sand

(Source: Department of Fisheries Aquaculture, 2012)

APPENDIX 2: QUESTIONAIRES

Section I: Information about household

1. Name of household:……………………………………………………… □ Male □ Female
2. Address:……………………………………………………….……………………………
3. Age:………………………………Telephone number:………………………………………
4. Education:……………………………………………………………………………..
5. Number of members in household:…………………………………………………(person)
6. Experience ....(year)
7. Kind of cage:

   □ Floating cage □ Fixed cage □ Submerged cage □ Other

Section II: Information about culture species in crop 2010-2012

A.Culture species

8. Which species do you culture?

   □ Lobster □ Other……………..

9. How many cages do you have?...
10. How many cages do you use for lobster culture?...
11. How is size of your cage? Width………(m) x Length…………(m) x Depth………(m)
12. Please indicate about the information of lobster species cultured in your farm as table following?

	Item	Number of fingerling (individual)	Culture time		Survival rate (%, from the beginning to harvest)
			from month (mm/yy)	to month (mm/yy)	
1	Spiny lobster				
2	Green lobster				
3	Red lobster				
	…				

B. Costs

13. How many labors do they work in your farm in detail of the table?

Labor	Quantity (person)	Working time (hours)/ person/day
1. Member of household		
2. Hired labor		
3. Total labor		

14. Please indicate in the table below about initial investment costs and operation costs?

	Item (Mil. Of VND/crop)	Quantity (unit)	Price/unit	Total cost (Mil. Of VND/crop)	Using from year	Depreciated time (years)
A	**Fixed cost**					
I	***Initial investment***					
1	Cages system					
2	Boat					
3	Housing cottage					
II	***Equipments and tools***					
3	Electricity generator					
4	Diving equipment					
5	Diving cloths					
6	Net washing equipment					
7	Other					
	…					
B	**Variable cost**					
1	Seed cost					
2	Feed cost					
3	Antibiotic and vitamins cost					
4	Electricity/energy					
5	Fuel					
6	Other					
	…					

C. **Culture period**

15. Where do you buy lobster seed from?

☐ Fishermen ☐Middlemen ☐Other……………………………….….

16. Please indicate about the technical information during phases of cultured time?

Species	Nursery time	Grow out phase 1	Grow out phase 2	Grow out last phase
1. Spiny lobster				
- Size of individual from ……….g/cm to ……….g/cm				
- Size of cage……m x…….m x……m				
- Stocking density (individual/cage)				
- Cultured time (month)				
- Feed (kg/day/cage)				
+ trash fish				
+ shrimp/crab				
+ shell/				
+ other				
2. Green lobster				
- Size of individual from ……….g/cm to ……….g/cm				
- Size of cage……m x…….m x……m				
- Stocking density (individual/cage)				
- Cultured time (month)				
- Feed (kg/day/cage)				
+ trash fish				
+ shrimp/crab				
+ shell/				
+ other				
3. Red lobster				
- Size of individual from ……….g/cm to ……….g/cm				
- Size of cage……m x…….m x……m				
- Stocking density (individual/cage)				
- Cultured time (month)				
- Feed (kg/day/cage)				
+ trash fish				
+ shrimp/crab				
+ shell/				
+ other				

D. **Outputs and revenue in 2010-2012**

17. Please indicate about the harvest in latest crop in detail (2010-2012)?

Species	CROP 2010-2012			
	Number of lobster (individual)	**Weight (kg)**	**Farm gate Price (VND)**	**Revenue (Mil of VND)**
1. Spiny lobster				
Weight of lobster class 1 - over 1kg/individual				
Weight of lobster class 2 – from 700g up to 1kg/individual				
Weight of lobster class 3 – from 500g up to 700g/individual				
Total				
2. Green lobster				
Weight of lobster class 1 - over 300g/individual				
Weight of lobster class 2 – from 200g up to 300g/individual				
3. Red lobster				
Weight of lobster class 1 - over 300g/individual				
Weight of lobster class 2 – from 150g up to 300g/individual				
4. other ….				

Section 3: Market Information in period from 2010 - 2012

18. Please indicate about market information following in period from 2010- 2012?

About Labor cost

	Salary (Mil. Of VND)	Year 2012	Year 2011	Year 2010
1	Hired labor			

Price of feed

	Kind of feed	Year 2012	Year 2011	Year 2010
1	+ trash fish			
2	+ shrimp/crab			
3	+ shell/			
4	+ other			

Seed price

	Species of lobster	Year 2012	Year 2011	Year 2010
1	Spiny			
2	Green			
3	Red			
4	Other			

Farm Price at harvest time

	Species of lobster	Year 2012	Year 2011	Year 2010
1	Spiny			
2	Green			
3	Red			
4	Other			

Section 4: Other information

A. Feeding

19. Do you have any technical support from other?

□ Friend/relatives □Other…………………………..........................

20. Do you often measure the temperature and salinity of your culture area?

□ Yes □ No

If answer No, please tell the reason:……………………………...

21. Do you often apply the treatment regimen on lobster of the authority from 2008?

□ Yes □ No

22. Do you often use antibiotic and vitamins with feed for lobster?.

□ Yes □ No

23. Who advices you to use them?…………………………………………….........................

24. Where are you often buy them?...

25. How many days do you use them in months? …………………………….........................

26. Please let me know the reason for disease outbreak and loss in lobster in your area?

□ Pollution in water □ High density in cages □ Other.................................

27. Do you remember when your latest loss in lobster happened ?

□ Crop 2006 – 2007: how much………………………………………………..............

□ Other ……….………..…………………………………………………………..

B. Credit:

28. Do you often borrow money for lobster culturing from 2010 ?

□ Yes □ No

If yes, please answers by filling this table:

Source	Year 2010			Year 2011		
	Amount of money (Mil. Of VND)	Interest rate/month (%)	Period (month)	Amount of money (Mil. Of VND)	Interest rate/month (%)	Period (month)
Bank						
Relative						
Other						

C. Cages rearranged project of the authority:

29. Have your cages been rearranged by the authority?

□ Yes □ No

30. Have you been cut the number of cages by the authority in this project?

□ Yes □ No

If yes, please answer in which month……………………….....................................

31. Do you satisfy with this project?

□ Yes □ No □ other…………………………..

THANK YOU VERY MUCH FOR YOUR INTERESTING INFORMATION!!!