

Clam farming risks in Thai Binh province, Vietnam: impacts and causes

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Abstract: *Large part of the world population are seeking livelihood from coastal aquaculture, and have been experiencing increased difficulties because of the poor development plan for coastal area by governments, polluted water discharges from inland agricultural and industrial activities, and increasing negative impacts of climate changes. This study explores risks faced by clam farming sector in Thai Binh province, as well as their causes and impacts on farmers. Our survey revealed that there have been several important risks occurred in clam production which can be grouped in term of nature of origin: human-caused and natural ones. These risks have impacted on all relevant aspects of clam farming: production, market and financial risks. They are caused by several reasons, including extreme weather events, waste water discharges, production techniques; market or financial access. Of these risks, human-caused ones are more severe and more difficult for farmers to cope with (than natural ones). Therefore, the governments are suggested to take more effective roles in coordinating and managing different activities of relevant stakeholders (such as inland farming and industrial producers, better inland discharge schemes, more flexible credit system functions) so that human-caused risks for clam farming could be minimized.*

Keywords: *farmer's livelihood, farming risk, market, aquaculture, Thai Binh province.*

1. Introduction

About 60% of the world population are living on and seeking their livelihood from ocean-aquaculture production, and experiencing increased difficulties because of the poor development plan for coastal areas by governments, pollution discharges from inland agricultural and industrial activities, and increasing negative impacts of climate changes (Doukakis, 2005). Vietnam's difficulties are further exaggerated with its long coastal line (over 3,260 km) and many farmers are seeking their livelihood from aquaculture in 112 estuaries. This country is ranked the 18th in the world risk index in 2015 with the vulnerability index of 50.87% (Garschagen et al., 2016).

Vietnamese aquaculture has been observed with an annual growth rate of 5-7% for the last ten years, in terms of volume and value. The aquaculture sector has contributed significantly to social security (i.e., labour absorption) and national economy (Quyen, 2012). In 2014, this sector gained more than US\$7,800 million from exports (Vietnam GSO, 2015).

Most of studies in Vietnamese aquaculture have been done in the South, focusing on major aquatic animal production such as shrimp (Bush et al. 2010), catfish (Tru 2011), or other fish production (Armitage and Marschke 2013; Pucher et al. 2015). Yet, no comprehensive research has been done on clam production especially in the Northern coastal areas meanwhile clam productions have been remarkably developed since last decades (Thuyết & Dũng, 2013).

This study focuses on the clam¹ production in the Thai Binh province – the largest area of clam production in the north and north central coastal region of Vietnam. The study aims to answer two major research questions: (1) What are the risks that clam farmers have been experiencing;

¹ Latin name: Meretrix Lyrata

and (2) What are the causes and the impacts of these risks on the local clam production and farmer's livelihood?

2. Literature review

Risk and Uncertainty: Researchers often make a distinction between “risk” that implies knowledge of numerical probability of loss that affects an individual or a specific group of farmers, and “uncertainty” that implies an outcome that is uncertain and unknown in probabilities (Aimin, 2010; McIntosh, 2008). However, other researchers argued that a distinction between risk and uncertainty is not operative because in most cases, probabilities are very rarely known and therefore, they are just as subjective beliefs (OECD, 2009). There is a combination between these two definitions, in which risk is uncertainty that involves probability of economic losses, possible harm to human health, repercussions that affect resources (irrigation, credit), and other types of event that affect individual welfares. In other words, uncertainty is necessary for risk to occur, but does not always lead to a risky situation (Harwood, Heifner, Coble, Perry, & Somwaru, 1999). Despite a parallel existence of these two perspectives, distinction between risk and uncertainty still blurs and varies somewhat depending on the sector. In general, definitions of risk and uncertainty incorporate a concept of: (1) uncertainty of outcome; (2) probability or likelihood, and (3) consequence or impact. Therefore, “risk” is the potential for realization of undesirable, adverse consequences to production, human life or environment (Bondad-Reantaso, Arthur, & Subasinghe, 2008).

Agriculture Risk Classification: Because of differences in risk definitions, there are many standpoints for risk classifications in general and agriculture risks in particular. Huirne et al. (2000) and Hardaker et al. (2004) distinguish two major types of risk in agriculture. First, business risks which include production, market, institutional and personal risks, and second, financial risks that are resulted from different methods of financing a farm business. Musser and Patrick (2001) following Baquet et al. (1997) define five major sources of risk in agriculture based on its causes: (1) production risk; (2) market risk; (3) institutional risk; (4) human risk; and (5) financial risk. OECD (2009) classifies agriculture risks into four groups, encompassing (1) production risk; (2) market risk; (3) financial risk and (4) institutional/legal risk. Meanwhile, researchers also use level of impacts of risks to divide agriculture risks into three layers: (1) micro (idiosyncratic) risk affecting an individual or household; (2) meso (covariant) risk affecting households or communities; and (3) macro (systemic) risk affecting regions or nations. However, boundary between different types of risk is somewhat blurred since farmers might suffer from a combination of risks at the same time because these risks are inter-dependent and/or inter-correlated.

Aquaculture risk: Aquaculture is facing similar risks of agriculture in general but further with those related to aquaculture, such as disease, equipment failures, or unexpected competitions (Bondad-Reantaso et al., 2008; McIntosh, 2008). Given a longer production cycle, as well as larger initial investments required in aquaculture as compared with other agricultural subsectors like annual crops and animals, aquaculture is often faced with more serious risks (Engle, 2010), especially in the context of climate changes and their unpredicted hydrological cycles. Handisyde et al. (2006) and Del Silva & Soto (2009) (cited in (Barange & Perry, 2009) noted that climate changes bring various direct and indirect impacts on aquaculture that certainly cause more stresses and vulnerabilities to this sector, and thus implies a higher possibility of loss. Moreover, the extensive global economic crisis has exposed farmers to severe conditions in dealing with a variability in in- and output prices (Miranda & Vedenov, 2001).

Risk impacts and vulnerability: Recently, a significant aspect studied by risk scientists is associated with issues of social protection against poverty, particularly in developing countries (Dercon, 2005). In this context, the term “vulnerability” is used to mention level of consequences

of risk that could cause potential harm to the farmers (Adger, 2006; McCarthy, Canziani, Leary, Dokken, & White, 2001; Sarewitz, Pielke, & Keykhah, 2003). Sarewitz et al. (2003) even asserted that vulnerability reduction is a human right related issue while risk reduction is not. Accordingly, measuring and decreasing impact of risks is more important than trying to eliminate them. Impacts of risk are generally a negative outcome of an event (hazard) occurring on several aspects of farmer's farming practices and their life including economics (weather extremes in food-producing regions could reduce crop yields up to 25% and certainly lead to food price increases (Porter et al., 2014)), social (a substantial proportion of world population are falling into deeper poverty as they are struck by negative shocks (WorldBank, 2014)), and environment (caused by human-made catastrophes such as the Fukushima power plant disaster of the Gulf of Mexico oil spill (Kreft, Eckstein, Junghans, Kerestan, & Hagen, 2014) etc. Such consequences, which must be identified by the degree, the geographical extents, and duration of the effects, may be expressed qualitatively (with level of impacts from low to high) or quantitatively (in terms of monetary value of loss of number/proportion of affected people) (Arthur et al., 2009).

3. Methodology

3.1. Study Site

Thai Binh is located in the “rice bowl” of the Red River Delta of Vietnam, and remained an agriculture-based province. Sixty-six percent of the provincial workforce is devoted to the agricultural sector. Even though much change in the provincial GRDP (Gross Regional Domestic Product) structure has happened toward more industrial and service sector contributions over the last 30 years under the market-based economic policy of Vietnam, agriculture, forestry, and aquaculture still contributes 25%–35% of the total provincial value of production in recent years. Most farmers have been traditionally living on food crop production and animal raising. About 26% of farmers living along coastal areas seek their livelihood from coastal aquacultural activities, mostly in combination with other traditional livelihood activities. In 2015, the total value of GRDP of Thai Binh was estimated at \$1.956 trillion and GRDP per capita was about \$1377. In which, total aquaculture production generated a value of \$174 million (H. D. Nguyen, 2015).

Among coastal provinces in the north of Vietnam, Thai Binh has the largest clam farming areas (i.e., 3,430 ha), followed by Nam Dinh (1,710 ha), Thanh Hoa (1,200 ha), and Quang Ninh (1,000 ha) (MARD, 2014). According to the Thai Binh Agriculture and Fishery Extension Center, salinity in intertidal area is around 1.5‰–2.5‰, favouring aquaculture development. The total area that has potential for aquaculture is around 17,000 ha (MARD, 2014), of which 15,119 ha (or roughly 89% of the total potential area) have been brought into aquaculture production with many types of species, such as shrimp, fish, and clam. In 2014, the total clam production generated a value of VND 445 billion (about US\$20 million) for the province (*see Figure 1 & 2*).

There are 12 communes of the province involved in clam farming. These are located along 50 km of coastline in the province. For the study, three communes were selected. These have the largest clam farming area as well as the longest history of clam production in the province. These characteristics allow researchers to capture the risks and farmer's resilience/capacity in clam farming over a relatively long period, i.e., from 2006–2014. There are 1,310 households doing clam farming in the three communes at the time of the study (“Geographical Database,” 2016; Nationsonline, 2016) (*see Figure 3*).

3.2. Data Collection

Fieldwork was carried out in the study site from August, 2014 to April, 2015. Secondary data regarding policies on intertidal land planning, and allocation, financial and technical supports for clam production was gathered from different local government offices and published papers/reports. Primary data was collected by using different research tools. Data on clam farming and marketing practices and risks, and farmer's capacity and strategies to recover from different risks that occurred between 2006 and 2014, was collected. The data was then combined to identify

impacts of policies on clam farming practices, consequent risks and farmers' coping strategies. The three research tools used for field research were:

Key Informants' interviews (KIs). Eleven key persons from local governments at three administrative levels: province, district, and commune, and clam traders were interviewed in order to obtain data on government policies and enforcement related to intertidal land planning and allocation; government (technical and financial) supports for clam farming; clam trader's performance in relation to local clam farming practices and their views on factors that govern local clam farming and marketing practices. (KIs include one person in the Thai Binh provincial aquaculture department; two people in aquaculture sub-departments in two districts; heads and aquacultural extensions of the three communes; and five clam traders.)

Focus group discussions (FGDs). Three FGDs were conducted in the selected commune (one FGD/commune) with participation of 8–10 farmers who have good experience with clam farming and marketing practices. FGDs aimed to explore historical events of local clam farming and market, relevant government policies and impacts on clam farmers, as well as farmers' coping strategies to risks and policy constraints.

Household surveys. Household surveys aimed to capture in depth information on farmer's clam farming and marketing practices, such as farming costs and profit, risks they faced, their coping strategies, and consequences of risks to their farming practices, as well as their lives. Sample size of households for survey was calculated by the following equation:

$$n = \frac{N \times t^2 \times S^2}{N \times \Delta_x^2 + t^2 \times S^2} \quad (1)$$

where n = sample size; N = total households having clam farming in the three communes (1310); and t = confidence interval (2.17, with 97% confidence level).

Based on the first 31 households surveyed in the three communes for their clam farming loss, sample variance (S^2) of 194.88 and sample errors (Δ_x^2) of 2.52 were estimated.

For these parameters, $n = 157$ was generated.

3.3. Data analysis

In this study, a chronological analysis was applied to identify the impacts of government intertidal land-use policies on clam farming practices at the farmer level, the trend of clam farming and marketing practices, emergent risks, and farmers' coping strategies and consequences. In addition, a Mann-Whiney U-test was applied to test the impacts of different clam-raising plot sizes: those set by the Thai Binh government and those created by farmers in clam farming.

Mix method research: Mixed method was applied for this study (see Figure 4) because of the following advantages. Aquaculture risks are very diverse because they could impact many external factors such as species, environments, market and practices. Therefore, the range of hazards and the perceived risk is very complex (Bondad-Reantaso et al., 2008). The application of only one method (quantitative or qualitative) could lead to the bias result. Furthermore, to measure two basic characteristics of the aquaculture risk including its likelihood and consequences, we need to collect quantitative and qualitative data for the overall assessment (Creswell, 2014). Accordingly, the following methods were applied in this study:

- *Qualitative methods:* (1) Ethnomethodology was used to define the shocks happened in the clam farming in period 2006-2014 as well as to evaluate farmers about risks and (2) Risk assessment matrix was applied to rank the risks based on the consequences and likelihood of risk.
- *Quantitative methods:* (1) Mutual Information Index (MII) sensitivity analysis (with Monte Carlo simulation) was used to determine the sensitivity of "Profit per ha" to the

changes of factors and (2) Correlation & Mean comparison (such as Spearman's rho test, Kruskal-Wallis test) was applied to assess the impacts of each factor.

4. Results and discussion

4.1. Clam production in Thai Binh

Abnormal development trend

The clam production has started in Thai Binh since 1990s with a small area (150 ha), after a long time sticking with capturing natural clam. However, this aquaculture sector had been only developed in commercial orientation since 2001 and got outbreak of the extensive production in 2006. Unpredictably, the statistics revealed an abnormal trend in the clam production of this area in period 2006-2014. While the total production area had been continuously increased in this period, it reached the highest value in 2011 and then slowed down until 2014. This expansion was a response of farmers when they realized clam production of "super profit". Forty percent of the current clam farms with a total area of 2,100 ha started their clam production in the period from 2009 to mid-2012, as in this time, clam was named "golden animal". However, clam average yield and gross output were not at the same trend. Despite a sharp increase in the total area of production during 2009-2011 (nearly triple), the total gross output in 2012 suddenly reduced nearly US\$4.5 million and the average yield of this period was 18.6 tons/ha (3 tons lower than this figure in 2010). Two years later, a decrease in the total value of output happened again and was only equal to year 2010 while the total area of year 2014 is 2,000 ha more than that of year 2010 (*see Figure 1*). This abnormal trend presents fact that clam production suffered from different kinds of risk, from starting to harvesting stage, which then lastly caused an extraordinary variability in its both productivity and production value.

Profitable but risky production

The clam production has been considered as the most profitable subsector in the coastal farming system in Thai Binh province. Accounted for 59% of the total provincial aquaculture output in period 2009-2014 (MaiLien, 2014), this subsector generates a high income source for farmers, improving the socio-economic development of many local communities. Particularly, in some cycles during the period of 2009-2011, harvest earnings was triple of the investment cost, i.e. some clam farmers had received US\$22,000-27,000 per ha as a net profit (TTXVN, 2014). Result from the Monte Carlo simulation showed that mean of profit per ha in one year for clam production is US\$6,700 USD; but varying between juvenile and adult clam farming (US\$18,000 vs US\$3,300, respectively). The most special characteristic of clam raising is that there is no cost for feeding practices. The major cost goes for juvenile and labour, accounted for 70% and 20% of the total production cost, respectively (T. H. Nguyen & Nguyen, 2013), in which, labour is provided by farmers and other hired ones.

Farmers said that clam farming is somehow like "gambling". Given a long raising cycle, and largely dependent on external factors, clam farmers have to cope with more risks. The forecast report resulted from the Monte Carlo showed that rate of investment loss is 52% (*see Figure 5*); and in specific, those figures for adult and juvenile clam raising are 55% and 43%, respectively. Looking for the reason why farmers are invested in clam farming despite risks, the findings show that 75% agreed that this investment is attractive as a gambling, meaning that the more they lose, the more they want to reinvest with an expectation to win in following clam raising cycles. Box 1 below presents an opinion of one farmer who has 10-year experience in clam production and still remains his clam farming despite a loss of about US\$22,000 in 2012.

Box 1: Farmer’s opinion about investment in clam production: No risk – No gain

“Only clam can save clam farmer. Nothing is more profitable than investment in this sector. With one raising cycle like in the period 2009-2011, we may cover loss of 3 raising cycles like in 2012. I would like to take money back from the place I dropped my money”
(interviewed with a farmer in Thai Do Commune, Thai Thuy District on July 20, 2015)

The case of clam production is an excellent example of key insights on the process of risk management from the World Development Report in 2014: *“Taking on risks is necessary to pursue opportunities for development. The risk of inaction may well be the worst option of all”* (WorldBank, 2014). Therefore, risk management can be a powerful instrument for sustainable development. The next part will discuss on impacts and causes of risks in clam production, which would then be a good ground for assessing and giving recommendation to improve risk management strategies in agricultural sector in the future.

4.2. Impacts of Clam Farming Risks

Direct economic impacts:

Data on clam farming loss of 157 households interviewed for the period of 2006-2014 reflects a serious impact of loss in clam farming. In 2012, with 67% of clam area loss² (equals to 147.05 ha and owned by 42 households), farmers suffered from a total loss of more than US\$2.2 million. Some years later, percentage of clam raising area under loss kept slightly increase while the total loss decreased steadily. Because of these shocks occurred in the period of 2006-2014, 42% of interviewed clam farmers had minus average profit per year (*see Table 1*), with a loss of minus US\$79,000/per year as the most serious case reported.

A sensitivity analysis resulted from the Monte Carlo simulation showed that clam mortality rate was the main factor causing variation of farming profit with a negative impact (the higher clam mortality rate, the less profit received by farmers). The price ratio (calculated by the prices of clam at two points: starting and harvesting cycle) was the second major external factor which contributed to the 23.3% of variation of the profit (*see Figure 6*). However, given the different characteristics between juvenile and adult clam farming, impacts of these two factors on clam farming practices are also different. With a shorter cycle length (2-5 months) and higher technician equipment investment, profit from juvenile clam raising is more oscillated with mortality rate of minus 52% and changes of price caused 9% to its variation. Adversely, these two figures in adult clam farming are minus 34% and 24%, respectively (with a raising duration of 18 months in normal condition). Overall, for both farming systems, profit from clam raising depends more than 50% on the external factors.

Other socio-economic and environmental impacts

The fluctuation in the clam farming productivity and price causes a serious financial impact on farmers. Hundreds of billion VND investment lost each year in the period of 2012-2014. Thousands of farmers faced bankruptcy. About US\$20.8 million borrowed from banks could not be paid back yet (Long, 2013). For the 157 households interviewed, 16% stopped their clam farms as the result of capital bankrupt; 38% had to sell their fix assets (like houses, cars, motorbike or even clam fields) to have money to repay debts. Moreover, attracted by “profit-promising gamble” of clam raising, 45% of farmers have decided to borrow more to reinvest on clam farming, with an expectation and belief that “only clam can save clam.” Unluckily, not all of them have been

² Concept “Loss” referred to the situation when the profit of clam farming was minus

successful. Some of them had to leave their village as they could not afford to pay debts (at least, 3 cases in Dong Minh, 5 cases in Nam Thinh and 2 cases in Thai Do).

In parallel, other socio-economic and environmental problems such as reduced clam-based employment opportunities for local farmers, water (and even air) pollution caused by clam deaths have also more occurred in recent years (Tú, 2013). Human loss also happened when farmers working on the sea, especially for women. In 12/2014, in Tien Hai, there were six clam farmer deaths when boating to harvest clams, five of them were women. Some months later, in 2/2015, in Thai Thuy, two others were also missing because of their boat capsizing, and both were women.

Undoubtedly, livelihood of clam farmers is highly sensitive with clam farming risks, in both economic and human welfare terms. Therefore, for a sustainable livelihood for clam farmers, finding root causes of the risks is necessary for both farmers and government to adjust their actions accordingly for more effective risk management strategies.

4.3. Causes of the risks

The results from farmer's group discussion and key informant interviews revealed that there are three main types of risk affecting clam production, namely: production risks (causing clam mortality); market risks (causing difficulties in market access and declined clam market price) and financial risks (causing household's debts and bankrupts). Detailed information on each type of risks is discussed in the following sections.

Production Risks

Production risks cause clam mortality, slow clam growth and even deformation. These risks induce to reduction of clam yield. According to Thai Binh's statistics, clam yield varied much from 11 to 70 tons/ha during period of 2006-2014 (Thai Binh DARD, 2015). However, local governments and farmers have dissimilar opinions about root causes of risks. The only common agreement is "bad weather", and all the others are totally different. For instance, local government's report stated that high mortality rate mostly caused by farmers' own faults (such as adopting high clam raising density as compared to technically recommended density). By contrast, farmers evoked polluted water discharged from factories/paddy rice nearby as major causes for clam mortality. In general, there are 4 factors identified as major causes for clam mortality.

Weather factor: A clam production cycle normally lasts 18-24 months (from a starting of about 1,000 clam head/kg to a harvesting at 70 clam heads/kg). Therefore, during such a long duration, many environmental factors could seriously cause clam death. According to technical guides for aquaculture production published by the Thai Binh Department of Agriculture, suitable temperature for clam varies from 18 to 30°C (ThaibinhDARD, 2013). Whereas in the study site, climate temperature can be up to 38°C and lasted for several days continuously. Moreover, this coastal area is often suffered from at least 2 storms per year, some of them were disastrous like the Kammuri storm in 2008 or Son Tinh storm in 2012. In a preliminary study, (Tung, 2012) concluded that among weather factors, water temperature has most impact to the mortality rate of clam.

However, weather factors were not singly causing massive death of clam. In 2014, the highest temperature was 36.5°C with number of hot days was only 9 whilst in 2010, there were 22 days hot days at higher temperature of 38.3°C but average clam death rate in 2010 was lower than 2014 (see Table 2).

Disease and salinity level: An experiment with two widespread kinds of bacteria namely *Vibrio haveyi* and *V. alginolyticus* in 240 hours (10 days) shows that they do not have any direct effect on clam mortality and growth and therefore have no impact on the vitality of clam. Besides, salinity level does not cause clam death, but may affect clam adaptability when being moved to new raising environment, i.e., from juvenile filed to clam commercial production fields (Tung, 2012).

Density: There is a strong debate about impact of clam raising density on mortality rate. Report of Ministry of Agriculture and Rural Development about causes of massive clam death concluded that high clam raising density is one of the major reasons. Whilst the technical

instruction given by the Thai Binh Department of Aquaculture suggests a suitable clam raising density is at 300-400 head/m² (ThaibinhDARD, 2013), farmers even adopted a raising density at 700-800 head/m². High raising density certainly causes lack of feed for clams and other environmental factors that support clam growth such as light, oxygen...(PV, 2014). However, farmers also raise two questions to reheat the debate, including (1) two fields may have same clam density rate but one closer to waste water flows discharged from inlands had higher mortality rate; and (2) area in the middle of the two fields (with 1-2 m wide), there are very few clams (low density) but suffered from massive death as those inside the fields.

Several scientific studies indicated that clam raising density did not directly cause high clam death rate, though might having indirect impacts. The rise of clam density from 200 to 493-600 head/m² may surge farmers' income in first periods, but would lead to degradation of environmental factors that support clam growth (Thuyét & Dũng, 2013). Tung (2012) set up 4 experiments to determine impacts of raising density to clam growth. After two months, weight of 158 heads of clam (randomly chosen) from each experiment with density of 150 head/m², 300 head/m², 700 head/m² and 1,200 head/m² were 1,500g; 1,420g; 1,390g and 1,240g, respectively. The longer time of clam living in field, the more risk is expected, that certainly increases the overall mortality rate.

Polluted waste water flow: Similar to the issue of raising density, local government and farmers have opposing opinions. Along to the coastal line of Thai Binh, there are several drains for wastewater flow discharged from inland factories and rice field which are accused by farmers as causes for clam massive death. Farmers observed that clam death rate always increased when waste water was discharged. However, no official document of government has admitted this blame so far. Government officials argued that adjacent factories have operated since 2000s but the phenomenon of massive clam death just happened in recent years (since 2012 up to present). Moreover, when massive death clam happened, it would damage water environment since farmers could not collect all death clam which then exaggerates the situation (PV, 2014).

Meanwhile, result from research of Tung (2012) showed that water environmental conditions in the Thai Binh coastal area had signs of contamination, affecting growth of clams; although no records existed to prove possible correlation between contaminated water level and clam mortality rate. Many environmental elements were higher than Vietnamese technical standards³ applied for water quality of aquatic production such as total suspended solids, N-NO₂; N-NH₄⁺; P-PO₄³⁻; TSS. Clams are also very sensitive to Niclosamide - a chemical used for controlling golden snails in paddy (Tung, 2012).

Juvenile clam of low quality: This is claimed as part of reasons causing slow clam growth (inducing to longer raising cycle) and deformation phenomenon of clam. According to farmers, compared with 10 years ago, clam growth and resistance capacity, i.e., towards extreme climate conditions, are reduced. As discussed above, environment and natural depression process could weaken juvenile quality. But this is not the only reason. To quickly expand clam production both in raising area and density, farmers have to access different sources of juvenile clams, i.e., from neighbouring provinces such as Nam Dinh, Thanh Hoa province, or even from China and Taiwan, etc. because juvenile produced in Thai Binh only met about 17% of the total demand in the 2010s (ThaibinhDARD, 2014). Farmers reported that juvenile clam purchased from other locations were more vulnerable to new raising environment. Many clams have problems with deformation phenomenon.

Market Risks

Oversupply and unstable market: The expansion of clam raising area in the period of 2006-2010 could be explained by clam "super profit" experienced by farmers in early periods. However, after 2010, a continuous clam raising expansion promoted by Thai Binh Provincial government to expand clam production with a target of 100,000 tons of harvest clam/year in 2015 and 200,000

³ QCVN 10: 2008/BTNMT

tons/year in 2020 has really caused market shocks for clam farmers. Nearly, one thousand ha of intertidal area was newly brought into clam production between 2011 and 2014 in the province while clam demand market has suddenly decreased since 2012. An official record of Thai Binh Commercial Department revealed that before 2012, 50-60% of the total provincial harvest clam was sold to China through un-official export channels, 30% to the EU market and only 10% was sold in domestic market⁴. Nonetheless, in 2012, two growing food safety issues caused by illegal additives adopted by farmers and toxic industrial wastes (Lam, Remais, Fung, Xu, & Sun, 2013) which pushed the Chinese Government to reform laws, establish monitoring systems, and strengthen food safety regulations, especially for unofficial import channels. Accordingly, clam exports from Vietnam to China had been restricted and even forbidden (Phu, 2014). At the same time, further food safety requirements adopted by EU markets created additional barrier for Vietnamese aquaculture product exports, including clam.

Sudden changes of price and latency of response: Together with the decrease of total clam harvest caused by production risks, suddenly reduced market access and clam price (as a certain consequence of oversupply) caused a serious decline in the total value of clam production, despite the expansion of clam raising area. The rapid increase of clam price during period of 2006-2011, has been immediately followed up by its nonstop downturn for the following period of 2011-2014 (*see Figure 7*). Accordingly, price of juvenile clam fluctuated in the same trend. However, impacts of juvenile clam price can only be realized at the end of clam raising cycle, i.e., 18-24 months after juvenile purchase. The dot line in Figure 7 connects two points (start and ending points) for one clam raising cycle. Since the normal clam loss rate is 30%⁵, in optimistic cases, the gross profit rate is double in 2006-2007; nearly two and half times more in 2009-2011 but nothing in 2012-2014. In fact, this loss could be more serious as it has been impacted by many other risks in combination than price factor.

Limited information for farmers: Clam farmers do not have any official source of information about juvenile or commercial clam prices, good suppliers or demands of the markets, making farmers disadvantaged in negotiations with suppliers and collectors. 95% percent of the interviewees said that they do not know exactly where the buyers came from; 100% of them did not realize importance of making legal contracts with traders. There is no intervention/support from local governments for farmers in finding clam in- and output markets, no warnings about clam production and market risks, no protection when clam farmers were cheated by traders. The absence of governments' supports contributed to farmer's weakness (Markelova, Meinzen-Dick, Hellin, & Dohrn, 2009), meaning that they were really "passive in the game": the price of juvenile and meat clam is always imposed by suppliers and collectors/traders.

The problem was far more serious when farmers found no market to sell clams even though at low price. As in a passive position, when connected buyers leave the market, farmers only know to keep clams in their fields and "waiting for other buyers". As a result, clam raising cycle was increased (*see Table 3*). The results from discussion of the focus group of experienced clam farmers stated that 6-7 years ago, they needed only 12-18 months to finish a raising clam cycle, but it is now up to 18 – 36 months. Although the length of clam raising cycle does not have a strong correlation with clam mortality rate, the correlation coefficient is 0.124 with the significant level of 0.01 (*see Table 4*) showing the fact that the more time clam raising in the field, the more risk will happen to them.

Financial Risks

High barrier to access formal credit market: High investment requirement is one of the important characteristics of clam farming. Average investment cost for clam farming is of \$20,000-\$22,000/ha (T. H. Nguyen & Nguyen, 2013). The results of household survey showed that 70% of their investment as well as financial resource to recover after risks had come from

⁴ Information from Key Informant Interview in April 2015

⁵ Result from Focus Group Discussions in March 2015

credit system. However, risky characteristics embedded in clam production makes difficulties for clam farmers to access to formal credit system. The statistics from the State Bank-Thai Binh branch showed that up to September 2013, there were 1,752 farmers and small enterprises that borrowed money to invest in clam production, with a total loan amount of 457.6 billion VND (about US\$ 21 million) (Long, 2013). This amount was just equal to one third of the total of capital investment in the sector by farmers. In credit policy, banks can refuse to lend more money if farmers had not yet returned borrowed loans or they did not submit sufficient documents for extending loan period as required by the banks. Given increased risks in clam production in recent year, banks set stricter barriers for credit risk management policy (such as higher mortgage required). This pushed and directed farmers to informal credit market as it always requires less administration procedure and no credit limit; but with higher interest rates applied.

Informal credit market: With data of all the cases financed by credit from informal market, the Monte Carlo simulation resulted that the probability of loss with those cases is 57%, which is 5% higher than the common average. The high interest rate (5-10% higher) than formal market is one of the most important reasons made the mean of clam profit per ha (which was financed by informal credits) is much lower than the mean of groups financed by formal credit (*see Table 5*). High interest rates of informal loans coupled with other production and market risks brought farmers into more financial troubles. There have been lessons learnt that once poor farmers rely on informal loans with easy access, it will be difficult for them to escape from financial debt traps.

4.4. Risk classification

Segmenting risks into layers: A focus group discussions had been carried out in March 2015 to rank the different types of risk based on frequency of occurrence (likelihoods) and magnitude of loss (consequences). The results of discussion showed that risks which make clam farmers most worried include high clam mortality rate and sudden changes of market price. In recent years, those risks happened quite frequently and have caused serious losses (*see Figure 8*). Clam farmers revealed that a clam mortality rate of 30% is common and accepted. However, since 2009, clam mortality rate is around 55% on average caused by polluted water flows and around 40% by the extreme weather events (storm or hot weather). Parallel with these risks, sudden change of market prices, which had happened frequently since 2012, led to extreme chaos in clam production sector in the province.

Boundary between different types of risk is blurred because they are correlated with each other (OECD, 2009). For example, it is also factual in clam production for reason that when clam market price went down, farmers may have a response to risk by keeping clams in their fields, unlimitedly. Different from other types of agricultural productions that have a definite time to harvest, clam farmers can extend harvesting point as much as they want. However, the more time clams stay in fields, the more risks are expected from bad weather events and/or polluted waste waters. Therefore, although those risks are segmented in different layers, they should not be treated separately.

Nature of causes: There are several causes of aquaculture risks, but majority of them are human-caused rather than nature-made (*see Table 6*). From farmers' views, human-caused events (such as risks caused by polluted water) are more systemic than naturally originated ones. Farmers have revealed that they can forecast weather by relying on their experiences or national forecast weather programs and then taking some actions such as investment on netting system, harvesting time, or even decision on size of juvenile clams for new raising cycles. But human-caused events could happen whatever time of the year without prenotice to farmers, especially when polluted water is discharged silently.⁶ Similarly, Pigeon and O'Leary (2000) concluded in their study that

⁶ Source : Focus Group Discussion in Dong Minh (3/2015)

human-caused risk is normally more difficult to manage, because of two common barriers: (1) asymmetric information ; and (2) blamed and organizational politics.

5. Conclusions and Implications

Clam production plays an important role in the livelihood of the most farmers living along coastal area and in the total aquaculture production value as well as in the provincial annual income of the Thai Binh province, in general. After enjoying a lucrative economic return in the early 2000s, clam farming sector has been facing increasing risks, including production risks (i.e., high mortality rate, slow growing capacity and deformation phenomenon of clams); market risks (i.e., unpredictable changes of market prices with suddenly reduced tendency in recent years); and financial risks (i.e., caused by high investment demands of the sector as well as high interest rate applied by private credit system). These risks, in some intertwined manners, have exacerbated vulnerability of the clam farming practices and the farmers involved.

Even though the impacts of these risks on the clam production have been felt and quantified by farmers, their causes have not yet been well analysed, or in some extents, purposively ignored by local governments. As a result, the governments and the farmers are keeping blaming on each other for causes of risks that occurred, and finally farmers are the ones who have to pay more cost and even trapped into financial troubles. Many farmers have been badly hit by risks in clam farming, forcing them to quit clam farming whilst others are struggling to survive their farms with different strategies, notably by reducing clam farming scale, more careful selection of clam juvenile size, harvesting time, or netting system etc.

The government zoning and promoting clam production in early 2010s have boosted clam expansion and intensification in an absence of careful assessment on market demands, as well as schemes to promote clam market. This coupled with poor coordination for wastewater discharges from inland industrial and agricultural activities have exaggerated risks for clam farming practices. Stricter food safety policies adopted by clam importing countries like China and EU have further reduced market opportunities for clam farmers. All has explained for plagues faced by clam farmers in recent years.

There are always winners and losers in all types of daily business. Clam farming can not be exceptional. However, since clam farming is observed with more losers than winners in recent years, and many losers have been faced lethal bankrupts from their clam investment, alternative clam development strategies are badly needed.

Exposed with different types of risks, both natural and human-caused ones, it has been clearly observed that farmers alone cannot effectively cope with these risks. As described earlier, clam farming risks are much more human-caused rather than naturally originated. Therefore, governments should play better roles in coordinating and managing different activities of relevant stakeholders (such as inland farming and industrial producers, better inland wastewater discharge schemes, more flexible credit system functions) so that human-caused risks for clam farming could be minimized. In addition, governments could also help improving local people capacity to cope with other risks through improvement of information communication and financial mechanisms, towards building up a more effective and sustainable aquaculture risk forecast and management system.

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TABLES

Table 1: Profit per year of clam household (period 2006-2014)

Group base on loss frequency	% of HHs	Profit Per Year (Million VND)		
		Mean	Max.	Min.
<i>Gained in all cycles</i>	14%	323.17	1099.10	3.40
<i>Had more gain cycles than loss cycles</i>	44%	210.55	1405.87	-575.74
<i>Had more loss cycles than gain cycles</i>	24%	-123.15	103.74	-861.22
<i>Lost in all cycles</i>	18%	-177.33	-8.60	-1745.25

Table 2: Weather statistics in ThaiBinh coastal area and average mortality rate of clam.

Indicator	Unit	Year									
		06	07	08	09	10	11	12	13	14	
(1) Number of storm	Storms	2	4	3	3	2	4	2	4	2	
(2) Highest temperature	°C	36.7	37.9	35.7	37.5	38.3	37.3	37.6	38.2	36.5	
(3) Number of hot days	Days	12	10	5	15	22	7	14	8	9	
(4) Average mortality rate	%	30	30	42	51	39	39	58	48	54	

(Sources: (1), (2), (3): ThaiBinh Statistical Department; (4): Household Survey)

Table 3 : Length of Clam cycle in period 06-14 (Unit: months)

Year	MEAN	MIN	MAX
2006-2011	18.87	15.23	26.40
2012	21.75	17.23	36.53
2013	20.59	15.23	39.60
2014	25.55	17.20	42.60

Table 4: Spearman's rho Test about the correlations between cycle length and mortality rate

		<i>Cycle Length (months)</i>	<i>Mortality rate (%)</i>
<i>Cycle Length (months)</i>	Correlation Coefficient	1.000	.124**
	Sig. (2-tailed)	.	.006
	N	481	481
<i>Mortality rate (%)</i>	Correlation Coefficient	.124**	1.000
	Sig. (2-tailed)	.006	.
	N	481	481

** . Correlation is significant at the 0.01 level (2-tailed).

Table 5: The result of Mann-Whitney Test for the hypothesis about “the borrowing sources and Profit per Ha”

Borrowing Source	N	Mean	Std. Deviation	Std. Error Mean
Formal Credit	255	143.17	577.35	36.16
Informal Credit	115	-39.56	518.17	48.32

Mann-Whitney Test Statistics

- Mann-Whitney U 11195.00
- Wilcoxon W 17865.00
- Z -3.642
- **Asymp. Sig. (2-tailed) .000**

Table 6: Causes of the risks: *Human-caused more than natural -made*

Type of Risk	Causes	Natural made	Human-caused
Production Risk	• Bad weather (Extreme weather events)	x	
	• Polluted waste water		x
	• High density		x
Market risk	• Overexpansion and unstable market		x
	• Sudden changes of price and latency of response		x
Financial Risk	• High barrier to access formal credit market		x
	• High interest rate in informal market		x

FIGURES

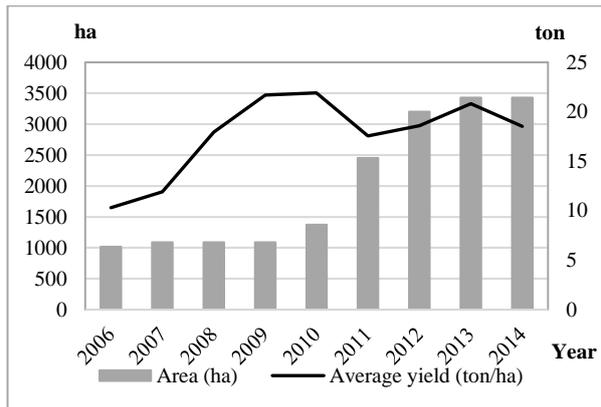


Figure 1: Clam farming area & average yield (2006-2014)

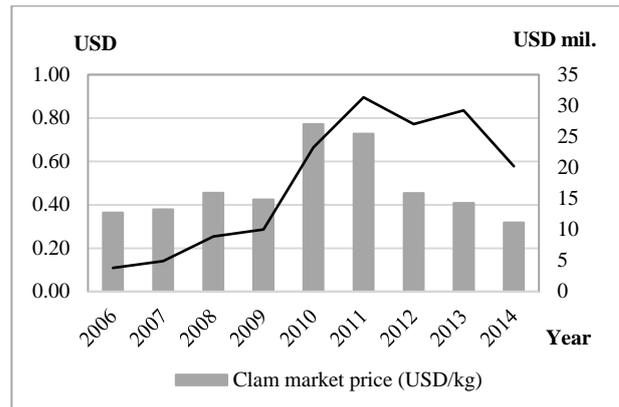


Figure 2: Clam market price and total gross output (2006-2014)

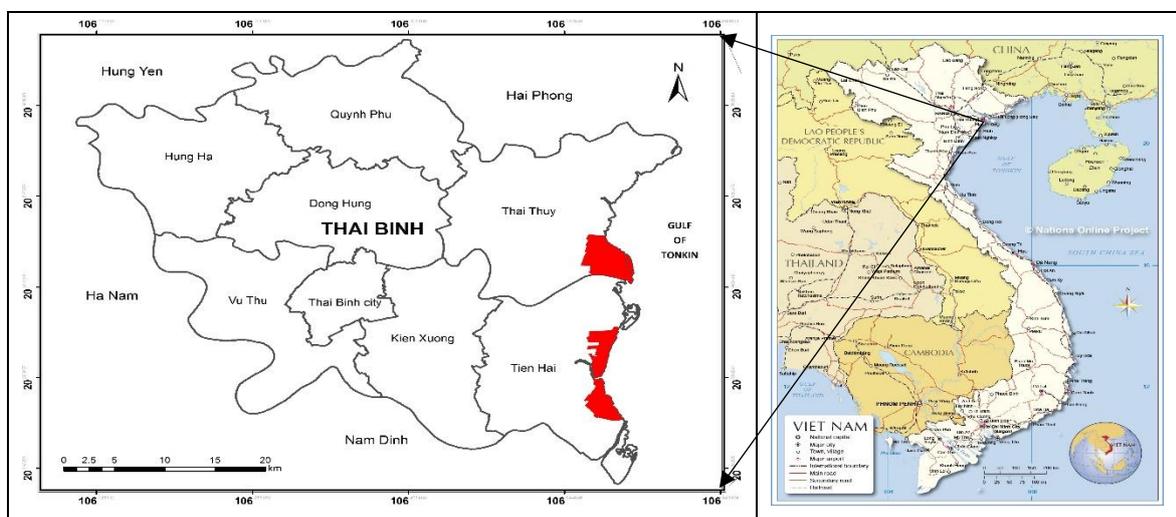


Figure 3: Map of the research sites.

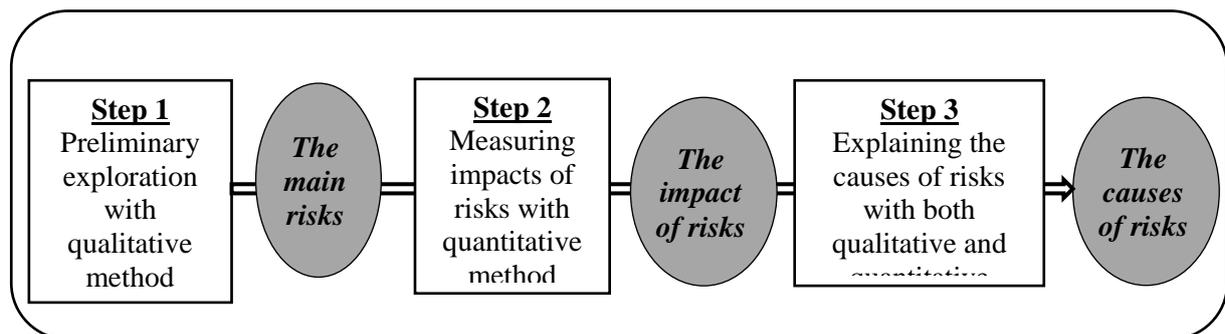


Figure 4: Sequential design for the research

Source: Adapted from (Creswell, 2014)

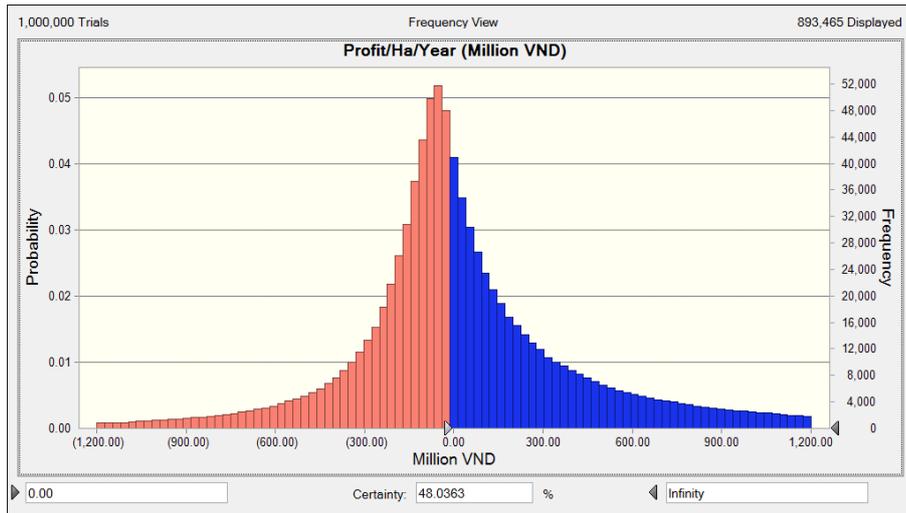


Figure 5: Clam Profit Probability Distribution

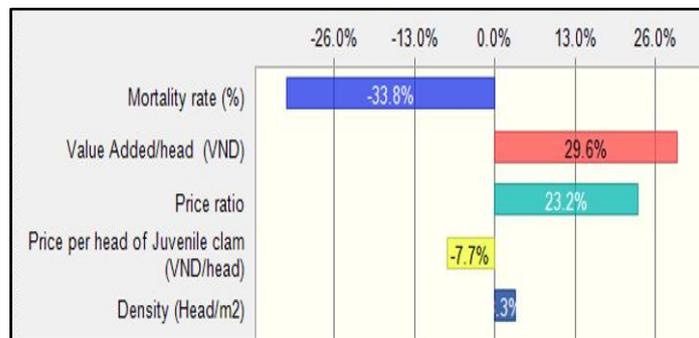


Figure 6: Contribution of factors to the variation of profit

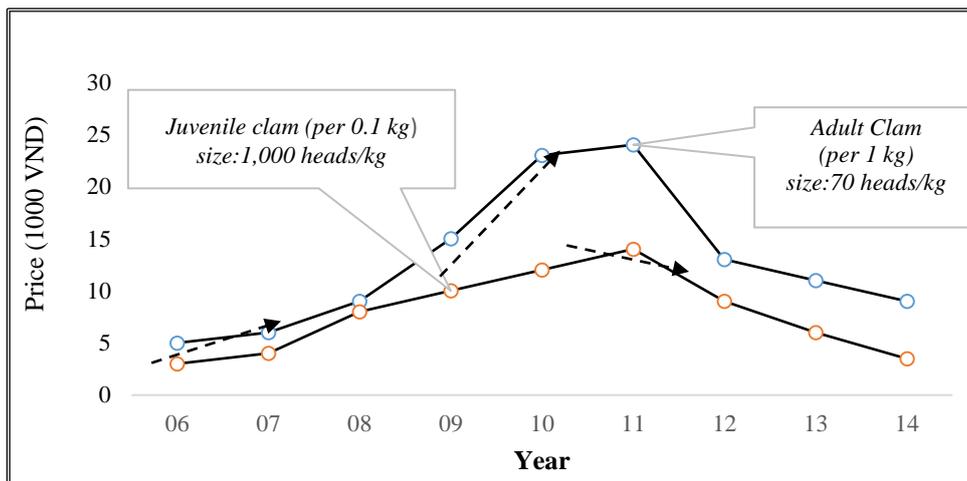


Figure 7: Fluctuation of price of Juvenile Clam and Adult Clam in 06-14

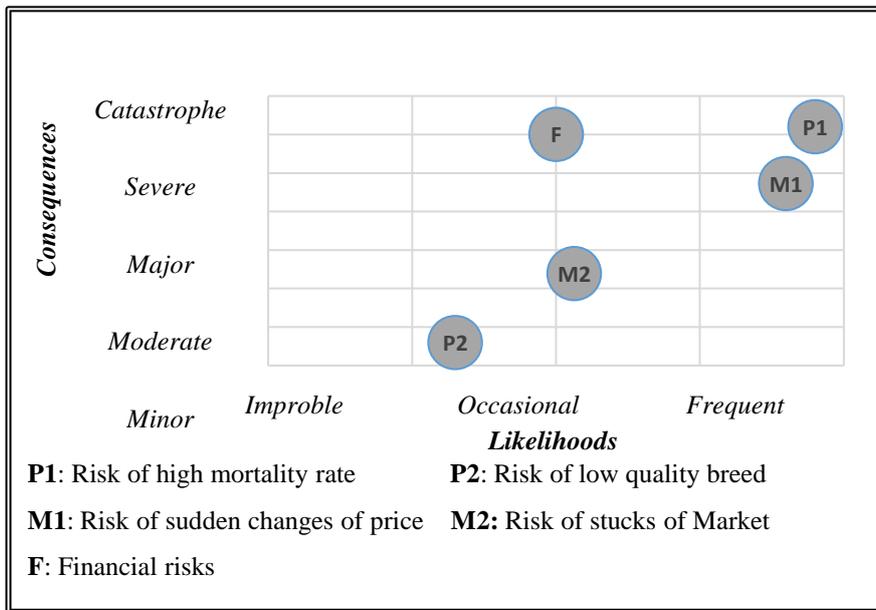


Figure 8: Risk Assessments