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Clam Farming Risks in Thai Binh Province, Vietnam: Impacts and Causes*

by

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KEYWORDS. — Farmer's Livelihood; Farming Risk; Market; Aquaculture; Thai Binh Province.

SUMMARY. — 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 areas by governments, polluted water discharges from inland agricultural and industrial activities, and increasing negative impacts of climate changes. This study explores risks faced by the clam farming sector in Thai Binh province, as well as their causes and impacts on farmers. Our survey has revealed that there have been several important risks in clam production which can be grouped in terms of nature of origin: human-caused and natural ones. These risks have impacted on all relevant aspects of clam farming: production, market and financial sector. They are caused by several factors, 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 play more effective roles in coordinating and managing the 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.

1. Introduction

Approximately 60 % of the global population live and seek their livelihood from ocean-aquaculture production and are currently experiencing difficulties because of poor development plans for coastal areas, pollutive discharges from

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inland agricultural and industrial activities, and the increasingly negative impacts of climate change (Doukakis 2005). Vietnam, with its long coastline (over 3,260 km) and numerous estuaries (one hundred and twelve in total) was ranked eighteenth in the 2015 World Risk Index, with a vulnerability index of 51 % (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 (Cao 2012). In 2014, this sector gained more than US$7,800 million from exports (Tran 2017).

Most studies in Vietnamese aquaculture have been done in the south, focusing on major aquatic animal production such as shrimp (Bush *et al.* 2010), catfish (Le 2011), or other fish production (Armitage & Marschke 2013, Pucher *et al.* 2015). Yet, no comprehensive research has been done on clam production, especially in the northern coastal areas while clam production has been remarkably developed for the last decades (Bui & Tran 2013).

This study focuses on the clam [1]* production in the Thai Binh province — the largest area of clam production in the north and north-central coastal region of Vietnam. It aims to answer two major research questions: (1) What are the risks that clam farmers have been experiencing?; (2) What are the causes and the impacts of these risks on the local clam production and farmer's livelihood?

2. Literature Review

2.1. Risk and Uncertainty

Researchers often make a distinction between "risk", which implies knowledge of numerical probability of loss that affects an individual or a specific group of farmers, and "uncertainty", which implies an outcome that is uncertain and unknown in probabilities (Aimin 2010, McIntosh 2008). However, other researchers have 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 events that affect individual welfare. In other words, uncertainty is necessary for risk to occur, but does not always lead to a risky situation (Harwood *et al.* 1999). Despite a parallel existence of these two perspectives, the distinction between risk and uncertainty

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* Numbers in brackets [ ] refer to the notes, p. 76.

still blurs and varies somewhat depending on the sector. In general, the 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 *et al.* 2008).

2.2. 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) distinguished two major types of risk in agriculture. First, business risks which include production, market, institutional and personal risks, and secondly, financial risks which result from different methods of financing a farm business. Musser & Patrick (2002) defined five major sources of risk in agriculture based on its causes: (1) production risk; (2) market risk; (3) institutional risk; (4) human risk; (5) financial risk. OECD (2009) classified agriculture risks into four groups, encompassing (1) production risk; (2) market risk; (3) financial risk; (4) institutional/legal risk. Meanwhile, researchers also use the level of risk impact to divide agriculture risks into three layers: (1) micro (idiosyncratic) risk affecting an individual or household; (2) meso (covariant) risk affecting households or communities; (3) macro (systemic) risk affecting regions or nations. However, the borderline between the different types of risk is somewhat blurred since farmers might suffer from a combination of risks at the same time because these risks are interdependent and/or intercorrelated.

2.3. 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, which certainly cause more stress and vulnerabilities to this sector, and thus imply 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).

2.4. Risk Impacts and Vulnerability

Recently, a significant aspect studied by risk scientists has been associated with issues of social protection against poverty, particularly in developing countries (Dercon 2005). In this context, the term "vulnerability" is used to mention the level of risk consequences that could do potential harm to farmers (Adger 2006, McCarthy *et al.* 2001, Sarewitz *et al.* 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 the impact of risks is more important than trying to eliminate them. Risk impact is generally a negative outcome of an event (hazard) occurring on several aspects of farmers' farming practices and their life, including economic (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; World Bank 2014), and environmental aspects (caused by human-made catastrophes such as the Fukushima power plant disaster or the Gulf of Mexico oil spill; Kreft *et al.* 2014), etc. Such consequences, which must be identified by the degree, the geographical extent, and duration of the effects, may be expressed qualitatively (with level of impact 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 has 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 happened toward more industrial and service sector contributions over the last thirty years under the market-based economic policy of Vietnam, agriculture, forestry and aquaculture have still contributed 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 Thai Binh GRDP was estimated at $1.956 trillion and GRDP per capita was about $1,377, in which total aquaculture production generated a value of $174 million (Nguyen 2015).

Among coastal provinces in the north of Vietnam, Thai Binh has the largest clam farming areas (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 areas 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 (figs.1 & 2).

There are twelve communes of the province involved in clam farming. These are located along 50 km of the 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 to 2014. There were 1,310 households doing clam farming in the three communes at the time of the study (Geographical Database 2016, Nationsonline 2016) (fig. 3).

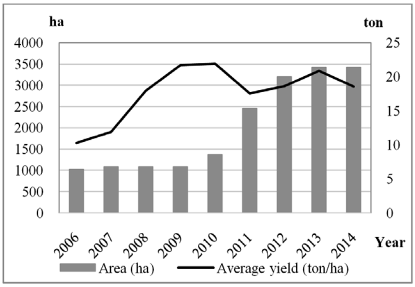


Fig. 1. — Clam farming area and average yield (2006-2014).

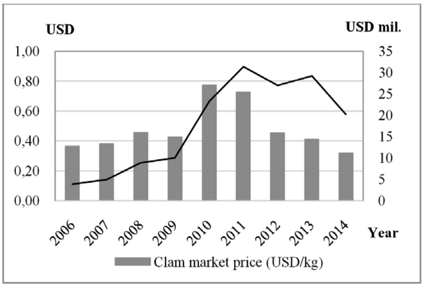


Fig. 2. — Clam market price and total gross output (2006-2014).

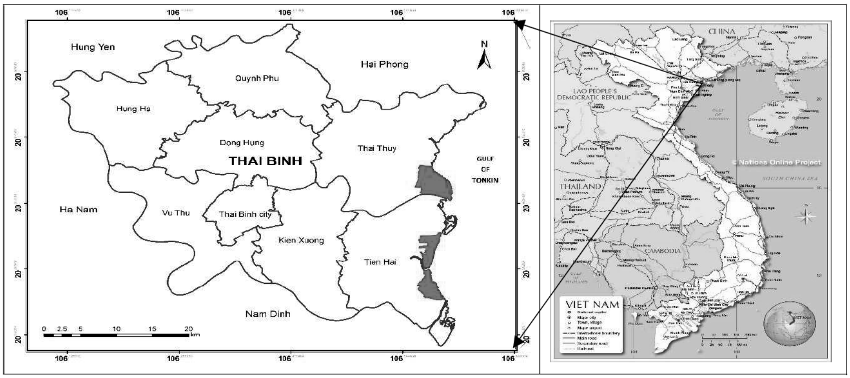


Fig. 3. — Map of the research sites.

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 support for clam production were gathered from different local government offices and published papers/reports. Primary data were collected by using different research tools. Data on clam farming and marketing practices and risks, and farmers' capacity and strategies to recover from the different risks that occurred between 2006 and 2014, were collected. The data were 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) support for clam farming; clam traders' performance in relation to local clam farming practices and their views on the factors that govern local clam farming and marketing practices. (KIs include one person in the Thai Binh provincial aquaculture department, two people in aquaculture subdepartments 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 in 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, whose aim was to capture in-depth information on farmers' clam farming and marketing practices, such as farming costs and profit, the risks they faced, their coping strategies, and the consequences of risks on their farming practices, as well as their lives. Sample size of households for survey was calculated by the following equation:

$$n = \frac{N \times t^2 \times S^2}{N \times \Delta_x^2 + t^2 \times S^2}$$

where n = sample size; N = total households having clam farming in the three communes (1,310); and t = confidence interval (2.17, with 97 % confidence level). Based on the first thirty-one 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's 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.

3.3.1. Mix Method Research

A mixed method was applied for this study (fig. 4) because of the following advantages. Aquaculture risks are very diverse because they could impact many external factors such as species, environment, market and practices. Therefore, the range of hazards and the perceived risk are 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 clam farming in the period 2006-2014 as well as to evaluate farmers about risks; (2) a 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; (2) correlation & mean comparison (such as Spearman's rho test, Kruskal-Wallis test) was applied to assess the impact of each factor.

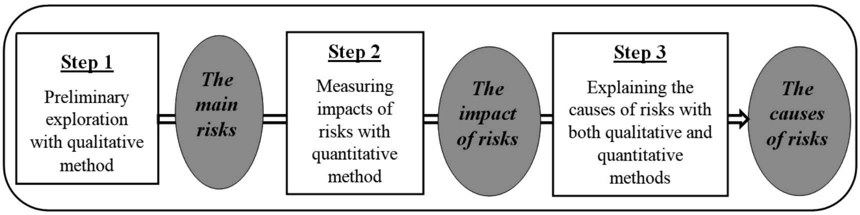


Fig. 4. — Sequential design for the research (*source*: adapted from Creswell 2014).

4. Results and Discussion

4.1. Clam Production in Thai Binh

4.1.1. Abnormal Development Trend

The clam production has started in Thai Binh since the 1990s with a small area (150 ha), after a long-time sticking with capturing natural clam. However, this aquaculture sector has been only developed in commercial orientation since 2001 and gradually expanded in the following years and reached approximately 1,000 ha in 2006. Unpredictably, the statistics revealed an abnormal trend in the clam production of this area in the period 2006-2014. While the total production area had been continuously increasing 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 that 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 of almost US$4.5 million and the average yield of this period was 18.6 tons/ha (three 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 was 2,000 ha more than that of year 2010 (see fig. 1). This abnormal trend shows that clam production suffered from different kinds of risk, from starting to harvesting stage, which then lastly caused an extraordinary variability both in its productivity and production value.

4.1.2. Profitable but Risky Production

The clam production has been considered as the most profitable subsector in the coastal farming system in Thai Binh province. Accounting for 59 % of the total provincial aquaculture output in the period 2009-2014 (MaiLien 2014), this subsector generates a high income source for farmers, improving the socioeconomic development of many local communities. Particularly, in some cycles during the period 2009-2011, harvest earnings were the triple of investment cost, *i.e.* some clam farmers had received US$22,000-27,000 per ha as a net profit (TTXVN 2014). The result from the Monte Carlo simulation has shown that mean 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, accounting for

70 % and 20 % of the total production cost, respectively (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, largely dependent on external factors, clam farmers have to cope with more risks. The forecast report resulting from the Monte Carlo simulation has shown that the rate of investment loss is 52 % (fig. 5), and specifically that those figures for adult and juvenile clam raising are 55 and 43 %, respectively. When farmers were asked why they invested in clam farming despite the risks, 75 % of them reported that the investment was attractive as a form of gambling, meaning that the more they lost, the more they wanted to invest, based on the expectation they would win in subsequent clam raising cycles. Box 1 below gives an opinion of one farmer who has ten-year experience in clam production and still keeps 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” (interview 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” (World Bank 2014). Therefore, risk management can be a powerful instrument for sustainable development. The next part will deal with 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 the agricultural sector in the future.

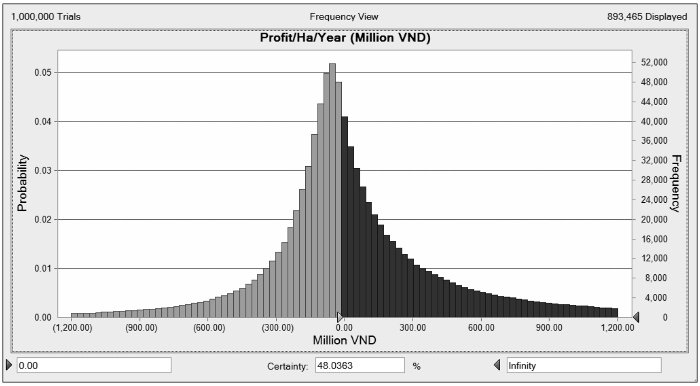


Fig. 5. — Clam profit probability distribution.

4.2. Impacts of Clam Farming Risks

4.2.1. Direct Economic Impacts

Data on clam farming loss in one hundred and fifty-seven households interviewed for the period 2006-2014 reflect a serious impact of loss in clam farming. In 2012, with 67 % of clam area loss [2] (amounting to 147.05 ha and owned by forty-two households), farmers suffered from a total loss of more than US$2.2 million. Some years later, the percentage of clam raising areas under loss kept slightly increasing while the total loss decreased steadily. Because of these shocks occurred in the period 2006-2014, 42 % of interviewed clam farmers had minus average profit per year (tab. 1), with a loss of minus US$79,000/per year as the most serious case reported.

Table 1
Profit per year of clam households (HHs) (period 2006-2014)

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

A sensitivity analysis resulting from the Monte Carlo simulation has shown that the 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 the profit variation (fig. 6). However, the impact of these two factors on clam farming practices differs between juvenile and adult clam farming due to differences between the two types of farming. With a shorter cycle length (two-five months) and greater investment in technical equipment, profits from clam hatchery farms oscillate more according to mortality rates; specifically, mortality rates caused profit variations of minus 52 % whereas price changes caused profit variations of 9 %. In contrast, these two figures in adult clam farming are minus 34 and 24 %, respectively (with a raising cycle duration

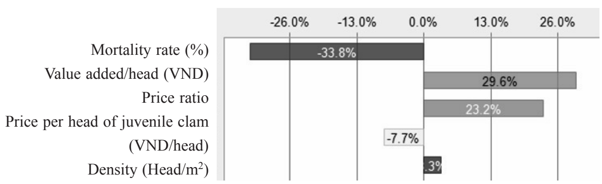


Fig. 6. — Contribution of factors to the profit variation.

of eighteen months in normal conditions). Overall, in all farming systems, more than 50 % of the profits from clam raising depend on external factors.

4.2.2. Other Socio-economic and Environmental Impacts

The fluctuation in the clam farming productivity and prices causes a serious financial impact on farmers. Hundreds of billion VND investment were lost each year in the period 2012-2014. Thousands of farmers faced bankruptcy. About US$20.8 million borrowed from banks could not be paid back yet (Long 2013). Out of one hundred and fifty-seven households interviewed, 16 % exited clam farming due to bankruptcy and 38 % had to sell their fixed assets (*e.g.* houses, cars, motorbikes or even clam fields) to repay debts. Moreover, attracted by the "profit-promising gamble" of clam raising, 45 % of farmers opted to borrow more money to reinvest in clam farming, with the belief that "only clam can save clam". Unfortunately, not all of these farmers were successful. Some of them had to leave their village as they could not afford their debts (there were at least three such cases in Dongminh commune, five cases in Namthinh commune and two cases in Thaido commune).

At the same time, other socioeconomic and environmental problems — such as reduced clam-based employment opportunities for local farmers and water (and even air) pollution caused by clam deaths — were occurring (Mai 2013). Human loss can also happen when farmers (especially women) work on the sea. In December 2014, in Tienhai, six clam farmer deaths occurred during clam harvesting by boat, five of them were women. Some months later, in February 2015, two women farmers in Thaithuy went missing when their boat capsized.

Clearly, the livelihood of clam farmers is highly sensitive to clam farming risks, in terms of both economic and human welfare. Therefore, for clam farmers to reach sustainable livelihood, identifying the root causes of these risks is necessary to enable both farmers and government to adjust their actions accordingly and implement more effective risk management strategies.

4.3. Causes of the Risks

The results from farmers' group discussion and key informant interviews have 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 households' debts and bankruptcy). Detailed information on each type of risks is discussed in the following sections.

4.3.1. 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 eleven to seventy tons/ha during the period 2006-2014. However, local governments and farmers have conflicting opinions about root causes of risks. Although the two sides agree that "bad weather" is a source of risk, they disagree about all other causes of risk. For instance, a report by a local government claimed that high mortality rates were primarily due to farmers' own decisions (*e.g.*, adopting high clam raising densities instead of technically recommended density). By contrast, farmers cite the discharge of polluted water from nearby factories and rice paddies as a major cause for clam mortality. In general, four factors are identified as major causes for clam mortality.

4.3.1.1. Weather Factor

A clam production cycle normally lasts from eighteen to twenty-four months (from a starting of about one thousand clam heads/kg to a harvesting at seventy clam heads/kg). Therefore, for 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 (Thai binh DARD 2013). Whereas in the study site, climate temperature can be up to 38 °C and lasted for several days continuously. Moreover, this coastal area often suffers from at least two 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 the biggest impact on clam mortality rate.

However, weather factors were not the only ones causing massive death of clam. In 2014, the highest temperature was 36.5 °C with only nine hot days whilst in 2010, there were twenty-two hot days at higher temperature of 38.3 °C but average clam death rate in 2010 was lower than in 2014 (tab. 2).

Table 2

Weather statistics in Thai Binh coastal area and average mortality rate of clam

Indicator	Unit	Year								
		06	07	08	09	10	11	12	13	14
(1) Number of storms	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): Thai Binh Statistical Department; (4): household survey.

4.3.1.2. Disease and Salinity Level

An experiment with two widespread kinds of bacteria, namely *Vibrio haveyi and V. alginolyticus* in two hundred and forty hours (ten 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 (Le 2012).

4.3.1.3. Stocking Density

The impact of clam raising density on mortality rates is the subject of a heated debate. The report of the Ministry of Agriculture and Rural Development on causes of massive clam death identified high clam raising density as a major cause. Although the technical instructions issued by the Thai Binh Department of Aquaculture recommend a suitable clam raising density at 300-400 heads/m^2 (Thai binh DARD 2013), farmers have adopted raising densities as high as 700-800 heads/m^2. High stocking densities certainly cause reductions in clam feed and in other environmental factors that support clam growth (*e.g.*, light, oxygen) (PV 2014). However, farmers have raised two issues that challenge these conclusions: (1) if two fields have the same clam density rate but one is closer to inland waste water flows, the field closer to waste water flows has a higher mortality rate; (2) areas between fields (which are 1-2 m wide) are home to very few clams (low density) but suffer from the same death rates as clams inside the fields.

Several scientific studies indicated that clam raising density did not directly cause high clam death rate, though it might have indirect impacts. The rise of clam density from 200 to 493-600 heads/m^2 may initially increase farmers' income, but would lead to degradation of environmental factors that support clam growth (Biu & Tran 2013). The research of Le (2012) carried out four experiments to determine the impact of raising density to clam growth. After two months, the weight of one hundred and fifty-eight heads of clam (randomly chosen) from each experiment with density of one hundred and fifty heads/m^2, three hundred heads/m^2, seven hundred heads/m^2 and one thousand two hundred heads/m^2 were 1,500 g, 1,420 g, 1,390 g and 1,240 g, respectively. The longer clam lives in the field, the greater the risk, which certainly increases the overall mortality rate.

4.3.1.4. Polluted Waste Water Flow

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

Meanwhile, results of TUNG's (2012) research showed that water environmental conditions in the Thai Binh coastal area had signs of contamination, affecting clam growth, although no records existed to prove possible correlation between contaminated water level and clam mortality rate. Many environmental elements were higher than the Vietnamese technical standards [3] applied for water quality of aquatic production such as total suspended solids, $N\text{-}NO_2$; $N\text{-}NH_4^+$; $P\text{-}PO_4^{3-}$; TSS. Clams are also very sensitive to Niclosamide — a chemical used for controlling golden snails in paddy (LE 2012).

4.3.1.5. Low Quality Juvenile Clam

This is claimed as part of the reasons for slow clam growth (inducing to longer raising cycle) and deformation phenomenon of clam. According to farmers, compared with ten 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, or even from China and Taiwan, etc. because juvenile clam produced in Thai Binh only met about 17 % of the total demand in the 2010s (Thai Binh DARD 2014). Farmers reported that juvenile clam purchased from other locations were more vulnerable to the new raising environment. Many clams have problems with deformation phenomena.

4.3.2. Market Risks

4.3.2.1. Oversupply and Unstable Market

The expansion of the clam raising area in the period 2006-2010 could be explained by clam "super profit" experienced by farmers in early times. However, after 2010, a continuous clam raising promoted by the Thai Binh provincial government to expand clam production with a target of one hundred thousand tons of harvest clam/year in 2015 and two hundred thousand tons/year in 2020 has really caused market shocks for clam farmers. Nearly, 1,000 ha of intertidal areas were 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 the Thai Binh Commercial Department revealed that before 2012, 50-60 % of the total provincial harvest clam was sold to China through unofficial export channels, 30 % to the EU market and only 10 % was sold in domestic market [4]. Nonetheless, in 2012, two growing food safety issues caused by illegal additives adopted by farmers and toxic industrial wastes (Lam *et al.* 2013), which pushed the Chinese government to reform laws, established monitoring systems and strengthened food safety regulations, especially for unofficial import channels. Accordingly, clam exports from Vietnam to China were restricted and even forbidden (Phu 2014). At the same time, further food safety requirements adopted by EU markets created additional barriers for Vietnamese aquaculture product exports, including clam.

4.3.2.2. 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) led to a significant decline in the total value of clam production, despite the expansion of clam raising areas. The rapid clam price increase during the period 2006-2011 was immediately followed by a continuous decline in the period 2011-2014 (fig. 7). Accordingly, price of juvenile clam fluctuated in the same trend. However, the impact of juvenile clam price can only be realized at the end of clam raising cycles, *i.e.*, eighteen to twenty-four 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 was 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 combinated risks other than price factor.

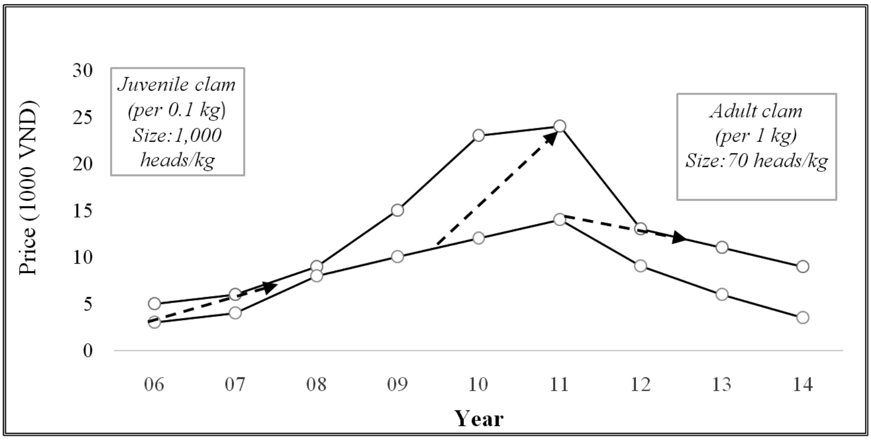


Fig. 7. — Price fluctuation of juvenile and adult clam in June 2014.

4.3.2.3. 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 markets, making farmers disadvantaged in negotiations with suppliers and collectors. Ninety-five percent of the interviewees said that they did not know exactly where the buyers came from; 100 % of them did not realize the 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' support contributed to farmers' weakness (Markelova *et al.* 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 at a low price. As in a passive position, when connected buyers leave the market, farmers can only keep clams in their fields and be "waiting for other buyers". As a result, the clam raising cycle increased (tab. 3). The results from discussion of the focus group of experienced clam farmers stated that six-seven years ago, they needed only twelve-eighteen months to finish a raising clam cycle, while it is now up to eighteen – thirty-six months. Although the length of clam raising cycles does not have a strong correlation with the clam mortality rate, the correlation coefficient is 0.124 with the significant level of 0.01 (tab. 4) showing the fact that the longer clam raises in the field, the greater the risk.

Table 3
Length of clam cycle in period 2006-2014 (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

<table>
<tr><th colspan="2"></th><th>Cycle length (months)</th><th>Mortality rate (%)</th></tr>
<tr><td rowspan="3">Cycle length (months)</td><td>Correlation coefficient</td><td>1.000</td><td>.124*</td></tr>
<tr><td>Sig. (2-tailed)</td><td>.</td><td>.006</td></tr>
<tr><td>N</td><td>481</td><td>481</td></tr>
<tr><td rowspan="3">Mortality rate (%)</td><td>Correlation coefficient</td><td>.124*</td><td>1.000</td></tr>
<tr><td>Sig. (2-tailed)</td><td>.006</td><td>.</td></tr>
<tr><td>N</td><td>481</td><td>481</td></tr>
</table>

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

4.3.3. Financial Risks

4.3.3.1. High Barriers 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-$22,000/ha (Nguyen & Nguyen 2013). Results of the household survey showed that 70 % of the investment as well as financial resources to recover after risk had come from credit system. However, risky characteristics embedded in clam production make it difficult for clam farmers to access formal credit system. The statistics from the State Bank-Thai Binh branch showed that until September 2013, there were one thousand seven hundred and fifty-two farmers and small enterprises that borrowed money to invest in clam production, with a total loan amount of 457.6 billion VND (about US$ 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 have not yet returned borrowed loans or if they have not submitted sufficient documents for extending loan period as required by the banks. Given the increased risks in clam production in recent years, banks have set up stricter barriers for credit risk management policy (such as higher mortgage required). This has pushed and directed farmers to informal credit market as it always requires less administration procedures and no credit limit; but with higher interest rates applied.

4.3.3.2. Informal Credit Market

With data of all the cases financed by credit from informal market, the Monte Carlo simulation has shown 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 why 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 (tab. 5). High interest rates of informal loans coupled with other production and market risks have 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.

Table 5
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

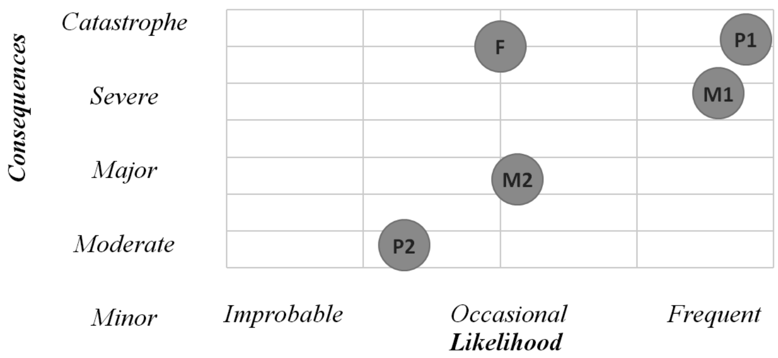
Mann-Whitney Test Statistics

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

4.4. Risk Classification

4.4.1. Segmenting Risks into Layers

A focus group discussion was carried out in March 2015 to rank the different types of risk based on frequency of occurrence (likelihood) and magnitude of loss (consequences). Discussion results have shown 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 (fig. 8). Farmers have revealed that a clam mortality rate of 30 % is common and accepted. However, since 2009, clam mortality rate has been around 55 % on average due to polluted water flows and around 40 % because of extreme weather events (storms or hot weather). Parallel with these risks, sudden change of market prices, which has happened frequently since 2012, has led to extreme chaos in clam production in the province.



P1: Risk of high mortality rate
M1: Risk of sudden changes of price
F: Financial risks
P2: Risk of low-quality breed
M2: Risk of market stocks

Fig. 8. — Risk assessment.

The borderline between the 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 the reason that when clam market price goes down, farmers may have a response to risk by keeping clams in their fields, unlimitedly. Unlike other types of agricultural productions that have a definite time to harvest, clam farmers can extend the harvesting point as long as they want. However, the longer clams stay in the fields, the greater the risk from bad weather events and/or polluted waste waters. Therefore, although those risks are segmented in different layers, they must not be treated separately.

4.4.2. Nature of Causes

There are several causes of aquaculture risks, but the majority of them are human-caused rather than nature-made (tab. 6). From farmers' views, human-caused events (such as risks caused by polluted water) are more systemic than naturally originated. Farmers have revealed that they can forecast weather by relying on their experience or national forecast weather programmes and then take some actions such as investment on netting system, harvesting time, or even decision on the size of juvenile clams for new raising cycles. But human-caused events could happen at any time of the year without prio notice to farmers, especially when polluted water is discharged silently [6]. Similarly, Pidgeon & O'Leary (2000) concluded in their study that human-caused risk is normally more difficult to manage, because of two common barriers: (1) asymmetric information; (2) blamed and organizational politics.

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 barriers to access formal credit market		x
	• High interest rate in informal market		x

5. Conclusions and Implications

Clam production plays an important role in the livelihood of most farmers living along coastal areas 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 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 in 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 way, have exacerbated vulnerability of the clam farming practices and the farmers involved.

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

Zoning and promoting clam production by the government in the early 2010s has boosted clam expansion and intensification in the absence of careful assessment of market demands and schemes to promote clam market. This, coupled with poor coordination for wastewater discharges from inland industrial and agricultural activities, has increased the 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 this explains the plagues faced by clam farmers in recent years.

There are always winners and losers in all types of daily business. Clam farming is no exception. However, since clam farming has been observed with more losers than winners in recent years, and many losers have been faced with lethal bankruptcy from their clam investment, alternative clam development strategies are badly needed.

Exposed to different types of risk, both natural and human-caused, 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 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 improve local people capacity to cope with other risks through the improvement of information communication and financial mechanisms, towards building up a more effective and sustainable aquaculture risk forecast and management system.

NOTES

[1] Latin name: *Meretrix Lyrata*.
[2] The concept “Loss” refers to the situation when the profit of clam farming is minus.
[3] QCVN 10: 2008/BTNMT.
[4] Information from Key Informant Interview in April 2015.
[5] Result from Focus Group Discussion in March 2015.
[6] *Source*: Focus Group Discussion in Dong Minh (March 2015).

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