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Household risk management strategies in coastal aquaculture in Vietnam: the case of clam farming in Thaibinh province

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HOUSEHOLD RISK MANAGEMENT STRATEGIES IN COASTAL AQUACULTURE IN VIETNAM: THE CASE OF CLAM FARMING IN THAIBINH PROVINCE

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Abstract

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Abstract

With over 3,260 kilometers of coastal line and 112 estuaries, 226,000 square kilometers of internal waters and territorial waters, the exclusive economic zone of more than 1 million square kilometers, and more than 4,000 islands, forming 12 bays and lagoons with a total area of 1,160 square kilometers, Vietnam has high potentials for aquaculture development. Vietnam's seafood output has been growing steadily in recent years (since 2000 up to 2016) with an average increase of 9% per year. Despite its advantages and positive development trends, Vietnam aquaculture has faced several issues including asymmetric information and high demand for quality products. The main cause of these issues is risks, from production to market risks. This study has explored the main risks faced by the coastal clam farming sector in Thaibinh province located in northern Vietnam. The risks can be classified into two types in term of the nature of their cause: man-made and natural ones, and three types in term of their impact: production, market and financial risks. The causes of these risks include extreme weather events, wasted water flows, production technics; market access or financial capacity. However, man-made risks are more severe and more difficult to cope with than natural ones.

These above risks have serious consequences for clam farming. For the three communes examined in this study, less than half of the farmers were yet recovered from the loss caused by several shocks although majority of them had mobilized capital to restart clam farming. About one third of the farmers had to sell their fixed assets to pay debts related to their clam investment, and ten households had left their villages under the pressure of debts. However, in such risky clam farming environments and increased market difficulties, not all farmers were seriously impacted. Indeed, it is surprising that one fifth of the surveyed farmers succeeded in all their clam raising cycles so far, and another quarter remained well resilient after the shocks. Different household risk management strategies applied in clam farming are thus discussed in the comparative analysis and discriminant analysis. In general, the tactics related to increasing farm size, applying technical innovation and accessing financial sources with no or a lower interest rate, provided better conditions for clam growth, reducing clam farming losses. They also facilitated speedier recovery from shocks.

There are many internal and external factors in the application of risk management strategies and tactics. Of the internal factors identified, include households' financial capacity and the experiences of the head of households had more impact while the education level and the job of the head of household seemed to have little influence on the choice and application of households' risk management strategies. External factors refer to the policy factors and the knowledge capacity enhancing activities in the clam farmers community. Among these activities, those of "groups for experience sharing" were found to have significantly greater impact than the training courses and activities of farmer's union. Besides, the government had played a role in directing farmers in clam farming practices, but not much in risk management.

Given that the tactics addressed the capital issues, land uses, and clam farming techniques had positively contributed to the result of household risk management strategies whilst experience gaining and sharing activities strongly impacted the application of these tactics. The intervention and policies of government in all levels to the farmers should therefore focus more on these issues. It is vital that the government's support policies, extension programs, training courses and farmer's union activities be practically oriented and suit farmers' desires. Furthermore, the addition of policies/interventions in market issues (for both input and output) should be taken into account because those risks were considered as meso level, which farmers cannot solve by themselves and thus definitely need the support from the government, from local to the state level. To support farmers in managing risks, several government interventions are needed: (1) improving the support system to household in clam farming such as increasing farm size, promoting linkages to market and training technic; (2) increasing investment in the treatment of the water management issue and protecting the ecosystem; and (3) promoting participatory policy formulation and its enforcement.

Keywords: aquaculture, clam farming, risk management, Vietnam

Résumé

Thi Thu Hang NGO. (2018). Stratégies de gestion des risques des ménages dans l'aquaculture côtière au Vietnam: Le cas de l’élevage de palourdes dans la province de Thaibinh. (Dissertation de doctorat en anglais). Gembloux, Belgique, Gembloux Agro-Bio Tech, Université de Liège, 236 pages, 55 tableaux, 50 figures, 17 photos et 15 encadrés.

Résumé

Avec plus de 3 260 kilomètres de lignes côtières et 112 estuaires, 226 000 km2 d'eaux intérieures et d'eaux territoriales, une zone économique exclusive de plus d’un million de km2, et plus de 4 000 îles formant 12 baies et lagunes d'une superficie totale de 1160 km2, le Vietnam présente un potentiel élevé pour le développement de l'aquaculture. La production de produits de la mer du Vietnam a connu une croissance régulière ces dernières années (de 2000 à 2016) avec une augmentation moyenne de 9% par an. Malgré ses avantages et ses tendances positives en matière de développement, l'aquaculture vietnamienne a été confrontée à plusieurs problèmes, notamment le phénomène d'information asymétrique et une forte demande de produits de qualité. La cause principale de ces problèmes est le risque, encouru de la production au marché. Cette étude a exploré les principaux risques auxquels est confronté le secteur de l'élevage des palourdes côtières dans la province de Thaibinh, située dans le nord du Vietnam. Les risques peuvent être classés en deux types en fonction de la nature de leur cause: ceux d'origine humaine et ceux d’origine naturelle, et en trois types en termes d'impact: le risque de production, le risque de marché et le risque financier. Les causes de ces risques comprennent les phénomènes météorologiques extrêmes, les écoulements d’eau gaspillée, les techniques de production; l’accès au marché ou la capacité financière. Cependant, les risques créés par l'homme sont plus graves et plus difficiles à gérer que les risques naturels.

Les risques cités ci-dessus ont de graves conséquences pour l'élevage de palourdes. Pour les trois communes étudiés dans cette étude, moins de la moitié des agriculteurs avaient encore récupéré de la perte, bien que le majorité d’entre eux aient mobilisé des capitaux pour relancer la culture de la palourde. Environ un tiers des agriculteurs ont dû vendre des immobilisations pour rembourser leurs dettes liées à leurs investissements dans les palourdes, et dix ménages ont quitté leur village sous la pression des dettes. Cependant, malgré les risques de production et les difficultés de marché accrues, tous les agriculteurs n'ont pas été sérieusement touchés. En effet, il est surprenant qu'un cinquième des agriculteurs interrogés aient réussi jusqu'à présent tous les cycles de récolte de palourdes, et qu'un autre quart soit resté résilient après les chocs. Différentes stratégies de gestion des risques des ménages appliquées à la culture des palourdes sont donc discutées dans l'analyse comparative et l'analyse discriminante. En général, les tactiques liées à l’augmentation de la taille des exploitations, à l’application de l’innovation technique et à l’accès à des sources de financement avec un taux d’intérêt inférieur nul ou faible ont permis de produire des palourdes dans de meilleures conditions réduisant les pertes d’exploitation. Elles ont également facilité une récupération plus rapide des chocs.

Il existe de nombreux facteurs internes et externes influant l’application des stratégies et des tactiques de gestion des risques. Parmi les facteurs internes identifiés, on note que la capacité financière des ménages et l’expérience du chef de ménage ont eu le plus d’impact alors que le niveau d’éducation et le travail du chef de ménage semblaient avoir peu d’influence sur le choix et l’application des stratégies de gestion des risques des ménages. Les facteurs externes se rapportent aux facteurs politiques et aux activités de renforcement des capacités de connaissance dans la communauté des producteurs de palourdes. Parmi ces activités, celles des «groupes de partage d’expériences» se sont révélées avoir un impact beaucoup plus important que les cours de formation et les activités du syndicat des agriculteurs. En outre, le gouvernement a joué un rôle en dirigeant les agriculteurs dans les pratiques d'élevage de palourdes, mais pas beaucoup dans la gestion des risques.

Étant donné que les tactiques concernent les problèmes de capital, les techniques d'utilisation des terres et d’élevage des palourdes ont contribué de manière positive au résultat des stratégies de gestion des risques des ménages. Alors que l'expérience acquise et les activités partagées ont fortement influencé l'application de ces tactiques. L'intervention et les politiques du gouvernement à tous les niveaux en faveur des agriculteurs devraient donc se concentrer davantage sur ces questions. Il est essentiel que les politiques d’appui du gouvernement, les programmes de vulgarisation, les cours de formation et les activités syndicales des agriculteurs soient axés sur les besoins pratiques des agriculteurs. En outre, l’ajout de politiques / interventions sur les questions de marché (à la fois pour les intrants et les extrants) devrait être pris en compte car ces risques sont considérés comme de niveau intermédiaire; les agriculteurs ne peuvent y faire face seuls et ont donc besoin du soutien de l'Etat. Pour aider les agriculteurs à gérer les risques, plusieurs interventions gouvernementales sont nécessaires: (1) améliorer le système de soutien aux ménages dans l'élevage de palourdes comme: augmenter la taille des exploitations; promouvoir les liens avec du marché et les formations des techniques, (2) accroître l'investissement dans le traitement de la gestion de l'eau et protéger l'écosystème, et (3) promouvoir la formulation de politiques participatives et leur application.

Mots-clés : aquaculture, élevage de palourdes, gestion des risques, Vietnam

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NGO Thi Thu Hang
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LIST OF ABREVIATIONS

ASEAN	Association of Southeast Asian Nations
DARD	Department of Agriculture and Rural Development
EU	European Union
FAO	Food and Agriculture Organization
FGD	Focus Group Discussion
GDP	Gross Domestic Product
GRDP	Gross Regional Domestic Product
GSO	General Statistics Office
HH	Household
MARD	Ministry of Agriculture and Rural Development
OECD	Organization for Economic Cooperation and Development
RMS	Risk Management Strategies
USD	United States Dollar (Currency unit)
VASEP	Vietnam Association of Seafood Exporters and Producers
VND	Vietnam Dong (Currency unit)

1

INTRODUCTION

1.1.Background and problem statement

Because the world is currently experiencing various fluctuations and contradictory trends, people have become increasingly concerned about risk. A number of research studies have focused on risk, which is widely defined as “the chance of something bad happening” (McIntosh 2008). In agriculture, risks are basically categorized into five types: production risk, marketing risk, financial risk, legal risk and human risk (Musser and Patrick 2002). Due to increases in extreme climate problems and socio-economic conflicts, agricultural risks have been exacerbated, both locally and globally (Cardona 2004, Fischer and Buchenrieder 2010, Yang 2010). Compared to other economic sectors, agriculture faces greater risks due to its significant dependence on societal events and natural processes. Agricultural risks often cause large losses for both farmers and agribusiness traders.

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 inland agricultural and industrial activities, and the increasingly negative impacts of climate change (Doukakis 2005). Among the various livelihoods supported by ocean-aquaculture production, clam farming is an aquaculture (or mariculture) practice in which clams are raised for human consumption. Clam farming entails long production cycles and substantial initial investments; consequently, clam farmers often face greater risk – both in scope and in magnitude – compared to other farmers (Engle 2010), especially in the context of climate change and its unpredictable effects on the hydrological cycle. Handisyde et al. (2006) and De Silva and Soto (2009) note that climate change has impacted aquaculture in ways that are both direct (e.g., the increased mortality rates of aquatic animals caused by extreme weather shocks) and indirect (e.g., farmers’ decreased income due to fluctuations in output volume; sudden changes in the prices of both inputs and outputs due to the availability of aquatic species), which has exacerbated the vulnerability of the sector and created a higher probability of loss. In addition, aquaculture production and its share in the food market are predicted to continue increasing and intensifying as a result of growing global demand for aquatic products, which will certainly amplify risks in the sector. More proactive and effective efforts and strategies from the various parties involved in this sector are necessary to help farmers become more capable of coping with aquaculture risks.

Vietnam, with its long coastline (over 3,260 km) and numerous estuaries (112 in total), was ranked 18th in the 2015 World Risk Index, with a vulnerability index of 51% (Garschagen et al. 2016). Climate change and natural resource degradation are considered the two major contributors to Vietnam’s recent reduction in agricultural productivity. The share of the agricultural sector in Vietnam’s trade balance experienced a declining trend in the 2013-2015 period; indeed, the agricultural growth rate became negative in the first quarter of 2016 (Nguyen 2016). In addition, further integration into the global market economy, with its unpredictable market demands, will generate additional risks for this agriculture-based country.

Risks can create lethal constraints for certain groups of farmers while presenting opportunities for others. To a certain extent, on a landscape scale, risk and opportunity often coexist. Specifically, whereas certain farmers might be adversely affected by risks, other farmers survive risks and/or successfully exploit the associated opportunities that emerge. In other words, risk taking is intrinsic to the development process and is at least better than a scenario characterized by inaction (WorldBank 2014).

Risks are considered the main reason for social differentiation, that is, the widening gap between the rich and the poor (Yang 2010, Bui et al. 2014). In Vietnam, the wealth gap has widened rapidly in recent years, driven by increased natural and socioeconomic risks (Nguyen et al. 2015, Hay 2016). In the agricultural sector, although farmers may be aware of risks, the increased cost of living and even pressure to repay debts cause farmers to continue to invest in their farm operations. Many farmers have suffered losses in agricultural production (Minot and Hill 2007), whereas others have enjoyed added profits. The research of Duc (2009) on the economic contribution of aquaculture in Vietnam indicates that in rural areas, this sector makes an important contribution to farm income and that there is a high rate of adoption of aquaculture among poor farmers. The fact that farmers face the same risks but obtain different results raises question about the underlying causes of farmers' successes or failures.

The present study focuses on clam farming households in Thaibinh province, Vietnam. Among the coastal provinces in North Vietnam, Thaibinh has the largest area of clam farming (3,430 ha), followed by Namdinh (1,710 ha), Thanhhoa (1,200 ha), and Quangninh (1,000 ha) (MARD 2014). According to Thaibinh Agriculture and Fishery Extension Center, approximately 17,000 ha of the provincial intertidal area has salinity of 15‰-25‰, which favors aquacultural development (ThaibinhDARD 2014). Of the intertidal area, 15,119 ha are used for aquaculture production of different types of aquatic animals, including shrimp, fish, and clams.

In the early 1990s, increased market demand for clam meat and a reduction of natural clams that could be collected for market created a demand for clam farming in Thaibinh. Initially, approximately 150 ha of intertidal area was claimed by a number of farmers for clam farming. The farming area was continously expanded in the following years, reaching approximately 1,500 ha in 2010. In 2011, the provincial government officially institutionalized clam farming and sought to boost the sector by zoning and bidding intertidal areas to farmers. In addition, loans were made available from official banks, such as Agribank and Policy Bank, for farmers to invest in clam farming. Clam farming rapidly expanded to approximately 3,500 ha in 2013. Farmers also increased clam raising densities with the expectation of greater harvests, i.e., from 300-400 juveniles/m^2 (2009 and earlier) to 1,000-1,200 juveniles/m^2 in 2012-2013. However, in contrast to farmers' expectations, clam yields decreased rapidly in 2011 due to high mortality rates caused by increased raising densities and unfavorable climate conditions, including storms and hot weather, during that year. In 2012, emergent market difficulties for clam meat caused financial problems for many farmers. In 2014, the provincial clam farming area decreased slightly, falling to 3,430 ha, with a total clam production value of nearly USD20 million (*with the exchange rate at USD1 = VND22,000*) in the province.

According to the report about the status of hard clam farming in some coastal provinces of North and Northern Central Vietnam, approximately 84.1% of surveyed farmers reported experiencing at least one occasion of massive death of cultured clams, meaning that only 15.9% of surveyed farmers did not suffer massive hard clam death (Bui and Tran 2013). As a consequence of massive hard clam deaths, farmers became jobless, and their suffering was exacerbated by bank debts. However, certain farmers were able to overcome the shocks or became very resilient as a result thereof – for example, the farmers who were counted among the 15.9% in the research of Thuyet and Dung (2013) – despite being in the same risky context. Some of these farmers were even called "clam kings" or "clam billionaires."

1.2.Research questions

With massive fluctuations in farming practices, market demand and prices, clam farming is an interesting area for an agribusiness study to identify the underlying reasons for the problems encountered and/or innovations initiated by farmers. The study starts with following research questions:

(1) What aquaculture risks are faced by clam households in Thaibinh province?

(2) What farming risk management strategies are being developed and adopted by clam households?

(3) Which factors affect the success and/or failure of these strategies?

1.3.Research hypothesis

Based on the country context and the actual clam farming situation at the study sites, the following hypotheses have been formulated in this study:

1. Clam households in the coastal aquaculture sector face different risks in clam cultivation;
2. Household risk management strategies in clam farming may vary among households, leading to different degrees of resilience to aquaculture risks; and
3. Household risk management strategies in clam farming are impacted by many factors and reflect issues related to government policies that support (or impede) the sector.

1.4.Research objectives

The study aims to provide insights on farming and marketing practices and on the underlying reasons for the success or failure of farmers' risk management strategies. These insights will not only provide valuable lessons for the farmers themselves but also provide guidance to different levels of government with respect to the development and implementation of policies that aim to support clam farming and the aquacultural sector in general. Specifically, the study aims to do the following:

(1) Understand clam farming risks based on the actual clam farming situation and practices in Thaibinh province;

(2) Analyze household risk management strategies in clam farming;

(3) Identify the factors that affect household risk management strategies in clam farming; and

(4) Develop recommendations to improve clam farming risk management for local farmers and different levels of government.

1.5.Scale and scope of the research

The scope of the research: This study focuses on clam farming – the agricultural subsector having a number of unique characteristics as compared with other aquacultural subsectors. Clam farming often requires a large amount of investment, may produce a high profitability, and encounters with different risks. With these characteristics, the subsector has been considered as “gambling” farming practices, which will be elaborated in Chapter 5.

The scale of the research: The research takes household for its analysis unit. Given the “gambling” nature, income generated from this sector, even very large in successful harvesting and marketing seasons, is often not the main income of the producers since households often diversify their income sources and none purely relies on clam farming. Within the research, analyses on risks, risk impacts, and coping strategies are pivoted at household level.

1.6.Structure of the thesis

This thesis comprises an introduction, six discussion chapters, and a conclusion and recommendation section. Chapter 1 (the introduction) provides general information on aquacultural practices in Thaibinh province and Vietnam. It includes information on clam farming and its risks, providing a background for the statement of research problems. Based on the research questions, hypotheses are developed, followed by the objectives of the study.

Chapter 2 reviews relevant concepts and findings from previous studies regarding risks in agriculture in general and in aquaculture in particular. In addition, the chapter contains reviews of household risk management strategies and of the actors and factors that influence households’ implementation of these strategies, which is measured by the extent of households’ resilience to risk.

Chapter 3 provides an overview of aquaculture, mollusk production and clam farming in Vietnam, offering readers additional insights on the country’s aquacultural context, including highlights regarding characteristics of aquacultural production and marketing practices in Vietnam.

Chapter 4 contains two parts. The first part provides information about Thaibinh province and the performance of the provincial clam sector. The second part discusses the research methodology.

Chapter 5 analyzes the causes and effects of risks in clam farming in Thaibinh province.

Chapter 6 discusses household risk management strategies that are implemented to cope with farming and marketing risks and the results of adopting these strategies as measured by the extent of households' resilience to risk.

Chapter 7 discusses the influences of different factors that affect the success and/or failure of households to cope with the risks of clam farming and marketing, including internal factors (for example, household characteristics) and external factors (such as social networks and government policies). The chapter ends with a conclusion section that describes the relevant implications for better household risk management strategies for local farmers and all levels of government.

Finally, Chapter 8 includes conclusions and recommendations. It summarizes the main findings with respect to the research questions and offers recommendations and policy implications for improving the support of clam farmers in their risk management strategies and moving toward sustainable aquaculture.

2

LITERATURE REVIEW

The first part of this chapter provides an overview and definitions of the concepts of risk and uncertainty and agricultural risk, followed by a discussion of the specific risks pertaining to the unique characteristics of the aquaculture sector. Then, a summary of risk assessment is provided in the second part of the chapter, which aims to describe the approach used to assess clam farming risks in Chapter 4. The third part of this chapter explains the concepts of household resilience and household risk management strategies for the purpose of providing background knowledge relevant to the assessment of the factual findings presented in Chapter 5 regarding the resilience and risk management strategies of clam farming households. This part is followed by an overview of findings from previous empirical studies on the impacts of internal and external factors on the application of household risk management strategies in order to allow a comparison with the impacts of those factors on household risk management strategies in the context of clam farming in Chapter 6, which in turn facilitates the development of policy implications based on the research findings of this study.

2.1. Aquaculture risks

2.1.1. Risk and uncertainty

"Risk" is a term that has been widely used in various sectors – including agriculture – in recent decades. In the most general terms, the Risk Management Agency of the USDA (United States Department of Agriculture) defines risk as "the chance of something bad happening" (McIntosh 2008). This definition mentions two important components of risk: (1) "something bad", which refers to an event or outcome that is adverse or a failure," and (2) "chance", which implies a degree of possibility that an adverse event will occur. Although the definition of risk may vary depending on sector, it always includes these two important components (Harwood et al. 1999, Bondad-Reantaso et al. 2008, Keil et al. 2008).

When discussing risk, many researchers distinguish between "risk", which implies knowledge of the potential numerical impact on the welfare of an individual or a specific group of farmers, and "uncertainty", which implies that the outcome is uncertain, and the probabilities are unknown (Hardaker et al. 2004, McIntosh 2008, Aimin 2010). However, other researchers argue that this distinction is not operative because probabilities are very rarely known and thus are merely subjective beliefs (OECD 2009). There is a combination of these two definitions that characterizes risk as uncertainty that involves the probability of economic loss, possible harm to human health, potential repercussions that affect resources (such as irrigation and credit), and the possibility of other types of events that affect a person's welfare. In other words, uncertainty is a necessary component of risk but does not always lead to a risky situation (Harwood et al. 1999). Despite the parallel existence of these two definitions, the distinction remains blurred and the meaning varies somewhat depending on the sector.

In the report "Assessment and communication of environmental risks in coastal aquaculture" by the Joint Group of Experts on The Scientific Aspects of Marine

Environmental Protection (GESAMP), the concept of "hazard" is discussed to clarify the meaning of "risk". Specifically, "hazard" refers to an agent, medium, process, procedure, or site that has the potential to cause an adverse effect (EUCommision 2000). In other words, a hazard is a (potential) source of risk that does not necessarily create risk; rather, a hazard creates risk only if an exposure pathway exists and if exposure creates the possibility of adverse consequences ((Covello and Merkhoher 1993), cited by the (Joint Group of Experts on the Scientific Aspects of Pollution 2008). Similarly, Downing et al. (2001) define risk as the probability of hazard occurrence, and hazard refers to a potential threat to humans and their welfare.

Sources of risk may be natural (such as storms or floods) or the consequence of human activity (for example, industrialization or the use of chemicals in agriculture) (Holzmann and Jørgensen 2001). When discussing risk, several characteristics are usually mentioned. Risk can be categorized as "systematic" or "non-systematic", depending on whether it may repeat over time with a pattern of probabilities that can be analyzed to generate a good estimate of actuarial odds (Newberry and Stiglitz 1981). Rothschild and Stiglitz (1970) propose three equivalent definitions of "riskier", i.e., (1) a distribution of outcomes Y is riskier than X if Y is X plus a random noise; (2) X is preferred by risk averse agents; and (3) Y is obtained by shifting some weight from the center to the extreme values of X (Rothschild and Stiglitz 1976) cited in (OECD 2009). A risk can also be characterized by low frequency and devastating effects (catastrophic) or by high frequency and low welfare effects (non-catastrophic). Furthermore, many risks are correlated. Typically, a risk has some degree of correlation with other risks. A risk can recur over time (repetition of risk) or occur with other risks; the correlation between risks can be positive or negative. In certain unique cases, an individual risk that is independent of any other risk is called an idiosyncratic risk (OECD 2009).

Whereas the definition of "risk" includes the concept of possibility, the term "shock" refers to adverse events that lead to a loss of household income, a reduction in consumption and/or a loss of productive assets (Dercon et al. 2005). However, the impact of shocks can be minimized through various ex ante adjustments that people make based on their knowledge that risk exists (Ligon and Schechter 2003, Christiaensen and Subbarao 2005). Therefore, to reduce the negative impacts of such events on human life, people should make increased efforts to understand and properly manage risk.

2.1.2. Agriculture risk

Risks are often more entrenched in agricultural production and the agricultural business sector because agriculture largely depends on external factors, for the primary reason that nearly all activities take place outdoors. Naturally, agricultural risk is constant and occurs everywhere (Hardaker 2000). Indeed, Aimin (2010) asserts that it is difficult to imagine an industry where risk and uncertainty are more important than they are in agriculture. Considerable research has been devoted to the effects of uncertainty and risk in agriculture, as well as to the management of risk and uncertainty in economic development.

Sources of agriculture risks

The sources of uncertainty and risk in agriculture are numerous and diverse, ranging from events related to climate and weather conditions to animal diseases; from fluctuations in prices for agricultural products to fluctuations in prices for fertilizer and other input; and from financial uncertainties to policy and regulatory risks.

First, climate change is likely to further increase agricultural households' risk exposure through changes in weather patterns and greater weather variability (Macours et al. 2012). The challenge presented by climate change will be more severe for agrarian economies in developing countries and in particular for the rural poor (Baez and Mason 2008). Diseases and infestations also significantly influence farm performance, as shown by the impacts of the outbreaks of classical swine fever in 1997/1998 and foot-and-mouth disease in 2001 (Huirne 2003). The use of new crop varieties and production methods often offers the opportunity to improve economic efficiency but may at times yield poor results, particularly in the short term. In contrast, the threat of obsolescence exists with certain practices (for example, using machinery that is no longer readily available), which creates a different kind of risk (Harwood et al. 1999).

Second, in agriculture, the production cycle is typically lengthy and normally requires ongoing investments in feed and equipment that may not produce returns for several months or even years. Meanwhile, agricultural markets are generally complex and involve both domestic and international considerations, which makes the prices of both inputs (such as concentrates, fertilizer, pesticides, and machines) and outputs (milk, rice, and others) difficult to predict with precision and thereby increases farmers' exposure to price-making forces (Huirne 2003).

Governments are another source of risk to farmers. Changes in laws and regulations related to farming can have far-reaching consequences for farm performance. The legal framework and the changes thereto may lead to liability and policy risks (for example, changes in regulations regarding the environment, pesticides, animal diseases, or land use) (Ngo et al. 2016).

In addition, farm businesses are often exposed to financial risks associated with borrowed capital, sudden changes in financial markets, fluctuations in interest rates on borrowed capital, and cash flow difficulties (if there are insufficient funds to repay creditors). The use of borrowed funds means that a share of the returns from the business must be allocated to the satisfaction of debt obligations. Even when a farm is fully owner-financed, the operator's capital is still exposed to the possibility of losing equity or net worth (Harwood et al. 1999, OECD 2009). Furthermore, farmers who work on their farms are themselves a risk to the profitability and continuity of the farm due to the farm environment and working conditions. In particular, a farm's survival may be threatened by death of the owner or the long-term illness of the owner or farm employees (Hanson et al. 2004).

Type of agriculture risks

Agricultural risks are categorized into five basic types: production risk, marketing risk, financial risk, legal risk, and human risk (Musser and Patrick 2002). Risks in agriculture have the potential to cause large losses for farmers and traders. However, driven by commercialization motivations, many farmers invest increasing amounts in their farms without adopting adequate agricultural risk mitigation strategies. Consequently, many rural households have suffered from the results of costly and risky agricultural production practices (Minot and Hill 2007).

Because of differences in risk definitions, there are many perspectives regarding risk classifications in general and agricultural risk in particular. Both Huirne et al. (2000) and Hardaker et al. (2004) distinguish two major types of agricultural risks. The first type is business risk, which includes production, market, institutional and personal risks; the second type comprises financial risks that result from the various methods of financing farm businesses. Musser and Patrick (2002) follow Baquet et al. (1997) and define five major sources of agricultural risk based on cause: (1) production risk, (2) market risk, (3) institutional risk, (4) human risk, and (5) financial risk. Applying a holistic approach that is grounded on the characteristics of agriculture, the OECD (2009) classifies agricultural risks into four groups, namely, (1) production risk, (2) market risk, (3) financial risk, and (4) institutional/legal risk. In addition, researchers use the impact levels of risks to divide agricultural risks into three tiers: (1) micro (idiosyncratic) risk, which affects an individual or household; (2) meso (covariant) risk, which affects groups of households or communities; and (3) macro (systemic) risk, which affects regions or nations.

However, the boundaries between different types of risks are somewhat blurred, because farmers can suffer from a combination of risks simultaneously; these risks are inter-dependent and/or inter-correlated. To illustrate this issue, several cases of farmers in Vietnam, India, Philippines, and China are described in the FAO report titled "*Innovative risk management strategies in rural & agriculture finance – The Asian experience.*" First, nature-related risks arise from both climate and disease, which can cause increased mortality rates and reduce productivity. Usually, the nature, frequency, and intensity of these damages are influenced by geographical parameters and by the degree of development of local physical and institutional infrastructures. Second, financial service providers recognize the presence of these systemic risks and will refuse to expand their supply when the risk incidence is high. Third, reductions in productivity and in the total volume of agricultural production will influence market performance, as will unforeseen variations in prices of goods and inputs and uncertainty regarding the availability of production factors (i.e., land, water, public services, skilled labor, fuel and other modern inputs). All of these issues contribute to the volatility of rural household incomes. From another perspective, there are risks derived from the lack of institutions to support the design and enforcement of contracts and to facilitate market transactions; in other words, existing legal frameworks and judicial processes are insufficient to ensure with a fair deal of certainty that transactions will be conducted in compliance with agreements. Fourth, in general, shortcomings of the political and institutional environments in low-income countries can be a source of exogenous risk, which reduces the attractiveness of investment in agriculture. Reduced investment in agriculture can in turn increase the difficulty of accessing formal financial systems for farmers and thereby create dependency on informal financial systems, which are very risky for farmers. Dependency on informal financial systems can lead to a loss of negotiating power in agricultural input/output trading; moreover, non-regulated loan collection practices create reputational and physical risks to household members (FAO 2017).

2.1.3. Aquaculture risk

Aquaculture activities include the breeding, hatching, cultivating, rearing, and growing of fish, aquatic life, or seaweed for harvest if these activities involve the occupation of a coastal marine area; they also include the taking of harvestable spat if the taking involves the occupation of a coastal marine area (McIntosh 2008). Generally, the risks associated with aquaculture are similar to those facing agricultural enterprises and are related to factors that can affect the aquacultural crop itself, for example, disease, equipment failure, or unexpected competition. Moreover, because aquaculture is very diverse (in terms of species, environments, systems, and practices), the range of hazards and the perceived risks are complex (Bondad-Reantaso et al. 2008, McIntosh 2008). Given the long period from inception to harvest, as well as the large initial investments required, aquatic farms often involve more serious risks compared with, for instance, annual crop production farms (Engle 2010), especially in the context of climate change and unpredictable hydrological cycles. Handisyde et al. (2006) and Del Silva and Soto (2009) (cited in (Barange and Perry 2009) note that climate change has various direct and indirect impacts on aquaculture that undoubtedly increase the stress and vulnerability of this sector and thus create a higher probability of loss. Moreover, the extensive global economic crisis has exposed farmers to severe conditions related to the variability of input and output prices (Miranda and Vedenov 2001). In aquaculture, in addition to traditional risks, the interaction between farming activities and the environment means that risks flow in both directions; the environment creates risks for aquaculture production and aquaculture production creates risks for the environment. Therefore, it is necessary to pay attention to environmental sustainability, food safety, and hygienic risks to the environment (Joint Group of Experts on the Scientific Aspects of Pollution 2008, Le 2011).

The main types of aquacultural risks

Among traditional agricultural risks, the most important risks for aquaculture are production risk, market risk, and financial risk. The paragraphs below will review the causes of those risks and their impacts on aquaculture production (Le and Cheong 2010).

Production risks

Due to the sensitivity of aquaculture to the environment, the success of aquaculture is highly dependent on the quality of the cultivating environment (Le 2011). Some of the more common causes of production risk are disease, predation, extreme climate events, water quality, power outages, and equipment failure, although these are not the only risks experienced by aquaculturists. The effects of each of those risks can lead to catastrophic losses, although their severity can differ and will likely change throughout the production cycle. Regardless of which potential risk becomes problematic, the result is an overall decrease in aquaculture production of a marketable quality, which in turn leads to financial loss (McIntosh 2008).

Market risks

Like production risks, market risks are often experienced by aquaculturists. Market governance mainly leaves aquaculture to the forces of supply and demand (Hishamunda et al. 2014). A lack of proper business planning can lead to an oversupply situation, which creates uncertainty about where and how farmers can sell their products. In addition to the risk of oversupply, other market risks include production costs that exceed market prices; an inability to supply existing markets; competition from other production strategies, including capture fisheries and other cultural technologies; competition from alternative commodities, such as beef, chicken, or pork; and competition from other aquacultural producers, whether they are local, regional, national, or international. Like production risks, which can reduce the quantity and/or quality of marketable product and result in financial losses, market risk can have dramatic impacts on farmers' bottom lines by sharply decreasing their income (McIntosh 2008).

Financial risks

In aquaculture, financial risk refers to potential losses associated with an aquaculture investment. Aquaculture investments may be public or private and are made on behalf of various stakeholders, including individual farmers, shareholders, farm enterprises, financial institutions and/or government institutions (Bondad-Reantaso et al. 2008). Aquaculture is a capital-intensive business and requires substantial investments, both to acquire capital (including land, equipment, building production facilities, and other items) and operating costs (such as breeding, food, and labor) (Engle 2010). The high level of capital required forces farmers to engage with the financial system, which creates a significant probability of interest rate problems or debt repayment difficulties in the event of a loss of the entire investment, especially if farmers fall into a "bad debt" trap in informal financial systems, which are very popular in rural areas.

Aquaculture risk is increasing due to conflicts in coastal aquaculture production

Aquaculture is an increasingly prominent feature of coastal environments. However, seafood production from capture fisheries has failed to increase significantly due to limited maritime resources, whereas demand for their products increases each year (Doukakis 2005). Therefore, aquacultural cultivation must undergo intensive development, which requires coastal use. Coastal use is increasing, which has led to increased spatial conflicts. In addition, interactions between coastal environments and watershed development are becoming increasingly significant (Stead et al. 2002). Overuse of this resource, combined with the interaction between aquacultural activities and the coastal environment, ultimately increases the risks from and to aquaculture production. For example, overuse of chemicals in aquaculture cultivation increases productivity but threatens coastal and marine ecosystems throughout the world. This category of ecosystems includes terrestrial ecosystems, areas where fresh water and salt water mix, nearshore coastal areas and open ocean marine areas. The coastal systems of the world are critically important for humankind but are under ever-increasing threats from activities both within and outside coastal zones (MilleniumEcosystemAssessment 2003).

In sum, aquaculture is generally considered a high-risk production activity (Engle 2010). However, as the benefits of aquatic animal production increase, the attention paid to concerns about aquacultural risks must also increase (Sheriff et al. 2008). The ability of the poorest populations to engage in aquaculture or to derive benefits from aquacultural activities and the reduction of the negative impacts of aquacultural risks depend on an understanding of the risks and opportunities and on the skill with which people manage those risks and opportunities.

2.2. Risk assessment

2.2.1. Impact of risk

The impact of risk is generally described as the negative outcome of an event (hazard) occurring in various aspects of a farmer's life, including economic (for example, weather extremes in food-producing regions have decreased crop yields by up to 25%, leading to increased food prices) (Porter et al. 2014), social (a substantial portion of the global population is falling into deeper poverty as a result of negative shocks) (WorldBank 2014), and environmental (including man-made catastrophes, such as the Fukushima power plant disaster or the oil spill in the Gulf of Mexico) (Kreft et al. 2014). A consequence is the potential worst-case impact of the risk on the organization after the magnitude of the loss is mitigated by current controls. There are several levels of consequences, including severe, major, moderate, or minor. Consequences are matched in magnitude by the present size and shape of the aquacultural industry. These consequences, which must be identified in terms of degree, geographical extent, and duration of effects, may be expressed qualitatively (with impact levels from low to high) or quantitatively (through monetary values or the number/proportion of affected people) (Arthur et al. 2009).

The downside risk is always the most important. In fact, the downside risk is more likely to occur when a risky situation depends on nonlinear interactions among several variables; this scenario is particularly relevant in agriculture (Hardaker et al. 2004). For example, aquacultural volume depends on several factors, including water environment and food, and large deviations from the central values of these variables in either direction will have adverse effects. A normal season could be defined as a season in which all variables reach their expected values in normal conditions. However, in a world characterized by continuous change, normal conditions are very unlikely to occur and the probability that yields will be below normal is likely to be high. In this case, the distribution of outcomes will be skewed towards lower yield values and thus downside risk becomes particularly important. The focus on downside risk has led to measures of risk that are based on downside consequences, such as the value at risk, which is based on a percentile of outcomes (e.g., the numeric probability of losing a given amount of money and maximum amount of money that could be lost). This measure of risk is frequently used in portfolio analysis and decision making, especially in the context of insurance and financial risk management (Philippe 2001) cited in (OECD 2009)).

Loss and vulnerability

Recently, a significant aspect of risk studied by risk scientists relates to social protections against poverty, particularly in developing countries (Dercon 2005). In this context, the term "vulnerability" refers the potential level of consequences caused by the farmers' risks (McCarthy et al. 2001, Adger 2006). Sarewitz et al. (2003) assert that vulnerability reduction is a human rights-related issue whereas risk reduction is not. Accordingly, measuring and decreasing the impacts of risks are more important than the elimination of risks. Vulnerability does not depend exclusively on risk characteristics but also on a household's asset endowment and availability of insurance mechanisms (OECD 2009). Ligon and Schechter (2003) construct a measure of 'vulnerability' that allows people to quantify both the welfare loss associated with poverty and the losses associated with a variety of sources of uncertainty.

Subsistence farmers in developing countries face many types of danger in their everyday lives, both in general and specifically related to their agricultural activities. Given low livelihood resilience at a particular time, a sharp decrease in income and consumption shock can have overwhelming consequences. Many practical studies and literature reviews on risk and vulnerability indicate that rural households in developing countries are constantly affected by multiple shocks (Fischer and Buchenrieder 2010). Indeed, the major economic crises and disasters that have occurred frequently in recent years and the crises that are most likely to recur show how vulnerable people, communities, and countries are to systemic risks, especially in developing countries. Millions of workers in countries as different as Argentina, Bulgaria, and Guyana not only have lower income and unstable consumption but also have a lower ability to find new work, lower social cohesion, and in some cases, higher domestic violence (WorldBank 2014). Examples of situations in which rural livelihoods in developing countries are increasingly vulnerable to risks posed by weather and climate include reductions in living standards due to lost income, loss of employment or the inability to find employment due to inadequate skills, falling victim to disease or crime, and suffering the disintegration of family due to financial strain or forced migration. In addition to their impacts on specific farming cycles, agricultural risks can reduce farmers' productivity for a period of years, because farmers often sell assets that they need for farming to smooth their consumption and thereby survive the poor harvest. Similarly, farmers may reduce their investments in subsequent seasons because they fear that they will lose their investments if a shock recurs (Barnett et al. 2008) cited in (Madajewicz et al. 2013). Among the people whose lives are affected by risks, two groups in particular are the most severely impacted: (1) poor farmers and (2) women. Poorer households tend to live in riskier areas, which puts them at risk of flooding, disease, and other chronic stresses; it also limits their financial capacity and knowledge, which in turn makes them less resilient. Women are differentially at risk from many aspects of environmental hazards, including, for example, the burden of working to recover homes and livelihoods following shocks (Fordham 2003) cited in (Adger 2006). Table 2.1, in next page, presents the different levels of several types of consequences and the corresponding loss score for each level.

Table 2.1: Risk's consequence types and scores

	Consequence type						Score
	Health & safety	**Image**	**Environment**	**Stakeholder interest**	**Economic loss (USD)**	**Major delays in projects or activities**	
Catastrophic	Multiple fatalities	International media coverage	Permanent widespread ecological damage	Special board meeting	> 1 million	> 1 year	5
Severe	Several fatalities	Sustained national media coverage	Heavy ecological damage, costly restoration	Raised at board meeting	500,000-1 million	> 6 months	4
Major	Single fatality	Regional media coverage or short-term national coverage	Major but recoverable ecological damage	Shareholder enquiry	250,000-500,000	> 3 months	3
Moderate	Serious injuries	Local media coverage	Limited but medium-term effects	Unions raise issue	100,000-250,000	> 1 month	2
Minor	Minor injuries	Brief local media coverage	Minor short-term effects	Staff raise issue	< 100,000	> 1 week	1
Note: The level of economic loss should be adjusted based on local context							

(Source: Stimpson&Co. 2007)

Because both “hazard” and “vulnerability” are included in the definition of risk, the two concepts are viewed distinctly. Specifically, risk is defined as a function of hazard (the source of a threat). In contrast, social vulnerability is defined as the probability of a consequence; in this context, risk refers to outcome. Thus, the probability of a negative outcome depends on the probability of the occurrence of a hazard and on the social vulnerability of the exposed system, which in turn determines the potential consequence of the hazard (Brooks 2003).

Moreover, risks are considered the main basis for social differentiation, that is, the widening gap between the rich and the poor (Yang 2010, Bui et al. 2014). In Vietnam, this gap has widened rapidly in recent years (The Wealth Report 2015), driven by increased natural and socioeconomic risks (Nguyen et al. 2015). In the agricultural sector, farmers may be aware of risks, but because they are driven by commercial motivations and (to some extent) the pressure to repay debts, they continue to invest in their farming operations. Many farmers have suffered losses in agricultural production (Minot and Hill 2007), although a number of farmers have seen increases in production. Whereas Stevenson et al. (2009) examine the main barriers to aquaculture adoption by the poor, Duc’s (2009) study on the economic contribution of aquaculture in Vietnam reports that rural aquaculture significantly contributes to farm income and has a high adoption rate among poor farmers. The fact that *«different farmers face the same risks but typically obtain different consequences»* raises questions about underlying causes of farmers’ wins and losses.

Whether adverse consequences are due to systemic or idiosyncratic risks, they can destroy lives, assets, trust, social stability or a combination thereof. One sustainability goal is to ensure a minimum level of well-being, which – among other things – depends on peasants’ ability to cope adequately with shocks and stresses that can plunge them into poverty. Despite impressive progress in poverty reduction in the past three decades, a substantial proportion of people in developing countries remain poor and are vulnerable to falling into deeper poverty or into the “debt trap” when struck by negative shocks. An increasing number of cases show that adverse shocks — the majority being weather shocks and economic crises — are major factors in pushing peasants below the poverty line and keeping them there (WorldBank 2014). Similarly, Adger, W.N., and Winkels, A. (2014) conclude that poorer households are forced to live in higher-risk areas, exposing them to earthquakes, landslides, flooding, tsunamis, and poor air and water quality. It could be said that the poor always suffer the most, and the degree to which a household is and remains vulnerable is a function of risk factors both internal and external to the household and of the capability of the household (determined by its asset portfolio) to manage these risks (Alwang et al., 2001).

2.2.2. Likelihood of risks

The term “likelihood” refers to the probability of the worst-case outcome after controls are considered. Likelihood assessment can be quantitative (based on the number of occurrences in a certain period) or qualitative (i.e., rare, unlikely, possible, likely, or almost certain). If the actual frequency of the event is known, the quantitative likelihood should be used rather than the qualitative likelihood.

Table 2.2: Likelihood scores

	Frequency	Qualitative	Threat Score
Frequent	At least once every year	Almost certain	5
Probable	At least once every 5 years	Likely	4
Occasional	At least once every 10 years	Possible	3
Remote	At least once every 50 years	Unlikely	2
Improbable	Less than one every 50 years	Rare	1

(Source: Stimpson&Co. 2007)

Likelihood risk assessment is the process of determining the probabilities of certain events and depends on a set of predictions about alternative futures. The process of prediction for decision-making purposes entails the analysis of the likelihood of certain future events to provide decision makers with a more informed basis for selecting one possible course of action over another. In this regard, it should be noted that there are numerous cases in which accurate assessment of risk (of either type) is impossible. For this reason, although experts can provide sophisticated and rigorous assessments of uncertainty to support risk assessments, a lack of experience with many phenomena and uncertainty regarding outcomes prevent exact estimates. For example, a probability of 95% was given for the prediction of an earthquake along the Parkfield segment of the San Andreas fault during 1985–1993, but this event still has not occurred (Toda and Stein 2002). Furthermore, extreme events are created by context. The character of an extreme event is determined not only by the physical characteristics of the phenomenon (e.g., a hurricane, monsoon rains) but also by the interactions of those characteristics with other systems (e.g., impoverished communities living on denuded mountain slopes in Nicaragua or on massive garbage dumps in the Philippines). More importantly, understanding and reducing vulnerability does not require accurate predictions of shocks. All decisions include some degree of informal probability analysis, but this informality is not critical. The point made here is not that vulnerability is divorced from probability but rather that vulnerability management does not depend on the precise predictive quantification of specific future events or classes of events (Sarewitz et al. 2003).

2.2.3. Risk classifications

Risks are often characterized by their frequency (i.e., the probability that they will occur) and their intensity (i.e., the magnitude of the loss). This characterization is often a simplification of a more complex reality in which the entire distribution of probabilities and outcomes must be considered. Furthermore, the links among the distributions of different risks are very important for any risk evaluation. The goal of risk assessment is to quantify the value of each potential risk and to determine the likelihood that it will occur (OECD 2009).

Risk assessment matrix

After ranking types of risks (based on their respective likelihoods and consequences) as discussed above, a specific risk can be assessed based on the matrix below. Table 2.3 (above) presents the results of risk assessment, which can later be used for risk mitigation decisions.

Mapping risks

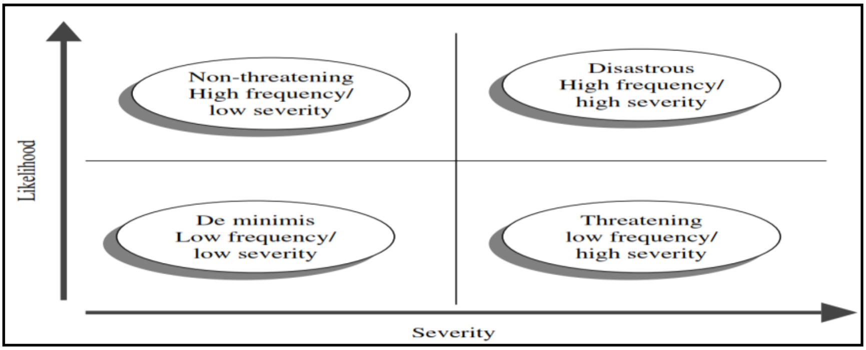
Risk mapping is often mentioned as the cornerstone of the risk identification process, both when describing various approaches to risk management and when formulating key steps to control risk. There are many ways to map risks, but the most common technique is probably to map a likelihood/severity chart (*figure 2.1*) to prioritize risks for management. The results of this method clearly help to

Table 2.3: Risk assessment matrix

		Consequences				
		Minor (1)	Moderate (2)	Major (3)	Severe (4)	Catastrophic (5)
Likelihood	Frequent (5)	Low risk	Moderate risk	Very high risk	Extreme risk	Extreme risk
	Probable (4)	Low risk	Moderate risk	Very high risk	Very high risk	Extreme risk
	Occasional (3)	Negligible risk	Moderate risk	Very high risk	Very high risk	Very high risk
	Remote (2)	Negligible risk	Low risk	High risk	High risk	Very high risk
	Improbable (1)	Negligible risk	Low risk	Modera te risk	High risk	High risk

(Source: Stimpson&Co. 2007)

differentiate between threatening risks (high severity and losses/low frequency) and non-threatening risks (low severity and losses/high frequency) but give no indication regarding what actions should be taken by management to change the existing risk profile. It should be noted that non-threatening risks may be measured accurately but managed to a lesser extent because their complete elimination is normally too expensive or impractical. In contrast, high negative impact/low frequency losses are not tolerated, and managerial action is triggered immediately to substantially mitigate such risks (Scandizzo 2005).

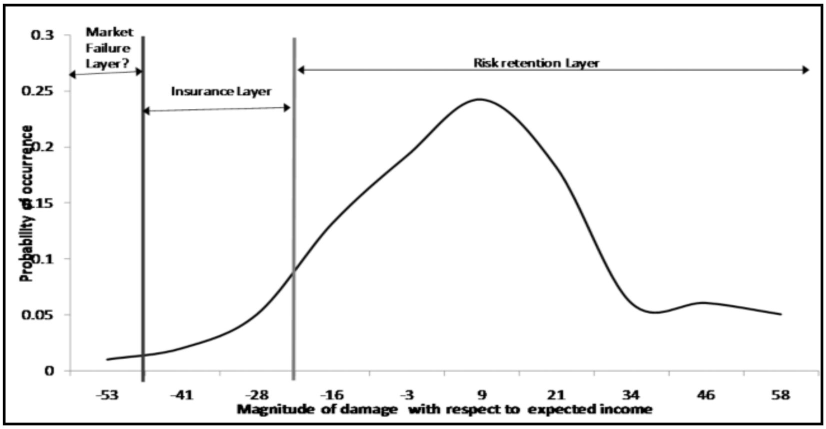


(Source: Scandizzo 2005)

Figure 2.1: Risk mapping

Segmenting risks into layers

Another basic but useful risk management technique is the segmentation of risk into different layers. This segmentation may help to match each set of risks with different layers of risk or with available management mechanisms. These layers can be defined in terms of the probability of occurrence and the magnitude of the losses, that is, the extent to which a risk is catastrophic (*figure 2.2*).



(Source:OECD 2009)

Figure 2.2: Probability density function and risk layers

The classification of risks with respect to two different criteria, i.e., the frequency of occurrence and the magnitude of losses, can lead to contradictory results if large losses are not associated with low probabilities. However, many risks or combinations of risks lead to a distribution of impacts where larger losses have lower probabilities. In this case, we can define three different layers that are simultaneously ordered from higher to lower probability of occurrence and from smaller to larger magnitude of production loss. Most results will be in the first layer, which indicates that the risk should be retained by the farmer, and only a minority of results will be in the third layer, which is the market failure layer. Following OECD (2009), the risk retention layer includes frequent events that cause relatively limited losses (normal risks); farmers are able to manage these risks efficiently and to smooth their incomes sufficiently. In the market insurance layer, risks are more significant but less frequent; farmers can use insurance or other market options to manage such risks (marketable risks). Finally, in the market failure layer, risks generate very large and systemic (correlated) losses at low frequencies, making them difficult to pool through insurance (catastrophic risks).

Although this distinction is easy to implement when the boundaries between layers are well-defined, this is not always the case. In all possible classifications, the boundaries between different types of risks are blurred because risks can be correlated, as previously explained in part 2.1.1. (for example, price or production risk is often associated with various singular events that are also denoted as risks). The first difficulty is defining the underlying variable in the distribution of risk. For example, to evaluate the production risk in a farming season, the variable could be the distribution of production/yields or the distribution of income. The variables can create differences or may be impacted simultaneously by the market factor. The second difficulty is obtaining an up-to-date probability distribution and time data series, because farmers seldom record historical farming information. The third issue is defining boundaries in terms of probability or losses. Note that risk classification will be helpful only if there are appropriate instruments to address the risks in each layer (OECD 2009).

It is common in the literature to segment risk by matching risk consequences and then defining appropriate tools to transfer, pool, or manage risk. These layers are typically defined in terms of the probability of occurrence and the magnitude of the loss – in other words, the extent to which the risk is catastrophic. The most efficient instruments to manage risk may differ across layers. Governments may decide to intervene or to implement appropriate policies to support farmers' risk management (Antón et al. 2013).

2.3. Households resilience and household risk management strategies

2.3.1. Household resilience

The term "resilience" has recently become ubiquitous in scientific and policy debates (Darnhofer 2014). In a social system, resilience is defined as the ability of the system to withstand loss (Buckle 2006) caused by external changes and shocks while maintaining its livelihood and identity (Adger et al. 2002, Norris et al. 2008). From a forward-looking perspective, the resilience concept is concerned about the capacity to cope with changes through renewal, restructuring (Folke 2006), and creativity (Maguire and Hagan 2007). Based on these aspects, two distinctive approaches to understanding resilience have been created; one focuses on the ability to "bounce back", whereas the other goes further by considering the ability to "bounce forward" (Davoudi et al. 2012, Scott 2013).

Furthermore, in terms of connections, the concept of resilience has been identified in a linked social and ecological system; in this context, resilience concerns the capacity for renewal, reorganization and development; the achievement of creativity and transformation within a social-ecological system; and the ability of the system to maintain its identity ((Adger 2000, Walker et al. 2004, Cumming et al. 2005, Folke 2006, Maguire and Hagan 2007) cited in (Nguyen and James 2013)). This concept is interesting because it focuses not only on the ability to overcome difficulties but also on hope, adaptation and transformation (Shaw and Maythorne, 2013). Therefore, in both its social and ecological senses, resilience is an important factor in sustainable development, especially in a world characterized by unpredictable changes (Adger and Winkels 2014, Darnhofer 2014). However, few livelihood studies use this concept to answer the question of how livelihoods "can cope with and recover from stresses and shocks" or to conduct related resilience analyses (Marschke and Berkes 2006).

Aspects of resilience

There are three common aspects of household resilience (Carpenter et al. 2001). The first is the speed of recovery following a disturbance (De Bruijn 2004), which can be measured based on the length of time until the system can be restarted and recovered. The second aspect is the magnitude of shock-related disturbances that can be absorbed before the system changes (Berkes et al. 2008). The measure of this characteristic could be the level of household income volatility or the smoothness of household consumption over time (WorldBank 2014). The third aspect relates to the capacity to integrate experiences and create opportunities from shocks (Carpenter et al. 2005). In his study of social-ecological resilience, Darnhofer (2014) confirms that farm resilience includes a buffer capability, an adaptive capability and a transformative capability. The term capability refers not to an asset but rather to the ability to create opportunities from risk, mobilize resources, develop and implement plans, and actively learn as part of an iterative, reflexive process.

Buffer capability denotes the ability of a farm to withstand a disruption without changes to its structure or function. In other words, shocks such as sudden price changes, extreme climate events, equipment failure, and droughts are weathered without substantial changes to the farm or to the farmer's life. Although there may be some impact, the farm "bounces back" through the temporary reallocation of resources. The reallocation of resources may involve mobilizing labor reserves, using excess capacity (saving money) with redundant machinery or storage facilities, or implementing provisional shifts among established back-up marketing channels. Buffer capability is particularly important for weathering small disturbances (e.g., extreme weather shocks such as storms and heat shocks during important crop periods) and in the initial phases of coping with large shocks (Darnhofer 2014).

Adaptive capability is the ability of the farm to develop while maintaining its current status in the presence of changes or shocks (Folke et al. 2010). It requires the ability to identify problems; establish priorities; mobilize resources; combine experience and knowledge in order to adjust to changing contexts or internal preferences; and plan after a shock. Adaptive capability is linked to on-going experimentation, which entails the use of both successes and failures as learning experiences (Glover 2012, Shaw and Maythorne 2013), and to flexibility and diversity (Darnhofer et al. 2010). Farms draw on their adaptive capabilities to cope with changes that intensify over time and to exploit new opportunities, such as those offered by information technologies.

Transformative capability relates to the ability of farmers to create untested beginnings from which to evolve into a new way of living (Walker et al. 2004). A transformation implies a transition to a new system in which a different suite of factors becomes important in the design and implementation of response strategies or the identification of opportunities in a difficult context. For example, a farming system organized around cattle on rangeland can be transformed into an ecotourism business (Cumming 1999) and farmers living in flood areas can collect fish and crabs in the flood season to maintain their livelihoods (Nguyen and James 2013). Transformative capability relies on the creative capacity to reconceptualize meanings and relations and to create fundamentally new farms with drastically different linkages and feedbacks, implying a commitment to innovation and novelty and the ability to imagine alternatives and possible futures (Schoon et al. 2011). In reality, a variety of conflicting processes occur simultaneously during a transition period, with old and new logics becoming intertwined, which necessitates the ability to recognize and seize opportunities. Competency is an important factor in this process (Augier and Teece 2009).

To conclude, farm resilience describes the ability to integrate these three capabilities to enable the farm to address sudden shocks and unpredictable changes and even to benefit from such events (Darnhofer et al. 2010). These three capabilities relate to change processes with different durations, from short-term resource shifts to long-term transformations. They also encompass the full range of changes that farmers may experience, i.e., from stability with no changes at all to the system (buffering a shock) to incremental and steady change (adaptation) and further to radical and innovative change (transformation). Indeed, the processes involved in these three types of changes are not necessarily separate but rather tend to partially overlap (for example, buffering a shock may be a short-term response undertaken while adaptive measures are implemented to take effect over the medium term) in a creative and flexible manner, all for the purpose of supporting the resilience of farmers and their households to all of the shocks that may occur during their lives (Darnhofer 2014).

2.3.2. Household risk management strategies

Households are always the first line of support when confronting risk and pursuing opportunities. A household is defined here as a group of individuals related to one another by family ties (kinship). Hence, the farmer is the agent best positioned to understand the dimensions, characteristics and correlations of the risks that affect both his farm and his family, as well as the resources available to cope with this risk. Therefore, it is the farmer’s responsibility as the manager of his own farming business to take appropriate actions to manage the risk associated with his economic farming activity (OECD 2009). In fact, empirical research shows that households manage to protect their consumption from shocks, albeit not completely. Studies in Bangladesh, Ethiopia, India, Mali, and rural Mexico show that households protect their consumption at least partially after shocks by using a combination of several strategies, including increasing the labor supply within the household. A study in Indonesia reveals that although households face significant income risks from several types of shock, they manage by themselves to achieve a level of insurance that covers at least 60 percent of this risk (WorldBank 2014).

Section 2.1.2 presents information regarding many potential sources of agricultural risks faced by farmers. If farmers refuse to acknowledge these risks, they should simply stop farming. Otherwise, they must accept and learn how to manage these risks. Risk management strategies begin with decisions made on the farm and in the household regarding the set of outputs to be produced, the allocation of land, the use of inputs and techniques (such as irrigation), and the diversification of activities on and off the farm. Farmers can also manage risk through market instruments such as insurance and futures markets. However, not all risks are insurable on the markets; therefore, farmers must select a strategy that both reduces risks and enables farmers to cope when shocks occur (OECD 2009).

Risk management strategies can be grouped into three categories based on their respective purposes: (1) prevention strategies, which aim to reduce the probability that an adverse event will occur; (2) mitigation strategies, which are designed to reduce the potential impact of an adverse event; and (3) coping strategies, which aim to relieve the impact of the risky event once it has occurred (Holzmann and Jørgensen 2001). Prevention and mitigation strategies focus on income smoothing, whereas coping strategies focus on consumption smoothing. These strategies can be implemented at different institutional levels: individual households, community arrangements, market-based mechanisms, and government policies. Thus, to select and implement the appropriate strategy, it is useful to segment risks into three different layers (*figures 2.1 and 2.2*) based on their consequences and likelihoods. Typically, at the household level, farmers should only manage risks that are frequent in occurrence but do not imply large losses. The management of risks in other layers requires the support of the community and the government (from local to central).

In terms of timing, household risk management strategies involve both ex ante and ex post activities. Ex ante activities include precautionary measures to reduce the probability of hazard occurrence or mitigate the potential negative impact of a hazard; these measures focus on smoothing income. In contrast, ex post coping activities aim to smooth consumption after the household has been affected by a hazard (Morduch 1995).

The main groups of tools and strategies available to farmers are presented in table 2.4. The menu of tools and strategies differ based on context (i.e., *type of agricultural production, community activities, and government policy or intervention*) and farmer characteristics (*for example, farmers' size, location, access to information, attitude, and household assets)*. A farmer can choose the combination of tools and strategies that best fits his risk exposure and his level of risk aversion (OECD 2009).

Table 2.4: Overview of risk management measures and costs

<table>
<tr><th></th><th colspan="2">Risk reduction</th><th>Risk Coping</th></tr>
<tr><th></th><th>Prevention</th><th>Mitigation</th><th></th></tr>
<tr><td>Ex ante</td><td>Technological choices
Innovative technological applications</td><td>Crop sharing
Diversification of production</td><td rowspan="2">Use family savings
Borrow from neighbors/relatives
Borrow from formal credit system</td></tr>
<tr><td>Ex post</td><td></td><td>Diversification of market channels</td></tr>
</table>

(Source: OECD 2009)

Risk management strategies for agricultural risks

<u>Strategies for production risks</u>

Management of production risks (such as disease, predation, water quality degradation, and power outages) can be accomplished through a number of methods, including the following: (1) changing conventional agricultural practices, which is a simple method that can provide significant protection from certain risks; (2) building redundancy into the operation (e.g., back-up generators, oxygenation systems), which can mean the difference between inconvenience and failure; (3) improving feed management, which can increase growth ratios, improve water quality, and ultimately result in a safer product; (4) taking proper precautions to protect against disease outbreaks, which can significantly reduce the severity of outbreaks by minimizing cross-contamination; and (5) understanding appropriate chemical and drug therapies, which can ensure that disease outbreaks are properly managed when they occur and prevent disease organisms from becoming resistant to treatment, making the exclusionary approach to disease risk management the best option. In addition, diversification of production to include other species and categories of production (e.g., food fish, baitfish, ornamentals, plants, sport fish), the application of innovative production technologies (e.g., ponds, raceways, land renovation, recirculating systems), and enlarging land area may help to alleviate certain productions risks. Although these options will likely be more difficult to implement compared with changing production techniques, they will also provide a level of protection to reduce the mortality rate and ultimately increase gross output (McIntosh 2008).

Strategies for market risks

Traditionally, farmers are price takers rather than price setters; therefore, they suffer when there are sudden changes in price (i.e., when input prices go up and output prices go down). One marketing strategy to offset the risk of price changes is the creation of a unique identity to differentiates one's products based on superior quality or other desirable characteristics (McIntosh 2008). Alternatively, a farmer can simply offer to sell his products when demand exceeds supply (i.e., earlier or later than its traditional season).

Other strategies that are commonly applied in US farming involves market contracts, production contracts, enterprise diversification, vertical integration, and crop insurance. Production contracting is an important instrument of risk prevention for farmers whereby farmers enter into production contracts with enterprises (processors or marketing companies) that require timely delivery, satisfaction of rigid quality standards, uniform product characteristics, and highly perishable products (Barry et al. 1992, Kliebenstein and Lawrence 1995). Alternatively, the non-farming company could be a resource provider and take a greater degree of control in farm production. Under such contract schemes, market risks are shifted almost entirely to the contractors; the farmers bear only "idiosyncratic" risks related to product quality, production losses, or farm efficiency (Harwood et al. 1999). Market contracts (including hedges, forwards, futures and options) are verbal or written agreements between a farmer and a collector that set a price and/or an outlet for agricultural production before the harvest or before the commodity is ready for market (Perry 1997). However, most marketing contracts merely reduce market risks and do not completely remove price risk (with the exception of the "flat price" contract) (Le 2011).

Strategies for financial risk

In developing countries, the majority of farmers are poor and thus lack capital to invest in agriculture. Moreover, their incomes depend mainly on farm performance, which fluctuates based on production and market risks. As a result, in addition to production and market risks, farmers must cope with a series of financial risks when they use third-party capital to invest and to smooth their consumption in the event of crop losses. To cope with these risks, households can adopt ex ante strategies, including savings and insurance contracts, income diversification, migration, precautionary actions and community-level arrangements (such as collective insurance schemes, informal financial instruments (e.g., credit associations) and other risk-sharing mechanisms). Typically, agricultural insurance programs are intended to transfer risk from one party to another – usually, away from the producer and toward the insurance underwriter. However, this type of insurance program, which is similar to aquaculture commodity insurance in the United State, has not yet become commonplace (McIntosh 2008) for reasons that reflect the complexity of the agricultural sector and the diversity of mindsets and behavior among farmers (WorldBank 2014).

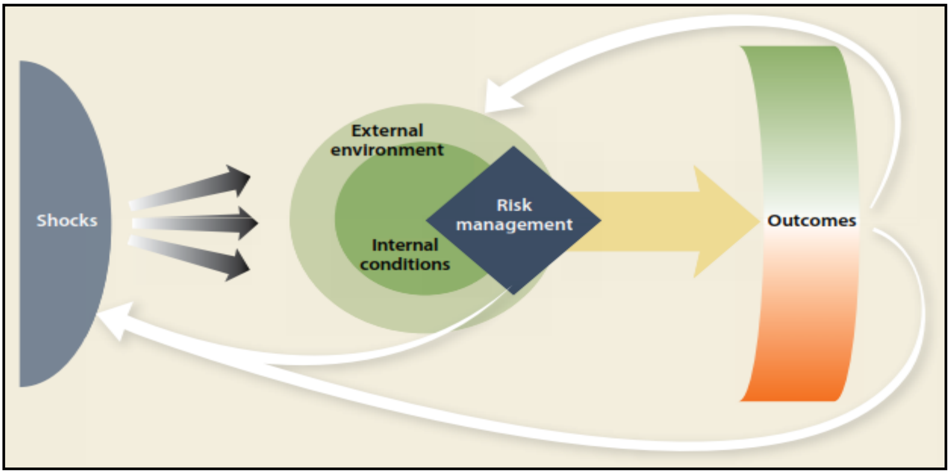
Optimal diversification that minimizes risks and allows farmers to reach long-term steady incomes is next (Baez and Mason 2008). All clam households have adopted other livelihood activities in addition to clam production, to varying degrees and of different types, which allows them to benefit from the effective use of household labor and reductions in purchased input, similar to other diversification models in developing countries (Rahman et al. 2011). Diversification is one of the most common risk management strategies adopted by clam farmers to protect their families and clam farms from agricultural risks, similar to other farmers in Southeast Asia (Fischer and Buchenrieder 2010), Africa (Barrett et al. 2001) and even Europe (EC 2001). The income from diversification activities is used to cover farmers' daily spending, because clam farming does not generate consistent monthly cash flows.

Principles of risk management

As in all businesses, risks will always exist in agriculture, and the approach taken by farmers to manage agricultural risk is almost as important as the risk itself. There are numerous alternative risk management methods, each of which is characterized by uncertain outcomes and varying levels of expected return and entails costs that farmers must weigh against the risk itself. Moreover, because farmers vary in their attitudes toward risk and in their ability to address risky situations, risk management is not a "one size fits all" activity (Harwood et al. 1999). To effectively manage risks, farmers should consider the three guiding principles of risk management: (1) do not risk more than you can afford to lose; (2) do not risk a lot for a little; and (3) understand the likelihood and severity of potential losses. Thus, farmers should assess the likelihood and severity of loss from each possible risk and then decide the best method for managing those risks (McIntosh 2008).

Another important principle is that risks can present a lethal constraint for certain groups of farmers while creating opportunities for others. Thus, to some extent, on a landscape scale, risk and opportunity occur together. In fact, given certain risks, although a substantial proportion of farmers will be badly hit, other farmers will withstand such risks and/or implement successful alternatives to earn their livelihoods. In other words, risk taking is intrinsic to the process of development and is at least better than a scenario of inaction. Indeed, the greatest risk may be to take no risk at all (WorldBank 2014).

2.4. Factors affecting to the application of household risk management strategies



(Source: World Bank 2014)

Figure 2.3: The risk chain and factors that influence risk management

As mentioned above, risk management strategies implemented by households require certain resources and conditions/environments to be effective. In other words, there are several factors relevant to the application and success of household risk management strategies, and these factors can be grouped into two categories: (1) internal conditions and (2) the external environment (*figure 2.3*). The next section will present a detailed review of the literature on the impacts of each factor.

2.4.1. Internal conditions

Households are small but complex units, and their characteristics can have a substantial influence on the ability of the household to function as a first line of support for confronting risks and exploiting opportunities. In particular, financial capital (asset constraints), education (the ability to translate information into knowledge and knowledge into action), and perception (attitude toward risk) impact the ability of households to manage risks effectively.

2.4.1.1. Financial capacity

The research of Fischer & Buchenrieder (2010) shows that although more well-off households often have access to so-called (ex ante) adaptive risk management strategies, poorer households must rely primarily on (ex post) risk coping strategies, which exacerbates the long-term vulnerability of poorer households. The lack of sufficient capital is a disadvantage of the poor when adopting necessary strategies to prevent and mitigate agricultural risks. For example, researchers have shown that access to credit sources, agricultural land, and diversity of income sources positively influences household resilience to climate shocks in Vietnam and Indonesia (Adger

1999, Keil et al. 2008, Nguyen and James 2013). In addition, the extent of available household assets affects the ability of a household to reallocate assets in response to risk. Asset reallocation not only affects short-term returns and their variability but also impacts the longer-term vulnerability of a household through its effect on savings and investments ((Zeller et al. 1997) cited in (Keil et al. 2008)). For example, a lack of capital restricted the ability of farmers in Cantho, Vietnam, to apply technology despite their positive perceptions of technology (Truong and Yamada 2002). Research conducted in China, in Pingyu, where the average household income is the lowest among the research sites, indicates that the lack of funds prevents the use of agricultural technology. When the government provides subsidies and low-interest loans, the number of farmers willing to adopt new technologies increases by 40% (Aimin 2010).

2.4.1.2. Education

Obviously, long-term adaptation is most difficult for poor, low-skilled and low-educated households. Farmers that remain in agriculture need new skills and training to adopt new technologies, cultivation techniques, inputs and more profitable and climate-resistant seed varieties. Better education therefore facilitates the transition of rural households to non-agricultural sectors by training them in new skills and enhancing their knowledge, which in turn increases their productivity and expands their work opportunities and earning prospects. These skills also help them to engage in more efficient ex ante income diversification and to interpret climate forecasts and risks more precisely (Baez and Mason 2008).

Moreover, understanding risk is a starting point for making good management decisions in situations where adversity and loss are possible and for developing strategies to mitigate the possibility of adverse events. It also helps farmers to avoid extreme outcomes, such as bankruptcy. The research of Ayener et al. (2015) confirms the influence of the household head's education level on the level of on-farm diversification strategies. Simply stated, risk management involves choosing among alternatives to reduce the effects of risk; therefore, it typically requires sufficient knowledge to evaluate the trade-offs between changes in risk, expected returns, entrepreneurial freedom, and other variables (Harwood et al. 1999).

2.4.1.3. Perception

Many researchers indicate that household resilience is affected by internal factors, such as perceptions or attitudes toward risks and the ability to learn and benefit from change. Marschke and Berkes (2006) find that learning to live with change and creating opportunities for self-organization are important factors in household resilience in Cambodian fishing villages. In Northern Australia, four perceptions were identified as the primary factors in fishery household resilience: (1) perception of risk associated with change, (2) perception of the ability to learn, plan and innovate, (3) perception of the ability to cope, and (4) the level of interest in changes in the Australian context (Marshall and Marshall 2007). Aynew et al. (2015) show that risk behavior is positively associated with on-farm diversification and that farmers with higher risk premiums are more likely to opt for farm diversification. A person who is risk averse is willing to accept a lower average return to obtain lower uncertainty, and the trade-off depends on the person's level of risk aversion.

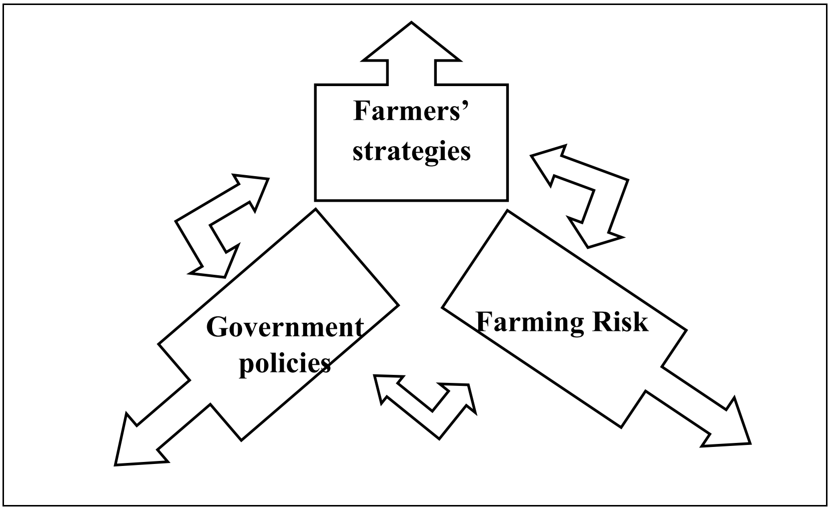
2.4.1.4. Other characteristics

In addition to the above-described internal conditions, several other household characteristics have been shown to affect household risk management strategies. The study of Le & Cheong (2010) in the Mekong River Delta in Vietnam reveals the impact of women on family decisions; specifically, female farm heads tend to be more concerned about the importance of expansion and education as risk management strategies. In Latin America, Baez & Mason (2008) show that families with better health are better able to adapt in an optimal manner and to undergo economic transitions. In rural Vietnam, trust is likely to be especially important in farmers' decisions regarding the selection of risk management strategies. Trust is important in this context because many households have limited numeracy and financial literacy, which reduces their ability to independently evaluate risk strategies. Consequently, they are in a situation in which they must follow the advice of the others, such as local officers or extension officers, making trust essential (Wainwright and Newman 2011).

2.4.2. External factors

2.4.2.1. Government support/intervention

Government policy should be considered a resource that plays a significant role in the management and protection of natural resources (*figure 2.4*). To support farmers in the management of natural resources and in risk mitigation, the governments of many countries have developed policies and regulations related to agriculture in general and to aquaculture in particular (Engle 2010). However, many government policies have failed to achieve their expected results in terms of the support of farmers in coping with farming risks. For example, agricultural protection policies issued and implemented by the Japanese government during the post-war reconstruction period caused domestic prices to exceed international prices by 40% in the 1950s and by 120% in the 1990s, which harmed Japanese farmers in subsequent years (Anderson 2009). Another example is the disaster assistance program created by the U.S. government, which was criticized due to its high costs and the fact that producer benefits were offset by lower market revenues (Glauber and Collins 2002). Similarly, research of Truona & Yamada in Cantho, Vietnam, shows that although farmers have a positive perception of technology, they face difficulties in technology application due to a lack of direction from the government and the lack of a compensation policy to ensure adequate yields.



(Source:McIntosh 2008)

Figure 2.4: The holistic approach: a "system" with three axes

When launching an interventionist policy, governments often consider at least three criteria: (1) fiscal constraints; (2) social relief for serious catastrophes; and (3) market orientation (Skees et al. 2005). However, a government policy that addresses certain risks can cause other risks to emerge. For instance, an increase in output volume due to a policy that addresses farming risks could generate market risks related to product oversupply. Agricultural risks are thus affected by the interrelations and interdependencies among markets, government actions, and farmers' production and marketing strategies (OECD 2009). Many countries have devoted public resources to the development and maintenance of insurance products that protect farmers against production risks because, in principal, insurance products with "ex ante structured rules" have many budgetary advantages over "ex post disaster assistance" (Skees et al. 2005).

It is very common for government policies to have redistribution objectives other than increased efficiency, especially with respect to the reallocation resources in existing markets (OECD 2009). However, in reality, not all interventions will effectively protect the poor, because effectiveness depends heavily on a multitude of components and circumstances. When agricultural risks occur, serious losses affect all farmers but have a particularly severe impact on the poor, who have less access to assets or financial instruments that would help them to cope with distress. Thus, the poor are more vulnerable to agricultural risk (Dercon 2005).

2.4.2.2. Impact of the community

Communities are groups of people who interact frequently and share a location or identity. They include neighborhood groups, religious groups, and cooperatives and function based on trust, common interests, mutual support systems and social norms. Through these networks, communities can help their members by sharing idiosyncratic risks and jointly confronting common risks and opportunities

(WorldBank 2014). In practical terms, there seems to be a general consensus that certain types (or layers) of risk (i.e., catastrophic risks) cannot be managed by private individual actions and therefore require the power of a group or community (OECD 2009). For example, cooperatives are a popular vehicle in Canada for managing several categories of activities related to agricultural risk management. Specifically, these cooperatives support their members by applying risk management strategies that include the active sharing of information on best management practices and risk management strategies and the combination of its members various capabilities. Due to their size, these cooperatives can hire specialists and enable farmers to collectively meet customers' volume and product scope needs; they also provide market power to farmers. Cooperatives frequently develop and implement quality standards and systems to help members to meet customers' quality and volume needs, which in turn helps farmers to maintain their market access. Moreover, cooperatives provide members with purchasing power, enabling them to obtain much lower input costs that are comparable to those obtained by major competitors (Antón et al. 2011). However, fundraising challenges and management issues have caused some cooperatives to fail or restructure (Fulton, 2009). Support groups are another form of community. For example, organic farmers in the United States have formed support networks to help each other and to communicate with consumers. By working in groups, they can actively promote locally grown organic agriculture on behalf of themselves and their fellow farmers. These efforts have helped to retain customers and have even induced consumers to remain loyal during difficult times. Wisconsin farmers agree that organic farmers cooperate and learn from others' experiences in the spirt of an 'old fashion neighborhood', where farmers share labor, machinery, ideas and information and greatly support each other in the selection and effective implementation of appropriate risk management strategies (Hanson et al. 2004).

3

AQUACULTURE PRODUCTION AND CLAM FARMING IN VIETNAM

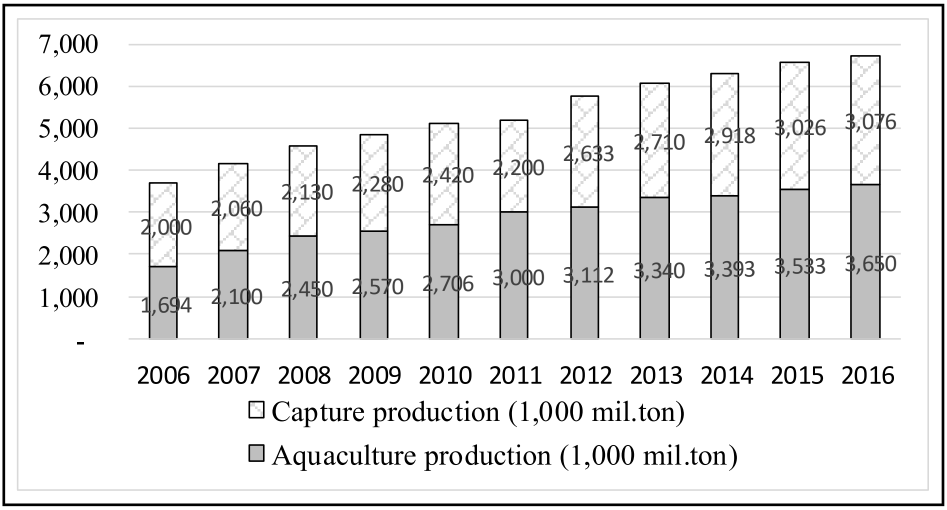
This chapter presents an overview of aquaculture production, mollusk production and clam farming in Vietnam for a better understanding of the country context as it relates to the study objectives. There are four sections in this chapter. The first describes and analyzes aquaculture production performance in Vietnam from 2006 to 2016. In the second section, the potential resources for and growth of mollusk production during 2010-2016 are analyzed. The third section discusses the history, growth and challenges of clam farming in Vietnam in recent years. The fourth section presents several forecasts for the development trend of the aquaculture sector in Vietnam (including mollusk production and clam farming) based on a summary of the current situation.

3.1. Aquaculture production in Vietnam

3.1.1. Performance of aquaculture activities in Vietnam

With over 3,260 kilometers of coastline and 112 estuaries, the internal and territorial waters of Vietnam cover 226,000 square kilometers. The exclusive economic zone covers more than 1 million square kilometers and includes more than 4,000 islands, 12 bays and lagoons and a total area of 1,160 square kilometers. Clearly, there is significant potential for aquaculture development in Vietnam. The country's sea area is relatively high in biodiversity and is also the birthplace of numerous tropical marine species in the tropical Pacific region, accounting for approximately 11,000 species of discovered organisms. The country also has a dense network of rivers and lengthy sea lanes, which are very favorable characteristics for the development of fishing and aquaculture. Every year, the aquaculture sector contributes significantly to social stabilization and the national economy (Cao 2012). Vietnam's seafood output has grown steadily in recent years (from 2000 to 2016), with an average increase of 9% per year. In the last ten years, the fisheries/aquaculture sector has grown significantly in both volume and value, with growth rates of 5-7%/year (*figure 3.1*).

Since the early 2010s, the Vietnamese government has aimed to turn Vietnam into a leading global seafood exporter, and this objective is included in the fisheries development strategic plan to 2020. By following this plan, the aquaculture industry is expected to contribute up to 30-35% of agro-forestry-fisheries GDP (by the end of 2020, the entire fisheries group will account for 7 million tons, and aquaculture production will account for 65-70% of that volume) (Nguyen et al. 2016). However, natural aquatic resources are becoming increasingly depleted and fishing activity levels have not improved, meaning that the production of fish from fishing activities has decreased over the years, falling by 6.42% per year on average. With a government policy that promotes their development, aquaculture activities have experienced strong growth; for example, output has increased continuously in recent years, rising by an average of 12.77% per year. Fishery production in 2016 is estimated at approximately 6,700 thousand tons, reflecting an increase of 2.7% over the previous year. Fish accounted for 4,843.3 thousand tons of fishery production (an increase of 2.5%), and shrimp accounted for 823.9 thousand tons (an increase of 3.3%) (*figure 3.1*).



(Source:VASEP 2017)

Figure 3.1: Vietnamese capture fisheries and aquaculture production (2006-2016)

3.1.2. The five aquaculture zones in Vietnam

Aquaculture production and export activities in Vietnam have developed across the country with a diverse range of fisheries. In this regard, the country can be divided into several major producing zones, including the following:

The Northern coastal region includes the provinces of Quangninh, Haiphong, Thaibinh, Namdinh and Ninhbinh. The aquaculture sector in this region focuses mainly on clams, scallops, and shrimp.

The North Central and Central Coast region comprises the provinces of Thanhhoa, Nghean, Hatinh, Quangbinh, Quangtri, and Hue. The focus of this region is brackish marine aquaculture, with the main species being shrimp, scallops, abalone, fish, crabs, and red snapper.

The Coastal South-Central region includes the provinces of Khanhhoa, Quangnam, Danang, Quangngai, Binhdinh, and Phuyen. The aquaculture activities of this region involve the brackish water surface and mainly produce tilapia and shrimp, among other species.

The Southeast region comprises 4 provinces: Ninhthuan, Binhthuan, Baria - Vungtau, and Hochiminh City. It focuses mainly on freshwater aquaculture and on reservoir and brackish water fish, including tilapia and numerous kinds of shrimp.

The Coastal areas of the Mekong Delta include the provinces of Tiengiang, Bentre, Travinh, Soctrang, Baclieu, Camau and Kiengiang. Aquaculture activities in this area focus on shrimp, pangasius, blood cockle, clams and certain marine fish species.

The inland provinces include those with relatively dense canal systems, such as Hanoi, Binhduong, Cantho, Haugiang, Dongthap and Angiang. Aquaculture in these provinces focuses mainly on fresh water production, including pangasius, tilapia and carp.

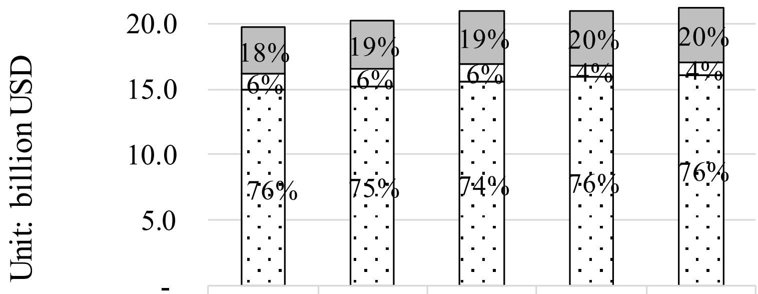
3.1.3. The role of the aquaculture sector in the Vietnamese economy

The aquaculture sector is becoming an important sector in the Vietnamese national economy, making significant contributions to the international economic integration process. Moreover, this sector has made a positive contribution to the restructuring of the agricultural and rural economy and has helped to alleviate poverty and eliminate hunger by creating more than 4 million jobs. According to the General Statistics Office (2017), in 2016, the entire economy grew by 6.21%. The Agro-Forestry-Fishery group increased by only 1.36%, its lowest annual growth since 2011, and contributed 0.22% points to overall economic growth. The value of agricultural, forestry and fishery production in 2016 (at current prices) is estimated at VND 870.7 trillion, reflecting an increase of 1.44% over 2015. Agriculture accounted for VND 642.5 trillion, for an annual increase of 0.79%; forestry reached a value of 28.2 trillion VND, increasing by 6.17%; and aquaculture reached VND 200 trillion, increasing by 2.91%. Within the Agro-Forestry-Fishery group, the fishery sector alone increased by 2.80%, contributing 0.09 percentage points to overall growth. The growth experienced in 2016 reflected many difficulties caused by climate change and severe weather events, including extremely cold weather in the Northern provinces; rain and flooding in Central Vietnam; severe drought and saline intrusion in the South-Central Coast, Central Highlands, South East, and the Mekong Delta; and marine environmental incidents in four central provinces.

The contribution of aquaculture to the restructuring of rural and agricultural areas

In general, the agricultural economy shifted towards efficiency during 2012-2016, gradually increasing the proportion of fisheries and decreasing the proportion of forestry. GSO (2017) statistical figures show that the fisheries sector, which accounted for 18% of the agricultural economy in 2012, accounted for 20% of total GDP of the agriculture-forestry-fisheries group in 2016, whereas forestry decreased from 6% in 2012 to 4% in 2016 (*figure 3.2*).

The structure of aquacultural activities has shifted in a positive and effective manner, gradually increasing the proportion of aquaculture and fishery processing while gradually reducing the proportion of natural aquatic resource capture. This shift is consistent with the trends of decreased natural resource consumption and increased fishery product consumption. This transition not only enhances aquacultural product value but also contributes to the identification of opportunities in new markets for the export of Vietnamese fishery products, which in turn contributes to the creation of employment opportunities for the labor force and helps to ensures a sustainable livelihood for farmers in the context of recent climate change.



	2012	2013	2014	2015	2016
Aquaculture	3.65	3.79	4.04	4.14	4.26
Forestry	1.20	1.25	1.34	0.89	0.94
Agriculture (culitvation & livestock)	14.94	15.28	15.64	16.00	16.11

(Source : GSO 2017)

Figure 3.2: Value and proportion of the Gross Domestic Product group of "Agro-Forestry-Fisheries" by economic activities (in the period 2012-2016, at constant 2010 price)

3.1.4. Marketing and export activity in the aquaculture sector

Domestic market

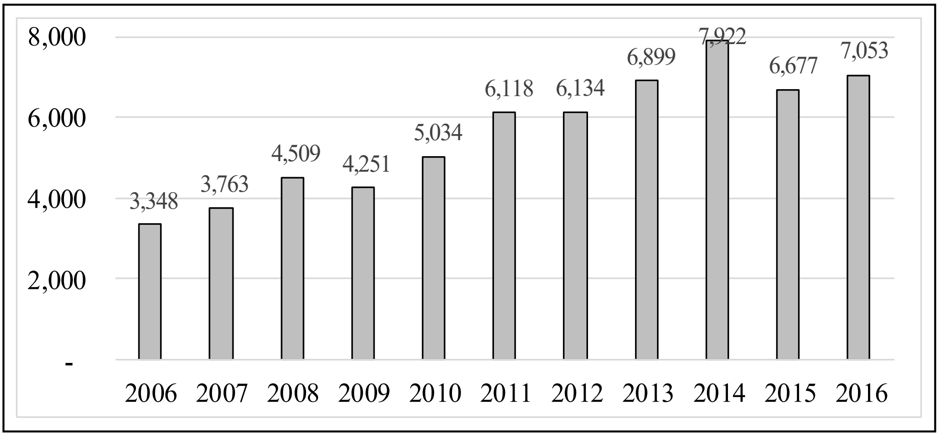
The domestic market for aquacultural products has been measured only in the last several years, but the consumption of Vietnamese seafood per capita has increased at an average rate of 5% per year during 1990-2010. If this trend continues in the near future, the consumption of seafood in 2020 is forecast to be 37 kg per person. Aquaculture products are mainly sold through a system of small retailers. There is no close cooperation between producers and enterprises, which has led to many difficulties for farmers selling aquaculture products. Moreover, the distribution of benefits among market actors is not equitable, and farmers constantly suffer losses. Furthermore, Vietnamese seafood products are not branded in the global market, especially in the consumer segment. Normally, Vietnamese seafood is exported to importers and then labeled or branded by importers or distributors before it reaches consumers. Consequently, profits for those producing enterprises are not attractive.

Aquaculture export activities

The export of Vietnamese aquacultural products has grown significantly during the last 20 years. This growth has made Vietnam be one of the five largest seafood exporters in the world. Vietnam's seafood exports have experienced rapid growth due to the strong development of the aquaculture sector, particularly the production of catfish and brackish shrimp (black tiger shrimp and white shrimp). Seafood export turnover, which was VND 550 million in 1995, has grown at an average annual rate of 15.6% and more than quadrupled between 2000 and 2014, increasing from nearly USD1.5 billion to USD7.8 billion. In 2015, seafood exports encountered difficulties as a result of decreased shrimp prices combined with the increase in the value of the U.S. dollar. However, export turnover of aquatic products reached USD7.05 billion in 2016, reflecting a 7.3% increase over 2015 (*figure 3.3*). In the past five years, seafood exports have consistently ranked 4th among important Vietnamese export commodities, following textiles, leather & footwear, and crude oil.

In 2016, Vietnam exported seafood products to 160 countries and territories. The three main export markets are the EU, the US and Japan, which account for 17.3%, 20.6% and 15.7% of the value of Vietnamese exports, respectively. Other export markets include China (12.2%) and ASEAN countries (7.5%). The number of factories and processors' freezing capacity both increased rapidly during 2001-2015. A number of large companies, such as Minhphu Group, Vinhhoan corporation, and Hungvuong joint stock company, were formed in the Mekong Delta region. In 2016, seafood exports reached USD7.05 billion, reflecting an increase of 7.4% compared with 2015. The composition of export products remained consistent with the previous year for shrimp (44%), pangasius (24%) and tuna (7%). Shrimp exports reached USD3.15 billion, for an increase of 7% (because raw materials decreased in manufacturing countries while demand continued to increase); catfish exports increased by 7%, reaching USD1.66 billion (Chinese exports experienced strong growth in this segment); and tuna exports recovered after 3 years of decline, reaching USD485 million, for an increase of 7%. Major export markets have recovered gradually since 2015. In particular, the US accounted for USD1.44 billion, for an increase of 9.7%; the EU increased by 3.6%, reaching USD1.17 billion; Japan reached USD1.1 billion, for an increase of 6.1%; Korea accounted for USD608 million, increasing by 6.3%; China experienced a sharp increase (52%) and reached USD685 million; and ASEAN countries reached USD515 million, for an increase of 6.1% (Tran 2017).

Despite positive trends and the development of an advantage, Vietnamese aquaculture has faced to several challenges, including the following: (1) intense competition from other exporting countries; (2) technical barriers to trade in markets such as the United States, Europe, Japan, Taiwan, and China; and (3) the lack of Vietnamese branding in import markets for seafood products in general and for shrimp and pangasius in particular. In recent years, exports to China have experienced significant growth, making China the fourth largest export market for Vietnam. However, demand in the Chinese market fluctuates and there is information asymmetry between the supply and demand sides of the market. In addition, seafood products exported to China primarily comprise raw materials, meaning that the value-added is low. Furthermore, in recent years, Vietnamese aquaculture has been forced to cope with several types of risk throughout the business cycle, from production to market (in both domestic and international markets) (Phuong & Minh, 2005). Despite these risks, no research to date has conducted a detailed discussion about the types of risk faced by aquaculturists in coastal areas or about the mechanisms used by aquaculturists to cope with those risks.



(Source:Tran 2017)

Figure 3.3: Value of Vietnamese aquaculture exports (2006-2016) (Unit: mil.USD)

3.2. Mollusk production in Vietnam

3.2.1. Potential natural resources for mollusk production in Vietnam

Vietnam is a coastal country with over 3,260 km of coastline (excluding island coasts). According to the United Nations Convention on the Law of the Sea in 1982 (UNCLOS), Vietnam has an area of over 1 million square kilometers – which is more than three times the size of the mainland – and accounts for 30% of the South China Sea. Vietnam's sea area includes over 4,000 large and small islands; there are also two offshore islands (HoangSa and TruongSa). This area boasts many high-bio-productivity ecosystems, including mangroves, coral reefs, and seagrass beds. It also possesses rich and diversified fishery resources, with a large area potentially available for the development of aquaculture in general and the development of mollusks in particular. Mollusk cultivation plays an important role in Vietnam's seafood export activities and accounts for a significant portion of the substantial contribution of aquaculture to annual Vietnamese GDP.

Vietnam’s coastal area has 28 provinces, which extend from Quangninh (which borders China) to Kiengiang (which borders Cambodia). Mollusk production accounts for over 95% of the volume of aquacultural output in this area and thus makes a significant contribution to economic development and social stability in coastal communities. According to aggregated data from the coastal provinces, the total potential area for mollusk culture in the coastal provinces (from Quangninh to Kiengiang) is 206,350 ha. The two largest sectors of the total potential area are the

Red River delta (with 43,650 ha) and the coastal provinces of the Mekong Delta (with 113,800 ha), which account for 21.1% and 55.1% of the total area, respectively. The North Central and Central Coastal areas have a combined potential mollusk area of 42,700 ha. In the South East coastal provinces, the potential mollusk area is approximately 6,200 ha, which is concentrated in BariaVungtau in the Longson area and in Cangio district, which is a coastal district of Hochiminh city. Potential areas for mollusk culture development are presented in table 3.1.

Table 3.1: Potential areas for mollusk culture development in the coastal provinces (Year 2015 - Unit: ha)

Area	Total	Potential natural resource areas			
		Sea area	Intertidal area	Waterfront area	Coastal lagoon
1. The Northern coastal region	43,650	18,000	23,000	2,650	-
2. The North Central and Central Coast regions	42,700	20,000	9,000	2,200	11,500
3. The Southeast region	6,200	300	5,600	300	-
4. The Coastal areas of the Mekong Delta	113,800	600	112,000	1,200	-
TOTAL	**206,350**	**38,900**	**149,600**	**6,350**	**11,500**

(Source: Tran et al. 2016)

3.2.2. The current mollusk production situation in Vietnam

In Vietnam, the primary mollusk species are clams, oysters, scallops, geoduck, and snails, among others. Bivalve mollusks are mainly cultured in improved extensive farming systems; in such systems, farmers do not need to feed the mollusks because they mainly eat zooplankton and organic humus found in the environment. Other mollusk species, such as snails, are raised using intensive and semi-intensive farming models, which involve the process of raising must-use food. Mollusk culture has been developing rapidly in Vietnam, and many mollusk farming zones have been created, creating large volumes of commodity products for domestic consumption and export. The most popular forms of mollusk farming include tidal culture for clams, scallops, and snails, among other mollusks; cage rafts, hanging racks, hanging straps, hanging trays, and cages for oysters, geoduck, blue mussels, and pearl oysters; raised bottom cages for geoduck; and cement tanks for abalone and snails.

Mollusk culture zoning in Vietnam

- Zones for clam raising are mainly based in the Northern coastal provinces and the coastal provinces in the Mekong Delta and include Quangninh, Haiphong, Thaibinh, Namdinh, Ninhbinh, Thanhhoa, Nghean, Hatinh, Tiengiang, Bentre, Travinh, Soctrang, Baclieu, and Camau.

- Zones for oyster raising are mainly based in Chanh River - Pharung, Yenhung, Vandon, and Baitulong in Quangninh province; the Cathai district (Haiphong city); farming areas of the Hoicau and Gianh River estuaries and Langco-Hue lagoon; Thinai lagoon and DeGi lagoon in Binhdinh province; the sea areas of Naidam - Ninhthuan and Binhthuan; the farming area of Chava River, Longson Commune, and Vungtau (Baria - Vungtau); the Cangio district (Hochiminh City); and certain farming areas in Bentre and Camau.

- Zones for sweet snail raising are mainly based in Quangninh province and in the central coastal provinces, namely, Phuyen, Nhatrang, Ninhthuan, Phuquoc island, and Kiengiang.

- Zones for geoduck raising are mainly based in the Red River Delta provinces, especially Quangninh and Haiphong, and the coastal provinces of the North Central and Central Coasts (such as Khanhhoa and Phuyen).

- Zones for scallop raising are mainly in Quangninh province; in lagoons and intertidal areas, such as DeGi lagoon, Thinai lagoon, the Binhthuan coastal area, and Cangio district (Hochiminh city); and in commodity production areas, such as Tiengiang, Bentre, Travinh, Soctrang, Baclieu, Kiengiang, and Camau.

- Zones for raising other mollusk species (e.g., green mussels, abalone, pearl) are as follows. Currently, abalone zones are mainly in Quangninh, Haiphong, Phuyen and Khanhhoa; zones for pearl culture are mainly in Quangninh, Khanhhoa, and Phuquoc (Kiengiang); zones for green mussel culture are based in the provinces along the central coastal areas, namely, Hue, Phuyen, Khanhhoa, and Ninhthuan.

To date, the EU has recognized 20 “safe mollusk farming” areas in the following 12 provinces: Quangninh, Namdinh, Thaibinh, Ninhbinh, Thanhhoa, Hatinh, Binhthuan, Kiengiang, Travinh, Bentre, Tiengiang and Hochiminh city (*picture 3.1*). In those areas, the estimated potential annual volume of mollusk harvests is 200,000-220,000 tons (NAFIQAD 2015).

(Source:NAFIQUAD 2015)

Picture 3.1: Map of 20 "safe mollusk farming" areas recognized by the EU

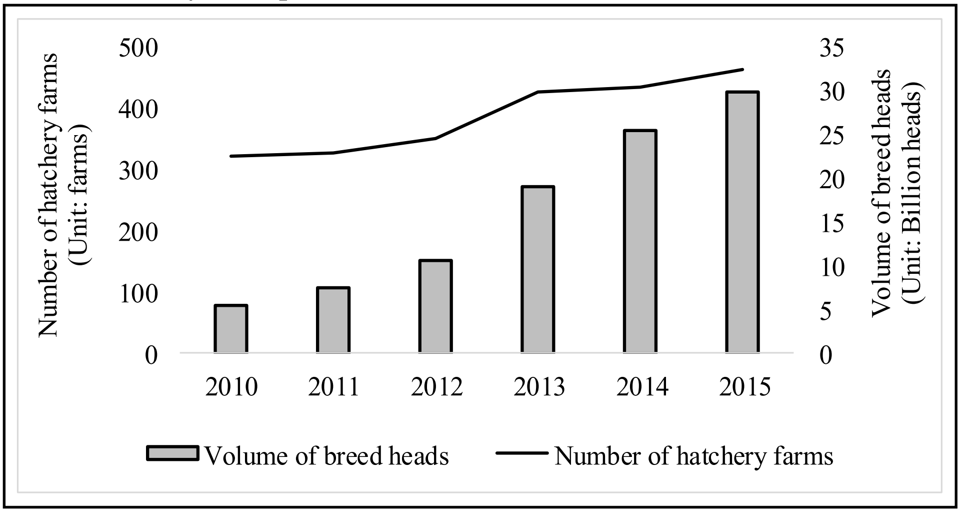
Among the abovementioned ecological areas, mollusk farming is mainly based in the northern coastal region and in the coastal areas of the Mekong Delta (*table 3.2*). The cultivated areas for mollusk species in these ecological regions are all smaller than their potential areas, meaning that mollusk culture can be extended further. However, the exploitation of these areas for mollusk raising should be considered carefully based on factors such as market potential, production efficiency and environmental impact. The implementation of technology for breed production and commercial farming of key species (such as clams, oysters and scallops) will contribute to the expansion of the mollusk farming area and productivity in the near future.

Table 3.2: Area and output volume of mollusk production by ecological zone (2015)

	Unit	Total	Clams	Oysters	Sweet snails	Scallops	Geoducks	Other species
I. Area	**Ha**	**40,685**	**18,720**	**2,465**	**990**	**11,440**	**81**	**6,989**
1. The Northern coastal region	Ha	9,774	7,264	2,020	80	100	70	240
2. The North Central and Central coast region	Ha	6,399	1,978	152	910	1,215	11	2,133
3. The Southeast region	Ha	1,354	1,118	163		73		
4. The Coastal areas of the Mekong Delta	Ha	23,158	8,360	130		10,052		4,616
II. Output volume	**tons**	**265,310**	**186,910**	**11,965**	**4,303**	**48,330**	**155**	**13,647**
1. The Northern coastal region	tons	138,232	128,320	9,040	80	150	118	524
2. The North Central and Central coast region	tons	25,697	19,799	843	4,223	435	37	360
3. The Southeast region	tons	13,241	11,781	1,240		220		-
4. The Coastal areas of the Mekong Delta	tons	88,140	27,010	842		47,525		12,763

(Source: Tran et al.2016)

Mollusk hatchery farm performance

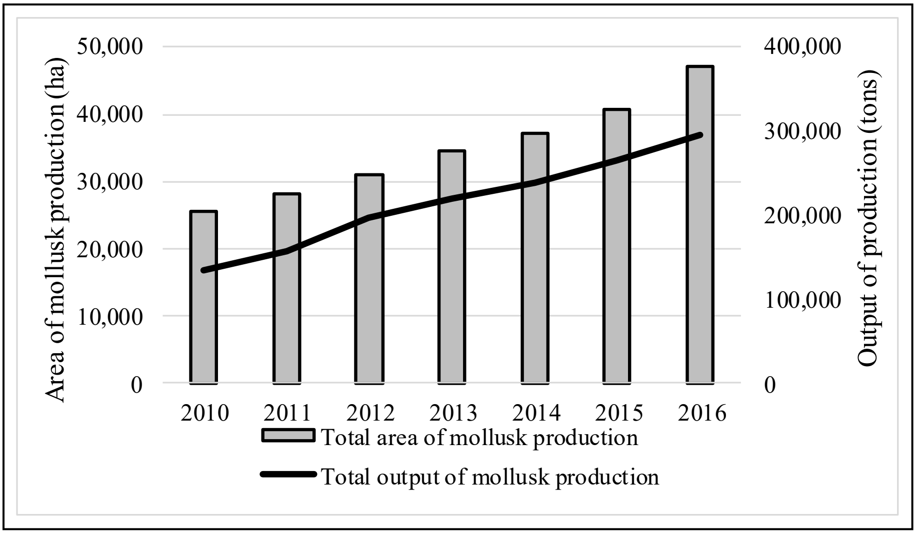


(*Source:(Tran et al. 2016)*)

Figure 3.4: Production of mollusk hatchery farms in Vietnam (2010-2015)

Mollusk breeding production areas are mainly based in Quangninh province (for geoducks and oysters); Namdinh province and Thaibinh province (for clams); and Khanhhoa province, Ninhthuan province, Bentre province and Tiengiang province (for clams, sweet snails, and other mollusks). As of 2015, 465 hatchery factories/farms had been established for mollusk breeding. Those hatchery farms and factories produced 30 billion mollusk heads (*figure 3.4*), supplying 50% of the demand for the mollusk breed. However, investment in infrastructure in areas in which hatcheries and production areas are located is poor; in particular, there is no centralized wastewater treatment system for breed production areas and equipment for mollusk research and production remains limited.

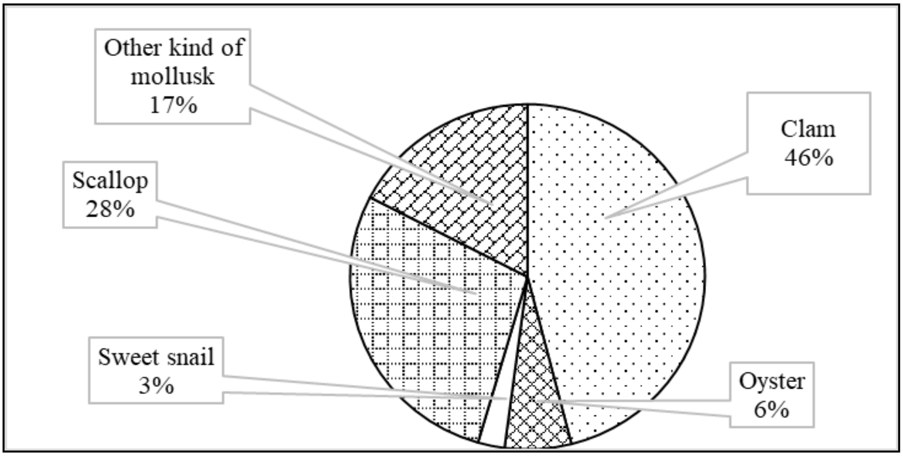
3.2.3. Mollusk aquaculture performance 2010-2016



(Source:Tran et al. 2016, D-Fish 2017)

Figure 3.5: Mollusk production in Vietnam (2010-2016)

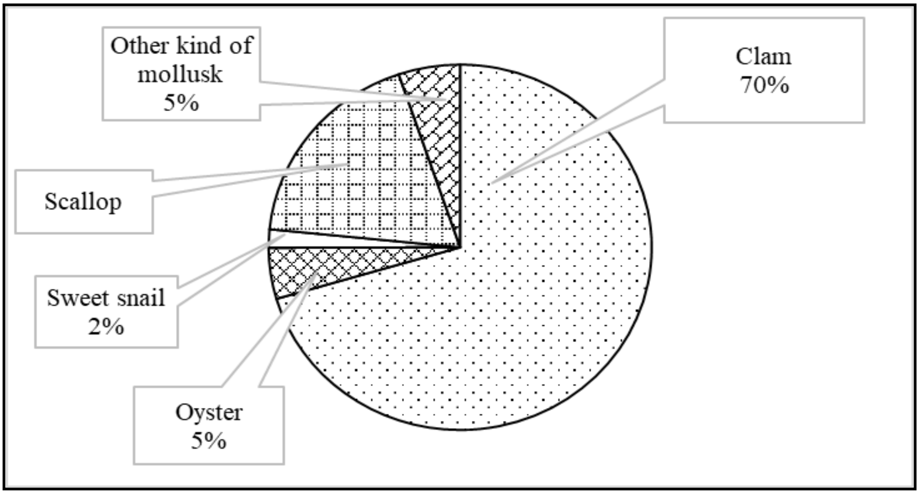
In 2016, the total area of mollusk production reached 47,129 ha, reflecting an average annual growth rate of 11% during the 2010-2016 period. Output reached 294,472 tons, for an average annual growth rate of 14% during 2010-2016 (*figure 3.5*). The increase in area size is less than the increase in output, indicating the impact of substantial investment in science and technology on productivity.



(Source: Tran et al. 2016)

Figure 3.6: Allocation of total mollusk area in Vietnam (2015)

Among bivalve mollusk aquaculture types, clams account for the largest proportion in terms of both area and production (i.e., 46% of total area and 70% of total volume (*figures 3.6 and 3.7*), followed by scallops and oysters. In general, the production and output of all types of mollusks increased over the 2010-2015 period. The exception to this growth trend is geoduck farming, which is experiencing a downward trend due to a disease outbreak in 2013 that caused a decrease in farming area between 2014 and 2015.



(Source: Tran et al. 2016)

Figure 3.7: Proportions of mollusk output by types of product in Vietnam (2015)

Models of mollusk production in Vietnam

There are two main models of mollusk farming: (1) the individual household model and (2) the cooperative model. The household model, which is a small-scale model, is very popular and the most highly developed model in the coastal provinces. If the scale of production becomes larger, farms using this model will develop into companies and mobilize capital from their members. The second model, the cooperative model, involves the management of coastal fishery resources by cooperatives with numerous members. With the cooperative model, fishery resources benefit society as a whole, serving the broader community and contributing to improvements in social welfare through two mechanisms: profit sharing among cooperative members and the establishment of funds to support production and other social welfare activities.

In addition, vertical integration of mollusk producers and sellers has been achieved in certain locations in the Mekong Delta. However, relations between actors in the mollusk value chain are weak and regulations remain unclear; consequently, vertical integration has not yet produced significant benefits for all actors in the chain.

Mollusk production policies

A number of policies related to mollusk development have been implemented. Such policies address mechanisms for investment; capital support for organizations and individuals engaged in mollusk production and seafood processing; support for aquacultural risk management; controls relating to environmental protection and disease prevention; the promotion of brands and trade; and other areas.

- In accordance with the Prime Minister's Decision No. 2194 / QD-TTg of December 25, 2009, the state budget supports the construction of infrastructure for breeding production areas using both advanced technology and original breeding production methods. State budgets include investments to upgrade national marine breeding centers; the building of necessary technical facilities and facilities for mollusk farming areas; investments in scientific and technological research and the import of new and advanced technologies; the collection, import and preservation of breeding varieties; and funding for trade promotion, brand building and fishery extensions.

- Government Decree 67/2014 / ND-CP dated 07/07/2014 addresses land rental fees and water surface rent exemptions for aquaculture by organizations, households and individuals.

- Government Decree 55/2015 / ND-CP dated 09/06/2015 provides credit policies for organizations and individuals engaged in the development of breeding production and processing of aquatic products.

- Government Decree No. 210/2013 / ND-CP dated 19/12/2013 establishes preferential policies and additional investment support for enterprises that invest in aquaculture and the processing of aquaculture products.

Post-harvest mollusk processing

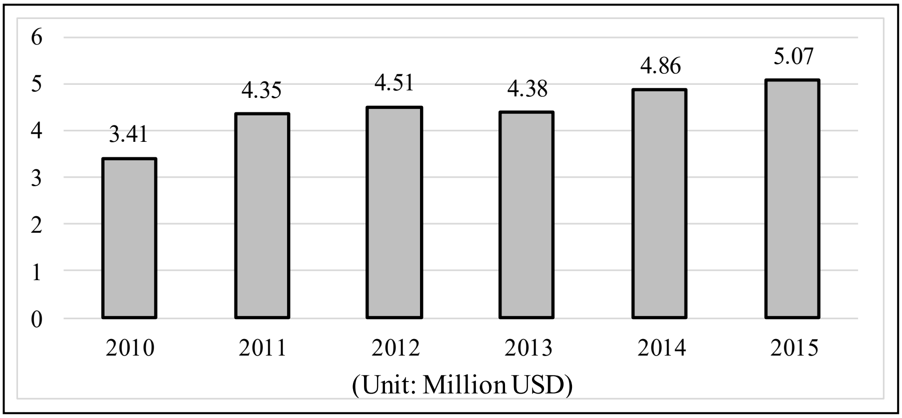
To ensure clean and safe products for consumers, certain bivalve mollusks (such as clams and oysters) must be soaked in water to remove toxic algae, impurities, organic humus and intestinal bacteria before they are processed or eaten. The post-harvest handling of mollusk species also requires a clean water system and ozone-treated water for storage prior to processing or sale. Therefore, relations between producers and processors have become closer and stronger. Mollusk processing plants are also required to follow quality assurance programs to ensure food hygiene, safety and traceability throughout all steps of the process. In the South-Central Region and the Mekong Delta, there are approximately 15 factories that process bivalve mollusks for export, with a primary focus on Bentre clams and frozen clams. Such factories include BESEACO, AQUATEXBENTRE and FAQUIMEX. Other well-known companies exist, such as Cautre export processing company (in Hochiminh City), the private enterprise Songtien 2, and Bentre seafood export and import joint stock company. These companies mainly process frozen and boiled clams, raw clams, frozen clams and clam meat boxes. Another company, Hainam Co., Ltd., locates in Hochiminh city and processes scallop products.

3.2.4. Marketing and export activities for mollusk products

Domestic market

Most mollusk products for domestic consumption are in fresh form and are sold in wholesale markets, small markets and restaurants. According to staticstic of the Food and Agriculture Organization (FAO) regarding Vietnamese per capita consumption since 1900, bivalve mollusks account for only 5% of total seafood consumption. With a population of over 90 million people in 2015, total domestic bivalve mollusk consumption was 178,487 tons. Based on current consumption levels combined with increasing trends in both population and consumption per capita, total demand for bivalve mollusk products is forecast to exceed 200,000 tons and 250,000 tons by 2020 and 2030, respectively (Tran et al. 2016).

In addition, domestic consumption includes consumption by international guests who visit or work in Vietnam. According to the Vietnam General Statistics Office, in 2009-2015, the total turnover of international visitors to Vietnam (working and visiting) was approximately 11.64 million visits / year, for an average of 1,725 days, with normal mollusk consumption. Tourists consume approximately 150-200 grams / day / person; average mollusk consumption is approximately 3,100-3,500 tons / year; and the average price of mollusks fluctuates between 50,000 and 70,000 VND / kg. Therefore, the total export turnover consumed in the domestic market has an estimated value of 4.4-5.0 million USD/year (*figure 3.8*).

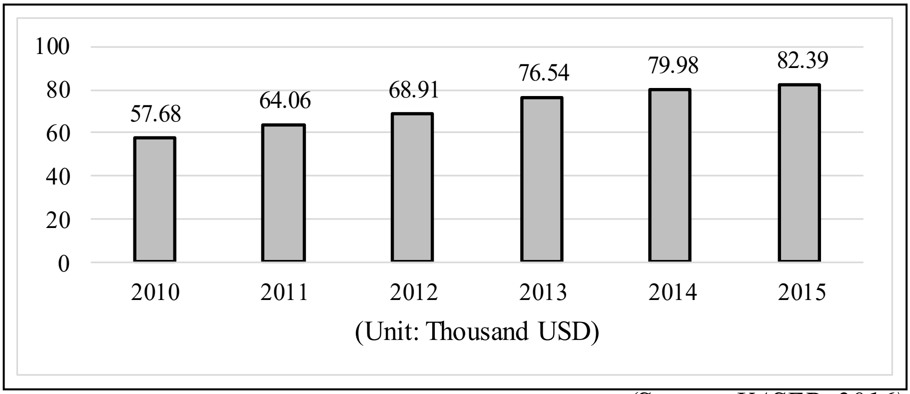


(Source: Tran et al. 2016)

Figure 3.8: Total export turnover consumed in the domestic market (2009-2015)

Export market

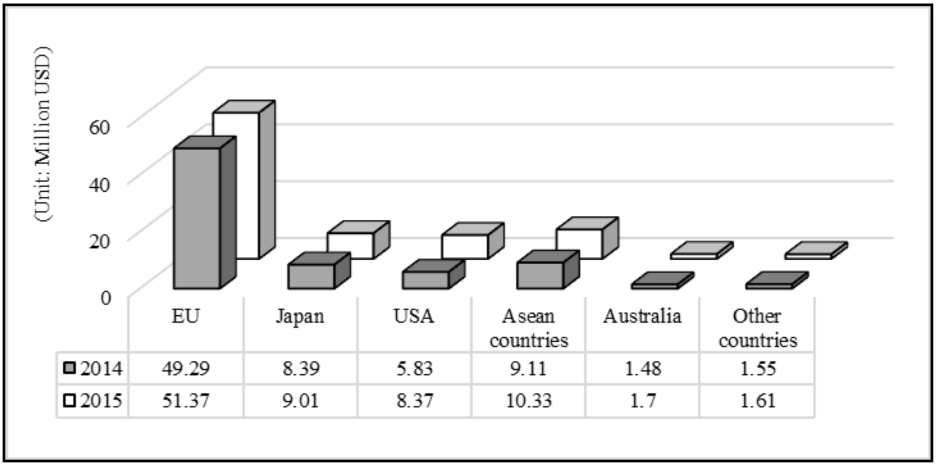
The mollusk sector plays an active role in the economy, resulting in a high GDP for aquaculture and enhancing Vietnam's seafood export turnover. By 2015, the export turnover of bivalve mollusks amounted to 82.39 million USD (a 3.0% increase over 2014 turnover) and accounted for 1.2% of total seafood export turnover (*figure 3.9*).



(Source: VASEP, 2016)

Figure 3.9: Export turnover of bivalve mollusks (2010-2015)

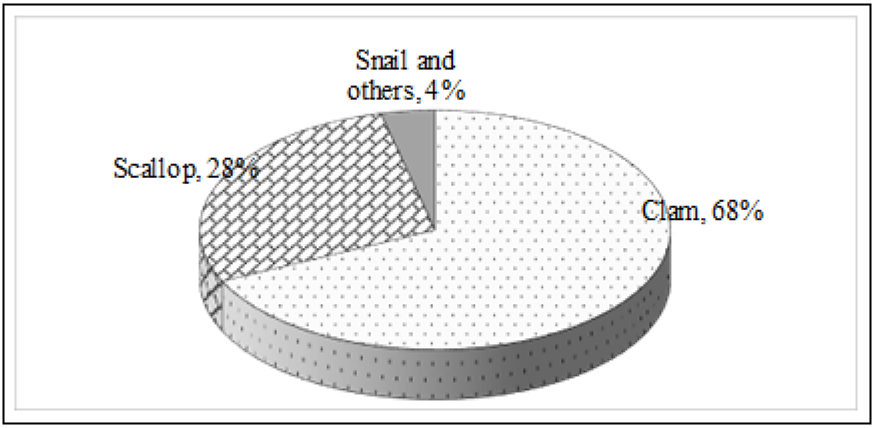
In 2015, Vietnam exported bivalve mollusks to 48 countries. In 2016, the number of countries importing Vietnamese mollusks increased by another 9 countries. The EU is the largest importer of Vietnamese clams, accounting for 64% of total export turnover, followed the USA (12%), Japan (10%), ASEAN countries (4%) and Korea (3%) (*figure 3.10*). It could be said that Vietnamese bivalve mollusks have great potential and will have many opportunities to expand into other export markets in the future.



(Source: VASEP, 2016)

Figure 3.10: Export turnover of bivalve mollusks by country (2014-2015)

The three main types of exported mollusks are clams, oysters and snails. Frozen/boiled steamed clams account for 76% of the total volume of Vietnamese mollusk exports, followed by scallops (20%) and snails and other species (4%). In terms of export value, clams account for approximately 68%; oysters account for less than 28%; and snails and another species account for less than 4% (*figure 3.11*).



(*Source: Tran et al. 2016*)

Figure 3.11: Shares of bivalve mollusk types in total export value

The quality of Vietnamese mollusk products remains low due to various processing problems, including the lack of raw material management records; unreliable records of quality management programs (especially regarding heat treatment); and the use of heat treatment methods that do not adhere to EU, US and Japanese regulations. Therefore, the prices for Vietnamese bivalve mollusks are low compared to the same products from other countries. In general, the average price for mollusk exports has not changed significantly over the 2008-2015 period. The average price is only 2.1 USD / kg (ranging from 1.82 to 2.27 USD/kg, for an annual growth rate of 3.2%). The US market has the highest average price, with a growth rate of 12.93% per year; the annual growth rates for the Asian market, Japanese market and EU market were only 10.5%, 3.36% and 0.8%, respectively.

3.2.5. Challenges in mollusk production in Vietnam

Capital issues: There is a lack of investment capital to implement the master and detailed plans for mollusk farming areas, both nationally and in each province. Moreover, there is no specific incentive policy for mollusk farmers; the government has yet to issue a specific policy for the provision of loans to support development of the mollusk culture, especially large-scale aquaculture.

Breeding source issues: Breeding sources for mollusks such as clams and oysters remain natural. However, natural breeding sources are only available in certain areas and are not managed properly, leading to the risk that these natural resources could be exhausted. High-value species such as snails, abalone, and geoducks should be promoted, and breeding production should be supported to promote restoration.

Market issues: The consumption market for mollusk culture products is unstable, with significant price fluctuations. Demand for mollusks is substantial in both export and domestic markets, but food safety management remains inadequate. Processing technology is simple and does not yet meet the requirements of import markets;

moreover, many harvested areas have not been certified as meeting export conditions.

Technical issues: Many households have significantly increased stocking density levels, resulting in high mortality rates in many areas. Research on farming environments and diseases has not kept pace with production requirements. Warnings of extreme environmental events are not issued in a timely manner, leading to the deaths of clams, scallops and oysters in numerous locations. Technology for harvesting and preserving post-harvest products remains manual in many places; the lack of new technology has caused low production efficiency and variable product quality.

In general, although mollusk culture in the coastal provinces of Vietnam has yielded significant results and made a positive contribution to economic development, it was spontaneous in nature and lacked detailed planning. Farmers' technical knowledge is quite limited, leading to inefficient production, environmental pollution and unsustainable development. Transportation to and from farming areas remains problematic, which affects the supply of input materials and the delivery of harvested products to processing plants. Social conflicts have arisen when farmers endeavor to expand their farming areas because it creates competition for water surface usage with other activities, such as shipping traffic and tourism. To develop mollusk culture, coordination among various sectors is necessary to organize production, incorporate mollusk production models into other fishery models and into ocean tourism activities, and exploit the potential benefits of maritime resources in a sustainable manner.

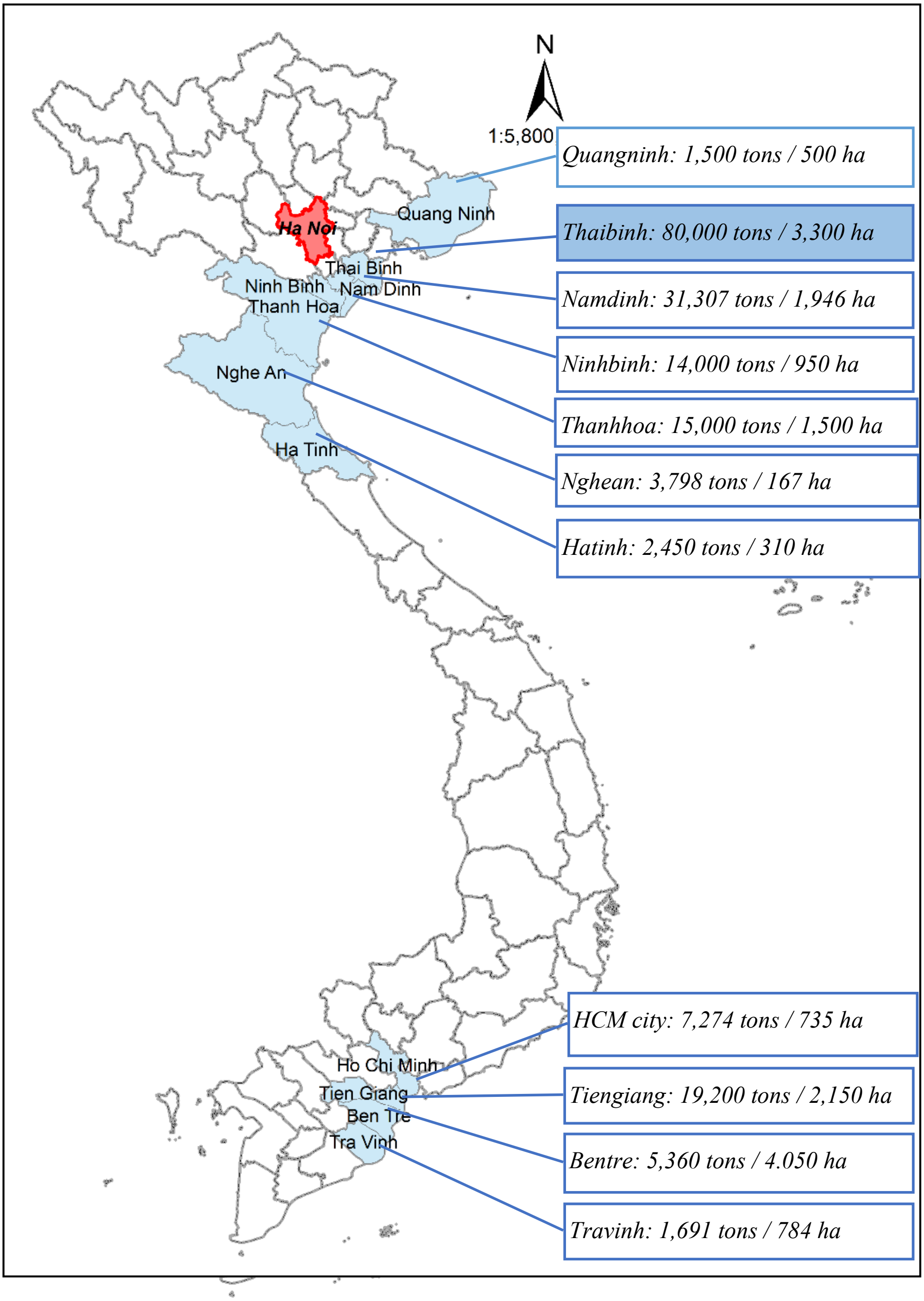
3.3. Clam farming in Vietnam

3.3.1. The history of clam production in Vietnam

According to Truong (1999), the first clam culture in Vietnam was introduced in Bentre and Tiengiang in the 1970s. It began with the collection and storage of natural clams to satisfy the food needs of the local people. In the years following 1975, clam aquaculture expanded to other coastal provinces as the consumption of clam meat in Hochiminh City and neighboring provinces increased. In 1982, clam products were first exported to foreign countries, which fostered the development of clam farming areas by attracting investments from private enterprises and cooperatives. The exploitation of natural clam culture before 1980 accounted for an annual output volume of only 300-400 tons; by 1982-1986, annual output volume had increased to 700-800 tons; and in the early 2000s, the total annual production of clams in the East Coast area south of the Mekong (the Mekong Delta and Hochiminh City) reached 70-80 thousand tons (Le et al. 2007). At the same time, the northern coastal provinces (namely, Quangninh, Namdinh and Thaibinh) began to develop clam culture and ultimately became the strongest clam aquaculture provinces in Vietnam.

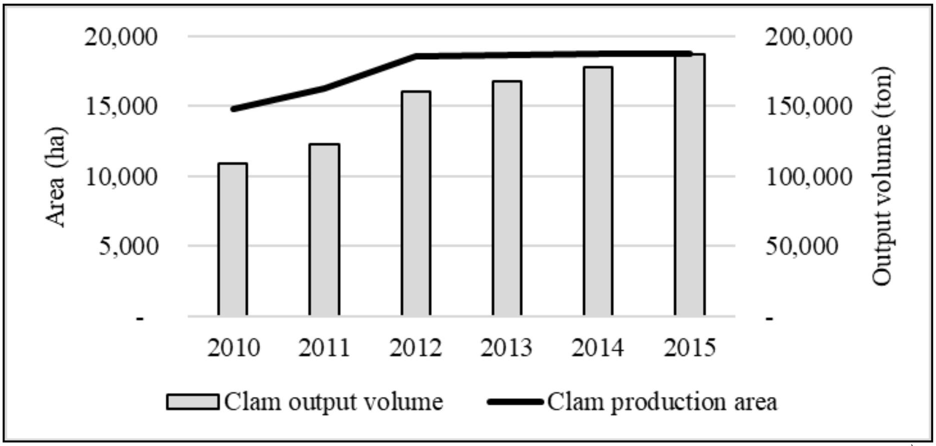
The clam aquaculture area has developed along the coast of Vietnam, from the coastal provinces in the North to the coastal provinces of the Mekong Delta. Among these coastal provinces, Bentre has the largest clam area (more than 4,000 ha), followed by Thaibinh (3,300 ha) and Tiengiang (2,150 ha). However, the two provinces with the highest clam production in 2016 were Thaibinh (with 80,000 tons) and Namdinh (with 31,307 tons) (*picture 3.2*).

Clam production accounts for large proportions of both total bivalve mollusk area and total bivalve mollusk yield in Vietnam (*figure 3.6 and figure 3.7*). In 2002, the clam farming area covered 9,715 hectares and yielded 95,012 tons. By 2012, the clam farming area had nearly doubled (reaching 18,532 hectares) and yield increased to 160,000 tons. Since 2012, the clam culture area has not increased but output volume has risen steadily, reaching 186,910 tons by 2015 (*figure 3.12*). At present, there are 3 Meretrix clam species being cultured in Vietnam: stone clams, oil clams and white Bentre clams.



(Source: MARD,2016)

Picture 3.2: Clam production in some provinces of Vietnam (2016)



(Source: Tran et al. 2016)

Figure 3.12: Clam aquaculture development in Vietnam (2010-2015)

3.3.2. Clam farming models in Vietnam

There are two models of clam production: private and cooperative. In the private model, clam farming is managed at the household level. This model is popular in the northern coastal provinces. With the private model, the individual farmer invests his own money, obtains all of the benefits, and copes with all aquacultural risks. In contrast, the cooperative model is a co-management model based on capital investment, exploitation of resources for product sales, and the protection of coastal resources. The cooperative model is highly developed in the Southern coastal provinces. Many cooperatives have been established in these provinces, including 10 cooperatives in Bentre province, 4 cooperatives in Travinh province, and 1 cooperative in Baclieu province. As a result of the co-operative model, clam resources are linked to society, serving not only individual interests but also the greater community.

Clam hatchery production

Previously, clam breeds were supplied mainly from natural sources. However, due to the massive expansion of clam consumption, natural clam breeding sources were insufficient to meet demand, which caused substantial difficulties for clam farmers. Then, with funding from the aquaculture support program of the Vietnamese government, the Research Institute for Aquaculture No. 1 successfully researched clam breeding production technology at the commodity scale and transferred this technology to certain companies in Bentre, Namdinh, Thaibinh and Nghean, among other provinces. As a result, many farmers implemented hatchery clam farming because of its high profitability and low risk relative to clam meat production farming. However, hatchery clam farming is more technically demanding. By 2012, massive volumes of Chinese breeding clams were imported to Vietnam at prices that were one-half or even one-third of Vietnamese breeding clam prices. Consequently, breeding clam prices sharply declined, and many clam hatchery farms suffered enormous losses. However, many Vietnamese clam farmers have found that the survival rate of Chinese breeding clam seeds is lower than the rate for local breeding clam seeds due to difficulties experienced by the Chinese seeds in adapting to new environmental conditions after a lengthy transport process.

(a)Frozen clam product

(b)Vacuum-packed clam product

Picture 3.3: Vietnamese clam products for export

Post-harvest clam processing

After harvest, clams are often processed to meet export demand. Processed clams for export include IQF frozen boiled clams, boiled clams, canned clams, vacuum-packed raw clams and salted clams, among others (*picture 3.3*). Currently, there are approximately 50 clam processing factories in Vietnam, most of which are based in southern provinces such as Bentre, Tiengiang and Travinh. Only 3 factories in the north process clams for export, in Haiphong, Thaibinh and Thanhhoa provinces.

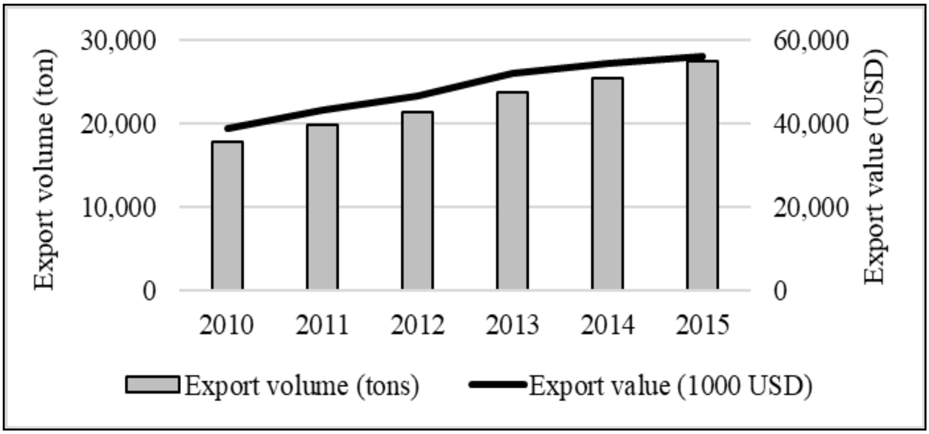
3.3.3. Clam marketing and export activities

Domestic market

The domestic market accounts for only approximately 10% of total clam production due to low seafood consumption by the Vietnamese. The study of Nhu & Kumar (2005) titled 'Evaluation of the current socio-economic and technical conditions for raising clams and shrimp in the Northern Central area of Vietnam' reported that Vietnamese households in the study area consumed 128 kg of clams per year on average. Clam products consumed in the domestic market are mainly fresh (i.e., completely unprocessed). These products are often sold in traditional markets, the supermarket channel or hotel restaurants. In the domestic market, clam prices are often unstable and very low, typically only one-half of the export price.

Export market

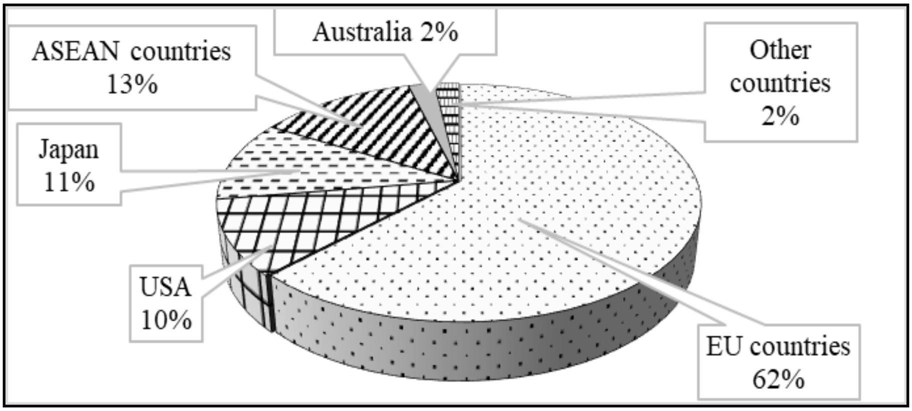
Official export channel



(Source: Tran et al. 2016)

Figure 3.13. Vietnamese clam exports (2010-2015)

The official export market for Vietnamese clams in 2010-2015 increased steadily in both volume and value, reaching a volume of 27,479 tons and a value of more than USD 56 million in 2015 (*figure 3.13*) and accounting for 68% of the total export value of bivalve mollusks. Frozen, salted and canned clam products are exported to the EU, Japan, USA, Korea, Thailand, Taiwan and Hongkong, and frozen clams are exported to France, China, USA, Korea, Japan and Taiwan. Among Vietnam's export markets, EU countries account for the largest share (62%), followed by Japan (11%) and the United States (10%) (*figure 3.14*). However, in the 2010-2013 period, the volume of Vietnamese clam exports to these countries tended to decrease due to increasingly stringent technical requirements. However, during the same period, frozen clam exports to North America tended to increase, reaching average growth rates of 3.7% (in volume) and 4.4% (in value). The International Marine Conservation Council issued the MSC (Marine Stewardship Council) standard for Bentre clam products, which facilitated the export of clam products to many markets around the world.



(Source: Tran et al. 2016)

Figure 3.14: Shares of the clam export market (2015)

Unofficial export market

Over the past several years, approximately 70% of total clam production in Northern provinces has been exported to China through border gates and open roads in Dienbien, Laichau, Langson and Mongcai. Products exported through this channel are mainly in raw or frozen form. However, in June 2012, Chinese traders abruptly stopped importing clams from the Northern provinces, which caused prices to sharply decrease to one-half of previous price levels (during the peak period, clam prices ranged from 23,000 to 25,000 VND/kg; by the end of 2012, prices had dropped to 10,000 to 11,000 VND/kg). Moreover, even at that very low price level, it was difficult to sell clams, which eventually caused large amounts of clams to remain in fields in the coastal provinces from Quangninh to Thanhhoa (Nguyen 2013). There were several main reasons for this situation. First, clams in the Northern provinces are low in quality – the clam meat is small in size, impure and sandy. Low clam quality is the result of uncontrolled breeding sources, which include numerous sources in China and Taiwan. In addition, excessively high stocking densities cause a deficiency of natural food, which limits clam growth rates. Second, the Chinese government severely restricted the unofficial import channel in order to promote the official channel. The low quality and safety of Vietnamese clams, which were produced by uncontrolled farming, in addition to the lack of certificates of origin and quality led to many difficulties in the unofficial export channel.

3.3.4. Challenges in clam farming in Vietnam

Disease: In 2010-2015, there were many mollusk epidemics, which led to massive clam mortality rates. Clam death has occurred continuously in Haiphong, Namdinh, Thaibinh, Thanhhoa and certain Mekong Delta provinces (Tiengiang, Bentre and Baclieu), mainly in high tidal areas. Clams of all sizes died (but mostly those at 50-90 head/kg), and the mortality rate ranged from 20% to 80% (but mainly remained at

50%-60%). In 2015, there were 3,409 ha of clam farms in 22 communes in 10 districts of 6 provinces: Thaibinh (168.9 ha), Nghean (320.47 ha), Hatinh (67.6 ha) ha), Baria-Vungtau (38 ha), Tiengiang (1,609.42 ha) and Bentre (1,205 ha). All provinces suffered serious losses, due mainly to the effects of the Perkinsus sp infection and subsequent pathogens in the context of adverse environmental changes (Tran et al. 2016).

Extreme weather events and environmental pollution: Climate change and increasing environmental pollution are also major causes of problems in clam farming. The clam is a special species whose growth depends completely on the environment. Vietnam was ranked 18th in the 2015 World Risk Index, with a vulnerability index of 51% for predicted impacts of climate change (Garschagen et al. 2016). Environmental factors (including temperature, salinity, pesticide residues in the water and mud, and algae that are toxic or cause blooming red tides) are the main factors affecting clam cultivation. Intense sunlight, high temperatures and salinity over several days cause excessive levels of COD, NH4 and H2S. Even worse, suspended solids exceed their limits (in certain places, levels are 5-6 times higher than permitted, making the water very opaque). Salinity sensitivity experiments have shown that salinity has a strong influence on the growth and development of clams (Le 2012).

Technical issues: Currently, most clam farmers do not possess sufficient scientific knowledge of farming techniques, leading to unplanned farming activities (Ngo and Nguyen 2015). Uncontrolled diseases and high stocking densities have caused mass clam deaths in certain localities, with some individual households suffering mortality rates of 60-70%. Many studies have demonstrated the effect of farming techniques on clam growth rates and farming efficiency (Le and Le 2015). In short, the technical limitations of clam farmers constitute the greatest barrier to the development of clam culture in Vietnam.

3.4. Chapter conclusion

Vietnam is now among the top five exporters of aquacultural goods in the world, ranking just below China and India, and it plays an important role in the global supply of aquacultural resources (Tran 2017). Due to decreasing maritime resources, the structure of Vietnam aquaculture has shifted from capture activities to cultivation activities. This shift has driven the development of mollusk production in Vietnam, whose coastline boasts substantial potential natural resources for mollusk farming. Among the types of mollusk raised, clams account for the largest shares of both farming area and output volume. Moreover, clam exports accounted for nearly two-thirds of the total value of bivalve mollusk exports from Vietnam in 2015. Nonetheless, the development of clam farming in Vietnam faces many challenges, including disease, climate change and technology limitations, which constrains the ability of Vietnamese clam farmers to meet the high product requirements of the international market. Therefore, it is necessary to identify means to overcome these challenges and ultimately support sustainable development of Vietnamese aquaculture.

4

RESEARCH SITE AND METHODOLOGY

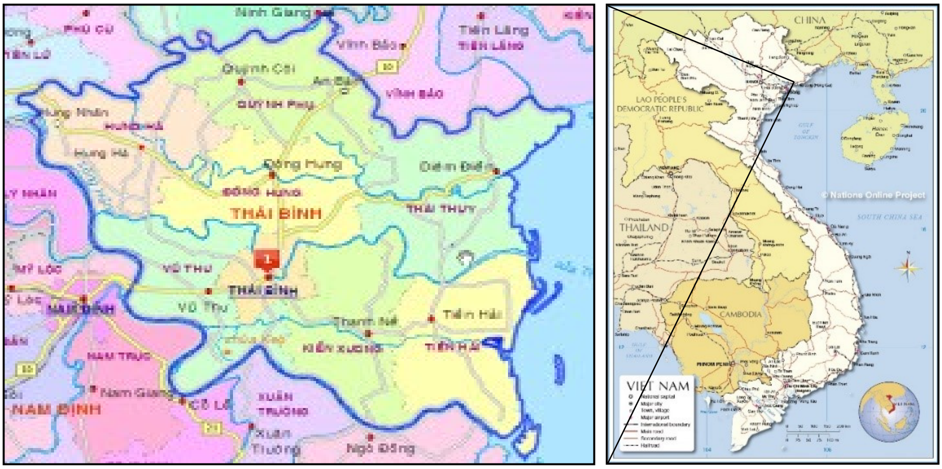
This chapter has two parts. The first provides a general introduction to the selected study site, Thaibinh province, and describes its characteristics, especially those related to agricultural production and the aquaculture sector. The performance of the clam farming sector at the provincial level is also presented. The second part of this chapter explains the methods used to achieve the study objectives. In particular, the analytical frameworks are described, and the research design, sample selection, data collection and data analysis methods are elaborated.

4.1. Research site

4.1.1. General information about Thaibinh province

4.1.1.1. Geographical conditions

Thaibinh is a delta province with a relatively flat terrain and a slope of less than 1%. Its altitude varies between one and two meters above sea level, descending from northwest to southeast. The west and southwest of Thaibinh are bordered by the two provinces of Hanam and Namdinh; the north is bordered by Hungyen and Haiduong provinces; and the east is bordered by Haiphong city. The natural land area of Thaibinh province is 1,545.84 km^2, which is small compared to other provinces in the country, but this province has become part of an important rice production area in Vietnam. The total area of the province accounts for 0.5% of the total country area and contains Thaibinh city and 7 districts, namely, Donghung, Hungha, Kienxuong, Quynhphu, Tienhai, Thaithuy, and Vuthu.



Picture 4.1: Map of Thaibinh province

Natural resources

Land resources: The land of Thaibinh province is mainly deposited by the Red river and Thaibinh river systems; thus, it is generally good and favorable for the comprehensive development of agriculture with numerous diverse plant and animal structures. In general, there are 5 types of land: agricultural land, forestry land, special-purpose land, residential land and unused land. The natural land area of

Thaibinh is allocated relatively evenly among the districts, with each district having from 20 to 25 thousand ha. Two coastal districts (Tienhai and Thaithuy) have conditions that allow expansion of their land areas to the sea (given the present deposition levels, it is estimated that over the next 10 years, the area encroaching the sea may equal the area of 1 commune).

In 2014, land for agricultural production covered 108,840 ha, accounting for 68.6% of the natural land. The land fund for agricultural land is mainly for planting rice and annual trees, which account for 79.1% of the land area; aquacultural land covers 12,895 ha, accounting for 11.9%; and the remaining land is garden land, which is for planting perennials. From 1991 to the present, the agricultural land fund (especially that for cultivated land) has been used for high-intensity cultivation levels of cultivated crops (i.e., wet rice). Forestry land (protected forests) accounts for 885 ha, which is concentrated in two coastal districts and accounts for nearly 0.8% of Thaibinh's natural land area. The ability to expand forestry land (e.g., by planting aediculas, casuarinas…) could add 4 - 6 thousand ha (depending on the ability to encroach further into the sea). Special-purpose land accounts for 19% of the province's natural land and has increased in area over time, mainly for the development of transport and other infrastructure. Residential land presently covers 13,357 ha, which is only 8.6% of the province's natural land area. Unused land measures 501 ha, accounting for 0.3% of the natural area, and is concentrated in the alluvial flat area near the sea.

Mineral resources: Thaibinh is home to several natural mineral resources, including the following: (1) Tienhai C Gas mine (which has been exploited since 1981, has an average annual natural gas yield of approximately 20 million m3, and contributes to the production of porcelain enamel and construction materials in the Tienhai industrial zone); (2) Tienhai mineral water (which has a depth of 400 meters and reserves of approximately 12 million m3; it has been exploited since 1992 and has an annual output of more than 10 million liters); (3) brown coal (the majority of which is located in two coastal districts, namely, Thaithuy and Tienhai; it has reserves of more than 30 billion tons but has not yet been exploited due to its depth, which is between 600 and 1,000 m); and (4) hot water sources (in the Duyenhai commune in the Hungha district, including one hot water mine at a depth of 50 m (57°C) and another one at a depth of 178 m (72°C); these are very good for heath treatments and tourism development). The fuel gas and mineral water sources have high potential volumes and thus create favorable conditions in Thaibinh for the development of the gas industry and the processing of mineral water for high quality products.

Water resources: Located southeast of the Red River Delta, Thaibinh is surrounded by three rivers (Luoc River, Hong River and Hoa River) and has a 50 km coastline with 5 estuaries (*figure 3.1*). Although these water resources provide opportunities for fishing, aquaculture and coastal trade, they also constitute a natural threat to life and property through storms, rising tides, cyclones, etc. In addition, the province includes approximately 6,000 ha of ponds and lakes interspersed among the residential regions and villages, and the 4 major rivers have a combined surface area of one thousand hectares. In general, water resources in the coastal area of Thaibinh are favorable for aquacultural development.

Characteristics of the hydrological climate:

Weather seasons: Thaibinh's coastal area is low and flat and has relatively uniform climate conditions. The radiation regime and hours of sunlight in this area are consistent with national averages. It is characterized by relatively high temperatures and has two distinct seasons (namely, the hot and cold seasons), which coincide with two wind seasons (i.e., the southeast wind season and northeast wind season). The hot season runs from May to September, when the average temperature ranges from 24.7ºC to 29.4ºC; the highest average temperature is normally in July. This season is suitable for the development of many organisms, including aquaculture species. However, it is also the period of the highest rainfall (i.e., 180-280 mm/month) and thus coincides with floods from upstream waters that flow through the Red river and Thaibinh river systems. These events may change the environmental factors – for example, by causing sudden decreases in salinity or high turbidity – and thus affect the area species and provide natural food for the coastal tidal area. The cold season lasts for 3 to 4 months, beginning in December and ending in March, with temperatures that range from 17.5ºC to 17.7ºC. January is normally the coldest month, with an average temperature of approximately 17.5ºC. In the cold season, rainfall amounts to only 15.8-43.4 mm/month. At the same time, upstream water is blocked due to water retention in the reservoirs, which reduces water discharge flow and thereby decreases natural food supply to the tidal area.

Hurricanes: Thaibinh is coastal province and therefore is affected by storms. It experiences an average of 2-3 storms each year, normally during April to October but primarily in August. During stormy periods, heavy rainfall accounts for an average of 200-300 mm, representing 30% of the total rainfall of the entire rainy season. Heavy rainfall freshens the environment, decreases pH levels, and affects the quality of the water for aquaculture.

Tidal regime: The coastal area of Thaibinh is characterized by a uniform tidal regime, with diurnal tides that decline from north to south. The tidal level varies between 3.0 and 3.5 m, averages between 1.7 and 1.9 m and has a minimum level of 0.3-0.5 m. The highest annual tide level can reach 4.0 meters, and the lowest annual level is approximately 0.8 meters. Every month, there are two 5- to 7-day periods of flow tide and two 5- to 7-day periods of ebb tide. Each cycle lasts from 11 to 13 days, with the tide fluctuating between 1.5 m and 3.0 m. In the middle of the cycle, ebb tide occurs, lasting 2-3 days with a low level of 0.5 - 0.8 m. Flow tides greater than 3.0 m occur between 152 and 176 days per year.

Water environmental factors: In the flood season, coastal salinity levels are low, with an average of 9-17 ‰. In the dry season, coastal salinity increases to 23 ‰ -32 ‰. The average pH value ranges from 7.9 - 8.3, which is suitable for aquaculture species. Dissolved oxygen is unevenly distributed based on the level of water pollution, which differs across areas.

Table 4.1: Some economic indicators of Thaibinh province (2012-2016)

	Unit	Year				
		2012	2013	2014	2015	2016
Gross Domestic Regional Product (at current price) (GDRP)	Billion USD	1.83	1.96	2.22	2.46	2.77
GDRP from agriculture, forestry and aquaculture	Billion USD	0.72	0.71	0.80	0.84	0.90
GDRP per capita	USD/ capita	1,062	1,149	1,283	1,403	1,562
Aquaculture area	Ha	14,434	15,119	15,047	14,689	14,685
Aquaculture production output volume	1,000 Tons	152	169	166	183	198
Aquaculture production value (based on current prices)	Million USD	238.59	253.32	306.68	353.50	390.73

(*Source: ThaibinhSO 2017*)

4.1.1.2. Population and labor resources

In 2016, the average population of Thaibinh was 1,789 thousand people (an increase of 8.8‰), which accounted for 1.89% of the total Vietnamese population. Females accounts for 51.66% of the population, and males account for 48.33%. The average population density in Thaibinh is 1,128 people/km^2, which is 3.7 times higher than that of the entire country.

In 2016, the total number of people in the labor pool age group was approximately 1,110.8 thousand. The labor pool in Thaibinh is supplemented every year and increases relatively quickly from the following sources: soldiers who complete their obligations; high school graduates who will not enroll in university, professional junior college, or vocational school; and college and university graduates who return to the province to work. There is significant pressure to secure employment. Labor density has tended to increase in the industrial and construction sectors and decrease in the agricultural sector. In 2016, laborers working in all national economic sectors accounted for approximately 98.9% of the people of working age. The shares of the labor pool in various sectors are as follows: agriculture, forestry and fisheries account for 51.9%; industry and construction account for 29.5%; and the service sector accounts for 18.6%. Overall, Thaibinh province has very favorable labor resources, with relatively high educational backgrounds and a hard-working nature. This manpower ably meets local demand created by socio-economic development, as well as the needs generated by international cooperation.

4.1.1.3. Socio-economic situation

Thaibinh is located near several large urban centers, including Hanoi (the capital of Vietnam), Haiphong city and key Northern economic regions (which include 7 provinces and capitals, namely, Haiphong, Hanoi, Quangninh, Haiduong, Hungyen, Bacninh and Vinhphuc). In general, given Thaibinh's advantageous administrative boundaries, flat terrain, convenient communication systems, relatively developed rural infrastructure, and transportation system (which includes 2 national highways – number 39 and number 10 –and the inland waterway transport system), the province has many favorable attributes to attract investment, encourage development of the economic and industrial zones, promote commercial exchanges between Thaibinh and the other provinces in the region and between Thaibinh and foreign countries, especially those in South East Asia.

In 2016, the gross regional domestic product (GRDP) of Thaibinh was estimated at USD2.77 billion, which reflected an increase of 12.6% over 2015 (the highest growth rate since 2012) and exceeded plans by 10%. During the 5-year period of 2012-2016, the GRDP per capita of Thaibinh increased steadily, reaching approximately USD1,562 in 2016, for an increase of 11.3% compared with 2015. GRDP per capita in Thaibinh equaled 70% of the Vietnamese GDP per capita average (ThaibinhSO 2017, WorldBank 2017).

4.1.1.4. Agricultural production

Thaibinh remains an agriculture-based province and is located in the "rice bowl" of the Red River Delta of Vietnam. Sixty-six percent of the provincial workforce is dedicated to the agricultural sector. Although the provincial GRDP structure has experienced significant change over the past 30 years due to Vietnam's market-based economic policy, with a shift toward the industrial and service sectors, agriculture, forestry, and aquaculture have continued to contribute 25%–35% of the total provincial production value in recent years (*table 4.1*). Most farmers have traditionally lived on food crop production and livestock activities. Thaibinh's agricultural land area covers 964,000 hectares and is suitable for growing high-productivity and high-quality paddies, various vegetables and good-quality fruits.

In the 2011-2015 period, the agricultural production of Thaibinh province shifted towards commercial commodity production and the average production value increased by 3.9% / year. The production of plants and livestock have increased in terms of productivity, quality and efficiency. The average value of each cultivated hectare ranges from 86.8 million VND (2010) to 120.8 million VND (2015). The cultivation area produces rice at a rate greater than 0.13 ton / ha / year, and paddy output is over 1 million tons / year. The area characterized by "large-field models" continues to expand (in 2015, there were 177 regions with 10,546 hectares; 111 regions had "production contracts" at the beginning of the crop season). Farm husbandry has also developed well, matching production to consumption, enhancing the ability to actively control diseases in cattle and poultry, and minimizing damage.

The production structure has shifted, with the share of poultry increasing rapidly. There has also been an increase in the shares of F1, F2 and F3 pigs and other foreign breeding pigs.

4.1.1.5. Aquaculture production

In 2016, aquaculture production generated USD390 million, increasing by 10.53% compared with 2015 (ThaibinhSO 2017). Approximately 26% of farmers living in coastal areas seek their livelihood from coastal aquacultural activities, typically in combination with other traditional livelihood activities.

Currently, in Thaibinh province, marine and brackish water aquaculture is developing in terms of both area and yield. The total potential area for aquaculture is approximately 17,000 ha (MARD 2014), 15,119 ha of which have been converted to various types of aquaculture production, such as shrimp, fish, and clams. Currently, the farming area is showing a tendency to increase due to the exploitation of intertidal areas to raise mollusks. Clams always account for a significant proportion of total provincial aquaculture production (i.e., approximately 60%). In 2013, 15,119 hectares of aquaculture were cultivated, out of which 3,033 hectares were for marine aquaculture and 3,496 hectares were for brackish water aquaculture. The volume of marine aquaculture was 71,452 tons, which had a value at 375,260 million VND, and productivity yield was 24.50 tons/ha. Also, in 2013, the volume of brackish water production was 6,553 tons, for a value of 75,672 million VND, and the productivity yield was 1.79 tons/ha. By 2016, the total area dedicated toaquaculture was estimated at 14,685 hectares (of which marine aquaculture accounted for 3,300 hectares, brackish water accounted for 3,485 hectares, and fresh water accounted for 7,900 hectares). The total output of aquatic products was estimated at 198 thousand tons, with marine aquaculture accounting for 80,000 tons, brackish water aquaculture accounting for 8,031 tons, and fresh water aquaculture accounting for 40,466 tons. The growth rates for these three sectors over 2015 were 10.34%, 8.78% and 4.86%, respectively.

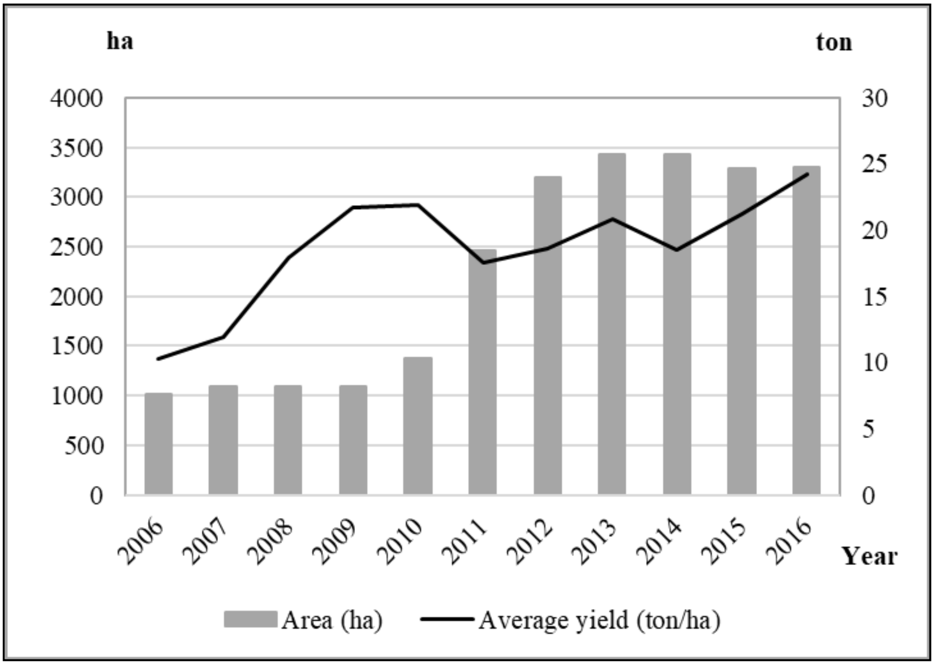
The major aquaculture species in Thaibinh are Bentre clams, Black tiger shrimp, crab, sea bass, brown seagrass, tilapia, yellowtail, etc. “Extensive farming” and “innovatively extensive farming” models remain most popular but are gradually being replaced by the “intensive farming” and “semi-intensive farming” models. The species that is most commonly raised using the intensive and semi-intensive farming models is white shrimp, which has high yields (10-15 tons /ha). As of 2015, there were 153 cages in the province; by April 2016, there were up to 400 cages. Contemporaneously, aquatic product processing has contributed to the growth of aquaculture and fishing, creating jobs and increasing income for many workers in coastal areas. To meet demand for processed products from capture fisheries and aquaculture, many large-scale fish processors have been established in the province, such as Rich Beauty Food Co., Ltd; Thuytan Fish Processing Factory; Thaibinh Seafood Joint Stock Company; Diemdien Fishery Joint Stock Company; and Minhphu Co., Ltd. Seafood Processing. However, there have been several problems caused by outdated processing technologies, illogical factory locations, the release of polluted wastewater into the environment, quality control systems, and food safety, among other things. These issues must be addressed.

4.1.2. Clam production in Thaibinh province

4.1.2.1. The history of clam production in Thaibinh province

Statistics for year 2013 indicate that among the coastal provinces in the northern area of Vietnam, Thaibinh has the largest clam farming areas, with 3,430 ha, followed by Namdinh (1,710 ha), Thanhhoa (1,200 ha), and Quangninh (1,000 ha) (MARD 2014). In 2016, total clam farming in Thaibinh accounted for 3,300 ha, and Thaibinh was ranked second among Vietnamese provinces in term of clam production area, following Bentre province (*picture 3.2*). According to the Thaibinh Agriculture and Fishery Extension Center, salinity in the provincial intertidal area is approximately 15‰-25‰, which favors aquaculture development. It is thus an intertidal area suitable for clam farming among the coastal provinces in the north of Vietnam (ThaibinhDARD 2014). Thaibinh has many potential advantages in clam culture development. First, due to the flows of the main river mouths (Red River, Tra Ly River and Thaibinh River), the tidal area has expanded to approximately 25,000 ha; the middle tide covers 6,178 ha, and the tidal area favorable for the development of marine and brackish water aquaculture, including clam culture, covers 18,822 ha. Second, the system of algae and estuarine estuaries is formed annually, which creates favorable beaches and minimizes the impact of substantial waves and winds on the intertidal area that is favorable for clam culture development. Moreover, the internal sand area can be converted into clam culture. Third, Thaibinh coastal farmers have many years of experience in clam culture, which will facilitate the transfer of knowledge and technology from people in farming areas to people in other coastal communes as the clam culture area expands.

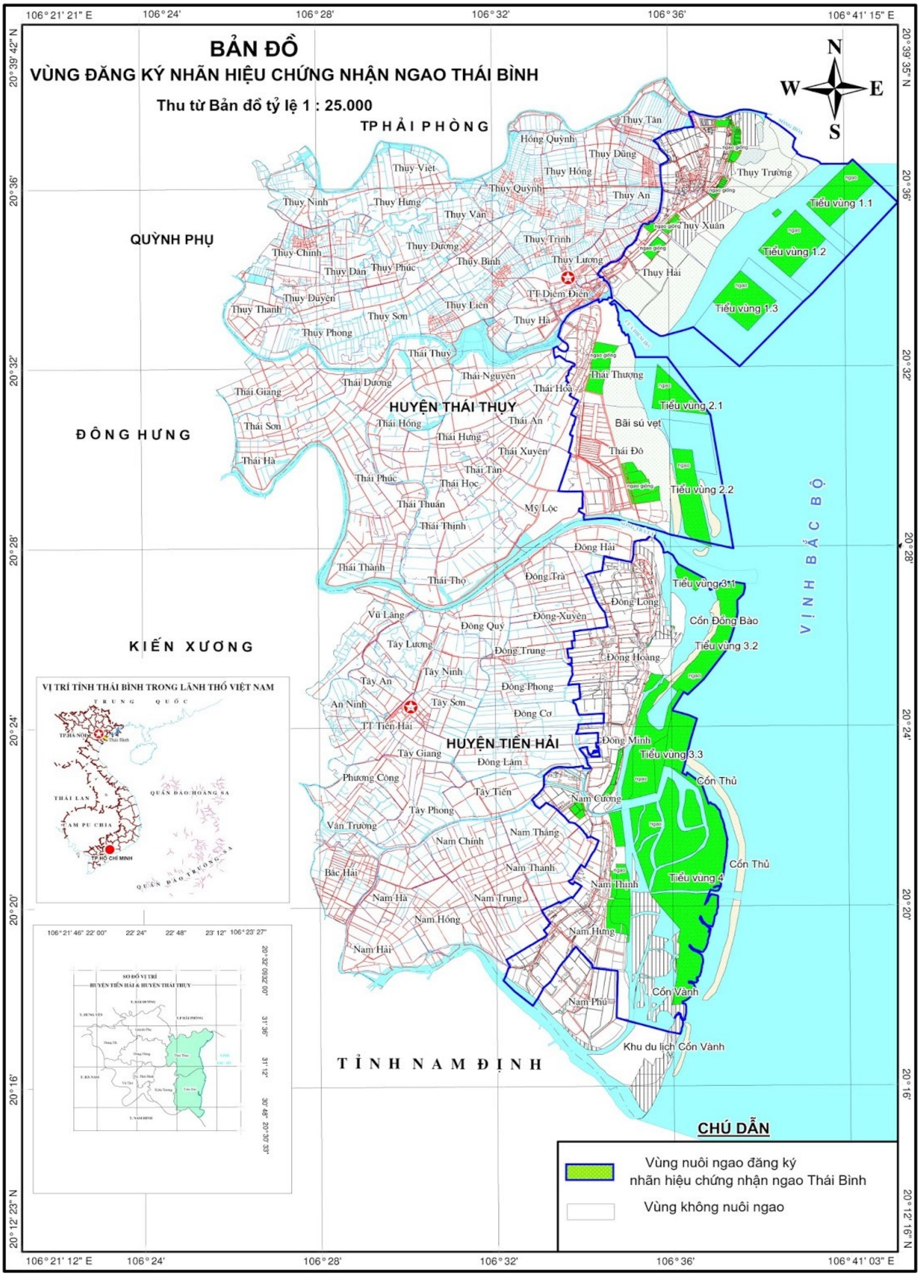
In Thaibinh, clams are raised in two districts along the coast, Tienhai and Thaithuy (*picture 4.2*). Clam culture began in this area in 1989 due to increased consumer demand for clams. Certain households in Dongminh Commune and Namthinh commune (both in the Tienhai district) used poles and polymer nets to collect natural clam seedlings and then managed, monitored and harvested when the clams reached commercial size. During this early period, clam culture was formed with an initial area of 150 ha and then increased to 400 ha. Output reached 4,200 tons in 1999 and 6,000 tons in 2001, most of which was exported to China and Hong Kong or consumed domestically. In 2002, clam culture farmers in Namthinh Commune in the Tienhai District purchased Bentre White Clam (Meretrix lyrata) breeding from Bentre and Tiengiang provinces for trial clam farming. The results of the trial showed that Bentre Clams (Meretrix lyrata) adapted well to the weather conditions, climate and coastal environment of Thaibinh and even outperformed local clam varieties in terms of productivity and economic efficiency. Since then, farmers have attracted investments to replace local clam varieties with "Bentre White clams". Meanwhile, in Thaithuy district, clam farming is concentrated in Thaido commune, which had an area of 90 ha in 1997, 140 ha in 2005, and 169 ha in 2006. However, because farmers were inexperienced, production efficiency was not high and area clam farming accounted for only for 4.18% of the total district aquacultural area. At this stage, clam farming was conducted spontaneously, without government-developed production plans. Clam farmers found that clam production was profitable, so they used nets to zone clam plots in places where numerous natural clams existed. These farmers raised and received benefits from natural clams only.



(Source: Thaibinh DARD, 2017)

Figure 4.1: Clam production in Thaibinh (2006-2016)

By August 2011, the potentially high profits from clam aquaculture became clear. To exploit opportunities in the coastal tidal areas, the People's Committee of Thaibinh province issued Decision No. 1757 / QD-UBND, dated 05 months 8 in 2011, which specified a planned clam farming area of 3,000 ha by 2015, comprising 1,700 ha in Tienhai district and 1,300 ha in Thaithuy district. In 2012, the “Bentre White clam” was grown in over 3,000 hectares of tidal area in the two coastal districts of Thaithuy and Tienhai. Production reached 59,000 tons, and the market expanded to include EU countries, marking a new stage in coastal tidal clam culture in Thaibinh province. Clam farming areas were quickly enlarged to approximately 3500 ha in 2013. In 2014, the clam farming area shrank slightly due to chaos in clam farming productivity in 2011 and reduced demand for clams in 2012 (*figures 4.1*). Consequently, total clam production in Thaibinh province in 2014 had a value of VND 445 billion (approximately 20 million USD, with an exchange rate of 1USD = 22,000 VND). As of 2016, the total clam culture area remained at 3,300 ha and produced 80,000 tons of clam, for an average yield of 24.24 tons/ha.



(Source: Thaibinh DARD, 2017)

Picture 4.2: Thaibinh clam production map

4.1.2.2. Clam hatchery production

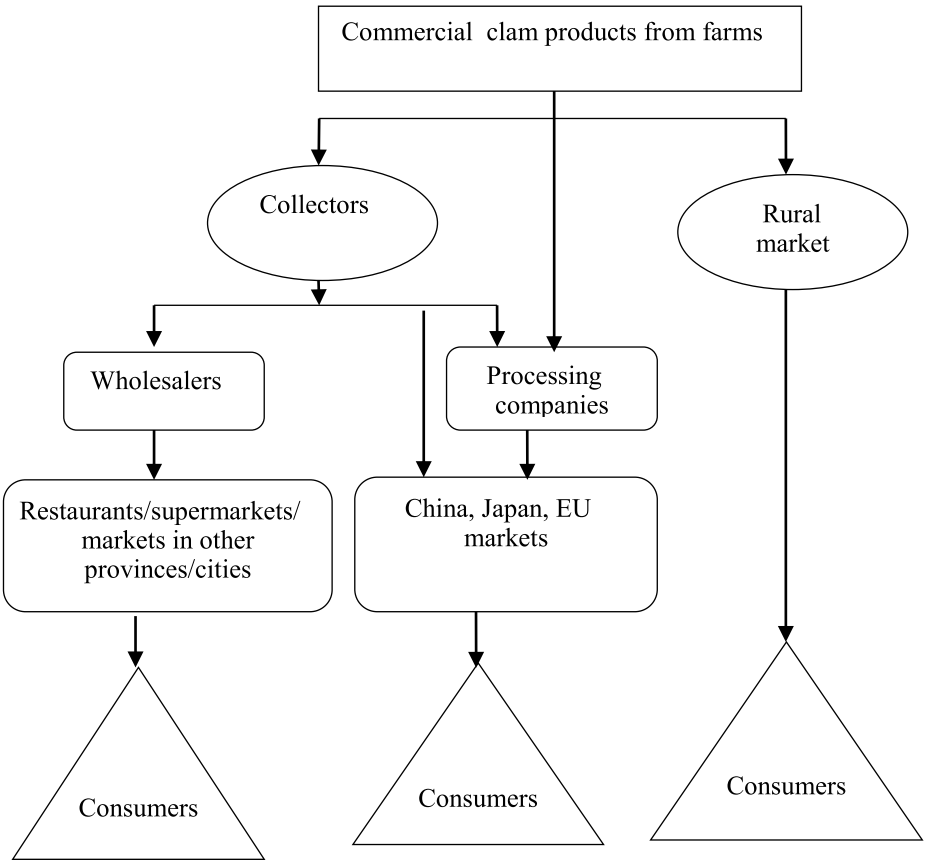
Currently, there are two companies in Thaibinh involved in clam breed production: Truongdai Co., Ltd. (in Vanh island, Namphu commune, Tienhai district, Thaibinh province) and Hailong Aquatic Breed company (in Duccuong village, Namcuong commune, Tienhai district, Thaibinh province). There are also many clam hatchery households. In both companies and in hatchery households, after juvenile clams have moved to the bottom, they are transferred from the tank to the nursery and can be sold to clam farmers. However, in Thaibinh province, clam breed producers can satisfy only approximately 15% of farmers' demand for clam breeding. Most of the remaining demand is satisfied by breeding from Bentre, Camau.

4.1.2.3. Clam processing activities

In Thaibinh province, there is one factory that processes clams before export. This factory is located in the Cua Lan industrial zone in Namthinh commune, Tienhai district. It was established in April 2010 with VND12 billion of registered capital. The total value of the company's assets is VND14.83 billion. The company is well-invested and has been granted European standards certification, meaning that it is authorized to sign orders for direct exports. In 2011, Thaibinh Clam Co., Ltd. established one frozen clam processing factory with a capacity of 20 tons per day. With a modern production line, the company has been able to export clams to Europe, Japan, Taiwan, Korea, etc. It was the first seafood export company to ship to the EU market. In 2016, Thaibinh Clams Ltd. invested in factory construction and established export processing enterprises. After investing nearly VND 20 billion in machinery and equipment to process frozen clam, thereby meeting market standards, the company exports 5,000 tons of clam annually to Europe and America, generating an annual revenue of approximately VND 120 billion. Based on its estimated capacity, tens of thousands of tons of clams can be exported from Thaibinh to a number of fastidious markets, such as Europe, the USA, Japan and Korea.

4.1.2.4. Clam sale channels

The market survey results show that clam farm products have been sold through 2 channels: (1) indirect (sold through collectors and retailers) and (2) direct (sold in rural markets). The proportion sold via the second channel is only 1% (*figure 4.2*). Clams are collected by traders who export the clams to international markets (China, the EU, etc.) or sell to major domestic markets, such as the large cities of Hanoi and Hochiminh City. An official record of the Thaibinh Commercial Department reveals that approximately 90% of products are exported to foreign markets and 10% are consumed in the domestic market. Prior to 2012, 50-60% of the total provincial clam harvest was sold to China through unofficial export channels, while 30% was sold to the EU market and only 10% was sold domestically.



(Source: Market survey, 2016)

Figure 4.2: Clam sale channels in Thaibinh

4.1.2.5. The "Thaibinh Clam" trademark

The "Thaibinh Clam" trademark is registered at the Department of Intellectual Property in accordance with Vietnam law. Stamps are designed based on the approved logo of the certification mark (*picture 4.2*), then printed and distributed to organizations and individuals who wish to use the certification mark. Organizations and individuals who use stamps for their products must follow the rules of the certification body, which is the Department of Agriculture and Rural Development of Thaibinh. All households and companies have the right to request that the Department of Agriculture and Rural Development of Thaibinh province issue or revoke certification, record certain changes to certification (for example, changes in name, address, type, and number of products using the certification mark in accordance with regulations) and withdraw the right to use certification. At present, the geographic area of clam cultivation using the "Thaibinh Clam" trademark comprises various communes and intertidal communes bordering Thuytruong, Thuyxuan, Thuythai, Thaithuong and Thaido in Thaithuy district and Donglong, Donghoang, Dongminh, Namthinh, and Namhung in Tienhai district.

(Source: Thaibinh DARD, 2017)

Picture 4.3: Thaibinh clam product logos

4.2. Research methodology

4.2.1. Analytical framework

As a problem that exists in all areas of life, "risk" has been the focus of a plethora of research in the natural sciences, applied sciences, social sciences, etc. Although researchers in different fields believe that they use the same basic concept, significantly diverse approaches have been implemented, which may impede successful, efficient and effective risk reduction (Cardona 2004). Furthermore, societal aspects change continuously, which leads to changes in risks (Aven and Kristensen 2005). The relations among the actors/factors in a risk management system are not only linear but also interactive. Cardona (2004) noted in his research that in developing countries, most aspects of life (e.g., natural, social, economic) can potentially cause physical damage. A linear analysis that addresses only one specific source of risk will lead to inefficient risk management tool choices in strategies and policies. Therefore, an improved approach that takes into account not only natural factors but also economic, social and political factors and analyzes a system in which these factors interact inter se is necessary. A holistic approach introduced by the OECD might be appropriate for addressing this need. The basic principle of this approach is to consider each element as part of a system that can only be analyzed (and the government policies evaluated) if the links among them are explicitly taken into account (OECD 2009).

Contents of a holistic approach

A risk management system should address the complex relations among three different axes, namely, the origin and characteristics of risk; the available tools and strategies to address risk; and government intervention or actions. All of three axes should be assessed simultaneously when considering risk management (McIntosh 2008) (*figure 2.4*).

Farming risks: Because each type of risk that occurs in agriculture has unique causes and characteristics, different strategies to address each type of risk are clearly needed. McIntosk (2008) mentioned several of the main types of risk for aquaculture farms, including marketing, production, financial and institutional risks, and described their characteristics and their levels, which range from micro (idiosyncratic) risk (which affects an individual or household) to meso (covariant) risk (which affects groups of household or communities) and finally to macro (systemic) risk (which affects regions or nations).

Farmer strategies**:** Risk management strategies can be grouped into three categories: (1) prevention strategies, which aim to reduce the probability that an adverse event will occur; (2) mitigation strategies, which aim to reduce the potential impact of an adverse event if it occurs; and (3) coping strategies, which seek to alleviate the negative impacts of a risky event and to enhance resilience (Holzmann and Jorgensen 2001). These three strategy types can be implemented by individual farmers; however, the effectiveness of the strategies depends on support from different institutional levels, including the farm/household/community, market and government levels.

Government policies**:** The term "government policies" implies the selection of policies that aim to improve efficiency and redistribute risk in a certain community/social network. In the risk management area, government policies relate to the interaction between government policies and farmers' strategies and to the support provided by the government's risk management measures. This section adopts a positive observational approach to identify potential roles of the government, namely, market creation, adjustments to market incentives, and the reduction, mitigation and coping with risk. Other issues discussed in this section include the interaction between government policies and market strategies, the support provided by government risk management measures and the difficulties of managing catastrophic risk, which can be accomplished both before the risky event takes place (ex ante) or after the event has occurred (ex post) (Cafiero et al. 2007).

Analytical framework

To analyze the impact of risk, the results of risk management strategies and tactics, and the influence of various factors on the application of strategies and tactics, the analytical framework is designed as shown in figure 4.3.

(1) **Risk assessment analysis**: Clam farming risks are assessed base on two criteria: (1) risk consequences, which are assessed based on the impact of a particular risk on a household (e.g., changes in income and livelihood), and (2) risk likelihood, which is assessed based on the frequency of shock occurrence during 2006-2014.

(2) **Assessment of household resilience**: Household resilience is assessed based on the ability to start a new clam cycle after a shock, which depends on the length of time needed to restart clam production and the length of time needed to recover clam farming losses.

(3) **Risk management strategy analysis**: All strategies will be classified as ex ante or ex post and by whether they aim to mitigate the risk or reduce the impact of the risk. The result of each strategy will be evaluated based on clam farming performance. In addition, all risk management strategies will be matched with risk layers to assess the appropriateness of those strategies.

(4) Analysis of the influence of various factors on the application of risk management strategies: Factors that influence the application of risk management strategies in households will be divided into two groups for purposes of analysis: internal factors (i.e., household characteristics) and external factors (i.e., government and community). Government policies and interventions are considered in relation to risk level to evaluate the appropriateness of those policies and interventions.

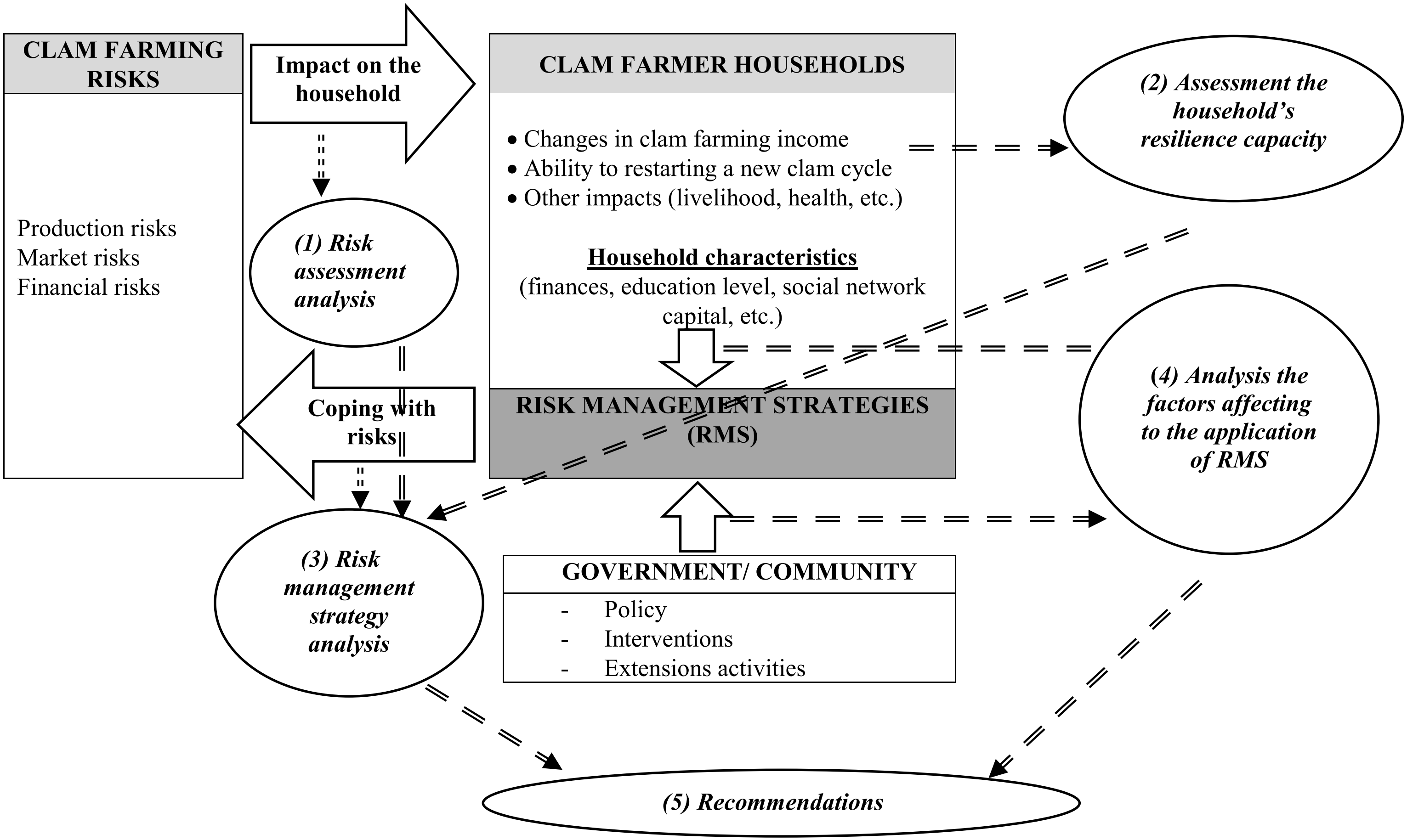


Figure 4.3: Analytical framework

4.2.2. Research design

To achieve the research objective, the study is designed with 6 steps, as presented in figure 4.4.

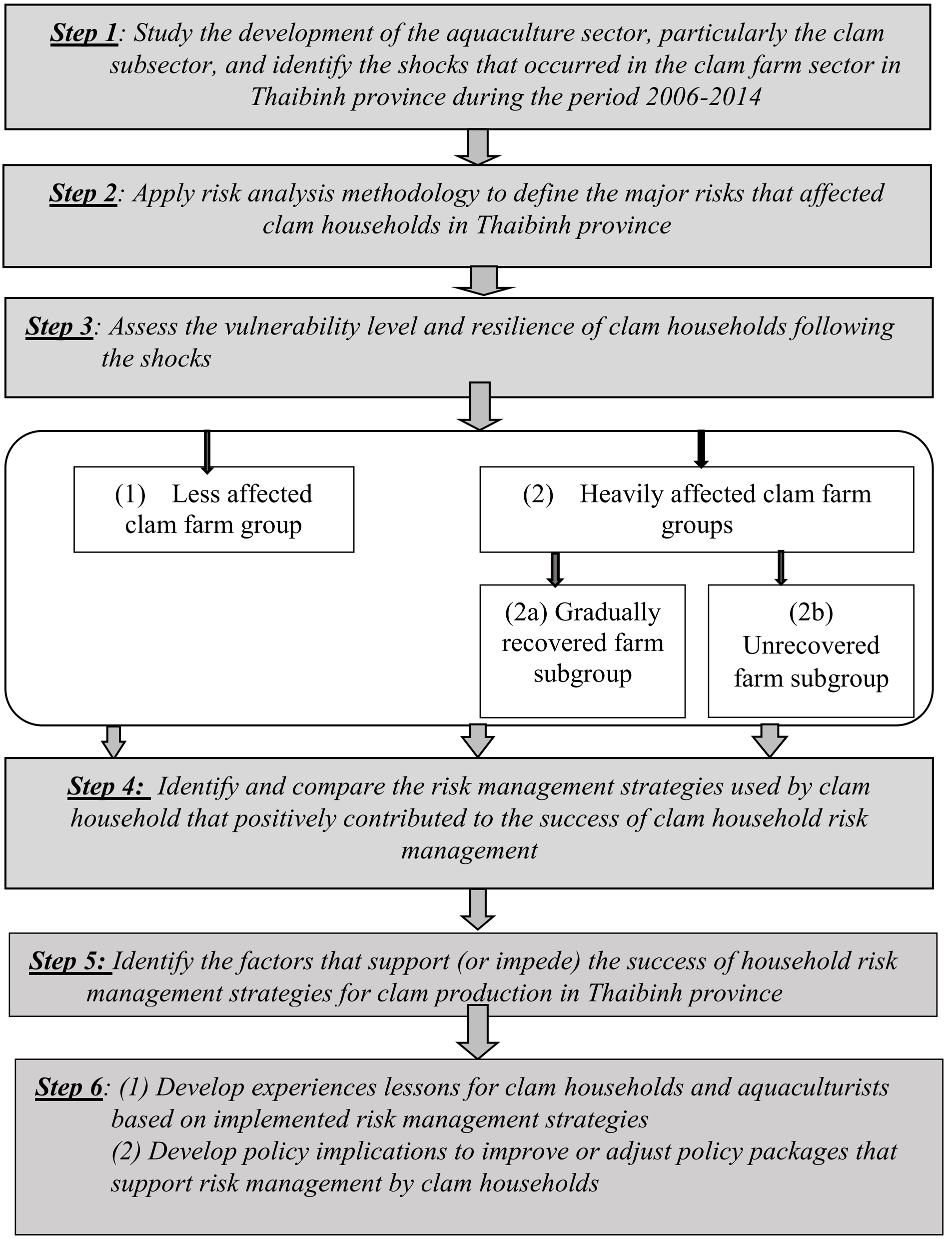


Figure 4.4: Research design

4.2.3. Sample size

There are 12 communes in Thaibinh that are involved in clam farming. These communes are located along 50 km of the provincial coastline. Three communes were selected for the study. The selected communes have the largest clam farming areas and the longest histories of clam production in Thaibinh. These characteristics allow the researchers to capture the risks and farmer resilience/capacity in clam farming over a relatively long period of time, i.e., from 2006 to 2014. During the study period, 1310 households in the three communes engaged in clam farming.

Detailed information about clam production in the two districts in which the communes are located:

Table 4.2: Total clam production area in Tienhai district (Unit: ha)

Commune	Year									Notes
	06	07	08	09	10	11	12	13	14	
Dongminh	250	250	250	250	274	274	357	357	357	Selected
Donghoang		16	16	16	16	56	56	114	114	
Donglong						25	145	151	151	
Namthinh	600	600	600	600	742	900	1002	1600	1600	Selected
Namhung		54	54	54	54	50	44	44	44	
Namcuong					04	40	40	45	45	
Namphu					30	35	55	55	55	
Total	**850**	**920**	**920**	**920**	**1120**	**1380**	**1700**	**2366**	**2366**	

(Source: Tienhai Division of Agriculture and Rural Development, 2015)

Table 4.3: Total clam production area in Thaithuy district (Unit: ha)

Commune	Year									Notes
	06	07	08	09	10	11	12	13	14	
Thaithuong								360	358	
Thaido	169	169	169	169	179	179	179	447	447	Selected
Thuytruong						166	172	287	287	
Thuyxuan						27	27	27	27	
Thuyhai						65	65	65	65	
Total	**169**	**169**	**169**	**169**	**179**	**437**	**443**	**1186**	**1184**	

(Source: Thaithuy Division of Agriculture and Rural Development, 2015)

In Tienhai district, there are 8 coastal communes, 7 of which are clam culture communes. Many of those communes have the potential to raise clams and have large clam farming areas. The historical data show that the two largest clam farming areas in this district are Namthinh and Dongminh. Both of these communes commenced clam aquaculture before 2006. Thaithuy has 27 km of coastline, a large tidal area (9,000 ha), and the ability to expand clam culture to approximately 5,000 ha. The historical data reveal that approximately 38% of the clam culture in this district is concentrated in Thaido and that this commune has the longest history of clam culture in Thaithuy district. For these reasons, the selected research sites are 2 communes in Tienhai district (Dongminh and Namthinh) and 1 commune in Thaithuy (Thaido). These communes also have been engaged in clam production for the longest periods of time.

Sample size

The sample size of households for the 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 engaged in clam farming in the three communes (1,310); and t = confidence interval (2.17, with a 97% confidence level).

Based on data regarding clam farming losses for the first 31 households surveyed in the three communes, a sample variance (S^2) of 194.88 and sample error (Δ_x^2) of 2.52 were estimated. For these parameters, n = 131, then it makes the prevalence sample is 10%. Also, the sample size of Thaido commune was increased from 11 to 31 in order to have clearly samples in different groups. As the result, a sample comprising 157 households was randomly selected from the 1,310 clam households in the 3 selected communes (*table 4.4*).

Table 4.4: Household sampling

District	Commune	Number of clam households	Prevalence sample	Sample size in calculation	Actual sample size
Tienhai	Dongminh	545	10%	55	58
	Namnhinh	660	10%	66	68
Thaithuy	Thaido	105	10%	11	31(*)
	TOTAL	**1,310**		**132**	**157**

4.2.4. Data collection methods

Fieldwork was conducted at the study site from March 2015 to August 2016 (*figure 4.5*). Secondary data regarding policies on intertidal land planning and allocation and financial and technical support for clam production were gathered from various local government offices and from published papers/reports. Primary data were collected using several research tools. Data on clam farming, marketing practices, risks, and farmers' capacity and strategies to recover from different risks that occurred between 2006 and 2014 were collected. Then, the data were combined to identify the impacts of policies on clam farming practices, the consequent risks, and farmers' coping strategies. The three research tools used in the field research were as follows:

Step 1: Key informant interviews (KIs)

Seventeen key persons from local governments at three administrative levels (province, district, and commune) and clam traders were interviewed to obtain data on government policies and enforcement related to intertidal land planning and allocation; technical and financial government support for clam farming; and clam traders' performance in relation to local clam farming practices and the traders' views on the factors that govern local clam farming and marketing practices. The KIs included one person in the Thaibinh provincial aquaculture department, two people in aquaculture sub-departments in the two districts, the heads and aquacultural extensions of the three communes, and five clam traders.

Step 2: Focus group discussions (FGDs)

Three FGDs were conducted in the selected communes (one FGD/commune). Each FGD involved 8–10 farmer participants who had good experience with clam farming and marketing practices. The FGDs aimed to explore historical events in local clam farming and the market; relevant government policies and their impacts on clam farmers; and farmers' coping strategies for risks and policy constraints.

Step 3: Household surveys

Household surveys aimed to capture detailed data regarding the farmers' clam farming and marketing practices, including farming costs and profits, the risks faced by farmers, their coping strategies, and the consequences of risks for their farming practices and their lives.

Step 4: Case Study

Twenty-three cases were studied using in-depth interviews to explain the quantitative analysis results obtained using household survey data.

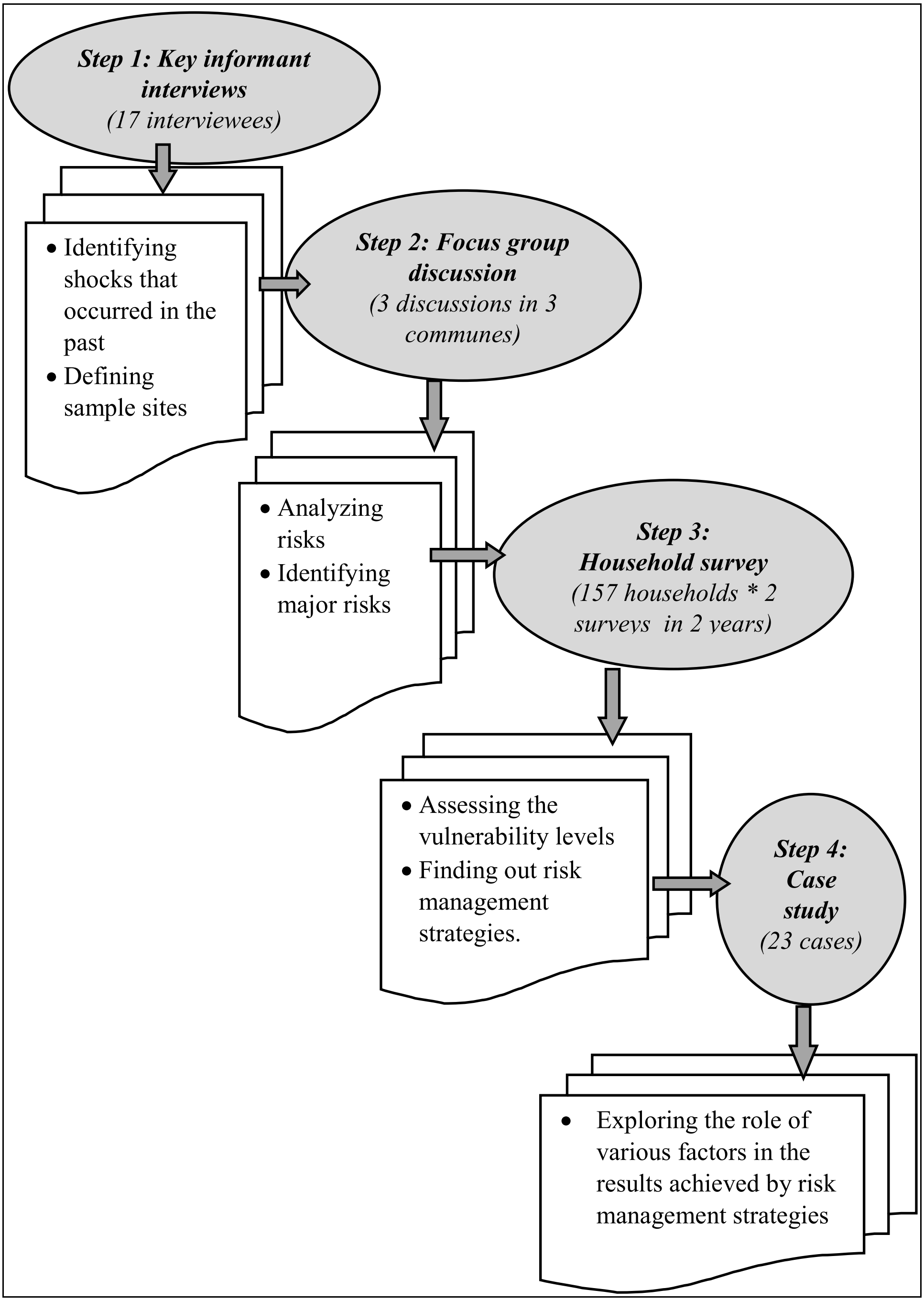


Figure 4.5: Survey procedure

4.2.5. Data analysis methods

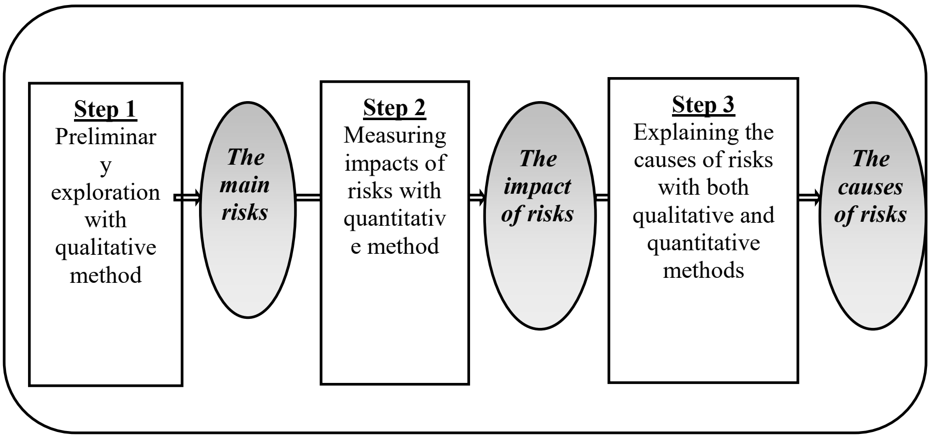
4.2.5.1. Mixed methods research for risk analysis

Mixed methods were employed for this research for the following reasons:

(1) Because aquaculture is impacted by many external factors, such as species, environments, markets and practices, the risks of aquaculture are very diverse. Therefore, the range of hazards and perceived risks are very complex (Bondad-Reantaso et al. 2008). The application of a single method could lead to biased results. Furthermore, to measure the two basic characteristics of aquaculture risk (likelihood and consequences), we need both quantitative and qualitative data.

(2) According to Patton (2005), there are trade-offs between quantitative and qualitative research methods. Quantitative methods use various standard approaches to measure the impacts/responses of subjects but are limited to a specific hypothesized framework. In contrast, qualitative methods permit the researcher to study selected issues in depth and in detail and increase the understanding of the cases and situations but reduce generalizability. We need to apply a mix of methods to reduce the limitations of both methodologies

(3) The sequential design (*figure 4.6*): first, a preliminary exploration will be conducted through a focus group discussion (qualitative method) to define the main risks. Then, a household survey (quantitative method) will be conducted to measure the impacts of risks based on a large sample. Finally, key informant interviews (a mixed quantitative and qualitative method) will be conducted to determine explanations for the results of the quantitative data. A more comprehensive view and more data about clam farming risks will be obtained through these strategies than could be obtained using either quantitative or qualitative approaches only.



(Source: Adapted from Creswel 2014)

Figure 4.6: Sequential design of risk analysis

Qualitative methods: (1) Ethnomethodology was used to identify shocks that occurred in clam farming in 2006-2014 and to evaluate farmers' risks, and (2) a risk assessment matrix was used to rank risks based on their consequences and likelihoods.

After identification, a risk will be analyzed and scored based on two criteria: (1) potential consequences and (2) likelihood of occurrence.

> **Consequences**: Consequences refer to the potential worst-case impact of the risk on the organization after the magnitude of the loss is mitigated by current controls. There are several levels of consequences, including severe, major, moderate and minor. Consequences have been matched in magnitude to the present size and structure of the aquaculture industry
>
> **Likelihood:** This term refers to the probability of the worst-case outcome after the controls are considered. The table below shows the categories of this criterion, which include frequent, probable, occasional, remote and improbable.

Risk assessment: After analyzing the identified clam farming risks as described above, the risks will be assessed and categorized into several groups, namely, (1) negligible risk; (2) low risk; (3) moderate risk; (4) high risk; (5) very high risk; and (6) extreme risk. Base on this classification, clam farming risks will be assigned to different layers: normal, insurance and catastrophic (*figure 4.7*).

b) Quantitative methods: First, an accounting method was used to calculate revenues, costs and profits of clam farming. Then, a Mutual Information Index (MII) sensitivity analysis (with Monte Carlo simulation) was used to determine the sensitivity of "profit per ha" to factor changes. Household surveys were conducted to collect information about the costs, revenues and profits of each household's fields for all clam cycles from 2006 to 2014.

Table 4.5: Variable inputs for profit measuring (Million VND/Ha/year)

P=[(V4*V1*(1-V8)*(V3+V9)*V10/100)-(V3*V4*V1/100+V5*V2+V6*V1+V7)]/V1/(V2/12)	
V1: Area of field (ha)	V6: Total fixed costs/ha (Million VND/ha)
V2: Cycle length (months)	V7: Other costs (Million VND)
V3: Price of Juvenile Clams (VND/head)	V8: Mortality rate (%)
V4: Density (Head/m^2)	V9: Value added per head of clam (VND)
V5: Monthly costs (Million VND/month)	V10: Price ratio

Using this data, a Mutual Information Index (MII) sensitivity analysis was used to measure the probability of profit (which itself is a function of a set of variables that includes area, cycle length, price of juvenile clams, density, monthly costs, other fixed costs, mortality rates, value added per head of clam and the price change ratio) based on the probability of each variable. Next, a sensitivity measure was calculated to determine the impact of each factor on profit variability (Christopher Frey and Patil 2002).

- Calculation of the MII using Monte Carlo simulation techniques in Crystal Ball software will help to overcome the computational complexity, which used to be considered a disadvantage that made MII difficult to implement (Merz et al. 1992). In this research, the data listed above were collected from the fields of 157 sample households for all cycles during 2006-2014. Therefore, in total, 640 samples were contained in the data set used for Monte Carlo simulation. The simulation was set with 1 million trials at normal speed.
- The results of the Monte Carlo simulation reveal the probability distribution of profits/losses in clam farming at the household level, a long with the fluctuation of all the variables mention above (area, cycle length, price of juvenile clam, density…). In addition, a sensitivity analysis using data from the Monte Carlo simulation is applied to determine which variables impacted the profit/loss indicator in clam farming performance.

4.2.5.2. Group classification based on clam farming performance and household resilience

Based on the time series data regarding clam farming performance in the period 2006-2014, using the criterion "the frequency of loss" (i.e., the number of loss cycles/total number of cycles of "clam raising plot"), the 157 sample HHs were divided into the following 4 groups:

(1) **L1:** No of HHs who gained in all cycles

(2) **L2:** No of HHs who lost in <20% of all cycles

(3) **L3:** No of HHs who lost in 20% => <100% of all cycles

(4) **L4:** No of HHs who lost in 100% of all cycles

With the exception of the group of households that had no losses in any clam raising cycle (Group L1), the HHs were assessed in terms of resilience capacity based on the speed of their recovery from losses in clam farming. In this regard, the following two questions were asked:

(Q.1): Did the HH restart after the loss? If yes, how long after the loss did the HH start a new clam raising cycle?

(Q.2): If the HH started a new cycle, did it recover from the loss? If yes, how long did it take to recover from the loss?

Based on their answers (after cross-checking the answers with the time series data about clam farming performance in the period 2006-2014), the HHs were divided in to 3 groups according to 2 indicators: (1) Restarted: the household restarted a new clam crop after previous clam losses and (2) Recovered: the household financially recovered from previous clam losses.

(1) **R1:** Restarted after the loss and recovered from the loss

(2) **R2:** Restarted after the loss but did not recover from the loss

(3) **R3:** Did not restart after the loss

Table 4.6: Assessment of clam household resilience

		Groups of households based on clam farming performance			
		L1	L2	L3	L4
Keep continuing		Group A			
Grouping based on resilience capacity after losses	R1		Group A	Group B	
	R2			Group C	Group C
	R3			Group C	Group C

The matrix below, which shows the loss frequency and resilience capacity, will be used to select 3 groups of households for the second survey.

The classification resulted in the 3 groups described below, which are used to compare differences among risk management strategies and to analyze the results of risk management strategies in the following step.

Group A: Households that were not affected or were slightly affected by previous clam farming and marketing risks.

Group B: Households that were seriously affected by previous clam farming and marketing risks but restarted clam production and recovered from farming losses.

Group C: Households that were seriously affected by previous clam farming and marketing risks and restarted clam production but have not yet recovered from previous farming losses.

4.2.5.3. Methodology for assessment of risk management strategies

4.2.5.3.1. Assessing the results of individual risk management strategies

The results of each risk management strategy were assessed based on a comparative analysis between two groups, one that included households that applied risk management strategies and one comprising households that did not apply risk management strategies. For this analysis, several tests (Green and Salkind 2010, StatisticSolutions 2013) were performed to identify differences in the results of risk management strategies between the two groups.

- Independent samples t-test, which compares mean value(s) of continuous-level (interval or ratio) data and normally distributed data. This test is based on the assumption that the variables in the analysis are split into independent and dependent variables. In the present research, this test is used to test the hypothesis regarding "profit per ha and sales channels" and the hypothesis regarding "borrowing sources and profit per ha".

- Mann-Whiney U-test, which is a non-parametric alternative to the independent samples t-test. This test is used to compare the equivalency of two sample means that come from the same population. In the present research, this test was applied to test the impacts of different clam-raising plot sizes, namely, plot sizes set by the Thaibinh government and plot sizes created by clam farmers.
- Kruskal-Wallis Test, which is a non-parametric alternative to the independent samples t-test. This test is used to compare more than two groups of sample means that come from the same population in order to test whether those sample means are equal. In this research, the Kruskal-Wallis Test is used to test the hypothesis regarding "sources of juvenile clams and mortality rates".
- Spearman's rho Test, which is a nonparametric measure of the strength and direction of association that exists between two variables measured on at least an ordinal scale. In the present research, this method is applied to test the correlations between cycle length and mortality rate.

4.2.5.3.2. Assessing the effect of tactics on the comprehensive results of clam household risk management

First, a differentiating comparative analysis about household risk management strategies applied by the three groups (which had different risk management outcomes) and the changes throughout the time series were used to identify strategies and techniques that made critical contributions to the success of clam household risk management.

At the same time, a multiple discriminant analysis (Brown 1998, Hoang and Chu 2008) was used to measure the impacts of household risk management strategies on the performance of different clam farming groups by examining differences among the 3 groups (which were categorized based on the outcomes of their risk management strategies) with respect to the application of risk management strategies. The classification functions can be used to determine the group to which each case most likely belongs. There are as many classification functions as there are groups, and each function allows us to compute classification scores for each case in each group by applying the following formula:

$S = C_0 + W_1*X_1 + W_2*X_2 + ... + W_m*X_m$

<u>In this formula,</u>

S is the resultant classification score used to divide the clam households into three groups based on the outcomes of their respective risk management strategies;

C_0 is a constant for the group;

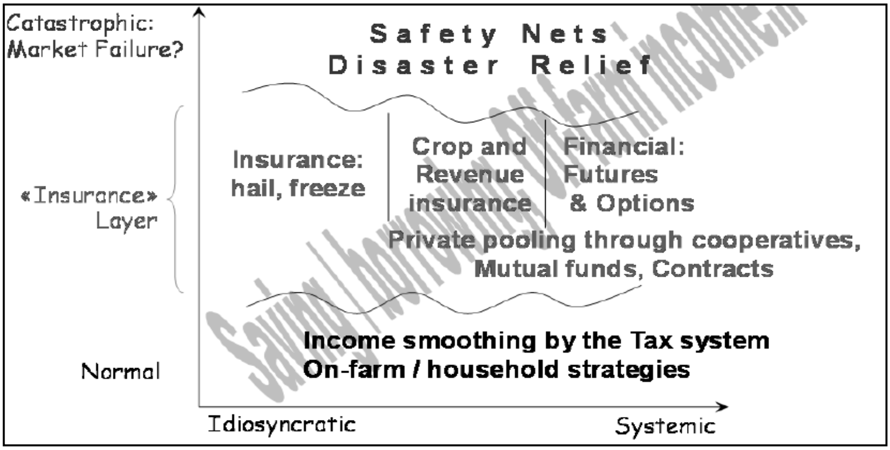
$W_{1..m}$ is the weight of each variable in the computation of the classification score for the group;

$x_{1..m}$ is the observed value of the variables for each case; and

The subscript 1, 2,..., m denotes the m variables, which are the tactics applied by clam households to manage clam farming risks.

4.2.5.3.3. Matching RSMs with Risk layers

First, the major shocks and their consequences for clam farms during a long period (2006-2014) are listed to identify the main risks for the coastal aquaculture research site. The identified risks are ranked and mapped to different layers based on frequency of occurrence and magnitude of loss. Second, the identified risks will be mapped to each risk management strategy (*figure 4.7*) to determine which risks have been addressed and to identify the gaps (if any) between risk management strategies and actual risks.



(Source: Adapted from Cordier et al. 2004)

Figure 4.7: Mapping risk management instruments

4.2.5.4. Methodology used to assess factors that affect the application of RMSs

4.2.5.4.1. Factors affecting household resilience

This study applied both qualitative and quantitative research methods to conceptualize household resilience to the shocks that occur in clam farming. First, a subjective well-being approach – which is widely applied in poverty and livelihood research in developing countries (Narayan et al. 2000) – was used to identify factors that contribute to farm resilience capacity at the household level. Then, the level of the impact of each factor/group of factors was quantified using exploratory factor analysis.

Subjective well-being approach: Subjective well-being (SWB) refers to how people assess their quality of life (Chambers 2004) and includes both emotional reactions and cognitive judgments. Notions surrounding well-being may theoretically offer a culturally appropriate surrogate for resilience (Carpenter et al. 2005). Eleven statements (*table 4.7*) related to the identified factors were included in the household survey to explore farmers' perceptions of their own resilience. These statements were measured using a 5-point scale: 1- strongly agree; 2- agree; 3- not sure; 4- disagree; and 5- strongly disagree.

Table 4.7: Eleven statements used to explore factors that affect household resilience

Statement 1:	I am confident that I have enough capital or can successfully obtain formal credit to restart a new clam cycle.
Statement 2:	In my opinion, decreased clam market prices are associated with opportunities for new clam production cycles.
Statement 3:	In my opinion, clam farming should be continued because its risks are tolerable.
Statement 4:	In my opinion, risks in clam farming are lower than those in other aquaculture activities.
Statement 5:	I am confident that diversified income-generating activities will help me to easily restart a new clam production cycle after a disaster.
Statement 6:	I am confident that clam farming losses have no serious impact on our daily basic needs.
Statement 7:	My household has received government support to recover from a loss.
Statement 8:	I have gained significant practical experience in clam farming in each failed season.
Statement 9:	I have applied new production tools/practices (developed by other farmers) that help to reduce clam farming risks.
Statement 10:	I am confident that changes in clam production techniques will help me to reduce the impact of (natural and market) shocks on clam farming relative to other households.
Statement 11:	In my opinion, a new clam production cycle started after a shock is more productive than the previous one.

Exploratory Factor Analysis (EFA): Multiple-choice questionnaires with Likert-scale responses were utilized to assess farmers' opinions about the above-listed statements. Data analysis was undertaken using NVivo (QSR) to manage the qualitative data and elicit key themes and using SPSS to analyze the quantitative data and produce a descriptive statistical analysis. Cronbach's alpha was employed to define the reliability of each variable. EFA was then conducted to combine related variables into "groups of variables" that have the greatest impacts on household resilience to losses incurred in clam farming.

4.2.5.4.2. Assessing the impacts of government policies and interventions

First, all government policy packages implemented during the history of clam farming will be listed to provide an overview of the level of government intervention/support in this sector. Then, the role of the government in improving efficiency and achieving equity objectives can be analyzed in a strict normative framework (normative approach) (OECD 2009) and the trade-offs of each policy for different targets can be identified. 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; trends in clam farming and marketing practices; emergent risks; and farmers' coping strategies and outcomes.

Next, the listed risks will be mapped to each set of policies to evaluate the role of each actor/factor in the system that includes these instruments and to identify the risks that have been addressed and the gaps (if any) between policies and actual risks.

In addition, the role of the government is incorporated into the "interconnective system" of government policies, farmers' strategies, farming risks, and the interactions among them to identify the economic benefits that can be obtained with risk management tools, the characteristics of risks faced by farmers in the area, and the challenges associated with developing and implementing government intervention (Skees et al. 2005).

4.2.5.4.3. Assessing the impacts of other factors

A factorial analysis using several tests – including ANOVA, the Welch test, Spearman's rho test, and Kendall's tau-c test – was conducted to evaluate possible links and correlations between household characteristics and household risk management strategies.

One-way ANOVA is statistical technique that assesses potential differences in a scale-level dependent variable caused by a nominal-level variable with 2 or more categories. A one-way ANOVA has only one independent variable. The Welch test is appropriate when the assumption of homogeneity of variances is violated. In this research, these tests are used to assess the difference in certain household characteristics, such as average annual income and total clam plot area, among others.

Spearman's rho test, which is a nonparametric measure of the strength and direction of the association between two variables measured on at least an ordinal scale, is applied here to test the correlations between household income and the level of application of risk management tactics.

Kendall's tau-c, Kendall's tau-b (τb) correlation coefficient is a nonparametric measure of the strength and direction of association between two variables measured on ordinal scale. In this part of the research, this test is applied to evaluate the impacts of certain household characteristics (e.g., education level, farm experience, job of the head of household, participation in training courses and farmers' associations) on the level of application of risk management tactics.

4.2.6. Limitation of the study

Although this research was carefully prepared, there were some unavoidable limitations. First, the research was conducted with sample size is equivalent to 10% of the population of the clam farmers in Thaibinh province. Due to sampling bias, it contained some limitation when generalizing the result for larger groups. Second, besides majority of famers having books recording the expenses and revenue related to clam farming, some farmers who owned small area of clam just answered the questionnaire based on their remembrances. The recall of those data might lead to the memory bias in information. Though it has been cross checked with other sources of infor, the statistics source still contained some data noise. In addition, the Monte Carlo simulation, which has been used to access the clam farming risks, also has constraint as some variables might autocorrelated with each other, such as the changes of production scale and the increase/decrease of the price. While this autocorrelation is accepted for the inputs of Monte Carlo simulation, it still caused some limitation in the risk assessment results.

5

CLAM FARMING RISKS IN THAIBINH PROVINCE

This chapter discusses the aquaculture risks in clam farming in Thaibinh province. It comprises four parts. The first part introduces household-level clam farming characteristics in Thaibinh province. The second part discusses the causes and effects of aquaculture risks in clam farming and assesses those risks based on their consequences and likelihoods. Based on this discussion and other observations about existing farming practices, the third part of this chapter debates several paradoxes in clam farming, because these paradoxes partially explain the vulnerability of clam farmers in Thaibinh province. The fourth part summarizes the mains research findings of this chapter.

The main content of this chapter has been presented in the paper namely "*Clam farming risks in Thaibinh province, Vietnam: impacts and causes*", which is confirmed to be published in *Journal of Bulletin des Séances* - KAOW-ARSOM (http://www.kaowarsom.be/documents/PDF%20BULLETIN/NGO.pdf).

5.1. Clam farming at the household level in Thaibinh province

5.1.1. Characteristics of clam raising models at the household level in Thaibinh province

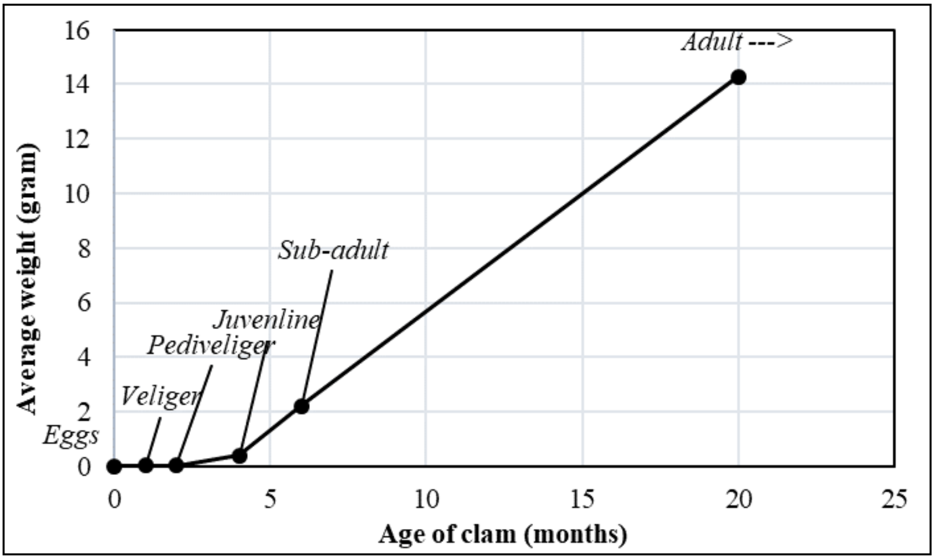
Clam farming practices have changed significantly over time. Initially, the sector was quite extensive in terms of clam raising density, labor and facilities investment. Over time, especially since the end of the 2000s, as the benefits of clam farming increased, the sector has become increasingly intense, with expanded farming areas, increased raising densities, and higher investments in labor, facilities, and even certain feeding practices.

Picture 5.1: Clam hatchery pond

Picture 5.2: Clam raising farm

Clam farming has certain unique characteristics that differentiates it from other aquacultural practices. Clam farming is primarily undertaken along the shallow coastal area, because plankton floating in the sea is a source of nutrients for clams. Food for clams is mainly a mix of organic matter (70-90%) and seaweed (10-25%)

and may change throughout the seasons. The clam raising cycle depends on juvenile size, the availability of natural food sources, and even market prices. Farmers can keep their clams in raising plots for quite lengthy periods before they harvest the clams for sale. However, the clam farming cycle in the study site is often not more than 4 years. According to the technical instructions of Thaibinh DARD, it takes approximately 12-18 months to raise clams from the juvenile size of 1,000 heads/kg to the size of 70 heads/kg (*figure 5.1*). The FGDs revealed that 6-7 years earlier, the length of a clam raising cycle was approximately 12-18 months; however, more recently, the cycle is between 18 and 30 months, primarily due to increased clam raising density, which has led to reduced feed source availability and other disadvantages (like environmental pollution) that are unfavorable for clam growth.



(Source: Thaibinh DARD 2013)

Figure 5.1: Clam life cycle

Clam raising practices

Clam raising practices can be categorized into 3 groups (hereafter called models): (1) Model 1 is the clam meat farm (*picture 5.3*); (2) Model 2 is the clam hatchery farm (*picture 5.4*); and (3) Model 3 is a combination of Models 1 and 2. Out of the 639 clam raising cycles identified during the study period (2006-2014), 67% applied model 1, 16% appliede model 2, and 17% applied model 3.

Average clam farming costs differ among the three models, i.e., average costs are USD25,950/ha, USD45,117/ha and USD45,930/ha for Models 1, 2 and 3, respectively (*table 5.1*). Farming costs can be divided into two groups: fixed and variable.

<u>**Fixed costs:**</u> Farmers must invest in protective net systems, guarding sheds, and temporary resting sheds. In addition, some farmers might add new sand to their clam raising plots to provide additional clam feed and mitigate environmental pollution.

On average, a guarding shed cost approximately USD900-USD1,300 and can last as long as 4-6 years, although it can be destroyed very quickly in the event of heavy storms. The cost of adding new sand depends on the farmer's assessment of natural feed availability in the farming plot and the farmer's investment ability. Sand-pumping services are now widely used by many farmers due to the expectation that new sand will improve the habitat for clam growth. For certain plots, the cost of new sand can be USD300-USD450/ha. The cost of a protective net system is approximately USD200-USD400/ha, on average, and varies based on the location of the clam raising plot and the clam raising model (i.e., the cost is higher for juvenile production). However, in general, the larger the clam raising plot, the lower the cost per ha for a protective net system.

Table 5.1: Costs and profits of three clam raising models

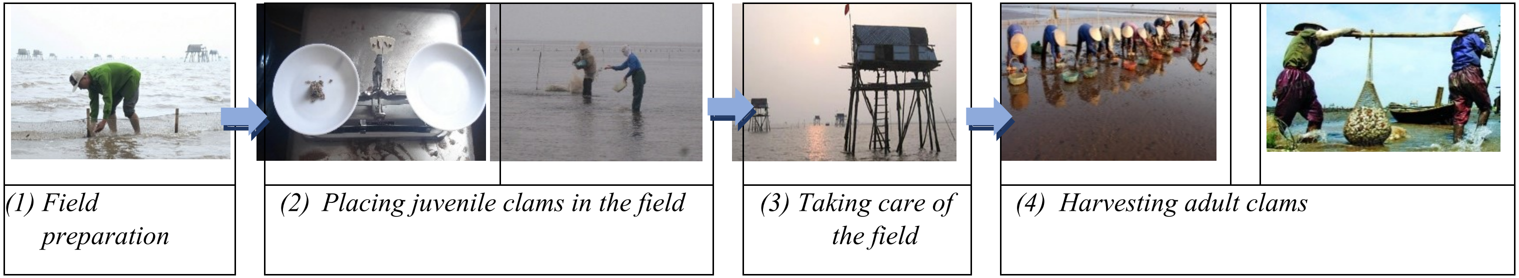
	Model 1	**Model 2**	**Model 3**
Profit per ha (USD) (**)			
Mean	2,032	10,420	30,000
Standard Deviation	29,265	76,621	83,887
Average cost per ha (USD) (*)	25,950	45,117	45,930
In which: *Labor cost (USD)*	5,236	116	6,982
Probability of loss	55%	43%	52%
Cycle length (months)			
According to technical instructions	12-18	2-6	20- 24
In reality (***)			
Min	7	4	8
Max	48	13	43

Note
(*) *Asymp. Sig. of Kruskal Wallis Test: .506*
(**) *Asymp. Sig. of Kruskal Wallis Test: .000*
(***) In reality, the sizes of juvenile and adult clams vary significantly. Moreover, the cycle length depends on clam growth rates and market availability.

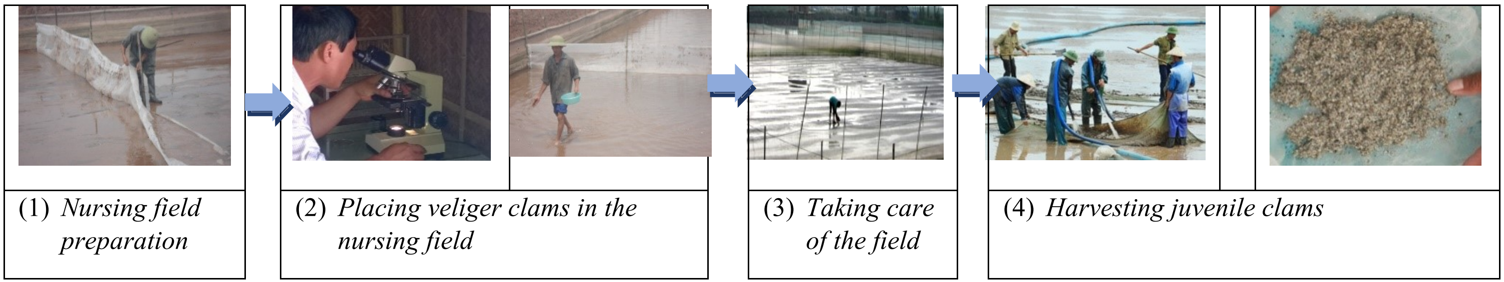
(Source: Results of Monte Carlo Simulation)

Variable costs: Variable costs include expenditures for juvenile purchases, land rental, farming and protection labor, and interest on loans, among other costs. Juveniles are very costly and normally account for 65-80% of total clam production costs depending on their size, raising density, and market price. The cost to rent land is approximately USD130-USD500. Labor costs include those for clam protection, the cleaning of nets, and the collection of dead clams and normally range from USD100 to USD200/month/person. Loan interest rates are often 10.8-20%/year, depending on the loan provider. With the exception of juvenile purchases, all variable costs are associated with the length of the clam raising cycle. Like fixed costs, variable costs are inversely correlated with plot size, mainly because a lower ratio of labor is required for larger plots.

A Mutual Information Index (MII) sensitivity analysis (with 1,000,000 trials in a Monte Carlo simulation) yielded several significant indicators for the three clam farming models (*table 5.1*).



Picture 5.3. MODEL 1: CLAM MEAT RAISING FARM



Picture 5.4. MODEL 2: HATCHERY CLAM FARM

5.1.2. Information about clam households

Table 5.2: Characteristics of clam farming households (2006-2014)

Average annual income *(Unit: USD)*	Mean: 11,625	Max: 56,819	Min: 2,728	Std. Error of Mean: 914.09 Std. Deviation: 11,453
Percentage of clam farming profits in total family income		Max: 50%	Min: 0%	Std. Error of Mean: 0.01 Std. Deviation: 0.17
Education level	Primary school			8%
	Secondary school			59%
	High school			26%
	Higher education			7%
Job of the head of household	Farmer			67%
	Employee			9%
	Business			20%
	Other			4%
Diversification activities	Other aquacultural activities			52%
	Rice production			64%
	Livestock			20%
	Paid jobs			38%
	Business			36%
	Other income sources (e.g., remittances)			8%

(Source: Household survey 2015-2016)

Most clam farming households are headed by men, two-thirds of which have a secondary school education level and only 7% with higher education levels, such as vocational school or university. During 2006-2014, the average annual income of clam farming households was USD11,625, which was much higher than the average income of rural Vietnamese households in that period (Tarp 2015). However, there are significant income differences among clam households; some households might have an annual income of up to USD56,819, whereas others earn only USD2,728 /year (*table 5.2*). During the study period, the average share of income from clam harvests in total household income was in a range from 0% to 50%. Among 157 surveyed households, 17 households (accounted for 11%) had income from clam contributed more than 40% in their total households' income, while 74 households received nothing from clam farming in period 2006-2014, because the profit in one or two cycles had been used to offset the loss from other cycles. When considering about clam farming, the farmers seemed to calculate the balance of two continuous cycles rather than to have an overview for the long period (i.e. 9-10 years). This explains why they kept continuing to invest while the loss happened. Clam farming is not considered as main livelihood which aims to earn money for their daily life, but the farmers want to invest to "blow up" their money. In their observation, they have only seen the high profitability in clam farming whereas the clam farming risks in their view has been underestimated. Part of the reason for this underestimation is up to 2014, there has no research about clam farming risks as well as the clam farmers have not been officially informed about the level of those risks.

Because the clam raising cycle is long (an average of 18 months for clam meat), all clam households have income sources other than clams. Income from other activities helps to ensure the survival and well-being of clam farming households. Rice production is mainly for the household's own consumption; income from livestock sales, wages and business activities are used mainly for daily spending needs; and profits from aquacultural production (such as shrimp and fish raising) are mainly invested back into aquaculture (including clam farming) and used to pay debts and interest on loans.

Clam farming performance in the 2006-2014 period

Among the 157 surveyed households, there were total of 285 clam raising plots. In the 2006-2014 period, 47% of those plots completed 3 clam raising cycles, 27% completed 2 raising cycles, 24.6% completed only 1 raising cycle, and 0.4% completed 4 or more raising cycles (*table 5.3*).

The average area of clam plots per household is 2.63 ha and ranges from 0.2 ha to 20 ha. Reasons for differences in plot size include the location of the land and the regulations of each commune (e.g., certain communes have an equal allocation policy (including Thaido), whereas others apply the auction principle (including Dongminh and Namthinh)). Moreover, clam plot size can vary due to differences in land use among farmers (Ngo et al. 2016). For example, some farmers rent out small sections of their land to others, whereas other farmers rent more land to increase plot

Table 5.3: Information about clam production (at household level)

Indicator	Unit	Mean	Min.	Max.
Number of plots/1 household	Plot	1.82	1	5
Number of cycles in a plot	Cycles		1	4
Total area of clam plots/household	Ha	2.63	0.20	20.00
Profit per year/household	USD	3,600	-79,330	63,904

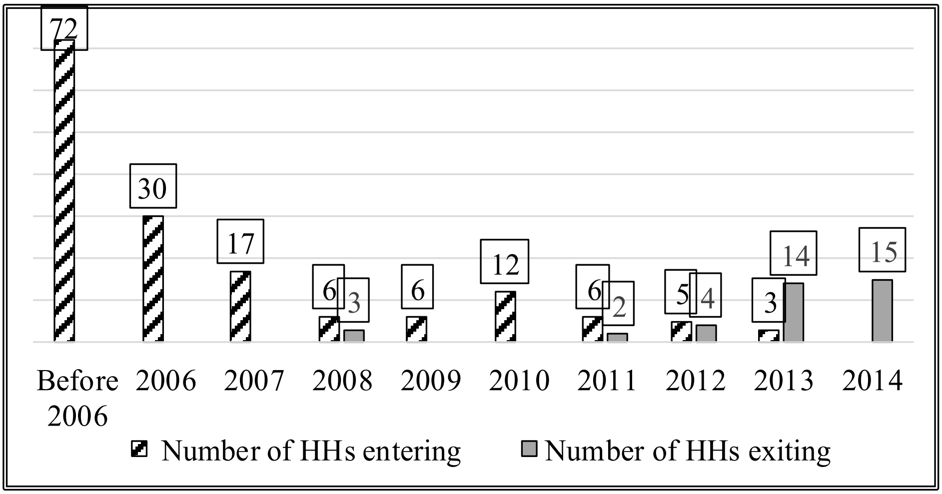
(Source: Household survey 2015-2016)

sizes. Although Models 2 and 3 generate higher profits, neither is as popular as Model 1 due to the high technical requirements of juvenile clam raising. Models 2 and 3 are also more sensitive to mortality rates compared with model 1. Moreover, farmers always under-estimate risk and over-estimate profits.

Certain plots are not individually owned but rather are shared among groups of 2 - 5 farmers who share costs, profits and risks. A farmer can join more than one plot share. Some shares are very successful, but others have had to disband due to conflicts among the sharing farmers.

Points of time at which farmers entered and exited the clam farming sector:

Forty-six percent of HHs started clam farming before 2006. The total number of clam farming households continued to increase until 2013, although the increases shrank over time. Thirty HHs joined the clam sector in 2006, 12 HHs joined in 2010, and 3 HHs joined in 2013. Out of 157 HHs, 38 left the clam sector. Of these, 3 HHs exited in 2008. No HHs left clam farming in 2009-2010, because clams were "golden animals" that generated "super profits" during that period. However, exits from clam farming restarted in 2011, when clam production began to decrease. In 2014, 15 HHs left clam farming and none entered (*figure 5.2*).

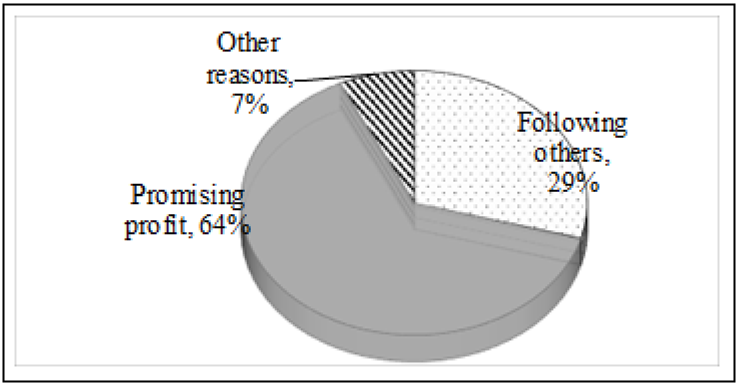


(Source: Household survey 2015-2016)

Figure 5.2: Timeline of household entry into and exit from clam farming

Reasons for entering and exiting the clam sector

Reasons for entering the clam sector



(Source: Household survey 2015-2016)

Figure 5.3: Reasons for entering the clam farming

As is the case in other business sectors, most farmers decided to enter clam farming because of the profits (*figure 5.3*). However, 29% of clam farmers entered the sector because they had seen others raising clams (e.g., neighbors, relatives). Seven percent of farmers provided other reasons for entry into clam farming (e.g., they did not know to do anything else, clam farming was considered less risky compared with shrimp or other aquaculture sectors). Three farmers who started in 2013 gave the same reason for starting clam farms when other clam farmers were suffering losses.

Box 5.1: Reason for entering clam farming when others are experiencing losses

"In 2013, everything was cheap : land, juvenile clams. I thought that the market situation would improve again, and I prepared for that."

(Source : Interview with a farmer in Dongminh Commune, Tienhai district – 18/07/2

Reasons why farmers continue clam farming when they experience losses

Normally, people will stop production activities when they experience losses. However, many clam farmers remained in the clam farming sector after experiencing serious losses. When questioned about the reason they invested in this sector despite the high level of risk, 75% of farmers in this group claimed that the investment was an attractive form of "gambling", meaning that the more they lost, the more they wanted to invest (if they had the money to invest) in order to recoup the losses of previous cycles. Presented below is the opinion of one farmer who has been involved in clam production for 10 years and who continued claim farming after a loss of nearly USD30,000 in 2012.

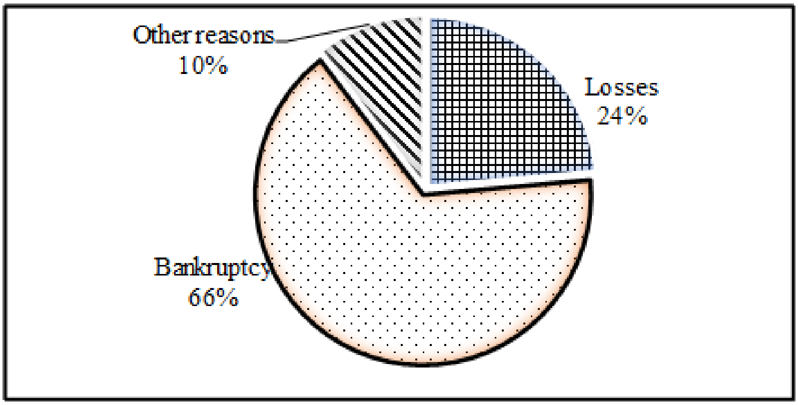
Box 5.2: Farmer's opinion about investment in clam production : No risk, no gain

"Only clams can save a clam farmer. Nothing is more profitable than an investment in this sector. With one cycle like those in the 2009-2011 period, we could cover the losses of 3 cycles like those in 2012. I would like to get money back from the place where I lost it"

(Source: Interview with a farmer in Thaido commune, Thaithuy district – 20/07/2015)

<u>Reasons why households exit clam farming</u>

Twenty-four percent of the interviewed households (38 HHs) discontinued clam farming, for a variety of reasons. Whereas the opportunity for "promising profits" was the most important reason to invest in this sector, 66% of exiting households decided to leave the sector due to bankruptcy (*figure 5.4*). These households indicated that if they had the money, they probably would have continued to invest in the clam sector. Only 24% exited because they did not want to suffer additional losses, meaning that they did not continue to invest despite having the money to do so because they could not see a future in clam production. Ten percent exited clam farming for other reasons, such as having no one to take care of the clam farm or believing that the land was unsuitable for clam raising.



(Source: Household survey (2015-2016))

Figure 5.4: Reasons for leaving the clam farming sector

Market access

There are two main sources for the purchase of juvenile clams. Farmers prefer to buy from well-known sources (like those in Namdinh) rather than purchasing directly from wholesalers in the commune. With regard to the sale of adult clams by farmers, there were two types of collectors (from the commune and from outside the commune) in 2006-2012, but clam collectors from outside the commune suddenly disappeared in 2013 (*table 5.4*). Among the interviewees, 95% stated that they did not know where the buyers came from and 100% indicated that they did not realize the importance of contract farming in clam production. Local governments provide no intervention/support to assist farmers in finding output markets, issue warnings about fluctuations in price or output demand, or protect clam farmers when they work with foreign strangers in the local area, etc.

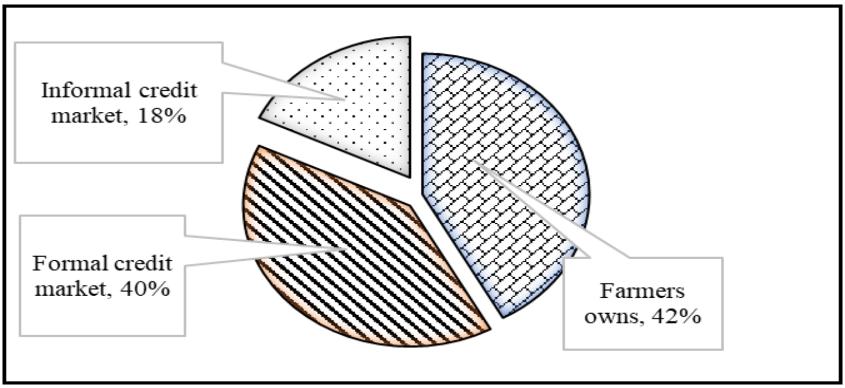
Table 5.4: Proportions of purchase/sales transactions via different sources

Breeding clam buying sources				**Adult clam collectors**		
Period	*Purchased*		*Raised themselves*	*Period*	*Local collectors*	*Non-local clam collectors*
	Local wholesaler	*Non-local wholesaler*				
2006-2014	18%	56%	26%	2006-2012	53%	47%
				2013-2014	100%	

(Source: Household survey 2015-2016)

Financial resources of clam farmers

In a sector with high capital requirements, farmers have access to several financial resources in addition to their own capital (*figure 5.5*). In the formal credit market, farmers can access banks and credit funds that offer low interest rates but require high-value assets as bond and have strict credit limits for "clam production profiles" because clam production is considered a "high-risk production investment". In contrast, the informal credit market has lower barriers in terms of bond assets and credit limitations, making it very attractive to poor farmers. However, higher interest rates (5-10% higher than in the formal credit market) and substantial economic pressure in the event of a loss of capacity to repay the loan (e.g., house dispossession, usurpation of high-value assets) place poor farmers in a situation that is "easy to join but difficult to escape".



(Source: Household survey 2015-2016)

Figure 5.5: Financial resources of clam farmers

5.2. Clam farming risks in Thaibinh province

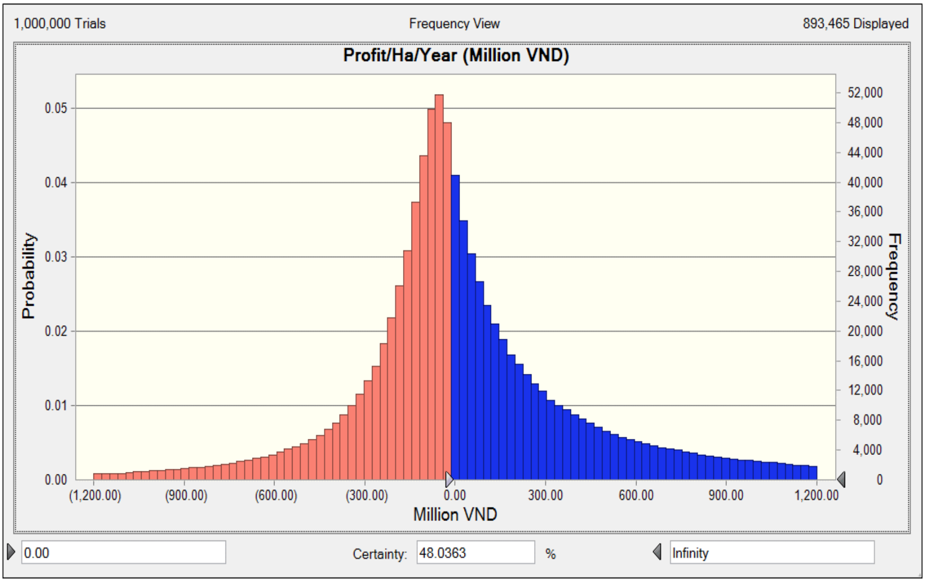
5.2.1. Shocks in clam farming in 2006-2014

Picture 5.5: Dead clams following a storm (7/2013)

Picture 5.6: Dead clams following an environmental shock (8/2014)

According to research regarding the status of hard clam farming in some coastal provinces of North and Northern Central Vietnam, approximately 84.1% of surveyed farmers reported that their farms had experienced at least one event of massive cultured clam death (Bui and Tran 2013). During the period 2006-2014, clam farmers in Thaibinh province had to cope with several shocks, which can be divided into two groups. The first group contains shocks causing serious declines in total yield volume despite annual increases in total production area. This type of shock is usually natural, for example, extreme weather events during this period led to excessive fluctuation in clam farm productivity. Because clams are highly sensitive to the environment, high mortality rates have been seen following temperature shocks, storms, polluted water flows and diseases (*table 5.5*). The shocks in the second group are those in the market, such as sudden changes in prices (input or output) and a surplus of clams in the market when supply greatly exceeds demand. Whereas the first shock group causes a decrease in productivity, the second group causes sharp declines in farmers' income.

The "boom" of clam production in 2010-2011 had caused the large increase in the volume of clam meat in year 2012, together with the diminish of demand for clam (as the result of the sudden disappear of the middle men), the price of clam meat sharply decreased. In the case of clam farming, the decrease in price might lead to the decrease of the productivity of the clam production. Because when the price went down or the output market stagnant, the farmers might have a response by keeping their clam in their farm unlimitedly. Different from other type of agricultural production which have a definite time to harvest, the clam farmers could extend the harvest point to whenever he wants. However, the more clams that are kept in the field, the greater the farming risks are, which finally increased the mortality rate of clam cycles and therefore exacerbates the farmers' situation. This fact explained the situation happened in the period from the second half year 2012 to 2014, when the price decrease happened together with the decrease of productivity.



(Source: Results of Monte Carlo Simulation based on data from household survey 2015-2016)

Figure 5.6: Probability distribution of clam profits

Farmers have said that clam farming is comparable to gambling. Given its long raising cycle and substantial dependence on external factors, clam farming involves significant risk. The forecast based on the Monte Carlo results shows that the rate of investment loss is 52% (*figure 5.6*); the loss rates for clam meat farms; clam hatchery farms and combination models in particular are 55%; 43% and 52% respectively. As mentioned in part 5.1.1, there are three models of clam farming, i.e. model 1 “clam meat raising farm”; model 2 “clam hatchery farm” and; model 3 “combination model”, which are different in term of profitability. However, the more profitable the model is, the higher technical it requires. This explains the reason of the choice of clam farmers to raise adult clam or juvenille clam. As part of the household’s strategy, the clam farmers will choose the model which they think it is under their control. Although model 2 and model 3 created higher profit but these models are not as popular as model 1 because the higher technician requirements for juvenile clam raising, because juvenile clam are more sensitive with water conditions, which cause higher mortality rate than model 1. On the other hand, model 1, with longer time of clam cycle, is more impacted by the sudden changes of price than the others, which finanlly has highest loss rate among three models. Model 3 has the highest level of profit, with the probability of loss at medium level, but is not the popular one because the constraint of the size of the land as well as the technican requirement.

When farmers were asked why they invest 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 that they would win in subsequent clam raising cycles. Clam production provides an excellent example of key insights on risk management in 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 in this chapter will discuss the impacts and causes of risks in clam production, providing a solid foundation for assessing and making recommendations regarding risk management strategies in the agricultural sector.

Table 5.5: Shocks in clam farming in Thaibinh province (2006-2014)

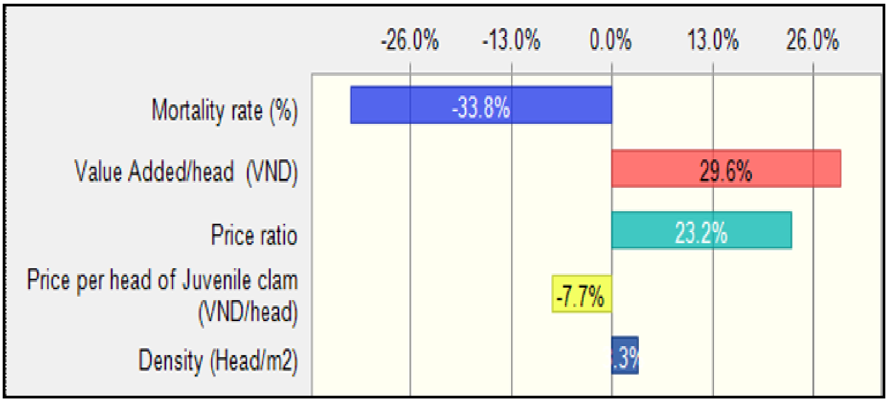
SHOCKS			**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Effect on producti-vity	Storms	*Number of storms*	2 storms	4 storms	3 storms	3 storms	2 storms	4 storms	2 storms	4 storms	2 storms
		Estimated mortality rate	10%-20%	10%-20%	10%-20%	30%-40%	10%-20%	10%-20%	30%-40%	20%-30%	30%-40%
	Heat shocks	*Highest temperature (number of hot days)*		37.9° 10 days		37.5° 15 days	38.3° 22 days	37.3° 7 days	37.6° 14 days	38.2° 8 days	36.5° 9 days
		Estimated mortality rate		10%-20%		10%-15%	10%-15%	10%-15%	10%-20%	10%-20%	
	Water pollution	*Year*				x	x	x	x	x	x
		Estimated mortality rate				15%-20%	20%-30%	30%-50%	40%-60%	50%-60%	60%-70%
	Disease	*Year*			x	x			x		
		Estimated mortality rate			15%	15%			15%		
Effect on profits	Changes in price	*Trend of changes*	↗	↗	↗	↗	↗	↗	↘	↘	↘
		Estimated level of changes	5%	10%	20%	30%	30%	30%	30%	30%	40%
	Oversupply in the market								x	x	x

(Source: ThaiBinh Statistical Department & Household survey 2015-2016)

5.2.2. Impacts of clam farming risks

5.2.2.1. Direct economic impacts

Data on clam farming losses during 2006-2014 for the 157 households interviewed in this study show a severe impact of losses on clam farming. In 2012, when farmers suffered a clam area loss of 67% (147.05 ha owned by 42 households), farmers' total losses amounted to more than USD2.2 million. During the next several years, the percentage of clam raising area lost continued to increase slightly, although the total loss decreased steadily. Due to the shocks that occurred in 2006-2014, 42% of interviewed clam farmers had negative average annual profits. A loss of USD79,000/per year was the most serious case reported.



(Source: Results of Monte Carlo Simulation based on data from Household survey 2015-2016)

Figure 5.7: Contributions of factors to variations in profits

A sensitivity analysis based on the results of the Monte Carlo simulation reveals that clam mortality rate was the main factor causing variations in farming profits, with a negative impact (the higher the clam mortality rate was, the lower farmers' profits were). The price fluctuation (calculated using clam prices at two points in time, i.e., the harvesting point and the start of the cycle) was the second most significant external factor, contributing to 23% of profit variations (*figure 5.7*).

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 (2-5 months) and greater investment in technical equipment, profits from clam hatchery farms oscillate based more on mortality rates; specifically, mortality rates caused profit variations of minus 52%, whereas changes in price 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 of 18 months in normal conditions). Overall, in all farming systems, more than 50% of the profits from clam raising depends on external factors.

5.2.2.2. Other socio-economic and environmental impacts

The fluctuation in clam farming productivity and prices has a serious financial impact on farmers. Investments amounting to hundreds of billions VND were lost each year during the 2012-2014 period. Thousands of farmers faced bankruptcy. Approximately USD20.8 million of bank debt could not be repaid (Hoang 2013). Of the 157 households interviewed, 16% exited clam farming due to bankruptcy and 38% had to sell their fixed assets (e.g., houses, cars, motorbikes, even clam fields) to repay debts. Moreover, attracted by the "promising profit gamble" of clam raising, 45% of farmers opted to borrow more money to reinvest in clam farming based on the belief that "only clams can save clams." Unfortunately, not all of these farmers were successful. A number of farmers had to leave their respective villages because they were unable to repay debts (there were at least 3 such cases in Dongminh commune, 5 cases in Namthinh commune and 2 cases in Thaido commune).

Picture 5.7: Clam field after massive clam death

At the same time, other socio-economic and environmental problems – such as reduced clam-based employment opportunities for local farmers and water (and even air) pollution caused by clam deaths (*picture 5.7*) – were occurring (Mai 2013).

Human loss is also possible when farmers (especially women) work on the sea. In 12/2014, in Tienhai, six clam farmer deaths occurred during the harvesting of clams by boat; five of the farmers who died were women. Several months later, in 2/2015, 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, to ensure a sustainable livelihood for clam farmers, identifying the root causes of these risks is necessary to enable both farmers and governments to adjust their actions accordingly and implement more effective risk management strategies.

5.2.3. Causes of risks

The information obtained from the farmer group discussion and key informant interviews revealed that there are three main types of risk that affect clam production, namely, production risks (which cause clam mortality); market risks (which cause difficulties related to market access and decreases in clam prices) and financial risks (which cause household debt and bankruptcy). Detailed information regarding each type of risk is discussed in the following paragraphs.

5.2.3.1. Production risks

Production risks cause clam mortality, slow clam growth and even deformities. These risks lead to reductions in clam yield. According to Thaibinh statistics, clam yields ranged from 11 to 70 tons/ha during 2006-2014 (Thaibinh DARD, 2015). However, local governments and farmers have conflicting opinions about the 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 following technical recommendations regarding density). In contrast, farmers cite the discharge of polluted water from nearby factories and rice paddies as a major cause of clam mortality. In general, 4 factors are identified as major causes of clam mortality.

***Weather factor*:** A clam production cycle normally lasts 18-24 months (from a starting point of approximately 1,000 clam heads/kg to a harvesting weight of 70 clam heads/kg). During such a long period, many environmental factors can cause serious levels of clam death. According to technical guides for aquaculture production published by the Thaibinh Department of Agriculture, a suitable temperature for clams varies from 18 to 30°C (ThaibinhDARD 2013). In contrast, at the study site, the climate temperature can be as high as 38°C continuously over a multi-day period. Moreover, the coastal area often experiences at least 2 storms per year, some of which are disastrous, such as the Kammuri storm in 2008 and the Son Tinh storm in 2012. In a preliminary study, (Le 2012) concluded that among various weather factors, water temperature had the greatest impact on clam mortality rates.

However, weather factors are not the only cause of massive clam death. For example, in 2014, the highest temperature was 36.5°C and the number of hot days was only 9, whereas in 2010, there were 22 days with temperatures as high as 38.3°C. Nonetheless, average clam mortality rate was lower in 2010 than in 2014 (*table 5.5*).

Disease and salinity levels: An experiment involving two types of widespread bacteria – namely, *Vibrio harveyi* and *V. alginolyticus* – over a period of 240 hours (10 days) showed that these bacteria have no direct effect on clam mortality and growth rates and therefore have no impact on clam vitality. Salinity level does not cause clam death but may affect clam adaptability when clams are moved to new raising environments, e.g., from juvenile fields to commercial clam production fields (Le 2012).

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. Whereas the technical instructions issued by the Thaibinh Department of Aquaculture suggest that a suitable clam raising density is 300-400 head/m^2 (ThaibinhDARD 2013), farmers have adopted raising densities as high as 700-800 head/m^2. High stocking densities undoubtedly cause reductions in clam feed and in other environmental factors that support clam growth (e.g., light, oxygen) (PV 2014). In addition, many studies have confirmed the inverse effect of density on survival rates (Le and Le 2015, Ngo and Nguyen 2015). 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 wastewater flows, the field closer to wastewater flows has a higher mortality rate; and (2) areas between fields (which are 1-2 m wide) are home to very few clams (low density) but suffer the same death rates as clams inside the fields.

Several scientific studies indicate that clam raising density is not a direct cause of high clam death rates, although it might have an indirect impact. The increase in clam density from 200 to 493-600 head/m^2 might cause a surge in farmers' income during the first few periods but will ultimately lead to the degradation of environmental factors that support clam growth (Bui and Tran 2013). The research of Le (2012) conducted 4 experiments to determine the impact of raising density on clam growth. After two months, the weights of 158 heads of clam (randomly chosen) with densities of 150 head/m^2, 300 head/m^2, 700 head/m^2 and 1,200 head/m^2 were 1,500 g; 1,420 g; 1,390 g and 1,240 g, respectively. The longer that clams live in the field, the greater the expected risk is. Moreover, the overall mortality rate increases.

Polluted wastewater flow: As is the case for the issue of raising density, local governments and farmers have opposing opinions on polluted wastewater flows. Along the coast of Thaibinh, there are several drains for wastewater that is discharged from inland factories and rice fields; farmers claim that the wastewater flow is a cause of massive clam death (*picture 5.8*). Farmers have observed that the clam death rate always increases when wastewater is discharged.

Picture 5.8: Map of clam farming zone& wastewater flow in Tienhai district-Thaibinh province[1]

However, the government has not yet officially accepted the farmers' claims, noting that the adjacent factories have operated since the 2000s but the phenomenon of massive clam death has only occurred in more recent years (i.e., since 2012). Moreover, when massive death clam occurs, the water environment is damaged because farmers cannot collect all of the dead clams, which exacerbates the situation (PV 2014). Nevertheless, the research in 2012 of Le Thanh Tung (Research Institute for Marine Fisheries) revealed that water in the Thaibinh coastal area exhibited signs of contamination, which affects clam growth; however, no records exist to prove a correlation between contaminated water levels and clam mortality rates. Many environmental elements were higher than recommended by Vietnamese technical standards2 for aquatic production, including total suspended solids; N-NO2; N-NH4+; P-PO43-; and TSS. Clams are also very sensitive to niclosamide - a chemical used in rice paddies to control golden snails (Le 2012).

Low-quality juvenile clams: The low quality of juvenile clams is also cited as a cause of slow clam growth (which leads to longer raising cycles) and deformation. Farmers assert that clam growth and resistance (e.g., to extreme climate conditions) are lower than they were 10 years ago. As discussed above, environmental issues and the natural depression process can reduce the quality of juvenile clams. However, these are not the only reasons for a decline in juvenile quality. Rather, in order to quickly increase clam production through expanded plot areas and raising densities, farmers have accessed different sources of juvenile clams – including sources in neighboring provinces (such as Namdinh and Thanhhoa), China and

[1] *Source:https://www.google.com/maps/place/Ti%E1%BB%81n+H%E1%BA%A3i+District,+Thai+Binh/@20.3766617,106.5180612,7407m/data=!3m1!1e3!4m5!3m4!1s0x314a00977e6991b9:0xba8797b82f547bc6!8m2!3d20.3609414!4d106.5584071*

[2] *QCVN 10: 2008/BTNMT*

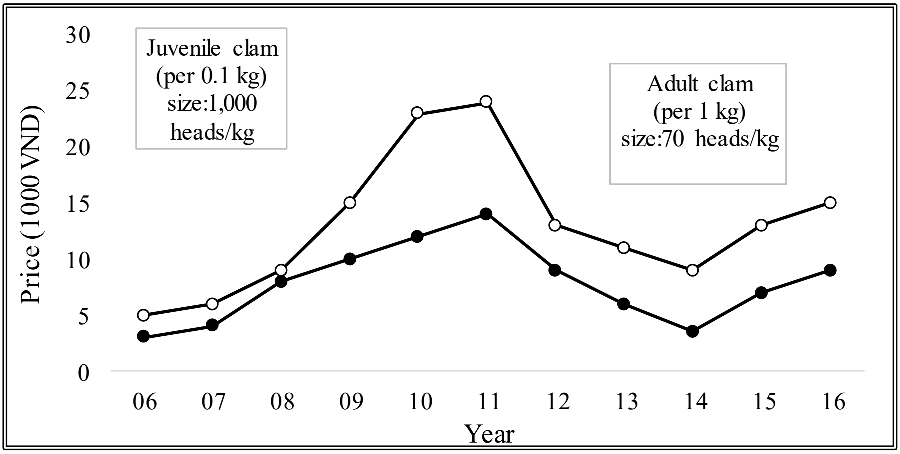
Taiwan – because the juvenile clams produced in Thaibinh could satisfy only approximately 17% of total demand in the 2010s (ThaibinhDARD 2014). Farmers have reported that juvenile clams purchased from other locations are more vulnerable to the new raising environment, and many clams have had problems related to the deformation phenomenon.

5.2.3.2. Market risks

The clam market is characterized by oversupply and instability. Expansion of the clam raising area in the 2006-2010 period can be explained by the "super profits" earned by clam farmers during that time. However, after 2010, the continuous expansion of clam raising operations promoted by the Thaibinh Provincial government – with targets of 100,000 tons of clam harvest/year by 2015 and 200,000 tons/year by 2020 – has caused substantial market shocks for clam farmers. Nearly one thousand ha of intertidal area was converted to clam production between 2011 and 2014, whereas clam demand has decreased since 2012. An official record of the Thaibinh Commercial Department reveals that before 2012, 50-60% of total provincial clam harvest was sold to China through unofficial export channels, 30% was sold to the EU market and only 10% was sold in the domestic market.[3] However, in 2012, illegal additives used by farmers and toxic industrial waste (Lam et al. 2013) caused two food safety incidents, which prompted the Chinese Government to reform its laws, establish monitoring systems, and strengthen food safety regulations, especially with respect to unofficial import channels. Accordingly, clam exports from Vietnam to China have been restricted and even prohibited (Phu 2014). At the same time, additional food safety requirements adopted in EU markets created new barriers for Vietnamese aquaculture export product, including clams.

Sudden changes in price and latency of response: In combination with decreases in total clam harvest due to production risks, reduced market access and lower clam prices (an inevitable consequence of oversupply) led to a significant decline in the total value of clam production despite expansion of the clam raising area. The rapid increase of clam prices during 2006-2011 was immediately followed by a continuous decline during 2011-2014 (*figure 5.8*). The prices of juvenile clams fluctuated in a similar manner. However, the impact on juvenile clam prices is not evident until the end of the clam raising cycle, i.e., 18-24 months after the purchase of juveniles. The dotted line in Figure 4.8 connects the start and end points of one clam raising cycle. Given a normal clam loss rate of 30%, the best-case gross profit rate doubled between 2006 and 2007 and increased nearly two and one-half times during the 2009-2011 period, but there was no growth in 2012-2014. This trend could become even more dire because it is affected by many other risks in addition to price.

[3] *Information from key informant interviews in April 2015*



(Source: Thaibinh Statistical Department,2017)

Figure 5.8: Fluctuation of juvenile and adult clam prices (2006-2016)

Limited available information to farmers: Clam farmers do not have access to any official source of information about juvenile or commercial clam prices, reputable suppliers or market demand, which creates a disadvantage for farmers in negotiations with suppliers and collectors. Among the interviewees, 95% reported that they did not know exactly where their buyers were from and 100% of them did not recognize the importance of entering into binding contracts with traders. Local governments provide no intervention or support to help farmers to find clam input and output markets, no warnings about clam production and market risks, and no protection from unscrupulous traders. The absence of government contributes to farmers' weak position (Markelova et al. 2009). Farmers are passive participants in the clam market, meaning that the prices of juvenile clams and clam meat are always imposed by suppliers and collectors/traders.

Table 5.6: Clam cycle lengths (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

(Source: Household survey 2015-2016)

This issue becomes quite serious when farmers are unable to find a market to sell their clams, even at low prices. When connected buyers leave the market, the farmers' passive position means that the only response is to keep clams in the fields and wait for other buyers. As a result of this strategy, the clam raising cycle becomes longer (*table 5.6*). The focus group discussion among experienced clam farmers revealed that 6-7 years ago, a clam raising cycle was 12-18 months, but the cycle is 18-36 months today. Although the length of the clam raising cycle does not strongly correlate with clam mortality rate, the correlation coefficient of 0.124 and significance level of 0.01 (*table 5.7*) show that risk increases as clams' time in the field becomes longer.

Table 5.7: Spearman's rho test of correlations between cycle length and mortality rate

		Cycle length (months)	*Mortality rate (%)*
Cycle length (months)	Correlation coefficient	1.000	.124**
	Sig. (2-tailed)	.	.006
	N	481	481
Mortality rate (%)	Correlation coefficient	.124**	1.000
	Sig. (2-tailed)	.006	.
	N	481	481

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

5.2.3.3. Financial risks

Farmers face high access barriers to formal credit markets. Clam farming requires a substantial investment – the average investment is USD20,000-USD22,000/ha (Nguyen and Nguyen 2013). The results of the household survey show that 70% of this investment (as well as the financial resources used to recover following risk events) come from credit system. However, the risky nature of clam production makes it difficult for clam farmers to access the formal credit system

Box 5.3: Farmers' difficulties in accessing the formal credit market

"*When I applied to borrow money for clam raising, the bank officer told me that I had to register higher-value assets as collateral because clam farming is too risky… I had only 1 "red-book" certification for my land, which was not enough… My application was rejected...*"

(*Personal interview with a farmer in Thaido commune, Thaithuy district on 20th July 2015)*

"*After the loss in August 2014, I decided to invest in a new cycle because juvenile clam prices were low at that time. However, I could not borrow from Agribank because the bank officer said that I need to repay the last loan before applying for a new one… If I had the money to repay the debt, I would not need to apply for a new loan…As a result, I had no choice but to seek informal credit...*"

(Personal interview with a farmer in Namthinh commune, Tienhai district on 19th July 2015)

Statistics from the State Bank-Thaibinh branch show that as of September 2013, 1,752 farmers and small enterprises had borrowed money to invest in clam production, with total loans equaling 457.6 billion VND (approximately USD 21 million) (Hoang 2013). This amount represented up to one-third of the total capital investment made by farmers in the sector. Credit policy allows banks to refuse to lend additional money to farmers if the farmers have not yet paid off existing loans or do not submit sufficient documentation to support an extension of the repayment period. Given the high risks in clam production in recent years, banks have imposed stricter policies for credit risk management (for example, requiring a higher mortgage). These policies induced farmers to access the informal credit market, which has fewer administrative requirements and no credit limits but does charge higher interest rates.

Table 5.8: The results of the Mann-Whitney test of the hypothesis regarding borrowing sources and profits 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

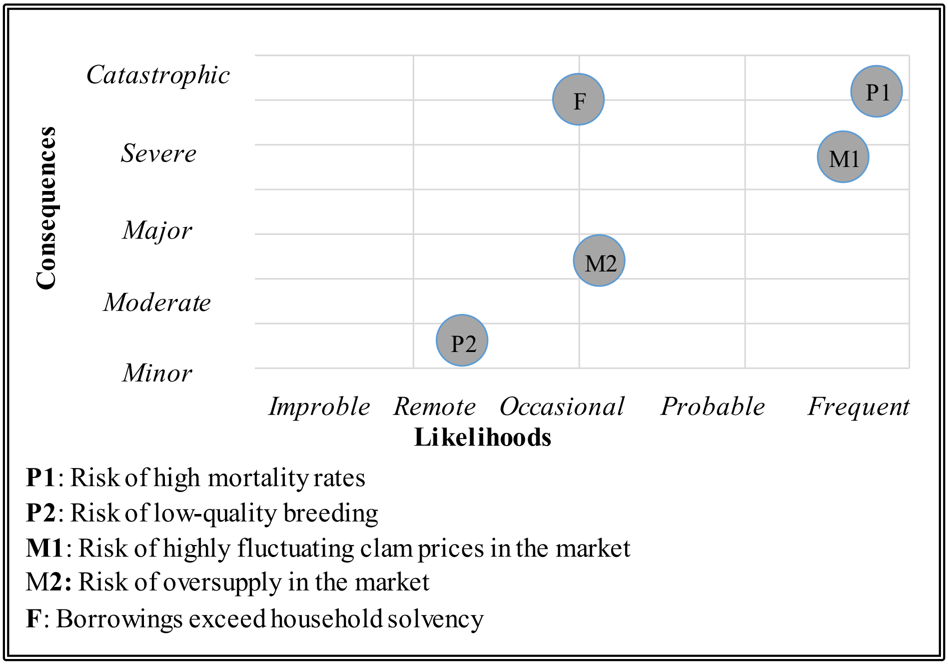
Mann-Whitney Test Statistics

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

Informal credit market: Using data from all cases in which credit was obtained from the informal market, the Monte Carlo simulation showed that the probability of losses was 57%, which is 5% higher than the common average probability of loss. The higher interest rate (5-10% higher) compared with the formal market was one of the most important reasons for the significantly lower mean clam profit per ha for cases financed by informal credit compared with the mean for groups financed by formal credit (*table 5.8*). The high interest rates of informal loans combined with other production and market risks caused farmers more financial trouble. Poor farmers have learned that although informal loans are easy to access, the associated financial debt traps are difficult to escape.

5.2.4. Risk assessment

Segmenting risks into layers: A focus group discussions was conducted in April 2015 to rank the different types of risk based on their frequency of occurrence (likelihoods) and magnitude of loss (consequences). The results of discussion showed that the risks about which clam farmers were most worried include high clam mortality rates and sudden changes in market prices. In recent years, those risks occurred quite frequently, causing major losses (*figure 5.9*). Clam farmers indicate that a clam mortality rate of 30% is common and accepted. However, since 2009, the average clam mortality rate due to polluted water flows is approximately 55% and the average mortality rate due to extreme weather events (storms or hot weather) is approximately 40%. The combination of high clam mortality rates with sudden changes in market prices has led to extreme chaos in Thaibinh's clam production sector since 2012.



(Source: Household survey & Focus group discussion 2015-2016)

Figure 5.9: Clam farming risk assessment

The boundaries between different types of risk are blurry because the risks are correlated with each other (OECD 2009). For example, when clam market prices decreased, farmers may have responded by keeping clams in their fields for longer periods. Unlike other types of agricultural production, which have definitive harvest times, clams are characterized by flexible harvest times that can be extended indefinitely. However, the longer clams remain in the field, the greater the risk of bad weather events and/or polluted wastewater. Therefore, although these risks are in different layers, they should not be treated separately.

5.2.5. Paradoxes of clam farming in Thaibinh province

<u>Paradox 1:</u> Clam farmers face high risks, but most of these risks are man-made

Clam farmers must cope with several kind of risks, including production, market and financial risks, which together caused a loss rate of 52% during the 2006-2014 period (Ngo et al. 2015). There are several sources of risks, but more risks are man-made than nature-made. Although bad weather is an important nature-made risk that causes clam mortality, two important man-made risks – "polluted wastewater" and "adoption of high clam raising density" – also cause clam mortality. In addition, all market and financial risks are "man-made" (*table 5.9*). From the farmer's perspective, man-made risks (e.g., the discharge of polluted water) are more unpredictable than natural risks are. Farmers state that they can forecast the weather based on their experience or national weather forecast programs and thus can implement appropriate solutions, such as changing the length of the clam cycle or changing the size of juvenile clams. In contrast, the discharge of polluted water can be unpredictable and unnoticeable, especially when such discharge is conducted silently and illegally (for example, the discharge of wastewater from the industrial zone into nearby clam fields). Similarly, Pigeon and O'Leary (2000) concluded that man-made risks are typically more difficult to manage, for two reasons: (1) information asymmetries; and (2) blame and organizational politics.

Table 5.9: Causes of risks : more risks are caused by man than by nature

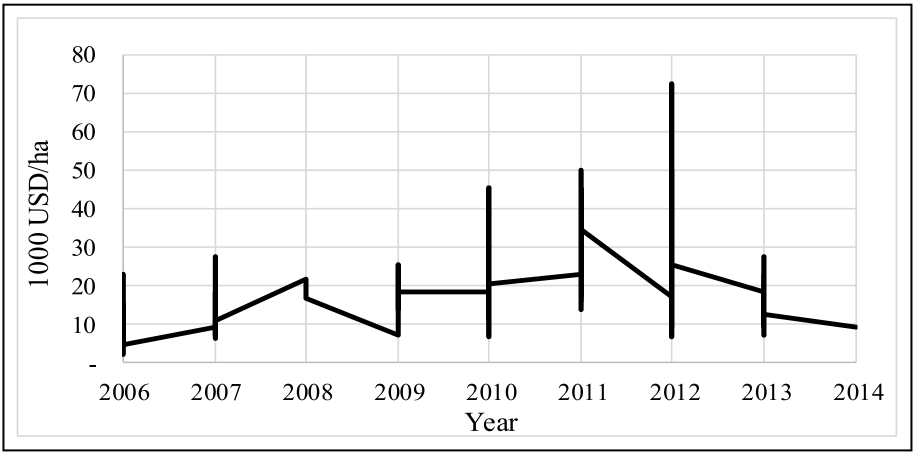
Type of risk	Causes	Natural made	Man made
Production risk	Extreme weather events	x	
	Polluted wastewater		x
	High density		x
Market risk	Overexpansion and market instability		x
	Sudden changes in prices and passive farmer response		x
Financial risk	High barriers to formal credit market		x
	High interest rates in informal credit market		x

<u>**Paradox 2:**</u> **Farmers continue to increase investment in juvenile clams, but the investment becomes less effective as it increases**

The results of the household survey showed an upward trend for investments by farmers in clam farming during the 2006-2012 period. According to technical instructions provided by the Thaibinh Department of Aquaculture, the average density for the growth-out clam raising model should be 400-500 head of clam/m2. However, farmers continued to increase juvenile clam investments during 2006-2012 (figure 4.10), making actual field density nearly four times higher than the technical instructions suggest. The reason for these continuous investment increases was that farmers expected that higher economic returns would correspond with higher clam density.

In fact, clam plots with higher juvenile clam investments did not reap higher profits for farmers but rather generated lower returns (compared with clam plots with lower juvenile clam investments)(Le and Le 2015, Ngo and Nguyen 2015). The increase of clam raising density from 200 to 400-600 head/m^2 might make a positive contribution to farmers' income in several early clam raising seasons, but after that, the exhaustion of natural food sources (and possible pollution from previous clam raising seasons) will cause problems for clam growth (Bui and Tran 2013) and even increase clam mortality. As mentioned above in part 5.2.3, the longer clams remain in the field, the greater the farmers' risk is.

<u>Paradox 3:</u> In clam farming, women have less involvement in decision making but are more vulnerable



(Source: Household survey 2015-2016)

Figure 5.10: Juvenile clam costs per ha (2006-2014)

As is the case in many other aquacultural activities in the Thaibinh coastal area, women have less involvement than men in decisions related to clam farming. Indeed, the involvement of women in decision making was seen only in the selection of juvenile clam sources or markets for selling harvested clams, and even in those cases, women had very small roles and little power. Meanwhile, women conduct several important activities, such raising capital for clam investment (up to 50% of women in survey households engage in this activity) and harvesting (up to 96% of women in survey household engaged in this activity) (*table 5.10*). Moreover, most participants in training courses were men whereas it was mainly women who faced danger in the fields while harvesting (*picture 5.9*). Consequently, women were more vulnerable than men despite the very limited role of women in decision making in clam farming.

Picture 5.9: Women in the fields and men in training courses

When clam farming investments are lost, the financial burden is divided equally between husband and wife, regardless of who made the major decisions regarding the investment. If husbands must migrate for work, their wives will face increased workloads and pressure from creditors. In addition, working in a polluted water environment and extreme weather conditions (e.g., excessive heat in summer or excessive cold in winter) cause health problems (hypothermia, sunstroke, inflammation, etc.) for farmers. Ninety percent of the people with health problems are women. Furthermore, the loss of human life has occurred several times when farmers are working in clam field, and women are more vulnerable to this risk (*table 5.10*). In 12/2014, in Tienhai district, six farmers died when boating to collect clams; five of them were women. In 2/2015, in Thaithuy district, two women went missing after their boat capsized.

Table 5.10: Gender in clam farming

Clam farming activities	*Raising capital (for clam investment)*		*Buying/ Renting land*		*Building guarding houses/ Plot preparation*		*Buying juvenile clams*		*Guarding clam plots/ raising practices*		*Harvesting and selling clams*	
	M	F	M	F	M	F	M	F	M	F	M	F
Decision making	100%		100%		100%		90 %	10%	100%		90%	10%
Conducting activities	50%	50 %	95%	5 %	100%		95%	5 %	100%		5 %	95 %

Loss and economic /social consequences after loss	*Financial burden/debt*		*Health problems*		*Loss of human life in clam farming*	
	M	F	M	F	M	F
	50%	50%	10 %	90%	15%	85%

(Source: Household survey & Focus group discussion 2015-2016)

5.3. Chapter conclusion

In general, clam production plays an important role in the livelihood of most farmers who live in coastal areas and in the total aquaculture production value and provincial annual income in Thaibinh province. After enjoying lucrative economic returns in the early 2000s, the clam farming sector has faced increasing risks, including production risks (e.g., high mortality rates, slow growing capacity and the deformation phenomenon), market risks (e.g., unpredictable changes in market prices, especially sudden reductions in prices in recent years), and financial risks (e.g., substantial investment requirements, high interest rates in the informal credit system). These risks, which interact with each other, have exacerbated the vulnerability of clam farming and farmers.

Although the impacts of these risks on clam production have been felt and quantified by farmers, their causes have not yet been well analyzed; in certain cases, such risks and their causes have been willfully ignored by local governments. Consequently, governments and the farmers continue to blame each other for the risks that occur, with farmers facing higher costs and even becoming trapped in financial predicaments. Many farmers have been severely impacted by risks in clam farming; some have been forced to quit clam farming, whereas others are struggling to maintain their farms using various strategies, including reducing the scale of clam farms and making more cautious decisions regarding juvenile clam size, harvesting time, and netting systems.

In addition to risks originating from nature, which have increased in the context of climate change, there are several paradoxes in clam farming that exacerbate farmers' difficulties: (1) the farmers face high risks in clam farming, but nearly all of those risks are man-made; (2) farmers continue to increase investment in juvenile clams, but the effectiveness of such investments decreases as their volume increases; and (3) women have less involvement in decision making but are more vulnerable compared with men. Although the origins of these paradoxes are unique characteristics of clam farming, it may nonetheless be possible to resolve them.

6

HOUSEHOLD RISK MANAGEMENT STRATEGIES IN CLAM FARMING IN THAIBINH PROVINCE

This chapter discusses clam farmers' responses to aquaculture risks. It is divided into four parts. The first part addresses household resilience after a shock occurs, that is, the speed of recovery after a disturbance, which can be measured by the length of time it takes to restart and recover the clam system. The second part provides a detailed description of risk management strategies implemented in clam households, which correspond to the types of risk in this sector. Then, the third part discusses the results each strategy and tactic and conducts a comparative comparison analysis to assess the contribution of each strategy to the success/failure of each group of households, which are categorized based on the household resilience level described in the first part of this chapter. The fourth part summarizes the main research findings of this chapter.

The main content of this chapter has been presented in the paper namely "*Assessment of household risk management strategies for coastal aquaculture: the case of clam farming in Thaibinh Province, Vietnam*", which is published in *Aquaculture International*, Volume 26(2), p451-468. DOI 10.1007/s10499-017-0226-y, ISSN 0967-6120.

6.1. Household resilience after shocks occur in clam farming

The clam farming cycle differs from that of other aquacultural animals (such as shrimp, crabs, and fish) because it is relatively long, i.e., two to three years. The longer farming cycle, which is primarily dependent on natural resources (i.e., nutrition for clams and intertidal conditions) and wastewater discharged from the inland, has made clam farming more vulnerable to risks, both natural and artificial. As mentioned in Chapter 4, the probability of losses in a clam farming growing season was estimated at 52% for the period 2006–2014. In this context, Vietnamese clam farmers have experienced increased difficulties. The majority of clam farmers have experienced aquacultural risks (i.e., 85% of the surveyed households experienced at least one loss cycle during the clam farming period). Risks included high mortality rates during the production process (for example, due to the inferior quality of juvenile clams, uncontrolled water sources, and natural disasters such as floods, storms, droughts, and rising sea levels) and unpredictable price fluctuations in the market (Lebailly et al. 2015).

Table 6.1: Impact of clam farming risks to farmer households

		Groups of households based on clam farming performance				
		No of HHs that gained in all cycles	*No of HHs that lost in <20% of all cycles*	*No of HHs that lost in 20% => <100% of all cycles*	*No of HHs that lost in 100% of cycles*	Total households
Groups of households based on number of clam plots	*No of HHs with 1 plot*	20	0	34	20	74
	No of HHs with 2 plots	2	6	35	5	48
	No of HHs with 3 plots	0	2	22	1	25
	No of HHs with 4 plots	0	0	7	2	9
	No of HHs with 5 plots	1	0	0	0	1
	TOTAL Households	23	8	98	28	157
	%	15%	5%	62%	18%	

(Source: Household survey 2015-2016)

Among the 157 households in the sample, 80% of them had lost in more than 20% of all clam cycles and 18% of them lost in all cycles (*table 5.1*). Consequently, thousands of farmers become jobless, and their problems were exacerbated by debt. According to statistics of Government Bank – Thaibinh Branch, after the market shock in 2012, the loans provided to 1,752 farmers and enterprises for clam production and services amounted to VND 457.6 billion, and this debt has been difficult for the Bank to recover. In Namthinh commune (Tienhai district), unmarketed clams were valued at up to VND 160 billion. In addition, unharvested clam farms accounted for 70% of all farms (Mai 2013), which caused severe environmental pollution. Nonetheless, certain farmers in the sample successfully overcame these shocks, which is consistent with the results obtained by Thuyet & Dung (2013) (15.9% of studied farmers survived despite being in the same risky context as those who did not survive). In the groups of households that suffered losses, approximately 25% restarted a new clam production cycle within 5 months after the disaster; 30% restarted within 6-10 months; approximately 23% restarted within 11-15 months; less than 10% restarted within 15-20 months; and the remainder restarted after 20 months (*figure 6.1*). Long waiting periods before restarting reflect farmers' difficulties in making decisions about clam production given the numerous inherent and unpredictable risks and farmers' limited financial capacity. A large percentage of farmers restarted clam production with borrowed money (i.e., 70% of the investments for new cycles were financed by creditors, including both state banks and private creditors). Consequently, although clam production was restarted, farmers remained trapped with the consequences of previous clam losses.

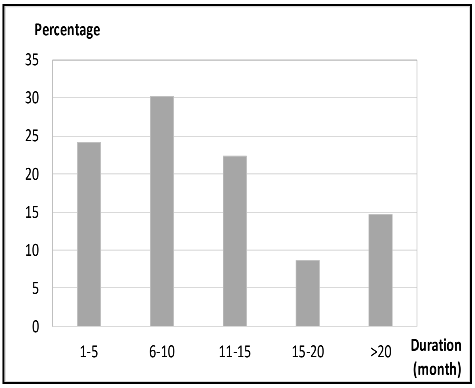


Figure 6.1: Time to restart new clam production after disasters

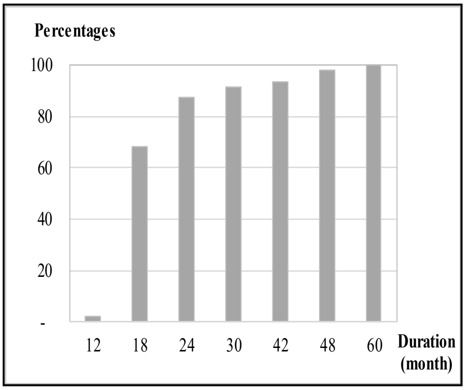


Figure 6.2: Time to recover from clam losses

Despite their efforts, only 40% of the farmers who restarted clam production claimed to have recovered from their losses. Only two percent of households reported that they had recovered from the loss within 12 months after it occurred (by raising juvenile clams, which have a shorter cycle but are riskier), whereas 66% of households reported recovery within 13 – 18 months after the loss. Recovery time for the remaining households was longer than 19 months, with some households needing up to 60 months to recover *(figure 6.2*). The difference in household recovery time reflects differences in the "resilience capacity" of farmers to overcome problems, preserve their livelihoods (Rose 2004), and withstand the losses (Buckle 2006).

Table 6.2: Clam farming performance of 157 surveyed households (Period: 2006-2014)

Clam farming performance	**Household resilience (%)**			
		***Restarted* [(1)] *and recovered*[(2)]**	***Restarted but not yet recovered***	***Not yet restarted or recovered***
Success in all clam raising cycles	15[(A)]			
Losses in < 20% of all clam raising cycles		5[(A)]	0	0
Losses in ≥ 20% of all clam raising cycles		25[(B)]	31[(C)]	6[(C)]
Losses in all clam raising cycles		0	13[(C)]	5[(C)]

Notes:

(1): Restarted: Household restarted clam farming after previous clam losses.

(2): Recovered: Households financially recovered from previous clam losses.

(A): Group A: Households were not affected or were only slightly affected by previous clam farming and marketing risks.

(B): Group B: Households were seriously affected by previous clam farming and marketing risks but had restarted clam production and recovered from farming losses.

(C): Group C: Households were seriously affected by previous clam farming and marketing risks and restarted clam production but had not yet recovered from previous farming losses.

Group A comprises 31 households (20% of the sample) that have not been affected or have been only slightly affected by previous clam farming and marketing risks. The average annual income of households in this group was USD24,047, and the average profits from clamming amounted to USD16,259 (*table 6.3*). Due to their success in clam farming, the farmers' lives have changed significantly. Not only can they afford sufficient food or purchase a house or other asset, but many of these farmers have become billionaires. Accordingly, farmers in this group have very positive view of clam farming aquaculture and consider it a main component of their livelihood. The majority of farmers in this group commenced clam raising activities quite early; for example, 58% of them started clam farming before 2006. Group A accounted for 20% of all surveyed households; in the separate communes, group A accounted for 12% of households in Dongminh commune, 25% of households in Namthinh commune and 24% of households in Thaido commune. Dongminh commune likely had the lowest proportion of households in group A because farmers in Dongminh have cultivated more clam cycles than those in Thaido (*in Dongminh, the average number of clam cycles was 4, whereas in Thaido, the average was only 3*) and have less experience in clam farming than farmers in Namthinh (*in 2014, the average years of experience of Dongminh farmers was 10 years; in Namthinh, the average was 14 years*). Moreover, based on their durable financial capacities, certain households who suffered losses needed only 5.4 months to restart clam production.

Table 6.3: Key performance indicators of household groups

Characteristic		Group A (N=31)	Group B (N=39)	Group C (N=87)
Proportion of 3 groups in Namthinh commune		25%	31%	44%
Proportion of 3 groups in Dongminh commune		12%	24%	64%
Proportion of 3 groups in Thaido commune		24%	13%	65%
Average annual household income (USD)	Mean	24,047	17,774	4,471
	Max	56,818	45,455	18,182
	Min	18,182	3,667	2,727
Average annual profits from clams per year (USD)	Mean	16,259	9,730	(3,656)
	Max	63,903	54,146	51,110
	Min	154,55	(3,644)	(7,929)
Average time need to restart clam production (months) (*Group A: 8 HHs, Group B: 39 HHs Group C: 69 HHs)*	Mean	5.4	9.1	13.3
	Max	6	40	48
	Min	1	1	1

Note: Robust tests of equality of means.

		Statistic[a]	df1
Average annual household income	Welch	77.533	2
Average annual profits from clams per year	Welch	26.670	2
Average time need to restart clam production	Welch	15.599	2

a. *Asymptotically F-distributed.*

Box 6.1 presents the story of one farmer in group A who has had great success in clam farming and has many plans for the future.

Box 6.1: The life of my family changed greatly thanks to "golden clams"

Realizing the great potential of clams, I learned about clam culture from Namthinh commune households and started raising clams by myself in the commune in 1999. Thanks to my previous farming experience, the location of the beach, and (in part) luck, my family continuously succeeded in terms of yield, quality and price. The family's assets are all derived from clams. Profits from clam farming from 2000 to 2012 amounted to VND 600-1.200 million per year. Since 2005, I have accumulated capital and saved it for investment in subsequent crops, gradually reducing my bank loans. Consequently, my cultivating and harvesting decisions do not depend on external loans. Hence, when prices dropped, I was not in a hurry to sell; rather, I invested more, because the price of juveniles was very low at that time. To cope with weather risks, it is important to pay more for a good location for clam farming.

In my opinion, farmers should continue to practice clam culture because the economic potential from clams is very large and shocks do not occur every year. Sometime, the shocks are also beneficial; for example, when the price of clams is low, the price of juveniles is correspondingly low. In general, the risks of clam farming are relatively low compared to other kinds of coastal aquaculture.

To be safe, clam farmers should make certain adjustments, such as reducing their farming areas or reducing clam density. In my case, my family used to invest nearly 1 billion VND, but since 201, I have only invested approximately 500 million in the same farming area.

(Source: Personal interview with a farmer – Dongminh commune- Tienhai district – 08/05/2016)

Group B: Households in this group had been seriously affected by previous clam farming risks but had restarted clam production and recovered from their losses (39 HHs = 25%). Due to clam farming losses, households in this group had a lower average annual income compared with households in group A (i.e., USD17,774/year). In addition, although the mean profits from clam farming in this group amounted to USD9,730/year, certain households had negative profits (*table 6.3*). It can be said that people in this group are very determined to engage in clam farming, because it took them only 9.1 months on average to restart clam production after a loss. Farmers in FGDs reported that given the average market price for clams in 2006-2014, approximately 20% of the expected income from clam harvesting would cover their financial investment (for juvenile clams and facilities, with no return for labor). In such cases, farmers can secure capital for reinvestment in new clam raising seasons. The results show that their efforts were well compensated. On average, it took farmers in this group 23 months to recover from losses. The proportion of Group B in Namthinh commune was 2.5 times higher than that in

Thaido commune, which indicates differences in resilience among farmers in different environments/contexts. The strategies applied by group B households to cope with risks will be discussed in part 6.2. Box 6.2 presents the story of a farmer in group B, who had experienced "ups and downs" in clam farming.

Box 6.2: Ups and downs in clam farming

I have been working in clam farming for many years. There have been many wins and many losses. Thanks to clams, our lives have changed significantly. However, clams have also caused bitterness. It is very sad that these failures were not caused by us…

A long time ago, when we did not yet know about clam farming, we barely had enough food to eat. Then, when we started clam farming in 2003-2004, we found that purchasing a car was easy. In 2011, I bought a car worth VND 800 million, and in 2012, I had saved VND 3 billion for to build a house.... However, by 2013, I had to sell the car, which I bought for nearly VND 800 million dong in 2011, for just 500 million to make payments on debt. At that time, one-third of the money saved to build a house was re-invested for the next new clam cycle.

Luckily, since 2015, things have been okay. My house has not been sold, although it has also not been finished. I do not have to borrow money, so I have no debt. When I sell clams, I will make money that can be used to build the house and repurchase the car.

We live in a coastal area, so we have to work with the sea. Without aquaculture, how can coastal people be rich? Moreover, honestly, we have determined that if we raise clams and the price remains stable, clam farming is less risky than shrimp farming….

(Source: Personal interview with a farmer– Thaido commune- Thaithuy district- 14/05/2016)

Group C: These households had been seriously affected by previous clam farming and marketing risks and had restarted clam production but had not yet recovered from previous farming losses or left clam farming after the loss (87 HHs= 55%). Because households in this group were strongly affected by clam farming losses, their average annual income was only one-sixth of the average annual income of group A and one-fourth of the average annual income of group B (*table 6.3*). Clam farming did not merely fail to contribute to their income but also had negative impacts on their lives, for example, by causing them to be caught in "informal credit" traps or forcing them to leave their villages due to unpaid debts. In this group, 79% of farmers had tried to start a new clam cycle after losses, but their efforts were apparently unsuccessful because their losses had yet not been recovered. Compared with the other groups, it took longer for this group to restart clam production (i.e., 13.3 months on average) due to their limited financial capacity.

Box 6.3: Heavy failure after only one clam cycle; immediate exit from clam farming

My family has been doing business for a long time. In 2012-2013, when my husband saw that clam farmers in the area were earning substantial profits, he decided to rent a plot and tried to enter the clam farming sector. People said that clam farming generates "super profits"; you might double or even triple your investment. Because we had money, we did not have to borrow… My household invested 1 billion in a 2-ha plot. But we had only money, not experience or technology…Almost all of the clams died…We had to pay a lot of money to clean the field – nearly VND 30 million/time…. Ultimately, we lost all of the money. I said to my husband that if we had used this one billion to do business like we used to do, we surely would have made a profit… It might not be as high as the profits of clam farmers, but it would involve less risk.

The lesson we learned is that when you lack experience, clam culture is not as simple as it seems. Without experience, it is like throwing your money into the sea....

After that serious loss, we stopped raising clams. However, I found that "clam collecting" is very profitable. Although the price of clams from the field is unstable, the price for consumers in the city is very stable and is always much higher than the price paid in the field. My family does business and has many relationships. When restaurants or shops in cities such as Hanoi or Haiduong place orders, I collect the clams and send them to the cities. It is very low risk and profits are guaranteed.

(Source: Personal interview with a farmer – Dongminh commune- Tienhai district- 09/05/2016)

Among the three communes, the proportion of group C farmers in Namthinh was lowest (44%), whereas the percentages for Dongminh commune and Thaido commune were 64% and 65%, respectively. More years of experience in clam aquaculture among farmers in Namthinh could explain the low proportion of group C households in this commune. The box below presents the stories of two farmers in group C who experienced losses and failures in clam farming. In the story presented in box 6.3, the farmer quit clam farming after suffering serious losses in one clam cycle. However, that experience opened a new opportunity for her.

Although he did not give up, the farmer in the story below (*box 5.4*) became very weary of clam farming and shifted to other agriculture activities.

Box 6.4: The more I try, the more I lose…

My household started raising clams in 2011, when I observed people gaining significant profits from clam raising. However, in July 2012, I suffered a massive loss... I had borrowed 300 million to invest. A storm caused the first loss, with an estimated mortality rate of 30%. Then, in August 2012, massive clam death occurred again, for unknown reasons. According to experienced farmers in my village, pollution from the internal wasted water sources were discharged through the sewer... I lost almost everything in that cycle.

However, I thought that "without doing something, I will receive nothing", so I tried again. In October 2013, I borrowed again and bought juvenile clams. In that cycle, clams did not die but the price decreased sharply. I could not wait for the price to increase again because I needed money to pay back the loan. I invested a total of nearly VND 400 million but earned less than VND 200 million.

I tried several times but was unlucky. I have decided to stop temporarily. I still have the clam fields because there are some clams in there, which I may sell later if the price goes up; otherwise, I will keep it in the farm. I will not sell or rent the clam field. If it becomes prosperous again, then I will restart clam farming.... After the periods of loss, I decided to buy cows and hope to earn money from them.

(Source: Personal interview with a farmer – Namthinh commune- Tienhai district – 11/05/2016)

6.2. Household risk management strategies for clam farming risks

6.2.1. Description of household risk management strategies and tactics

The Monte Carlo simulation calculated the probability of losses in clam production investments in each raising cycle; the estimate for the surveyed households in the 2006-2014 period was 52% (Ngo et al. 2015). A majority of the clam farmers had experienced farming risks; specifically, 80% of the surveyed households had experienced at least one massive clam farming loss. The most serious risk relates to high clam mortality rates during the farming process. Several causes were reported by farmers, including poor-quality juvenile clams, uncontrolled wastewater discharges, and natural disasters such as storms and droughts (in shallow raising areas). In addition, declines in market demand and price have become increasingly problematic in recent years. To cope with clam farming risks, farmers have developed several strategies to reduce their vulnerability. Each risk management strategy (*hereafter RMS*) comprises several tactics, which will be described in detail in the following part. A summary is presented in table 6.5, and the proportions of households that applied each tactic is presented in table 6.4.

RMS1: Increasing clam plot size

The reduction of clam mortality rates is a crucial target of farmers' RMSs. RMS1 is one of the two major strategies adopted by farmers to reach this target. This strategy is commonly implemented, especially after decision 11/2012/QD-UBND, which imposed a 2-ha limit on the size of clam farming areas allocated to individual households (ThaibinhGOV 2012). This limit was imposed for the sake of equity, in order to ensure that all households living along the coast would have the same opportunity to own a clam-raising plot. However, farmers claim that although small areas entail lower labor costs, enhance use efficiency (e.g., farming practices and protection) and decrease facilities investment (e.g., in living sheds, boats, protection fences), small plots have disadvantages when raising clams at different ages. Large clam plots allow farmers to employ a “combination clam raising model”, which has a lower mortality rate and helps to reduce losses caused by the phenomenon of “flying clams” (i.e., caused by storms). Furthermore, a large clam plot allows farmers to plan clam production in a manner that allows the cultivation of many small harvests throughout the year in order to match demand.

Farmers have used two tactics to enlarge farm areas. The first tactic is the rental or purchase of intertidal land from other farmers in the area. After 2013, a number of farmers gave up clam farming because of previous serious farming losses. Approximately 45% of the surveyed farmers rented and/or purchased additional adjacent intertidal land to enlarge their clam farming plots. However, this tactic is not easy to implement, for several reasons. First, many people who quit clam farming want to keep their intertidal land. Some people consider the land a type of asset. Others keep the plot as they wait for the next prosperous period of clam farming. Second, farmers want to rent land that is adjacent to their own, which allows them to extend their current plot. Of course, an acceptable renting fee is also required.

The second tactic is the formation of sharing groups among farmers who own adjacent intertidal plots in order to merge their plots into a single large plot. For instance, 21% of clam farmers in Dongminh, 46% of farmers in Namthinh, and 68% of farmers in Thaido have formed groups for the purpose of enlarging clam raising plots. This tactic supports not only RMS1 but also RMS5. However, this tactic can be applied only to adjacent plots. Initially, the profits earned by farmers’ groups were shared among all members. However, after several crop cycles, differing interests among the farmers and contradictory opinions about clam production and RMSs prevented the continuation of farmers’ groups and hindered further expansion of their clam farming plots. Conflicts among members were the primary reason that such groups disbanded after 2-3 clam cycles. In 2013, many groups disbanded, mainly due to differences of opinion on clam selling times and practices.

Box 6.5: Reasons to seek a large clam plot

Since 2011, there are only a few clam farmers. We raised clams on the largest plot possible. The size was limited only by the ability to exploit clam intertidal land. However, after seeing the high profit potential, everyone wanted to raise clams. According to the new land allocation policy of the provincial government, each family can have only 1 plot of 2 ha for clam raising.

In the old plot, which covered 5 ha of intertidal land, I raised clams in a combination model, i.e., with both juvenile and adult clams. When the juvenile clams were ready for sale, I sold only a portion of them; I placed the others in the area for raising adult clams. After shifting to a smaller plot, I have not raised breeding clams (juvenile clams), so I have to buy juvenile clams for breeding. As a result, the mortality rate increased immediately. In addition, when clam farming in a small area, the rate of “flying clams” following storms or strong waves is also very high....

However, after a serious loss in 2013, my neighbor, who had the clam plot next to *mine, decided to quit clam farming. I immediately rented this plot at a rate of 10 million VND/month. It is sufficiently large for me to raise clams using the combination model. The large plot has been divided into 3 zones. Initially, I stocked all three zones; after harvesting the 1st zone, he stocked and continued to harvest the second area. A similar method was used for the third zone. There are two advantages to this model. First, the mortality rate of clam clearly decreases. Second, I do not need to worry about selling clams at the wrong time. Rather, I can actively manage clam harvesting times to meet customer demand.*

(Source: Personal interview with a farmer – Dongminh commune- Tienhai district 09/05/2016)

RMS2: Improving clam farm practices

In addition to enlarging their clam plots, farmers seek to reduce mortality rates and market risk by improving clam farm practices. The purpose of this strategy is to increase productivity; shorten the clam cycle in order to avoid extreme weather shocks (such as storms and hot weather) and market downturns; and improve clam quality, which helps to stabilize the selling price of clam meat.

RMS2 includes three tactics. The first is to bid on intertidal plots that experience shows are good for clam raising. A farmer considers a plot "good" if it is rich in sources of nutrition and relatively safe from extreme weather shocks and wastewater flows. Clams will exhibit more rapid growth in such plots; consequently, the length of the clam cycle will be reduced, which in turn reduces the number of shocks likely to occur. In Namthinh and Dongminh communes, the rental fees for these plots are always higher compared with other land. Therefore, one important tactic of experienced farmers is to pay a higher fee to own a better plot. Whereas the minimum price has been set at VND 3 million/ha (ThaibinhGOV 2012), the prices of superior plots range from VND 10 million to 12 million/ha. According to experienced farmers, the additional cost of the land – VND 7 million-9 million – results in hundreds of millions of additional profits, making the higher price well worth it. However, although this tactic can be employed in Namthinh (employed by 75% of households) and Dongminh (employed by 47% of households) (*table 6.4*), it cannot be used in Thaido due to local government policy requiring that each household has an equal land area and that rental fees are consistent across the board (equal to the minimum price level) regardless the location and characteristics of the plot. The method used by the government to allocate land in this commune was to assign a code to each plot and then to randomly allocate a plot to each household based on the selection of codes.

The second tactic of RMS2 is to actively control the start and harvesting times of the clam production cycle. For example, farmers will start the clam raising season and manage juvenile age to reduce the effects of possible extreme weather events on young clams and complete the clam harvest before the storm season. The purpose of this tactic is to reduce the mortality rate by avoiding periods in which storms, temperature shocks, and other extreme weather events occur, especially for juvenile clams, which are very sensitive to environmental changes. Moreover, harvesting clams in periods of high demand helps to reduce the risk of low prices or the lack of a market. Although this tactic is not especially complicated, it is not easily implemented by all farmers because it requires the ability to purchase juvenile clams and to obtain access to the market to sell harvested clams at the preferred times. It also requires farmers' careful observations and experience, because the optimal times for clam production vary based on the water currents and nutrient availability in a particular area. This explains why not many people choose to raise clam in model 2 "clam hatchery mode" although it is more profitabile the other two models. Among the surveyed households, approximately 55% are sufficiently confident in their clam farming experience and capabilities to adopt this farming technique. However, the percentages across communes vary significantly (*table 6.4*). The story in the box below describes how one experienced farmer plans the clam cycle.

Box 6.6: Planning to reduce the risk of clam farming

"In my opinion, clam farmers need to know weather rules, tide fluctuations, etc., if they really want to reduce the risks of clam farming. I listen to the radio, record the weather changes that occur in each season, and use a tide calendar to forecast the weather and its impact on clam farming.

To plan, I need to define the start and harvest times of the clam cycle. For example, clams should be stocked in March or April, when the weather has few thermal shocks or storms; the other alternative is to start in early September, when the weather is cool, so that clams will not fly. Then, when the frosty weather of October arrives, the clams will be bigger and thus less affected by the cold. Similarly, harvesting time must be carefully defined. We should plan to harvest clams before the storm season. Also, listen to weather forecasts – if a storm or a series of hot days are expected, then the clams should be sold, even if it means selling at a lower price. Lower profits are always better than no profits.

Likewise, planning helps me to reduce market risk. I have seldom followed prevailing village trends, because following trends means buying at more expensive prices and selling at lower prices. I always try to buy breeding clams before or after others in the village do so. Consequently, my time of sale also differs from that of everyone else. I sell when no one else sells, or when most people have sold out.... Therefore, if there are losses due to decreases in price, I lose less than others do…".

(Source: Personal interview with a farmer – Dongminh commune – Tienhai district -10/05/2016)

Third, pressure from risks prompted some farmers to innovate to improve clam practices (e.g., through faster growth or reduced clam loss). Such innovations include filling clam plots with new sand (to reduce pollution and enrich nutrients), better fencing with double-net systems, and improved clam catching and cleaning techniques. Seventy-one percent of surveyed clam farmers in Thaibinh have applied these techniques to varying extents. Certain farmers frequently and actively apply innovative techniques, whereas others simply imitate other farmers in applying such techniques. This tactic significantly affected the results of household risk management. This issue will be discussed in more detail in part 6.3.

Clam farmers have applied “double-net systems” (*picture 6.1(c)*) around clam plots because they help to reduce losses caused by storms or strong waves during the production process. They also help to protect their clam fields from the threat of disease. The simultaneous application of “land-regenerating techniques” helps to increase nutrients in the plot, which makes clams grow quicker and thereby shortens the clam cycle. In addition, the less time the clams are kept in the field, the lower the risk faced by clam farmers.

(a)Clam catching machine | (b)Clam cleaning machine | (c)Double-net system

Picture 6.1: Innovative techniques developed by farmers to reduce risks

Traditionally, clam farmers catch clams when the tide withdraws, which means that clam harvesting depends heavily on weather conditions. The invention of the “clam catching machine” and “clam cleaning machine” (*picture 6.1 (a) &(b)*) has helped farmers to actively control the timing of catching clams, which in turn allows them to meet market demand and ensure the quality of clam products. Accordingly, these innovations help to reduce the risk of rejection in highly demanding markets (such as Europe) and the safety risks to humans working in the sea.

RMS3: Securing juvenile clam sources and diversifying the harvested clam market

In addition to coping with risks in the clam production process, farmers have developed strategies to manage market risks. Notably, farmers have searched for alternative market channels for both inputs and outputs (RMS3). With respect to inputs, 56% of the surveyed households purchase juvenile clams directly from producers in Namdinh (a neighboring province), 18% purchase juvenile clams from traders in the communes, and the remainder (26%) started their own juvenile nurseries[4] to reduce the cost of juvenile clams, reduce the biological risks in new clam raising[4] cycles, and increase the independence of their clam practices. The purpose of this tactic is to ensure the quality of juvenile clam sources (which lowers the mortality rate of juvenile clams and reduces the risk of clam deformation); it also reduces the risk of price increases for juvenile clams. The application of this tactic also explained the choice of farmers to raise clam in model 3 “combination model” for their clam farming.

[4] *Juvenile clams for nursery are very small in size, i.e. estimated at 100,000 heads/kg. These are also purchased in Namdinh province.*

Box 6.7: Lessons learned in the search for juvenile clam sources

Finding a juvenile clam source is difficult for farmers in Thaibinh. Previously, we relied on natural breeding. However, over time, as the number of clam farmers increased, the natural sources of breeding clams were nearly exhausted. The majority of juvenile clams sold by agents in the commune had been purchased from China through the unofficial import channel. Therefore, the quality of those juvenile clam sources was difficult to control. Not only was there a risk of high mortality rates and low productivity, but some clams developed distorted mouths as they grew and thus could not be sold.

Then, some other households and I decided to go to Namdinh to buy juvenile clams from some of the famous clam farmers, such as Mr. Hung in the Giaothuy district. They do business conscientiously and are very confident about their clam breeding sources. Even more importantly, they don't use tricks to make sales. The price of juvenile clams is approximately several million VND, which means that a deficiency of 100-200 grams of juvenile clams can result in a loss of a couple million VND. Nonetheless, when we brought the juvenile clam to home, a small portion died immediately due to the strange environment.

To address this issue, we learned how to breed clams. The big plot is divided into small pieces, and the clams are nursed in small compartments. The mortality rate has decreased significantly as a result of breeding juvenile clams in the same plot used to raise meat clams ... Furthermore, we can actively adjust breeding sources to suit the clam cycle plan.

(Source: Personal interview with a farmer – Dongminh commune-Tienhai district-10/05/2016)

Regarding the sale of harvested clams, there were two types of collectors in 2006-2012: local and external. The RMS3 is carried out with the aim to reduce the risk of low prices for adult clams, as well as the risk of oversupply or the lack of a market. During this period, 52% of farmers tried to diversify clam sales channels by selling to external collectors, because the prices offered by external collectors were higher than those offered by local collectors or obtained by selling directly to the local market. However, some external collectors did not pay the farmers after the collection of clams. In the middle of 2012, when clam prices decreased significantly, external clam collectors stopped coming to the area for clam purchases. In recent years, a number of local clam farmers have tried to find and sell to traders in Haiphong and Quangninh provinces. Some farmers even tried selling clams from their houses, but the sales were insignificant because the demand for clams in the commune was quite small. Picture 6.2 (a, b and c) shows several methods of selling clams, revealing the efforts of farmers to sell clams and resolve the issue of clams being stuck in the field.

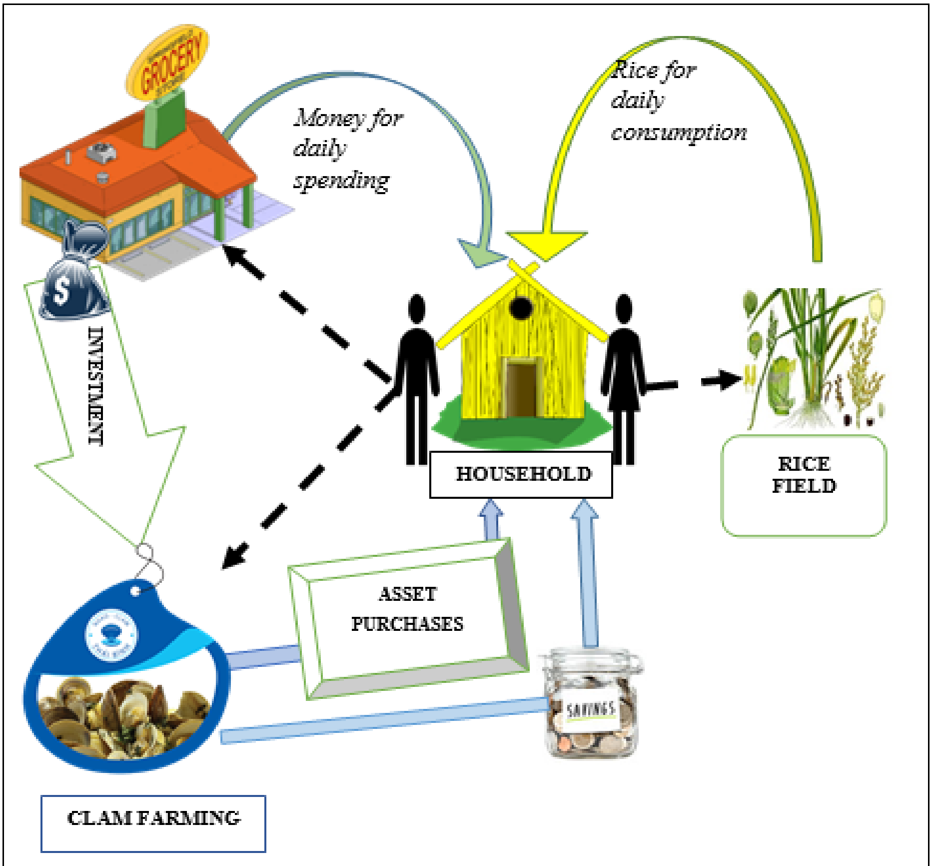
(a) Clam collector for export to China *(b) Clam collector in the commune* *(c) Selling clams at home*

Picture 6.2: Methods of selling clams in Thaibinh province

RMS4: Diversifying livelihood activities

Because the clam cycle is long (18 months on average), all clam farms have other sources of income. Having income sources in addition to clam farming is a central component of financial RMSs related to clam farming investments. Diversification of livelihood activities supports clam farming risk management by ensuring that financial resources are available to farmers for both their daily needs and their clam farming investments. More importantly, diversification helps clam farmers to protect their families' day-to-day lives, because income from clam farming is irregular. Income from other livelihood activities enhances household resilience after losses in clam farming.

Figure 6.3 details the livelihood of a clam household and the role of each income source in their life. In terms of risk management, income from the grocery store helped this farmer to reduce the risk of bad debt when he invested in clam farming. The profits from the shop combined with the rice grown in fields maintained by the farmer's wife helped the family to secure their lives. Their house and day-to-day lives are less vulnerable to clam farming risks.



(Case study of 1 clam household in Dongminh commune – 2015 Survey)

Figure 6.3: Diversification activities and their roles in household livelihoods

RMS4 is a strategy used to support daily household spending and contribute to debt repayment when clam farmers experience losses. All clam households have adopted other livelihood activities – of various types and to different extents – in addition to clam production. This diversification allows them to benefit from the effective use of household labor and reduced input purchases, similar to many other forms of diversification in developing countries (Rahman et al. 2011). During the 2006-2014 period, 52% of the surveyed households grew other aquatic animals, such as shrimp and fish; 64% had rice paddy production; and 20% had livestock. A small percentage of households also conducted non-farm activities, such as running restaurants or grocery shops.

RMS5: Accessing financial sources with no or low interest rates

Clam farming requires a substantial capital investment that often exceeds the financial capacity of an individual household. Most farmers have had to borrow money for clam investments. For instance, during the 2006-2014 period, approximately 70% of the farmers surveyed obtained loans from formal and informal credit systems. Formal credit systems are often bureaucratic and impersonal but offer lower interest rates (10.8%/year on average), whereas informal credit systems are much easier to access but charge higher interest rates (18%/year in 2010-2011).

Box 6.8: "Trick” that help me to borrow money from banks

After the loss in 2008, I applied to borrow money to invest in clam farming, but I was always rejected. The first time, the bank officer rejected my loan application because according to their security policy, clam farming was too risky, and the clam cycle was too long. After the government implemented its support policy, especially for aquaculture development, I applied again. However, I was rejected again, because the bank said that I didn’t have enough high-value assets for collateral.

Finally, I changed the purpose of borrowing in my loan profile. I stated that I would use the money to raise shrimp rather than clams. Then, my loan application was approved. So, I repeated this method several times, and it really worked.

However, I had a problem when they implemented a support policy for losses in clam farming. Because all of my borrowing profiles stated that I used the loans to raise shrimp, I received nothing from this government program…

(Source: Personal interview with a farmer – Thaido commune – Thaithuy district-15/05/2016)

In 2010, faced with increased clam production risks, farmers developed financial strategies to satisfy their investment demands while reducing their dependence on informal credit systems with high interest rates, including using family savings and/or taking interest-free loans from relatives; endeavoring to access the formal credit system; and forming “self-credit groups” that lend members a certain amount of money when necessary. These tactics aim to reduce the risk of being unable to repay debt (and thereby avoid the consequences thereof); reduce the risk of the dependence on external capital sources; and reduce the risks and consequences associated with high-interest loans in the informal credit market. Each tactic has pros and cons, and clam farmers have the flexibility to combine these tactics. Although tactic 5.1 is safest, the ability to use this tactic is limited by the financial capacity of farmers and their relatives. Thus, nearly 80% of clam households in the three communes utilized this tactic but nonetheless had to employ other tactics as well *(table 6.4)*. Tactic 5.2, like tactic 1.2 discussed above, can become problematic if conflicts arise among members of the group. Therefore, it is not a long-term solution. Tactic 5.3 can be applied over the long run but entails complicated administrative procedures and depends heavily on the local government and local bank system. Only 21% of clam households in Dongminh employed tactic 5.3, whereas the percentages in Namthinh and Thaido were 46% and 68%, respectively *(table 6.4)*.

Table 6.4: Percentage of households applying specific tactics in the three communes

Tactics		Dongminh	Namthinh	Thaido
T1.1	*Renting/purchasing additional intertidal land*	9%	26%	3%
T1.2	*Forming share groups*	21%	46%	68%
T2.1	*Bidding for clam plots in locations favorable for clam production (1)*	47%	75%	0%
T2.2	*Carefully planning clam production cycles (start and harvest)*	47%	75%	29%
T2.3	*Applying innovative techniques*	62%	84%	61%
T3.1	*Purchasing juvenile clams directly from production sources*	83%	81%	94%
T3.2	*Diversifying clam sales channels (2)*	53%	35%	84%
T4.1	*Raising other aquatic animals*	41%	44%	84%
T4.2	*Engaging in rice production*	71%	51%	81%
T4.3	*Raising livestock*	10%	16%	48%
T4.4	*Other activities*	76%	68%	84%
T5.1	*Using family savings and/or borrowing from relatives*	81%	85%	77%
T5.2	*Forming share groups*	21%	46%	68%
T5.3	*Accessing the formal credit system*	79%	88%	58%

(Source: Household survey 2015-2016)

Table 6.5: Description of clam household risk management strategies (RMS)

<table>
<tr><th rowspan="2">RMS</th><th rowspan="2">Name and code of tactic</th><th colspan="3">Purpose of risk management strategy</th></tr>
<tr><th>To cope with production risk</th><th>To cope with market risk</th><th>To cope with financial risk</th></tr>
<tr><td>RMS1: Enlarging clam plots</td><td>T1.1: Renting/Purchasing additional intertidal land</td><td rowspan="2">✓ Large clam plots allow farmers to apply the “combination clam raising model”, which has a lower mortality rate
✓ Reduces the rate of losses stemming from the “flying clam” phenomenon (caused by storms)</td><td rowspan="2">✓ Large clam plots allow farmers to plan clam production, which in turn enables multiple harvests during the year, with harvests tailored to meet demand.</td><td></td></tr>
<tr><td>RMS1: Enlarging clam plots size</td><td>T1.2: Forming share groups</td><td></td></tr>
<tr><td>RMS2: Improving clam farm practices</td><td>T2.1: Bidding for a plot in a location favorable for clam production
(Note: this tactic is applied only in Dongminh and Namthinh communes)</td><td>✓ Reduces the impacts of storm and temperature shocks
✓ Accelerates clam growth => reduces the length of the clam cycle -> reduces the number of shocks experienced during the cycle</td><td></td><td></td></tr>
<tr><td>RMS2: Improving clam farm practices</td><td>T2.2: Actively controlling start & harvest times</td><td>✓ Reduces the mortality rate by avoiding periods during which storms, temperature shocks, etc. are expected, especially for juvenile clams</td><td>✓ Harvesting at times of high clam demand reduces the risk of low prices or the lack of a market</td><td></td></tr>
</table>

Table 6.5: Description of clam household risk management strategies (RMS)

RMS	Name and code of tactic	Purpose of risk management strategy		
		To cope with production risk	***To cope with market risk***	***To cope with financial risk***
RMS2: *Improving clam farm practices*	**T2.3:** Applying innovative techniques	✓ "Double-net system" around clam plots helps to reduce losses caused by storms and strong waves ✓ Application of "land-regenerating techniques" helps clams to grow more quickly => reduces cycle length => reduces the number of shocks encountered	✓ "Clam catching machines" and "clam cleaning machines" help farmers to actively control the timing of clam catching => farmers can tailor supply to market demand and ensure the quality of clam products => reduces the risk of rejection in highly demanding markets (such as Europe); also helps to reduce risks to human life in the sea	
RMS3: *Securing juvenile clam sources and diversifying market for harvested clams*	**T3.1:** Actively searching for good sources of juvenile clams	✓ Reduces the mortality rate of juvenile clams and the risk of clam "deformation"	✓ Reduce the risk of high prices for juvenile clams	

Table 6.5: Description of clam household risk management strategies (RMS)

RMS	Name and code of tactic	Purpose of risk management strategy		
		To cope with production risk	***To cope with market risk***	***To cope with financial risk***
RMS3: *Securing juvenile clam sources and diversifying harvested clam market*	**T3.2:** Diversifying clam sales channels		✓ Reduces the risk of low prices for adult clams and the risk of oversupply or the lack of a market	
RMS4: *Diversifying livelihood activities*	**T4.1:** Raising other aquatic animals			✓ Protects day-to-day family life because income from clams is irregular. ✓ Income from other livelihood activities provides funds to enhance household resilience after losses in clam farming
RMS4: *Diversifying livelihood activities*	**T4.2:** Engaging in rice production			
RMS4: *Diversifying livelihood activities*	**T4.3:** Conducting livestock activities			
RMS4: *Diversifying livelihood activities*	**T4.4:** Conducting other activities			

Table 6.5: Description of clam household risk management strategies (RMS)

RMS	Name and code of tactic	Purpose of risk management strategy		
		To cope with production risk	***To cope with market risk***	***To cope with financial risk***
RMS5: *Accessing financial sources with no or low interest rates*	**T5.1:** Using family savings and/or borrowing from relatives			✓ Reduces the risk of being unable to repay debts (and thus avoids the consequences thereof)
RMS5: *Accessing financial sources with no or low interest rates*	**T5.2:** Forming share groups			✓ Reduces the risk of dependence on external capital sources
RMS5: *Accessing financial sources with no or low interest rates*	**T5.3:** Accessing the formal credit system			✓ Reduce the risk of high interest rates in the informal credit market (and the associated consequences)

(Source: Focus Group Discussion 2015)

6.2.2. Differences in the adoption of household's risk management strategies among three groups

Differences in RMSs adopted by households lead to differences in household resilience to clam farming risks. Of the surveyed households, approximately 20% have not been affected or have been only slightly affected by clam farming risks (*Group A in table 6.3*) and 25% have been seriously affected by clam farming risks but have restarted and recovered their clam production operations (*Group B in table 6.3*). In contrast, 44% of surveyed farmers have not yet recovered from previous clam farming losses (although they have restarted clam farming) and 11% have not yet restarted clam production (*Group C in table 6.3*). The next part will discuss differences in the preparation and responses of farmers in the three groups in coping with clam farming risks.

Table 6.6: Differences in the application of RMS tactic T2.3 across the three groups

Frequency of application	Group A	Group B	Group C
Often	58%	65%	15%
Sometimes	39%	20%	42%
Never	3%	15%	48%

(Source: Household survey 2015-2016)

The implementation of ex ante strategies involving the use of technology to reduce risks is the most distinctive characteristic of group A households compared with the other two groups. This use of this strategy explains why the impact of shocks on this group is relatively small. For instance, whereas 100% of the farmers in group A adopted T2.2, only 62% of those in group B and 37% of those in group C did the same. Even farmers' perceptions of certain tactics differ among the household groups. For example, farmers in group A and B consider T2.3 an important tactic for increasing clam farm productivity and reducing risks whereas farmers in group C viewed this tactic as less valuable. Accordingly, 97% of farmers in group A and 85% of farmers in group B often applied this tactic, compared with only 57% of farmers in Group C (*table 6.6*). In addition, FGDs indicated that many farmers in Group C simply imitated tactics used by their neighbors and did not necessarily understand how to implement these tactics or recognize the value thereof. Thus, whereas 58% of group A often applied innovative techniques, only 13% of group C did the same. Certain farmers simply imitated a tactic/strategy used by their neighbors or friends without understanding the requirements for its implementation. As a result, such tactics were costly and ineffective. The story in box 5.9 describes the experience of a farmer in group A and explains his attention to clam farming techniques.

Box 6.9: Innovative techniques not only help me to reduce risks but also create new opportunities

Strictly speaking, clam culture is like "gambling", 50% loss-50% gain. However, if you master the techniques and find a stable output market, then nothing is more profitable than clam farming.

Compared with fish farming or shrimp farming, clam farming is much easier because clams eat natural food. However, it is necessary to employ appropriate techniques to protect clams from changes in the water environment, storms, and strong waves and to maintain the average salinity at a level of 15-25 per thousand.

To master the technical issues, I went everywhere, from Bentre province in the South to China.... As a result, I always had new ideas before other farmers did. When natural clam seed was scarce, I gained significant profits by selling breeding clams; each year, I easily made a profit of a couple of billions VND. And when everyone else learned how to breed juvenile clams, I started to study methods to ensure the quality of clams from harvest to consumption; for example, preventing sand from getting inside of the clams to ensure their cleanliness or keeping clams alive when they are transported over long distances. If I can implement such methods, my clams can enter highly demanding markets without a price reduction.

(Source: Personal interview with a farmer – Namthinh commune – Tienhai district – 12/05/2016)

Unlike the farmers in group A, the farmers in group B were less focused on technical strategies and had been seriously impacted by risk events. However, the difference between group B and group C is that the farmers in group B were better prepared as a result of the adoption of capital strategies. Whereas 92% of the farmers in group B applied tactic 5.3, only 68% of group C did the same (*table 6.8; 6.9; 6.10*).

Table 6.7: The contribution of income from other aquaculture activities and businesses and remittances to clam household resilience to shocks

Level of contribution	Group A	Group B	Group C
High contribution	65%	23%	-
Moderate Contribution	29%	19%	-
Low Contribution	-	-	-
No contribution	6%	58%	-

(Source: Household survey 2015-2016)

Moreover, the diversification of farming practices provided more support to farmers in Groups A and B than to those in Group C. Indeed, the income from diversification activities was used to cover households' daily spending, because income from clam farming is irregular. However, the significance of other income-generating activities to farmers' ability to restart clam production and recover from aquaculture shocks depends on the type of activity and its contribution to total family income. Survey results showed that households with incomes from other aquaculture activities (e.g., shrimp or fish raising), businesses (clothes shops, clam collection, grocery shops), or sources of remittance recovered more quickly than those who only engaged in rice farming in addition to clam raising. Whereas 94% of group A and 42% of group B (*table 6.7*) relied on these sources of income to cover losses in clam farming, 77% of the farmers in group C relied exclusively on income from rice production. The story of a farmer in group B shows how her family demonstrated resilience after a loss.

Households in group C experienced similar shocks as those in group B but have exhibited resilience. Some farmers in group C quit clam farming after suffering

Box 6.10: Failure does not discourage me

From 2009 to now, on average, my house has suffered a loss of nearly VND 1 billion every two years. The reasons for the losses were very diverse. Fortunately, because my family had accumulated capital and income from shrimp farming, we did not have to borrow investment money from the bank.

Regardless of the cause, some cycles lose, some cycles gain. Overall, however, my family obtains high profits from clam farming. The important thing is that whatever you decided to do, you must stay determined, even when you fail. After each failure, it is necessary to learn from the experience so that you know how to avoid the issue in the future. For example, after a massive loss in 2009, I learned from my experiences with farming techniques. Accordingly, in 2010 I reinvested in everything – nets, piles, a guarding house, plot regeneration, etc. Clam size was adjusted to 8,000 – 10,000 heads/kg (previously, the usual size was 30,000 heads/kg). Stocking density was also reduced so that the clams would grow faster. The purpose is to shorten the cycle time and thereby minimize damage caused by unexpected factors. Consequently, at the end of 2011, my family gained huge profits....

In 2013, I lost money again because we were unable to sell the adult clams (collectors from outside the commune who used to come and purchase large volumes of clams suddenly disappeared), which led to sharp decreases in price. I think we need to actively seek markets so that we can continue to produce without having to plan for the output market.... Later, I tried to connect with some restaurants in Hanoi. Now, I have connections and regularly sell clams there. Not only my clams but also clams from my relatives. In 2015, prices increased again, and we certainly gained…

(Source: Personal interview with a farmer – Dongminh commune- Tienhai district – 09/05/2016)

losses. Among these farmers, 7% had ceased clam farm operations because of losses caused by production risk; 8% left the sector due to market risk, and 29% (*table 6.8; 6.9; 6.10*) left due to the consequences of financial risks. In addition to farmers who decided to leave the clam farming sector, some farmers tried to restart clam operations following losses, but as of 2015, they had not succeeded. As discussed earlier, the lack of appropriate strategies to enhance financial capacity is a common issue among households in group C. Indeed, the majority of farmers in groups A and B were able to mobilize their own savings (or savings borrowed from relatives) to restart clam production, whereas farmers in group C could finance only 6% (on average) of the total capital needed to restart clam production. A lack of land and poor access to credit markets prevents farmers, especially poor farmers, from implementing necessary risk management strategies and benefiting from aquaculture. This dilemma has also been mentioned also in the research of Stevenson & Irz (2009).

Box 6.11: No one, except "black-credit" dares to lend me any more money

After the sudden massive clam death of 2012, my family was quite shocked, it was like falling into an abyss ... What should I do? The storm had taken everything from my hands. It seemed like God was telling me to stop. Without capital, you can do nothing but stop. I had started in 2010 and suffered a loss in 2011, but I tried for one more clam cycle with the hope that it would compensate for previous losses. To get money for the new cycle, my family had to borrow from a bank with normal interest rates (i.e., there was no support in the form of lower interest rates) and from my relatives; I even had to borrow VND 50 million from informal credit sources. My bad debt burden is too heavy now, nearly VND 450 million. No one except "black credit" dares to lend me any more money, but I do not dare to borrow more from them… Now the only thing I can do is to shift to other livelihoods to earn money to repay my debts.

(Source: Personal interview with a farmer - Namthinh commune – Tienhai district – 15/05/2016)

Table 6.8: PRODUCTION RISKS AND HOUSEHOLD RISK MANAGEMENT STRATEGIES

Causes of Production Risk	PRODUCTION RISKS	Impacts of Production Risks
• Extreme weather events • Polluted wastewater • High density	• High mortality rate • Low quality breeding clams	• Low productivity • Deformed clams => Cannot be sold in the market

HOUSEHOLD RISK MANAGEMENT STRATEGIES

Before shocks ➔ **Tactics to reduce the probability of risks**	*After shocks* ➔ **Tactics to reduce losses**
T1.1: Renting/purchasing additional intertidal land **T1.2:** Forming share groups **T2.1:** Bidding for plots in favorable locations for clam production **T2.2:** Actively controlling the start and harvest times of clam crops **T2.3:** Applying innovative techniques **T3.1:** Actively searching for good juvenile clam sources	No tactics applied to reduce losses after shocks

Percentage of HHs in GROUP A who applied each tactic

Before shocks

T1.1	T1.2	T2.1	T2.2	T2.3	T3.1
32%	23%	77%	100%	97%	87%

After shocks

Percentage of HHs in GROUP B who applied each tactic

Before shocks

T1.1	T1.2	T2.1	T2.2	T2.3	T3.1
36%	28%	62%	62%	85%	85%

After shocks

Percentage of HHs in GROUP C who applied each tactic

Before shocks

T1.1	T1.2	T2.1	T2.2	T2.3	T3.1
0%	52%	34%	37%	57%	85%

After shocks

7% of HHs left the clam farming sector

Table 6.9: MARKET RISKS AND HOUSEHOLD RISK MANAGEMENT STRATEGIES

Causes of the Market Risk	→	MARKET RISKS	→	Impacts of the Market Risks
• Over-expansion and market instability • Sudden changes of price and passivity of response		• Market oversupply • Sudden changes in price		• Very low or negative profits from clam farming • Clams remain in fields -> risks increase

⇩

HOUSEHOLD RISK MANAGEMENT STRATEGIES

Before shocks ➔ Tactics to reduce the probability of the risks	*After shocks* ➔ Tactics to reduce losses
T1.1: Renting/purchasing additional intertidal land **T1.2**: Forming share groups **T2.2**: Actively controlling start and harvest times of clam crops **T3.1**: Actively searching for good juvenile clam sources **T3.2**: Diversifying clam sales channel	**T2.3**: Applying innovative techniques **T3.2**: Diversifying clam sales channels

Percentage of HHs in <u>GROUP A</u> who applied each tactic

Before shocks

T1.1	T1.2	T2.2	T3.1	T3.2
32%	23%	100%	87%	45%

After shocks

T2.3	T3.2
97%	46%

Percentage of HHs in <u>GROUP B</u> who applied each tactic

Before shocks

T1.1	T1.2	T2.2	T3.1	T3.2
36%	28%	62%	85%	46%

After shocks

T2.3	T3.2
85%	46%

Percentage of HHs in <u>GROUP C</u> who applied each tactic

Before shocks

T1.1	T1.2	T2.2	T3.1	T3.2
0%	52%	37%	83%	56%

After shocks

T2.3	T3.2	% of HHs that left the clam farming sector
57%	56%	8%

Table 6.10: FINANCIAL RISKS AND HOUSEHOLD RISK MANAGEMENT STRATEGIES

Causes of Financial Risks	FINANCIAL RISKS	Impacts of Financial Risks
• High barriers to formal credit markets • High interest rates in informal markets	Loans exceed household solvency (large principle plus high interest)	Losing house or land used as collateral for loans

HOUSEHOLD RISK MANAGEMENT STRATEGIES

Before shocks ➔ Tactics to reduce the probability of the risks	*After shocks* ➔ Tactics to reduce losses
T5.1: Using family savings and/or borrowing from relatives T5.2: Forming share groups T5.3: Accessing the formal credit system T4.1: Raising other aquatic animals	T4.1: Raising other aquatic animals T4.2: Engaging in rice production T4.3: Conducting livestock activities T4.4: Conducting other activities T5.2: Forming share groups

Percentage of HHs in GROUP A who applied each tactic

Before shocks

T5.1	T5.2	T5.3	T4.1
74%	23%	95%	55%

After shocks

T4.1	T4.2	T4.3	T4.4	T5.2
55%	61%	19%	71%	23%

Percentage of HHs in GROUP B who applied each tactic

Before shocks

T5.1	T5.2	T5.3	T4.1
87%	28%	92%	41%

After shocks

T4.1	T4.2	T4.3	T4.4	T5.2
41%	56%	10%	67%	28%

Percentage of HHs in GROUP C who applied each tactic

Before shocks

T5.1	T5.2	T5.3	T4.1
83%	52%	68%	54%

After shocks

T4.1	T4.2	T4.3	T4.4	T5.2	% of HHs that left the clam farming sectors:
54%	69%	25%	48%	52%	29%

6.3. Assessment of the results of household risk management strategies in clam farming

6.3.1. Results of individual risk management strategies

The data from the household survey revealed the result of each RMS, only some of which achieved their purpose. The table below shows the result of comparison tests for the outcomes of households who adopted each risk management strategy and those who did not. A discussion of each risk management strategy is presented in the following part.

Table 6.11: Comparison tests for the results of each RMS among 157 surveyed households

(Period: 2006-2014)

		Group of HHs that adopted RMS	Group of HHs that did not adopt RMS	Notes
RMS1	*Number of HHs*	n=85	n=72	
	Results of RMS1	Mean of mortality rate after adopting RMS1	Mean of mortality rate	*The difference in mortality rates between the two groups is significant at the 0.1 level*
		41%	47%	
RMS2	*Number of HHs*	n=125	n=32	
	Results of RMS2	Mean of mortality rate after adopting RMS2	Mean of mortality rate	*The difference in mortality rates between the two groups is significant at the 0.001 level*
		39%	61%	
RMS3	*Number of HHs*	n=143	n=14	
	Results of RMS3	Average clam crop length after adopting RMS3	Average clam crop length	*The difference in clam crop length between the two groups is not significant*
		25 months	22 months	
RMS4	*Number of HHs*	n=157	n=0	
RMS5	*Number of HHs*	n=151	n=6	
	Results of RMS5	WACC after adopting RMS5	WACC	*The difference in WACCs between the two groups is significant at the 0.001 level*
		11%	14%	

RMS 1: Enlarging clam plots

Regarding production risks, the adoption of RMS1 and RMS2 clearly reduced clam mortality rates. Groups that applied RMS1 had lower mortality rates compared with groups that did not apply this method. However, the difference in mortality rates between the two groups was not very large; the groups that adopted RMS1 had a mortality rate of 41%, whereas the groups that did not adopt RMS1 had a mortality rate of 47% (*table 6.11*). In general, strategies based on technical innovations obtained better results compared with strategies based on enlarging clam plots.

Table 6.12: Impact of plot size on profit/cost ratio (Period: 2006-2014)

Group statistics				**Ranks**		
Groups	N	Mean	SD	SE	Mean rank	Sum of ranks
Group1: Plots ≤ 2 ha	458	0.24	1.12	0.05	304.89	139641.50
Group2: Plots > 2 ha	181	0.48	1.06	0.08	358.22	64838.50

Mann-Whitney U: 34530.50;
Wilcoxon W: 139641.50;
Z: -3.29;
Asymp. Sig. (2-tailed):.001

The results of RMS1 (tactic T1.1) were tested with the Mann-Whitney U test, which revealed differences in profit/cost ratios between two household groups with different clam plot sizes (Group1 – maximum of 2 ha; Group2 –larger) (*table 6.12*). The differences between the two groups were due to the following three factors: (1) Cost: both variable and fixed costs are inversely correlated with field size; (2) Clam density: plots in Group2 have lower density and therefore lower mortality rates compared with Group1 (lower density allows clams to grow more quickly, which shortens clam production cycles and thus reduces production risks); and (3) Farming arrangements: larger plots allow group2 to raise clams in combination models, which are less risky than raising either juvenile clams or adult clams alone (according to farmers' experience). As revealed by farmer FGDs, the clam mortality rate of group2 was approximately 10% lower than that of group1. Farmers in the FGDs indicated that a plot size of approximately 3 ha is best for the local socioeconomic and farming context. These findings are consistent with the results obtained by Dey et al. (2005), who revealed significant inefficiencies among aquaculture farms in India, Thailand and Vietnam.

RMS 2: Improving clam farm practices

The mean mortality rate of groups who implemented RMS2 was only 39%, whereas the mean mortality rate for HHs that did not implement RMS2 was 61% (*table 6.11*). Tactic T2.2 generated good results because exercising active control over the clam production cycle helps to reduce the mortality rate of juvenile clams and allows clams to be harvested before the storm season. In combination with tactic T2.2, tactic T2.3 (the use of innovative techniques such as "double-net" fencing systems, the placement of new sand into clam raising plots, and clam catching and clam cleaning machines) contributes not only to the reduction of risks but also to increases in clam productivity.

However, although these techniques help farmers to cope relatively well with natural disasters (e.g., strong waves, lack of nutrients), they do not address man-made disasters (e.g., polluted water discharge or clam theft) because these man-made disasters remain beyond the farmers' ability to control. For instance, the "clam catching machine" was invented by a high school girl whose parents experienced serious losses due in part to the high cost of labor for clam harvests. The machine reduced the cost of clam harvesting from 40-50 million VND/ha to only 5-6 million VND/ha. Another example is the "clam cleaning machine", which was invented by a local clam farmer. It used to be that many harvested clams had sand inside of them. This led to reduced clam prices because traders either had to submerge the clams in salt water to cause the release of sand from their bodies or could only sell the clams in cheap rural markets. The clam cleaning machine cleans harvested clams before they are sold. These inventions contribute significantly to farmers' resilience, allowing them to continue clam production and recover from losses caused by risks associated with clam production and marketing.

Table 6.13: Spearman's rho test of the correlations between cycle length and mortality rate

		Cycle length (months)	*Mortality rate (%)*
Cycle length (months)	Correlation Coefficient	1.000	.124**
	Sig. (2-tailed)	.	.006
	N	481	481
Mortality rate (%)	Correlation Coefficient	.124**	1.000
	Sig. (2-tailed)	.006	.
	N	481	481

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

Another reason is that these tactics helped farmers to shorten the clam production cycle. Focus group discussions among experienced clam farmers revealed that 6-7 years ago, they needed only 12-18 months to raise clams from 1000 heads/kg to 70 heads/kg, but the length of time required has since doubled. One important reason for longer clam production cycles is the decline in nutrient levels in the coastal area in recent years. All households that used techniques such as adding new sand to clam raising plots or reducing stocking density had shorter clam cycles compared to others. Although clam cycle length is not strongly correlated with mortality rate, the correlation coefficient is 0.124 with a significance at the 0.01 level (*table 6.13*), indicating that the longer clams stay in the field, the more risks they face, which leads to higher mortality rates.

RMS3: Securing juvenile clam sources and diversifying the harvested clam market

Unlike RMS1 and RMS2, RMS3 did not have a very positive impact on management risk (i.e., it did not facilitate the sale of output at expected times, meaning that clam crops were left in the field for longer periods). However, when each tactic is examined in detail, it appears that each had some impact on searching for input and output markets in the clam sector.

Impact of juvenile clam sources on mortality rate

Table 6.14: Results of the Kruskal-Wallis Test for the hypothesis regarding the sources of juvenile clams and mortality rates

Juvenile source	N	Mean mortality rate (%)	Std. Deviation	Std. Error Mean
Local wholesaler	113	40	27	2.6
Outside wholesaler	357	44	25	1.3
Raised by themselves	169	36	18	1.4
Test Statistics				
Chi-Square	*11.006*			
df	*2*			
Asymp. Sig.	*.004*			

The results show that there is a difference in mortality rates between clam farms that purchase juvenile clams from other sources and those that raise juvenile clams themselves (*table 6.14*). The reason for this difference is that when juvenile clams are raised on the clam farm itself, they adapt better to the environment compared with juveniles purchased from other sources. Accordingly, self-raised juvenile clams have a lower mortality rate.

The difference in profit/ha among sales to different meat clam collectors

Before 2012, there were two types of collectors to which farmers could sell their clams. Collectors from outside the commune always offered higher prices and purchased higher volumes compared with collectors from inside the commune, meaning that farmers earned higher profits from sales to outside collectors (*table 6.15*). Therefore, during this period, farmers preferred to sell to outside collectors even though such collectors were strangers and some of them ultimately cheated clam farmers. However, in the middle of 2012, those collectors suddenly disappeared. Recently, there are only local collectors in the market.

Table 6.15: Results of the independent-samples T-test for the hypothesis regarding profit per ha and sales channels

Juvenile source	N	Mean profit per ha (Million VND)	Std. Deviation	Std. Error Mean
Clam collectors in the commune	203	158.73	645.97	45.34
Clam collectors from outside the commune	181	323.78	716.23	53.24

Levene's Test for Equality of variances: Sig: 0.290

T-Test for Equality of Means (in case equal variances are assumed): Sig.(2-tailed): 0.018

RMS 4: Diversifying livelihood activities

RMS4 is a strategy that smooths daily household spending and contributes to debt repayment when a clam farm experiences a loss. As mentioned previously, all HHs implemented RMS4 due to the unique characteristics of clam farming. Therefore, the results of RMS4 could not be compared between one group that implemented it and one group that did not. Nevertheless, the degree of implementation of RMS4 in each household led to different results, which will be discussed later in this paper.

The group of tactics in RMS4 (T4.1; T4.2; T4.3; and T4.4) makes an important contribution to household risk management by creating financial resources that can be invested in clam farming. Similarly, Fischer and Buchenrieder (2010) found that income diversification is the most common risk management strategy in developing countries. It is comparable to the use of financial instruments, which reduce dependence on loans and lessen financial risk (Harwood, Heifner et al. 1999).

RMS 5: Accessing sources of financing with no or low interest rates

To cope with financial risks, households applied a variety of diverse tactics, and most households adopted RMS5. However, the extent of household reliance on different financial sources depended heavily on farmers' capabilities, expected clam production, and marketing. Among households that commenced clam production in 2012, 34% used their own capital and/or capital from self-credit groups, 49% borrowed money from formal credit sources, and 17% borrowed money from informal credit sources. In 2013, those figures were 39%, 49% and 12%, respectively. In general, this RMS helped clam farmers to reduce the weighted average cost of capital (WACC) used in farming (*table 6.11*).

As a capital-intensive sector, clam farming often requires farmers to access several financial sources in addition to their own capital (*figure 5.5*). In the formal credit market, they access official banks and official credit funds that offer with low interest rates but require high-value assets as bond and impose restrictive credit limitations on borrowing for clam production profiles because clam production is considered a "high-risk production investment". In contrast, the informal credit market has lower barriers in terms of bond assets and credit limitations, making it very attractive to poor farmers. However, the informal credit market charges higher interest rates (5-10% higher than those in the formal credit market) and exerts greater economic pressure on farmers that lose the capacity for loan repayment (for example, houses are dispossessed, and high-value assets are usurped). Thus, poor farmers end up in a situation that is "easy to join but difficult to escape". On average, it appears that clam farms financed by informal credit generate no profits for farmers (*table 6.16*).

Table 6.16: Results of the independent-samples T-test for the hypothesis regarding 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

Levene's Test for Equality of variances: Sig: 0.347

T-Test for Equality of Means (in case Equal Variances assumed): Sig.(2-tailed): 0.003

6.3.2. Lessons learned based on the performance of three groups

<u>6.3.2.1 Lesson 1:</u> Tactics that address capital issues, land, and clam farming techniques have a positive impact on the results of household risk management strategies

There are significant differences in the adoption of RMSs among household groups A, B, and C (as defined above). Significant differences are found with respect to household adoption of tactics T1.1, T1.2, T2.1; T2.2; T2.3, and T5.3, whereas smaller differences are found for the other tactics (*tables 6.8, 6.9 and 6.10*).

Table 6.17: Discriminant analysis test about the impacts of the tactics to the result of household risk management

Name and code of tactics	Wilks' Lambda	F	df1	df2	Sig.
T1.1: Renting/purchasing additional intertidal land	.88	4.00**	2	60	.02
T1.2: Forming share groups	.96	1.32	2	60	.28
T2.1: Bidding for plots in favorable locations for clam production	.92	2.62*	2	60	.08
T2.2: Actively controlling start & harvest times for clam crops	.73	11.38***	2	60	.00
T2.3: Applying innovative techniques	.61	19.10***	2	60	.00
T3.1: Actively searching for good sources of juvenile clams	.99	.11	2	60	.90
T3.2: Diversifying clam sales channels	.99	.19	2	60	.83
T4.1: Raising other aquatic animals	.42	41.58***	2	60	.00
T4.2: Engaging in rice production	.83	6.25***	2	60	.00
T4.3: Conducting livestock activities	.89	3.88**	2	60	.03
T4.4: Conducting other activities	.99	.19	2	60	.83
T5.1: Using family savings and/or borrowing from relatives	.75	10.35***	2	60	.00
T5.3: Accessing the formal credit system	.92	2.84*	2	60	.07

<u>Notes:</u> **** Significant at the 0.01 level (2-tailed)*
*** Significant at the 0.05 level (2-tailed).*
** Significant at the 0.10 level (2-tailed).*

The adoption of RMS2 tactics, which relate to clam farming techniques, has allowed farmers to reduce the mortality rate of each crop. Tactic T1.1, enlarging clam plots, allowed farmers to benefit from economies of scale (Ngo et al. 2016). Tactic T5.3 enhanced household resilience by reducing financial risk; this finding is similar to that in (Wainwright and Newman 2011) regarding the role of the formal credit market in household risk coping strategies in rural Vietnam and to that in (Hurri and Nguyen 2015) regarding the specific case of coffee smallholders in Vietnam. This finding is also consistent with the results of the discriminant analysis regarding the impacts of tactics on outcomes of household risk management strategies (*table 6.17*).

Although there are also differences in the adoption of tactic T1.2 among the three groups, this tactic has not contributed to the success of household risk management like tactic T1.1 did, because tactic T1.2 was implemented for only 1-2 years after land re-allocation. As revealed by FGDs, after several raising seasons, a lack of effective coordination, different interests and contradictory opinions among group members about clam farming activities, marketing practices and technical innovation caused problems in farmers' groups. By 2015, 81% of established groups in the Thaido commune had disbanded. The corresponding figures for Dongminh and Namthinh were much lower, at 17% and 19%, respectfully. Consequently, in 2015 (when the fieldwork was conducted) the average clam raising plots in Dongminh and Namthinh communes were 2.46 ha and 2.90 ha, respectively, whereas the average plot size in Thaido commune was only approximately 1.68 ha.

The results of both analytical and comparative tests show that the tactics included in RMS3, which aims to reduce market risk, are unlikely to explain differences in household resilience to clam farming risks among the 3 groups; therefore, none of these tactics significantly contributed to household risk management. One reasons for the lack of contribution is that these tactics were implemented prior to 2013 and were not well planned prior to starting clam production. In addition, market risks are more easily explained at the meso/macro levels (Ngo et al. 2015) and are thus largely beyond individual farmers' control. Similar failures in market risk management among Vietnamese catfish farmers were observed in the research of Le & Cheong (2010), indicating that such tools are not practicable for farmers.

<u>6.3.2.2. Lessons 2:</u> To be effective, certain tactics require active and appropriate implementation rather than simple imitation.

Table 6.18: The proportion of money from family/relatives in financing clam farming activities

		Group A	Group B	Group C
T5.1: Using family savings and/or borrowing from relatives	*Mean*	27%	24%	6%
	Max	100%	50%	13%
	Min	0%	0%	0%
	Median	11%	22%	11%

(Source: Household survey 2015-2016)

The results of the discriminant analysis test show that certain tactics significantly contribute to household risk management, namely, T4.1, T4.2, and T5.1 (*table 6.17*). Statistical figures also show no difference in adoption among the three household groups (*table 6.8; 6.9;6.10*). The hidden reason for differences in outcome was the methodology used to implement these tactics. For example, diversification is one of the most common risk management strategies of clam farmers to protect their families and clam farms from agricultural risks, as is the case for other farmers in Southeast Asia (Fischer and Buchenrieder 2010), as well as farmers in Africa (Barrett et al. 2001) and even the EU (EC 2001). However, although nearly all farmers in all three household groups applied tactic 5.1 to overcome collateral constraints in the formal credit market, farmers in group C were able to finance only 6% (on average) of the total capital required to restart clam production from their own savings (or the savings of relatives). The corresponding figures for groups A and B were 27% and 24%, respectively (*table 6.18*).

Table 6.19: Average annual income from activities other than clam farming in the three household groups

Characteristic		Group A (N=31)	Group B (N=39)	Group C (N=87)
Average annual income from activities other than clam farming (USD)	Mean	9,115.42	8,255.73	3,052.95
	Max	18,027.27	18,318.18	10,918.18
	Min	0.00	0.00	0.00

Note: Robust Tests of Equality of Means

	Statistic[a]	df1	df2	Sig.
Welch	38.816	2	48.177	.000

a. Asymptotically F-distributed.

Similarly, although 100% of households have diversified into activities other than clam farming, the contributions of those activities to family income differ substantially. Specifically, whereas the households in groups A and B earned more than USD8,000 per year, on average, from other activities, the average for households in group C was just over USD3,000 (*table 6.19*). This level of additional income provides only enough for basic daily household spending, meaning that clam farmers in group C cannot rely on those activities for funds to invest in clam farming or to recover from losses. This difference among the groups explains the dissimilar results obtained by households that adopted the same strategy/tactic.

Table 6.20: Methods used by clam households to apply new clam farming techniques

Group RMS	Level of application		
	Discover	Learn and selectively apply	Simply imitate others
A	10%	87%	3%
B	36%	49%	15%
C	0%	9%	91%

(Source: Household survey 2015-2016)

There are also significant differences in the opinions/approaches of farmers regarding the application of new techniques in clam farming. The farmers in group A are more active and endeavor to master new techniques. In contrast, 15% of the households in group B and 91% of households in group C adopt new techniques simply because they see other farmers or neighbors using such techniques rather than fully understanding implementation and value of new techniques (*table 6.20*). This difference explains how farmers can employ similar RMSs and tactics but achieve different results. The lesson here is that strategies for risk management should be selected carefully and not applied simply by relying on or imitating others. RMSs are useful only if they are applied at appropriate times and in the proper contexts. The implementation of new techniques also requires that the correct methods be used.

6.4. Chapter conclusion

Clam farmers have experienced various types of risks, which have been exacerbated in recent years by the rapid expansion of clam farming areas and increasingly difficult markets. These risks have had severe consequences for most clam farmers; approximately four-fifths of the surveyed farmers had been seriously affected by risk. In the three communes considered in this study, less than one-half of the farmers have recovered from their losses, although they have mobilized sufficient capital to restart clam production; the remainder has not yet been able to restart clam production. Approximately one-third of the farmers had to sell fixed assets to repay debts related to their clam farm investments, and ten households left their villages due to pressure from debts.

However, despite the risks inherent in clam farming environments and increasing market difficulties, one-fifth of the surveyed farmers were successful in all clam raising cycles and one-fourth of showed resilience following shocks. Various household risk management strategies have been discussed in terms of the differences in clam farming and marketing practices among surveyed households. In general, adopted tactics relate to the expansion of plot size, application of technical innovations, and utilization of financial sources with no or low interest rates. Such tactics improved conditions for clam growth, decreased clam loss, and helped farmers to reduce aquaculture risks and recover more quickly from shocks.

7

FACTORS AFFECTING THE APPLICATION OF HOUSEHOLD RISK MANAGEMENT STRATEGIES IN CLAM FARMING

This chapter identifies and analyzes factors that affect the application of household risk management strategies. It comprises four parts. The first part analyzes the influence of internal household factors, such as financial capacity; social status and experience of the head of household; and household perceptions and knowledge of clam farming risks. The second part analyzes the impact of external factors, including farmers' networks, government policies and interventions related to clam farming, and market practices. The third part discusses the interaction between and among farming risks, household risk management strategies and government policies, which collectively explain the extent of household resilience to risks. The fourth part summarizes the main findings of the chapter and concludes.

Part of the content of this chapter has been presented in the paper namely "*Aquaculture Land-Use Policy: The Case of Clam Farming in Thaibinh Province, Vietnam*", which is published in *Sustainability*, 8, 1251(Special Issue), 12. DOI 10.3390/su8121251, ISSN 2071-1050.

7.1. Internal factors

There are many factors that influence the adoption of household risk management strategies. In this regard, the research identifies three major household characteristics: (1) household financial capacity; (2) the social status and experience of the head of household; and (3) perceptions and knowledge of the household regarding clam farming risks.

Statistical data show that all three of these basic household characteristics significantly impact both the adoption of RMS tactics and the extent to which adopted RMS tactics are successful in helping farmers to cope with clam farming risks (*table 7.1*). This finding is consistent with the research of Baez & Mason (2008) on household risk management strategies and their adoption in Latin America. Specifically, the authors concluded that the rate of recovery and after-shock steady states of households was enhanced by access to capital markets and higher levels of education; they also found that poorer households were impeded by their lack of capital in the adoption and success rate of risk management strategies (Fischer and Buchenrieder 2010). However, the effects of these factors on specific RMS tactics are very different.

7.1.1. Household financial capacity

Household financial capacity has different impacts on different RMS tactics. Specifically, it positively affects the adoption of RMS tactics 1.1; 2.1; 2.2; and 2.3 and negatively affects the application of tactics 1.2 and 4.2 (*table 7.1*).[5] The implementation of tactics T1.1 (acquiring more land), T2.1 (bidding for land), T2.2 (purchasing juveniles), and T2.3 (investing in technical innovation) requires sufficient financial capacity.

[5] *Please refer to table 6.5, Chapter 6, for the definition of the tactics*

Beginning in 2010, when farmers enjoyed high profits from clam production, competition among farmers for increased investment in clam farming intensified. This competition led to sharply increased demand for intertidal land. Consequently, the price of intertidal land increased, meaning that only farmers with sufficient financial capacity could bid individually for intertidal land, especially in Namthinh and Dongminh communes, where free bidding was adopted. Households with financial strength often did not implement tactic T1.2 (share groups), nor did they engage in rice production (T4.2), because rice production has a very low economic value. Furthermore, Spearman's rho tests of the correlation of "*income sources other than clam farming*" (i.e., *non-clam income sources*) were conducted to assess the above-stated findings. The results of Spearman's rho tests were indeed consistent, with the exception of small differences in the impacts of adopting T3.1; T4.2; and T4.4 (*table 7.1*).

The reason of those impacts could be that household income is generated in part by clam farming. Household factors and tactics used are thus inter-dependent on each other. For example, total income might not only affect the application of a particular tactic but also be affected by that tactic, which in turn might influence a farmer's decision regarding investment in the next clam raising cycle. Taken together, the results of these two tests indicate that financial capacity has a positive impact on the adoption T1.1; T 2.1; T2.2 and T2.3 and a negative impact on the application of T1.2 and T4.2.

Table 7.1: Impacts of household characteristics on the adoption of each tactics of RMS

		TACTIC													
		T1.1	**T1.2**	**T2.1**	**T2.2**	**T2.3**	**T3.1**	**T3.2**	**T4.1**	**T4.2**	**T4.3**	**T4.4**	**T5.1**	**T5.3**	**Notes**
Average annual income	CC(1)	.87***	-.65***	.47**	.47**	.57***	-.07	-.16	.10	-.56***	-.29	-.10	.15	.22	Spearman's rho Test
	Sig.(2-tailed)	.00	.01	.02	.02	.00	.74	.46	.64	.01	.18	.67	.49	.32	
Household income (*except income from clam farming*)	CC(1)	.267***	-.224***	.168**	.237***	.219***	.156**	-.058	-.073	.005	.-.03	-.13*	.04	.13	Spearman's rho Test
	Sig.(2-tailed)	.00	.01	.03	.00	.00	.05	.47	.37	.95	.71	.10	.62	.15	
Education level	Kendall's tau-c	-.09*	.25***	-.17**	-.04	-.09	.02	.16**	.24***	.04	.08	.14**	.02	-.07	Kendall Tests
	App. Sig.	.06	.00	.03	.64	.19	.70	.05	.00	.63	.26	.05	.81	.38	
Experience with clam farming before starting own farm	Kendall's tau-b	.32***	-.01	.88***	.83***	.21***	.02	-.23***	-.09	-.17**	-.24***	-.12	.20***	.22***	Kendall Tests
	App. Sig.	.00	.91	.00	.00	.01	.84	.00	.24	.04	.00	.13	.02	.01	
Job of the head of HH	Kendall's tau-c	-.09	-.12	-.14*	-12	.04	-.10	-.02	-.19***	-.02	.01	.04	-.04	.03	Kendall Tests
	App. Sig.	.15	.09	.06	.13	.52	.12	.82	.01	.83	.91	.60	.58	.66	

Notes: *CC: Correlation Coefficient*
****. Correlation is significant at the 0.01 level (2-tailed)*
***: Correlation is significant at the 0.05 level (2-tailed).*
**: Correlation is significant at the 0.1 level (2-tailed).*

Among the 3 groups, households in groups A and B have much higher incomes than those in group C. Higher average household incomes allow households in groups A and B to purchase and/or rent additional intertidal land to enlarge their clam raising plots. In contrast, the lack of capital of households in group C force them to rely more on tactic T1.2 compared with the other two groups. None of the survey households in group C rented and/or purchased additional intertidal land, but 45% of them joined farmers' groups (which allowed them to enlarge clam raising areas and to mobilize capital for farming investment). Meanwhile, 32% of group A purchased additional intertidal land adjacent to their existing fields and 23% joined farmers' groups. The corresponding figures for group B are 36% and 28%, respectively. There is a tendency in group A for households to have clam raising plots larger than 2 ha and a tendency in group C have plots smaller than 2 ha (*table 7.2*). Small clam raising areas and the lack of capital are major constraints on farmers' ability to cope with farming risks. Similar results were obtained in studies on farming systems (Truong and Yamada 2002) and on the aquaculture sector in particular (Stevenson & Irz 2009).

Table 7.2: Major characteristics of household groups

Characteristic	**Group A (N=31)**	**Group B (N=39)**	**Group C (N=87)**
Average annual household income (USD)	24,047**	17,774**	4,471**
Income (excluding from income from clam farming) (USD)	9,115	8,255	3,052**
Average size of clam raising plot (ha)	2.70*	2.10*	2.11*
Percentage of clam plots >= 2 ha[6]	74%	56%	47%

Notes:

**: *The mean difference between this groups and the others is significant at the 0.05 level*

*: *The mean difference is significant at the 0.10 level.*

[6] *Given the limited intertidal land area and increased demand for clam farming plots, Decision 11/2012/QD-UBND set a maximum size of 2 ha for clam raising plots owned by individual households and 10ha for plots owned by organizations ThaibinhGOV (2012). Decision 11/2012/QD-UBND Thaibinh-13/7/2012: Quy che quan ly vung nuoi ngao tren dien tich bai trieu "Regulation for management clam farming unit in intertidal area".*
. However, the Mann-Whitney U test reveals a substantial impact of clam raising plot size on farmers' cost/profit ratios; specifically, larger plots are more economically advantageous compared with smaller plots Ngo, T. T. H., et al. (2016). "Aquaculture Land-Use Policy: The Case of Clam Farming in Thaibinh Province, Vietnam." Sustainability ***8, 1251****(Special Issue): 12.*

7.1.2. Social status and experience of the head of household

The survey results show that 97% of the heads of household are men. Only 3% of heads of household are women, which occurs when the husband dies. As mentioned in Chapter 5, men are responsible for 90% of the decisions made relating to clam farming activities (*table 5.11*). Therefore, the social status and experience of men, as heads of household, will govern the adoption of RMSs in clam farming practices. This part discusses the effects of 3 head of household characteristics, namely, (1) education level; (2) primary job; and (3) farming experience prior to starting their own farms.

Table 7.3: Characteristics of heads of households

	Education level				**Job**				% with prior farm experience
	Primary school	Secondary school	High school	Vocational and higher education	Farmer	Employer	Business	Other	
In the entire sample of 157 HHs	8%	59%	26%	6%	67%	9%	20%	4%	46%
In Group A (N=31)	10%	58%	26%	6%	68%	13%	10%	10%	52%
In Group B (N=39)	10%	62%	26%	3%	64%	10%	26%	0%	62%
In Group C (N=87)	7%	59%	26%	8%	68%	7%	21%	5%	37%

Education level of the head of household

More than 60% of heads of clam households have primary or secondary school educations; only 26% graduated from high school. The distribution of education levels was fairly equal among the three household groups (*table 7.3*). The education level of the household head is found to have positive impact on the adoption of tactics T1.2; T3.2; T4.1; and T4.4 and a slightly negative impact on the application of tactics T1.1 and T2.1 (*table 7.1 and figure 7.1*). The low adoption rate of tactics T1.1 and T2.1 might be explained by the tendency of household heads with higher education levels to earn incomes from more secure jobs, for example, a job in a business that pays regular wages, which leaves them less time for clam farming. Accordingly, these households often do not rent and/or bid for additional intertidal land but instead simply maintain the land they have.

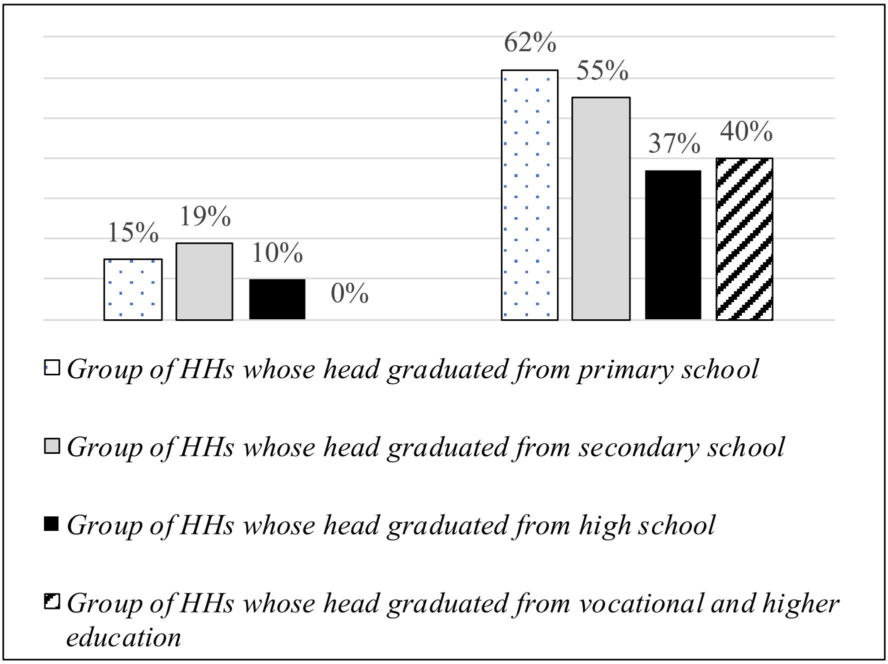


Figure 7.1: The adoption of T1.1 & T2.1 by education level of the head of HH

Job of household head

Among the surveyed households, approximately 67% are farmers, 9% have wage-paying jobs (e.g., they are officers in the local government or work at nearby factories), 20% own businesses, and the remainder have other types of jobs. Similar to household education level, the distribution of job types are consistent across groups A, B and C (*table 7.3*).

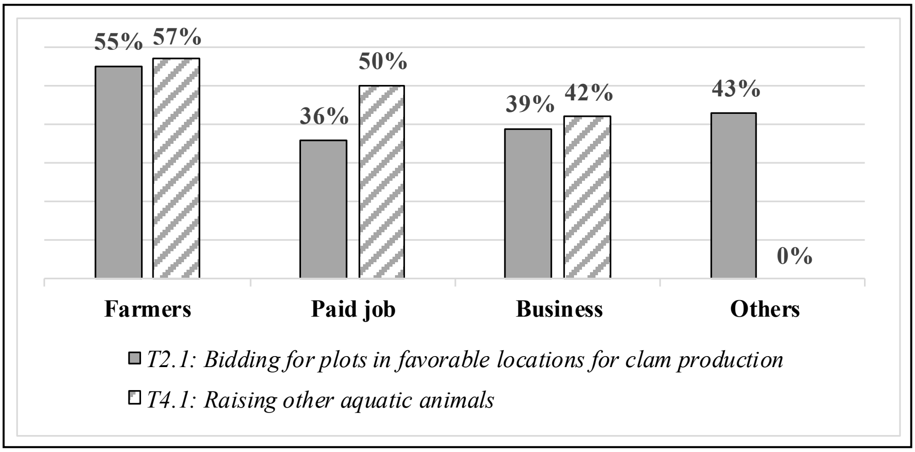


Figure 7.2: The application of T2.1 & T4.1 by job of the head of HH

Surprisingly, however, the job of the household head only affects the adoption of T2.1 and T4.1 (*table 7.1*). Moreover, the differences in the adoption of these two tactics among the three groups are not significant, as illustrated in figure 7.2. Household heads in the ‘farmer’ group paid more attention to these tactics compared with those in the other groups in part because aquaculture plays an important role in their livelihoods. Furthermore, when we asked the 36 people in the survey group who work as officers in the local government whether their positions affected their clam farming, 4 of them stated that they needed to be leaders in following government policies; 1 mentioned easier access to the official credit system; 4 cited the opportunity to participate in technical training courses; and 27 stated that there was no impact on their farming.

Previous farming experience

There were significant differences between the group of people who had prior farming experience and the group that had none in the adoption of several tactics. Specifically, substantial differences were seen in the adoption of T1.1; T2.1; T2.2 and T4.3 (*table 7.1 and figure 7.3*).

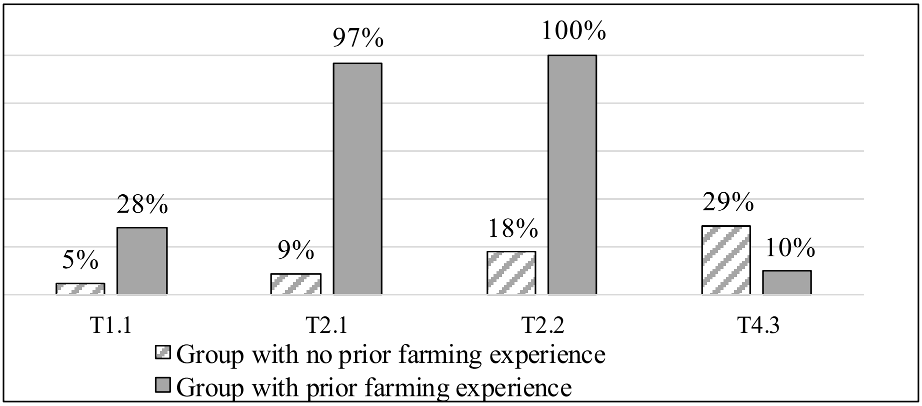


Figure 7.3: The application of T1.1; T2.1; T2.2; & T4.2 by groups with and without prior farm experience

Experienced people tended to enlarge their farms and apply more technical tactics compared to those without prior experience. Experience gained while working for other people might have made them more aware of the importance of techniques and the advantages of a larger calm farming plot. Moreover, experienced people invested more time and money in aquaculture activities and less time and money in livestock activities (T4.3). The results of the Independent-samples T-test for the hypothesis regarding the number of years of experience and profit per ha are presented in table 7.4. These results support the impact of experience on clam farming performance. Specifically, plots managed by farmers with more than 10 years of experience generated higher profits compares with plots managed by those with less experience. Experience helps farmers to make good decisions regarding the selection of juvenile clam sources and suitable start and harvest times (e.g., start before summer and harvest before storm season).

Table 7.4: Results of the Independent-samples T-test for the hypothesis regarding the number of years of experiences and profits per ha

Number of years of experience	N	Mean of profit/ha (*Million VND*)	Std. Deviation	Std. Error Mean
>= 10 years	230	174.18	586.78	38.70
< 10 years	409	68.55	621.50	30.73

Levene's Test for Equality of variances: Sig: 0.885

T-Test for Equality of Means (in case equal variances assumed): Sig.(2-tailed): 0.036

7.1.3. Household perceptions

The results of the EFA (Exploratory Factor Analysis) indicate that perception factors accounted for 66% of the variance (*table 7.6*) in resilience capacity among households. This factor had three components. Component 1, which accounted for 43% of the variance, comprised five statements (2, 8, 9, 10 and 11) related to the farmer's opinion regarding learning and gaining opportunities from failures. Component 2, which explained 13% of the variance, had three statements (3, 4 and 6) regarding the farmer's perceptions of clam farming risks and the impacts thereof. The last component, which accounted for 10% of the total variance, included two statements (1 and 5) regarding the farmer's confidence in household financial capacity and income from diversified activities that can invested in clam farming.

Interpretation of the impact of factors on household resilience

The results of the reliability analysis show that the index "Corrected Item – Total Correlation" for Statement 7 is -.010; accordingly, this statement was eliminated. The results of the second test (after the elimination of statement 7 in table 4.7) yielded a Cronbach's alpha coefficient of 0.844, which means that the remaining statements reliably contribute to the level of household resilience.

The Kaiser-Meyer-Olkin (KMO) index for sample adequacy is 0.805 and the significance of Bartlett's Test of Sphericity is 0.000 (*table 7.5*), indicating that factor analysis was suitable in this case (Williams et al. 2012).

Table 7.5: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sample Adequacy.		.805
Bartlett's Test of Sphericity	*Approx. Chi-Square*	700.44
	Df	45
	Sig.	.000

Interviewees' responses to all of the statements are quite interesting. Clam farmers expect high profits from clam farming but have had to rely significantly on diversified activities to sustain their livelihoods, as shown by the percentages of "agree" and "strongly agree" responses for statements 5 (82%) and 6 (74%). More surprisingly, despite the success of certain farmers in the use of new and innovative production tools, some respondents indicated that they did not see the utility of such tools (i.e., 16% chose "disagree" or "strongly disagree" for statement 9 in table 4.7). According to the latter group, clam farming risks are always "out of control"; therefore, they prefer to rely on luck or fate instead of investing more in their clam farms. However, in general, the more experience farmers had and the more confidence they had in their financial capacity, the greater their resilience to losses in clam farming. The results of the exploratory factor analysis, which are presented in part below, offer persuasive support for this assessment.

Table 7.6: Rotated component matrix[a]

Statements		Factor loading		
		1	2	3
Component 1: *Farmer's opinion regarding learning and gaining opportunities from failures*	S2	.844		
	S11	.812		
	S8	.753		
	S10	.662		
	S9	.612		
Component 2: *Farmer's perception regarding clam farming risks and the impacts thereof*	S6		.772	
	S4		.744	
	S3		.687	
Component 3: *Farmer's confidence in household financial capacity and income earned from diversified activities that can be invested in clam farming*	S5			.877
	S1			.748
Eigenvalues		4.289	1.310	1.046
% of variance		43	13	10

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.[a]

a. Rotation converged in 4 iterations.

Several factors were found to contribute to farmers' resilience. The results of the EFA indicated that perception factors collectively accounted for 66% of the variance (*table 7.6*) in resilience among households. There were three components of total perception. Component 1, which accounted for 43% of the variance, comprised five statements (2, 8, 9, 10 and 11) related to the farmer's ability to learn and gain opportunities from failures. Component 2, which explained 13% of the variance, had three statements (3, 4 and 6) regarding the farmer's perceptions of clam farming risks and the impacts thereof. The last component, which accounted for 10% of the total variance, comprised two statements (1 and 5) regarding the farmer's confidence in household financial capacity and income from diversified activities that can invested in clam farming. The results for these three factors are consistent with the results in other studies about household resilience in developing countries (Carpenter and Brock 2004, Marschke and Berkes 2006, Nguyen et al. 2013).

Component 1: Farmer's opinion regarding learning and gaining opportunities from failures

This component has the highest factor loading related to farmers' perceptions of what can be gained from failures. Although losses and the impacts thereof were the main reason (90%) behind farmers leaving the clam sector[7], certain farmers took

[7] Results of household survey – 2015-2016

advantage of shocks, gaining practical experience, opportunities and even inventions/improvements in production techniques.

Risk is both a burden and an opportunity (World Bank, 2014). Clam prices experienced severe declines in 2013-2014 (*table 5.5 in Chapter 5*). The clam production cycle that had started 18-24 months earlier, with large investments in juvenile clams, led to sharp decreases in clam market prices, resulting in serious losses for farmers. All farmers were hurt by the downturn in the clam market. However, juvenile clam prices also decreased, which allowed a number of farmers to quickly restart the clam production cycle, as explained by the farmers themselves.

Box 7.1: Gaining opportunities from shocks

In 2013, rental costs for clam production plots and juvenile clam prices were low. In my experience, after a sharp downturn, clam market prices can go up again. If farmers started new clam production cycles when juvenile clams were cheap, the probability of success could be as high as 80%. If a loss occurs (e.g., due to storms), it will be less serious because of the low initial investment.

(Personal interview with a farmer - Dongminh commune – Tienhai District – 17/07/2015)

I restarted the clam production cycle after the clam market downturn in 2013. The first reason I decided to restart was the low input cost. The second reason was that more food would be available for clams because many farmers had ceased clam production. The third reason was the expectation of a better clam market.

(Personal interview with a farmer - Thaido commune- Thaithuy district- 21/07/2015)

Consistent with the results of prior research on the capacity to transform and innovate (Folke 2006, Marschke and Berkes 2006, Nguyen et al. 2013), the pressure generated by clam farming risks prompted several innovations related to clam production at the local level, thereby improving clam production and harvesting practices. For instance, a “clam catching machine” (*picture 5.b in Chapter 5*) was invented by a high school girl whose parents had experienced a serious loss due in part to the high cost of labor for clam harvests. The clam catching machine reduced the cost of harvesting clams from 40-50 million VND/ha to only 5-6 million VND/ha. Another example is the “clam cleaning machine”, which was invented by a local clam farmer (*picture 6.1 in Chapter 6*). Often, harvested clams harvested had sand inside of them, which led to lower clam prices because traders either had to resubmerge the clams in salt water to cause them to release the sand or limit clam sales to cheap rural markets. The clam cleaning machine cleans harvested clams before they are sold. These inventions made a remarkable contribution to farmer resilience, allowing them to continue clam production and recover from losses caused by the risks associated with clam production and marketing.

Component 2: Farmers' perceptions of clam farming risks and the impacts thereof

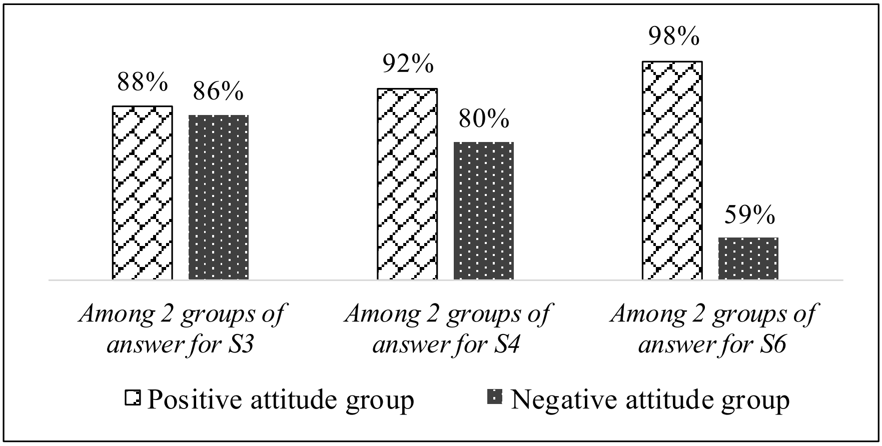


Figure 7.4: Percentage of households that decided to restart after losses

Consistent with the research findings of Marshal & Marshal (2007), the farmers' perceptions of the risks associated with clam production and marketing had an impact on their resilience. Their perceptions were driven by beliefs regarding the acceptable level of clam farming risk, a comparison between clam farming risks and the risks of other aquaculture activities (which may be alternative livelihood options), and the impact of clam farming risk on the smoothness of daily household expenditures. The more positive their attitudes about clam farming risks and the impacts thereof, the more confident they were about restarting and recovering. The percentage of households who decided to restart after losses in the group that gave positive answers (i.e., strongly agree and agree) was always higher than the corresponding percentage in groups with negative attitudes (i.e., disagree and strongly disagree) (*figure 7.4*). One explanation for this factor, which has been confirmed in many other studies on resilience (Carpenter et al. 2001, Folke 2006), relates to the degree to which households are capable of self-organization and their level of dependency on systems containing risk potential.

Furthermore, the perceptions of farmers regarding the acceptability of clam farming risks and the profitability of the clam farming sector affected their decisions. Presented below is the opinion of an experienced farmer with more than 10 years of experience in raising clams. He believes that although clam farming risks are high, they are simply a trade-off for high profits. For farmers who think like this, investments in clam farming are similar to "gambling" but are more equitable and easier to control. In other words, the notion that "the assumption of risk is necessary to pursue opportunities for development, and the risk of inaction may well be the worst option of all" (WorldBank 2014), combined with positive thinking about the future of clam farming, contribute to the confidence of farmers to restart clam production.

Component 3: Farmer's confidence in household financial capacity and income from diversified activities that can be invested in clam farming

Data on the losses of 157 households in period 2006-2014 showed the serious economic impacts experienced in clam farming. Specifically, in 2012, due to a loss of 67% of the clam area, farmers lost more than 50 billion VND. Among this group, 16% stopped clam farming because they became bankrupt and 38% had to sell fixed assets (such as houses, cars, motorbikes and even clam fields) to obtain money to repay debts. These outcomes explain why a farmer's confidence in household financial capacity and income from diversified activities affects the length of time needed to restart after a loss (*figure 7.5*). This result is in line with Tran (2014) and Carter et al. (2007), who found that households need time to balance their financial situations before recovering asset losses. However, Newhouse (2005) reached a contradictory conclusion, finding that negative shocks did not persist for a longer period of time in poor households.

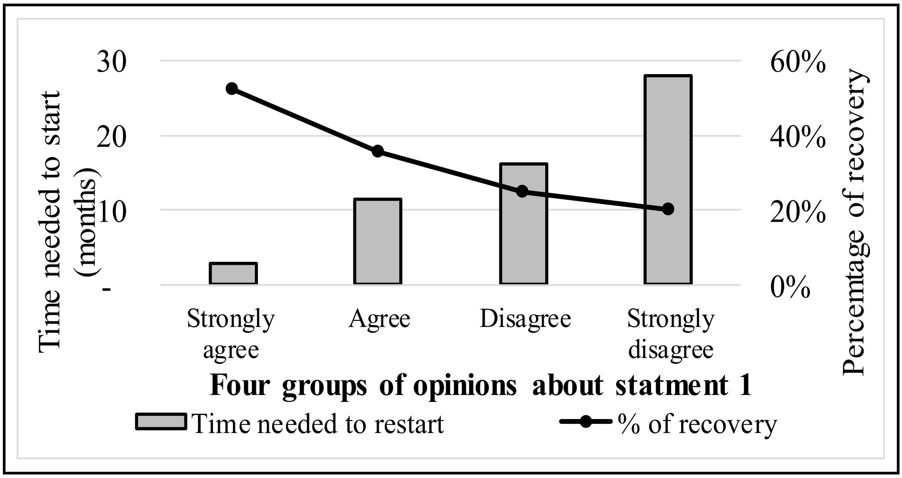


Figure 7.5: Time needed to restart, and percentage recovered relative to financial capacity

A substantial investment requirement is one of the most important characteristics of clam farming; the average total cost is 475.67 million VND/ha (Nguyen and Nguyen 2013). The results of the household survey revealed that 70% of the farmers' investments and financial resources used to recover following shocks came from the credit system. However, the high-risks nature of clam production makes it difficult for clam farmers to access the formal credit market, forcing them to resort to the informal credit market. Informal credit, with its high interest rates, is feared by poor households (Nguyen et al. 2013) because although informal loans are easy to access, the subsequent financial debt traps are difficult to escape.

The above-described situation explains why farmers seem reluctant to restart if they lack confidence in their financial capacity and have a lower probability of recovering losses. In contrast, if households are confident that they will not need to access the informal credit system (e.g., they have their own capital from non-clam activities or can borrow money from their relatives or banks with low interest rates), they can restart sooner (i.e., 3 to 10 months, as indicated by the farmers who chose "strongly agree" or "agree" for statement 1) (*figure 7.5*). Moreover, the two groups that had confidence in their financial resources had higher percentages of recovery compared with the other groups. The importance of financial capacity to the ability of farmers to overcome shocks has been a key finding in many studies of resilience in rural areas around the world (Marshall and Marshall 2007, Nguyen et al. 2013).

7.2. External factors

7.2.1. Government policies and interventions

7.2.1.1. Overview of policy packages applied to clam production in Thaibinh

Although clam production started in 1996[8] (with small fields in few households in Namthinh commune) and officially expanded in 2005, government support/intervention has been implemented only since 2009 (*table 7.7*). Clam production is an important part of Thaibinh aquaculture, accounting for 59% of the value of total annual aquaculture production in Thaibinh (Thaibinh DARD,2015). Therefore, it is covered by all of the regulations/policies that are applicable to aquaculture and agriculture in the province. Moreover, given the recent decline of the wild/capture sector and the development of the cultivation sector of aquaculture due to limitations on maritime resources, clam production is a pressing concern. Table 6.7 presents a timeline (2009-2015) of policy packages that directly impacted clam production. Six packages included regulations and policies regarding financial support, capital credit programs, land rental fees, breed clam production, post-harvest processing support and planning through 2020.

Those below-described policy packages can be divided into three groups based on its purposes: (1) the first group addresses capital support and includes packages 1a, 1b and 2; (2) the second group concerns breeding clam (juvenile clam) production and includes only package 4; and (3) the third group addresses land use issues and comprises packages 3, 5 and 6 (*table 7.7*). The following part will discuss in greater detail the impacts of these packages on clam farm risk management strategies.

[8] *Source: Focus group discussion in Namthinh commune (3/2015)*

Table 7.7: Policy packages related to clam production in Thaibinh province

1996	2005	2009	2010	2011	2012	2013	2014	2015
Start of clam production	*Expansion of clam production*	*(1a)*				*(1b)*		
			(2)					
			(3)					
				(4)				
					(5)			
								(6)

Notes:

(1a) Financial support for aquaculture production in the event of losses caused by natural disasters: 3 million VND – 5 million VND for losses of more than 70% and 1 million VND- 3 million VND for losses of 30%-70%.

(1b) Enhanced financial support for clam production in the event of losses caused by natural disasters: 40 million VND – 60 million VND for loss of more than 70% and 20 million VND- 30 million VND for losses of 30%-70%.

(2) Capital credit support program for agriculture production, including clams; maximum credit level of 50 million VND/household.

(3) Plan for the expansion of clam production, targeting 100,000 tons/year by 2015 and 200,000 tons/year by 2020.

(4) Favorable policy packages to promote breeding clam farm production and post-harvest clam processing enterprises.

(5) Regulations covering auctions for land rentals; applicable to land used for agricultural production and business.

(6) Government promotional program for aquaculture development; includes regulations to exempt aquacultural land from rental fees.

7.2.1.2. Impacts of Government policies and interventions

Impacts of financial support policies

Two financial support packages have been implemented. The first package provided financial support for aquaculture production in the event of losses caused by natural disasters. In 2009, the proposed support amounted to 3 million VND – 5 million VND per ha for losses greater than 70% and 1 million VND- 3 million VND per ha for losses ranging from 30% to 70%. However, given that the average investment in clam farming is more than 400 million VND per ha, the available financial support was considered quite small and most farmers did not care about it and did not use it as an ex post risk management strategy. In 2013, after serious losses were caused by storms, a new support policy was proposed that provided 40 million VND – 60 Million VND for losses greater than 70% and 20 million VND- 30 million VND for losses of 30%-70%. According to this plan, approximately 165 billion VND from the state budget would be used to compensate farmers for clam farming losses; 5 billion VND of the total was allocated to people in the coastal area of Thaibinh. However, the administrative process required a detailed report from the local government about the exact size of the area affected, the mortality rate, etc. Approval from the state government, which was required before disbursement, took a long time. Therefore, it took a long time for farmers to obtain loans. Furthermore, many farmers had sufficient funds to pay the land rental fee to the local government, meaning that their clam farming areas could not be claimed as losses. For these reasons, the financial support program implemented in 2013 was deemed to make no contribution to the adoption of risk management strategies by clam farmers despite support levels that were ten times higher than those in 2009.

The second financial support package was the capital credit support program for agriculture production, including clams (mentioned in Decree No. 41/2010/ND-CP of the Government on credit policy for agricultural and rural development), which had a maximum of 50 million VND/household. According to farmers, the flexibility of the policy and the low interest rate were attractive, although the credit limit was quite low compared with the actual investments made by farmers. In accordance with this program, the Vietnam Joint Stock Commercial Bank for Industry and Trade (Vietin Bank), Thaibinh Branch, lowered interest rates from 11%/year to 10%/year. For clam culture households, the Bank decreased the interest rate on old loans to 9.5%/year. In addition, on April 10/2014, the Vietin Bank offered an interest rate of 8%/year to 5 new customers and disbursed a total of 16 billion in loans. In the future, the bank will seek approval from the Industrial and Commercial Bank of Vietnam to lower interest rates on old loans to 8%/year.

Peak expansion of clam farming occurred during 2010-2011; thus, this period was characterized by high capital demand among clam farmers. Statistics indicate that since 2010, farmers have tended to rely on credit and their own financial resources rather than informal credit sources (*figure 7.6*).

According to the State Bank of Vietnam (SBV), at the end of September 2013, 1,752 enterprises and households had loans totaling 457.6 billion VND to raise clams. Of the total amount loaned, the Industrial and Commercial Bank had the largest outstanding debt (278.5 billion dong), followed by the Bank for Agriculture and Rural Development (152.3 billion VND) and the Bank for Investment and Development (14.4 billion VND) (Mai 2013). However, in 2013, clam farming risks increased sharply. Consequently, the barriers to borrowing from formal credit sources became higher due to banks' security policies. Higher barriers, combined with a complicated application process, caused farmers' interest in the program to decline and led to an increase in the use of tactics T5.1 (*Using family savings and/or borrowing from relatives)* and T5.2 (*forming "self-credit" groups)* instead of T5.3 (*accessing the formal credit system).*

Impacts of the policy promoting breeding clam production and post-harvest clam processing enterprises.

According to the preliminary summary report of Thaibinh DARD regarding 2 years during which the "2011-2015 planning proposal" was implemented, as of 2013, 2,708 clam households in an area of 2,472.41 ha had been managed under the plan. Clam farms in this area accounted for 11,515 tons of clam exported to EU markets with 490 "True Source Certifications" issued by the Thaibinh Agro-Forestry-Fisheries Quality Assurance Sub-Department. In 2013, supported by the favorable policy promoting breed clam farm production and post-harvest clam processing enterprises, 10 farms (3 large-scale operations and 7 medium-scale operations) produced 2.3 billion heads of breeding clams, satisfying 17% of the demand for breeding clams in Thaibinh. Regarding post-harvest clam processing, one factory processes 15-30% of the total annual output of the entire province.

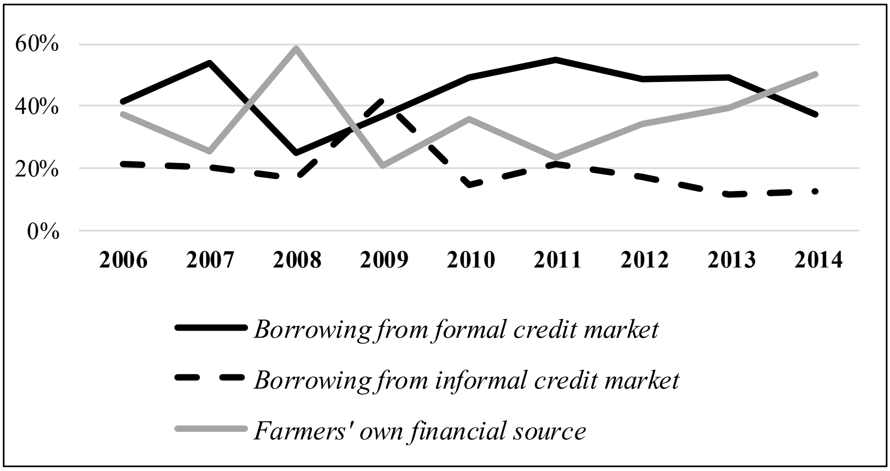


Figure 7.6: Proportions of sources used to finance clam farming

This program created more opportunities for the application of tactic T3.1 (*purchasing juvenile clams directly from production sources)* and tactic T3.2 (*diversifying clam sales channels)*. However, the scale of this program was relatively small compared with the demand for juvenile and adult clams, which explains why more than 50% of clam farmers implemented tactics T3.1 and T3.2 but did not successfully manage market risks in clam farming.

Impacts of land-use policies

The Thaibinh government has formulated policies on intertidal land use. In 2011, intertidal land allocation was officially implemented by Decision 1519/QD-UBND of the Thaibinh provincial government (ThaibinhGOV 2011). All intertidal land area was zoned and allocated to farmers who had an interest in clam farming. Many experienced clam farmers left their original clam farming plots to newcomers, who accepted higher taxes. In addition to the intertidal land-use policy, the Thaibinh government issued policies to provide financial and technical support for clam farmers (e.g., Resolution 24/2011/NQ-HDND) (ThaibinhGOV 2011) and to support juvenile clam production and clam processing technologies (e.g., Decision 05/2012/QD-UBND) (ThaibinhGOV 2012).

An interview of an official with the Thaibinh DARD (Department of Agriculture and Rural Development) revealed that within two years of implementing Decision 1519, 2708 clam households had been allocated a total intertidal area of 2472.4 ha in

Thaibinh (ThaibinhDARD 2014) Approximately 1000 ha were allocated to cooperatives and companies, for a total clam farming area of approximately 3500 ha in 2013 (*figure 4.1 in Chapter 4*). In addition, Resolution 24/2011/NQ-HDND and Decision 05/2012/QD-UBND provided favorable conditions for juvenile clam production and clam processing enterprises. In 2013, 10 farmers invested in juvenile production and produced approximately 2.3 billion juvenile clams, satisfying 17% of the total demand for juvenile clams in the province. In addition, a factory that invested in clam processing processed 15%–30% of the total annual clam harvest in the province.

Table 7.8: Enforcement of Decision 1519 in the three communes

Items	**Thaido Commune (in Thaithuy District)**	**Dongminh and Namthinh Communes (in Tienhai District)**
Intertidal land allocation approach	Every household is allocated an equal intertidal land area through a random selection process.	Land-use fees are bid by farmers through an auction process and range from 3 to 12 million VND (Vietnam Dong)/ha/year.
	The same land-use fee is applied regardless of the location of the intertidal land area (three million VND/ha/year).	The fees paid by farmers for intertidal land are based on their farming experience and financial capacity
Consequences	After land reallocation, the number of clam farms nearly doubled, going from 63 farms to 117.	After land reallocation, the number of clam farms decreased slightly, going from 600 to 510.
	32% of interviewed farmers had to stop clam farming due to bankruptcy.	17% of interviewed farmers stopped clam farming. One-half of these farmers experienced bankruptcy, and one-half stopped clam farming because of low profits.

However, enforcement of Decision 1519 differed among the three communes, particularly with respect to flexibility in land-use fees and the participation of farmers, which led to differences in farmers' clam investments and resilience levels. In the Thaido commune, the intertidal land area was allocated equally to households through a random selection process and there was a single fee level. In contrast, in the other two communes, farmers bid upon intertidal land area and different land-use fees applied to different intertidal land locations. In addition, experienced clam farmers were favored. Because of the low land-use fees in Thaido commune, the number of clam farmers in Thaido increased while the number of farmers in the other two communes decreased. Due to the increased risks in clam farming and marketing in recent years, more farmers in Thaido commune have faced bankruptcy (*table 7.8*).

Given the limited intertidal land area and the increasing number of farmers interested in clam production, Decision 11/2012/QD-UBND set limited the permissible size of clam-raising plots to no larger than 2 ha for individual households and no larger than 10 ha for organizations. This limit was imposed for the sake of equity, to provide all households living in the coastal area the same opportunity to own a clam raising plot.

Table 7.9: Average of size of clam-raising plots in the three communes

Commune	District	Average clam plot size (ha)
Dongminh	Tienhai	2.46
Namthinh	Tienhai	2.90
Thaido	Thaithuy	1.68

The inflexible intertidal land allocation approach resulted in an average clam raising plot size of only 1.68 ha in Thaido commune, whereas the more flexible land allocation approach adopted by the other two communes resulted in larger average clam raising plot sizes in Dongminh (2.46 ha) and Namthinh (2.90 ha) communes (*table 7.9)* (Ngo 2015, Nguyen 2015, Nguyen 2015)).

Table 7.10: Clam farming plot size and profit/cost ratio [a]

Plot size	Total clam plots (for all raising cycles from 2006 to 2014)	Mean of profit/cost ratio)	SD
Group 1: Plot size ≤ 2 ha	458	0.24	1.12
Group 2: Plot size > 2 ha	181	0.48	1.06

[a] The profit/cost ratio is a measure of profitability calculated by dividing net profits by total costs for 1 ha of clam production. This ratio shows how much profit (in dollars) a farmer receives from a one-dollar investment in this sector. The difference in the cost/profit ratios between the two groups is significant at p < 0.001.

In the Dongminh and Namthinh communes, farmers who shared common farming interests or were related to each other would bid for adjacent intertidal plots, which allowed them form groups and thereby enlarge the size of their clam raising plots. In 2011, during the land allocation process, 21% of clam farmers in Dongminh commune and 46% of clam farmers in Namthinh commune opted to merge their intertidal plots. Additionally, since 2013, many farmers have given up clam farming after suffering serious losses, which created opportunities for experienced farmers to enlarge their clam farming areas by renting additional intertidal plots. Approximately 45% of the surveyed households have rented additional land to enlarge their clam farm plots.

A Mann-Whitney U-test reveals a substantial impact of clam raising plot size on profit/cost ratio (profit/cost ratio is a measure of profitability calculated by dividing net profits by total costs for 1 ha of clam production. This ratio shows how many dollars (as profits) the farmer receives when he invests USD1 into the clam sector) (*table 7.10*). The difference between these two groups (Group 1: plots no larger than 2 ha; Group 2: plots larger than 2 ha) is caused by the following three factors: (1) Cost: both variable and fixed costs are inversely correlated with plot size (Nguyen and Nguyen 2013). (2) Density: group 2 uses a lower clam density and thus has a lower mortality rate compared to group 1 (this difference can be explained by longer and better clam farm experience among farmers in group 2 compared with farmers in group 1 (with more new farmers commencing clam production after 2011)). Lower clam-raising density also favors more rapid development of clams, which shortens the clam-raising cycle, which helps to reduce clam farming risks. Finally, (3) their farm structures allow group 2 farmers to divide clam farming plots into separate smaller plots (using a simple fencing system) to grow different clam sizes, i.e., juvenile and adult clams. This approach helps group 2 farmers to control juvenile clam sources and reduces clam mortality because the juvenile clams are acclimated to the farm conditions. In contrast, group 1 farmers have to purchase juvenile clams from external sources. In addition, raising clams of different ages allows group 2 farmers to have several harvests in a year. Having multiple harvests per year not only helps group 2 farmers to establish stronger relationships with clam collectors but also reduces market risk. Additionally, the farmers noted that the rate of clam loss caused by strong currents is lower in larger clam raising plots.

7.2.2. Network activities in the clam farming community

There are several network activities that aim to enhance the knowledge of clam farmers. These activities will therefore affect, to some extent, the application of RMSs in general and the tactics in particular. Network activities include (1) training courses offered to clam farmers, (2) joining the farmers' asociation and (3) experience sharing in numerous small groups of clam farmers.

Table 7.11: Network activities of clam farmers in the community

	Percentage participating in training	Percentage of members in farmers' association	Percentage joining experience-sharing groups		
			Often	*Sometime*	*Never*
Entire sample (157 HHs)	39%	67%	50%	37%	13%
In Group A (N=31)	48%	77%	77%	23%	0%
In Group B (N=39)	36%	67%	62%	31%	8%
In Group C (N=87)	38%	63%	34%	45%	21%

However, not all clam farmers participate in network activities. Table 6.11 shows the percentages of farmers in the entire sample and in each group of households who participated in each network activity. Only approximately 40% of farmers have ever participated in a training course on clam farming techniques; of those that did participate in training courses, 92% took courses offered by extension service offices, 5% participated in courses offered via mass media (e.g., a radio channel for farmers), and 3% did not know the organizer of the course. Approximately 65% of farmers have been members of farmers' unions, and most of those farmers joined unions as a result of local government propaganda. Although more farmers are interested in experience-sharing groups and sharing groups are quite open and do not charge membership fees, participation in this activity differed among household groups (*table 7.11*). The next part will discuss in greater detail the impact of network activities on the application of tactics in clam farming risk management.

Participation in training courses

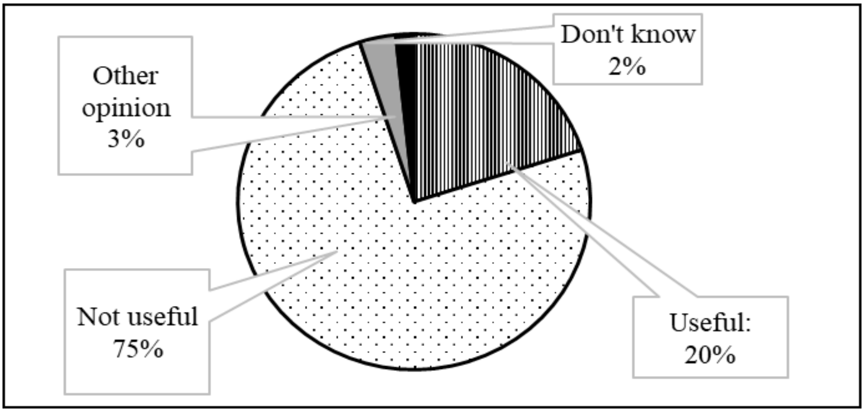


Figure 7.7: Farmers' assessment of training courses

The Commune People's Committee does not employ any permanent (full-time) fishery/aquaculture extension workers who can provide technical advice to clam farmers. In some years, Extension Departments at the district level offer technical training courses, but such courses do not greatly enhance farmers' knowledge. Indeed, 75% of farmers stated that these courses were not useful, whereas only 20% said that the courses helped them to implement clam farming techniques (*figure 7.7*). For these reasons, this activity had only a slight impact on the application of tactics T4.3 and T5.3 (*table 7.12*).

Membership in associations

Members of farmers' unions tended to apply tactic T2.1 more often than those who are not. Conversely, members of farmers' unions applied tactic 3.2 and each tactic in RMS4 less often than non-members did (*table 7.12*). However, union members claimed that they simply did what they were told to do by other farmers and were not influenced by the union. Moreover, 85% of farmers stated that they had not received any support from farmers' unions, whereas 13% indicated that they had received capital support (*assistance with administrative procedures involved in applying for loans from Agribank, Policies Bank or Bank for the Poor*) and only 2% mentioned technical support (*referring to connections with the extension office at the district level through the farmers' unions*) (*figure 7.8*).

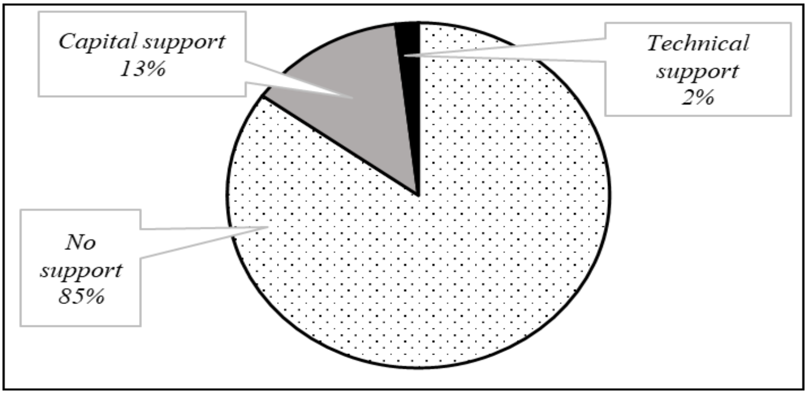


Figure 7.8: Farmers' assessment of support from associations

Group sharing

The high level of participation in experience-sharing groups had a positive impact on the application of tactics T1.1.; T2.1; T2.2; T2.3; T5.1; and T5.3 and a negative impact on the application of tactics T3.2; T4.1; and T4.2 (*table 7.12*). In other words, the greater the level of participation in experience-sharing groups, the more farmers focused on RMSs involving land expansion, improvements to techniques and raising capital (*figure 7.9*) and the less they focused on RMSs involving market risk and diversification.

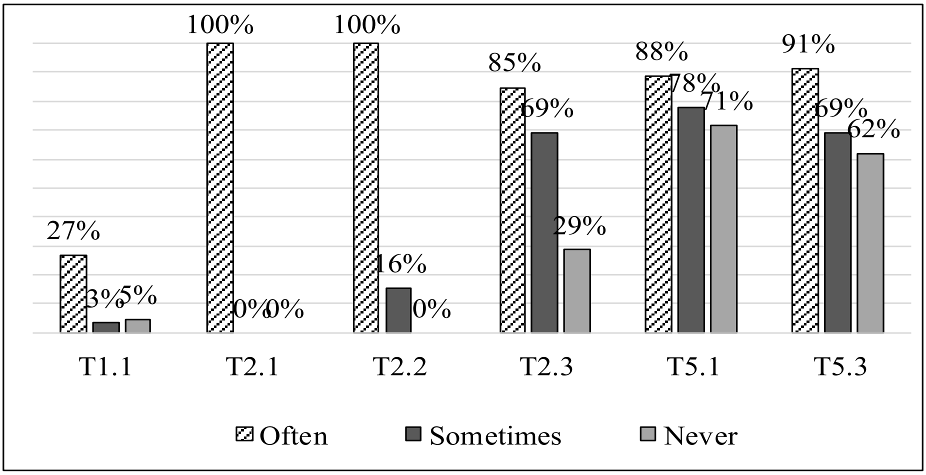


Figure 7.9: Differences in the adoption of specific tactics based on the frequency of experience sharing

The more active participation in knowledge- and experience-sharing groups by farmers in groups A and B explains their higher adoption of tactics related to farming techniques compared with farmers in group C. For instance, whereas 100%

of farmers in group A and 62% of farmers in group B adopted tactic T2.2, only 37% of farmers in group C did the same (*table 6.9*). Awareness of certain tactics also differs among household groups. For example, farmers in groups A and B consider tactic T2.3 an important method for increasing clam farm productivity and reducing risks whereas farmers in group C viewed this tactic as less valuable. Accordingly, 97% of farmers in group A and 85% of farmers in group B applied this tactic, compared with only 57% of farmers in group C. In addition, focus groups discussions revealed that many farmers in group C simply imitated tactics employed by their neighbors rather than fully understanding the operation and value of these tactics. This lack of understanding limited the efficiency of their tactical adoption.

Table 7.12: Impacts of social/network activities on the application of each tactics of RMS

		TACTIC												
		T1.1	**T1.2**	**T2.1**	**T2.2**	**T2.3**	**T3.1**	**T3.2**	**T4.1**	**T4.2**	**T4.3**	**T4.4**	**T5.1**	**T5.3**
1. Participate in training course	Kendall's tau-b	-.02	.06	-.10	-.04	.01	.10	.08	.09	.11	.17**	-.02	.10	-.16*
	App. Sig	.83	.48	.21	.66	.94	.18	.32	.26	.15	.04	.77	.17	.06
2. Join a farmers' association	Kendall's tau-b	-.06	-.16**	.27***	.13*	.07	-.16**	-.11	-.18**	-.27***	-.33***	-.04	.04	.12
	App. Sig.	.44	.04	.00	.09	.39	.03	.15	.02	.00	.00	.58	.66	.13
3. Group sharing	Kendall's tau-c	.24***	-.12	.91***	.92***	.33***	.04	-.24***	-.12	-.14*	-.20***	-.05	.14**	.257***
	App. Sig.	.00	.16	.00	.00	.00	.52	.00	.16	.08	.00	.49	.04	.00

Notes: *CC: Correlation Coefficient*

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

***: Correlation is significant at the 0.05 level (2-tailed).*

**: Correlation is significant at the 0.1 level (2-tailed).*

7.3. The interaction among farming risks, household risk management strategies and government policies

7.3.1. The interaction among three poles

All agricultural support measures affect risk in some way; for example, a measure might help to manage one type of risk but simultaneously exacerbate another kind of risk. After the planning proposal was approved in 2010, a surplus of demand for breed clams force drove the price up to 14,000 VND/100 heads (*figure 4.8 in Chapter 4*). To moderate the price of breed clams, favorable policies were implemented in 2011 to promote breed clam farms in Thaibinh. The subsequent establishment of 10 breed farms was able to satisfy 17% of the demand for breed clams and thus contributed to a decrease in price. Support in the input market combined with the official plan of the Thaibinh government greatly helped local farmers to expand their clam farm operations. However, the unofficial export channel to the Chinese market suddenly closed. As a result, there was a surplus of supply. Indeed, table 4.7 (*in Chapter 4*), which shows the average durations of clam production cycles, indicates that many clams raised in early 2011 were not sold until 2013-2014. Remarkably, there are 5 cases in Thaido of clam production cycles lasting more than 40 months due to the lack of buyers. The oversupply in the output market in 2012 and the sharp decrease in clam prices were caused not only by the sudden closure of the unofficial Chinese market but also by many other factors, including the interaction among farmers' strategies, government actions, aquaculture risks and market movements. In general, price and production are negatively correlated because of the way that they interact in the market. In 2014, the price of clam meat was approximately 7,000-9,000 VND/kg, which is one-third of the price in 2011. Figure 7.10 illustrates the connections among three factors.

Clearly, government support can solve certain types of risks while indirectly leading to other types of risks. Without appropriate government intervention throughout the clam production process, from the input market to the output market, there is a risk that market movements will cause immediate losses for farmers. In this regard, the problem with existing government intervention and policy packages might be the incompleteness of coverage throughout the entire process.

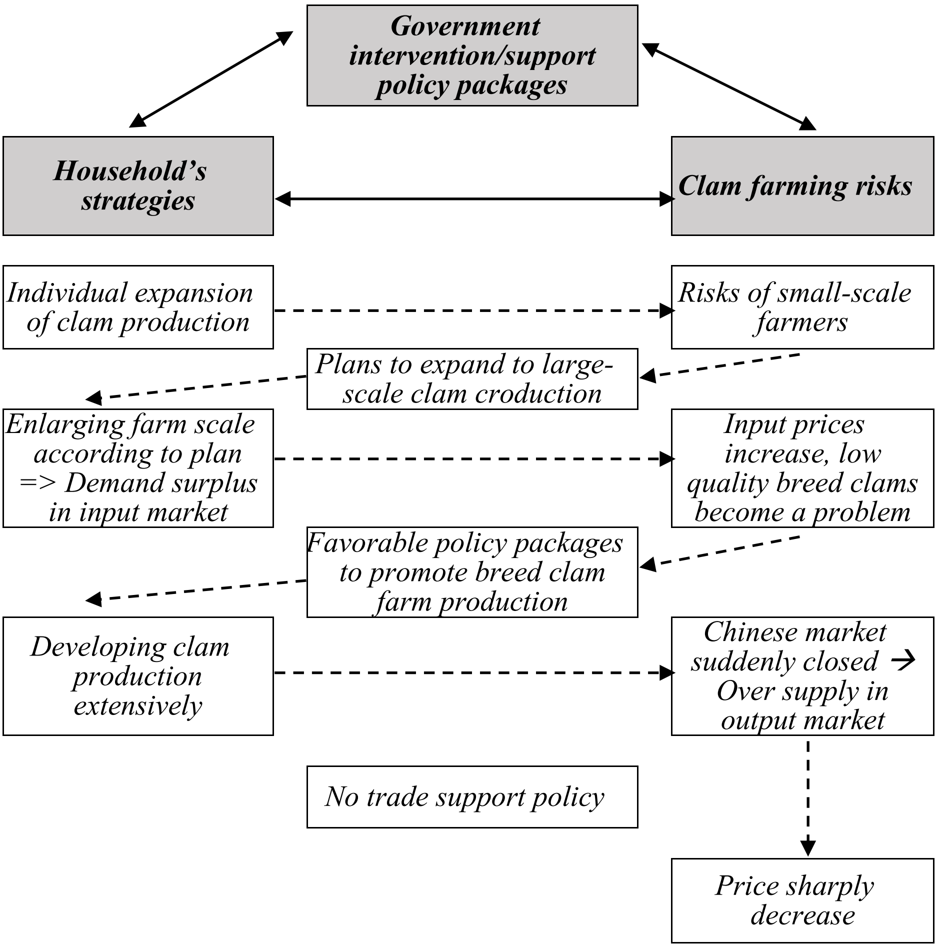


Figure 7.10: Interactions among government actions, household's strategies and clam farming risks

7.3.2. The gap between policies and actual risks

The first gap was revealed when policy packages were compared with actual risks (i.e., the risks of greatest concern to farmers). Among the 6 packages described above, only four of them address a single type of actual risk (*figure 7.11*). The two types of risk that are not supported by government policies are in the catastrophic layer and include risks stemming from polluted wastewater and low prices. Due to the scale of the effects of these risks, neither individual farmers nor groups of farmers can address them alone. Therefore, government intervention is needed (OECD 2009). In contrast, an existing government support policy addresses the risk of low-quality breed clams, which is in the retention layer, meaning that clam farmers are capable of managing this risk using strategies and instruments available in their community.

In market-oriented systems, the price is always set by agreements between sellers and buyers. However, the absence of government support in the clam market has placed farmers in a weak position, meaning that they are passive participants. Indeed, 95% of interviewees reported that they did not know exactly the where clam buyers came from. Buyers suddenly disappeared from the Thaibinh clam market, just as they suddenly appeared in the market and bought 60% of total clam production in 2009-2011. When community officers were asked whether they knew the profiles of Chinese traders who controlled the majority of the output market, the answer in all 3 communes was “No”, with some officers noting that they had no problems with the Chinese traders until their sudden disappearance, which created an imbalance in the Thaibinh clam market. None of these officers recognized the significance of contract farming, which is especially important for clam production given its high capital investment requirements and long production cycles. In addition, interviews with certain Vietnamese middle men (who actively connect to export markets on their own) revealed that there are no favorable trade policies for clam production (e.g., in terms of export administrative procedures or means of transport) despite the limited time available before clam death.

Risks in layers (a)	
Layer	**Type of risk**
Catastrophic layer	Production risk (risk of high mortality rate)
	Financial risk
	Market risk (risk of sudden change of price)
Insurance layer	Market risk (risk of oversupply of clams in the market)
Retention layer	Production risk (risk of low-quality breed clams)

Policy packages (a)		
Code	**Ex ante**	**Ex post**
(1)		x
(2)	X	
(3)	X	
(4)	X	
(5)	X	
(6)	X	

(Note: (a): refer to Figure 5.9; (b): refer to table 7.7)

Figure 7.11: Matching policy packages with risk layers

The second gap relates to the lack of government policy/intervention to reduce farmers’ vulnerability following risk events. Sarewitz, D., at el (2003) argued that vulnerability reduction should be prioritized over risk reduction. This argument is appropriate in clam production because although the risks have a low probability, farmers are extremely vulnerable due to their large investments in clam farming.

Moreover, clam farming risks can seriously damage both households living conditions and farmers' resilience.

It is clear that risk reduction implies a decrease in vulnerability level, but both should be addressed in a balanced package that includes both ex ante and ex post measures. In the policy packages mentioned above, five are in the ex ante group (*figure 7.11*). The only ex post package (number 1) has a quite limited impact, because the level of support offered is far below actual losses (maximum 60 million VND compensation if the loss rate is greater than 70%, whereas the total investment exceeds 450 million VND/ha). Furthermore, the application for government support involves complicated procedures, including the completion of numerous forms. Accordingly, to date, no farmer in the Thaibinh area has received this kind of support.

The absence of aquaculture insurance in clam production is the third gap in the system. Farmers clearly need an insurance system, with 82% of respondents indicating their willingness to buy insurance for their farms if it became available. However, due to the high level of risk that is inherent in clam production, no private insurance company dares to offer coverage in this market. Hence, it is crucial that the state government establish an insurance system for clam farms. Many countries have devoted public resources to develop and maintain insurance products that protect farmers against production risks, because in principal, insurance products with "ex ante structured rules" have many advantages over "ex post disaster assistance" in terms of budget constraints (Skees et al. 2005).

7.3.3. Equity and trade-offs in government policies

It is very common for government policies to have redistribution objectives other than increased efficiency, especially in the case of resource allocation in an existing market (OECD 2009). However, not all government interventions positively impact the poor. Rather, the effectiveness of such interventions depends heavily on numerous components and circumstances. In 2010-2011, when clam prices were rising, the demand for expanded production areas led to farmers requesting local government intervention to assist with land allocation. The two cases presented in table 6.8 demonstrate the differences in equity objectives between two local governments involved in clam land allocation, as well as the consequences of each approach.

The government in Thaido lowered the barriers to clam production to allow even poor households to have their own clam farms. When clam production risks occurred, all farmers suffered serious losses, but the poor were particularly hard hit because they had less access to assets or financial instruments that could help them to cope with their losses. This limitation makes the poor more vulnerable to agricultural risk (Dercon 2005). Moreover, the random method used to allocate plot locations made it difficult for farmers in groups to combine their respective plots, because they did not necessarily own adjacent plots. Consequently, such farmers were unable to achieve economies of scale. According to experienced farmers, clam farms under 3 ha are prone to failure due to the high costs of labor and safety net systems. In sum, despite the equity objective of the Thaido government, its policy did not protect the poor and actually had a negative impact on their situations.

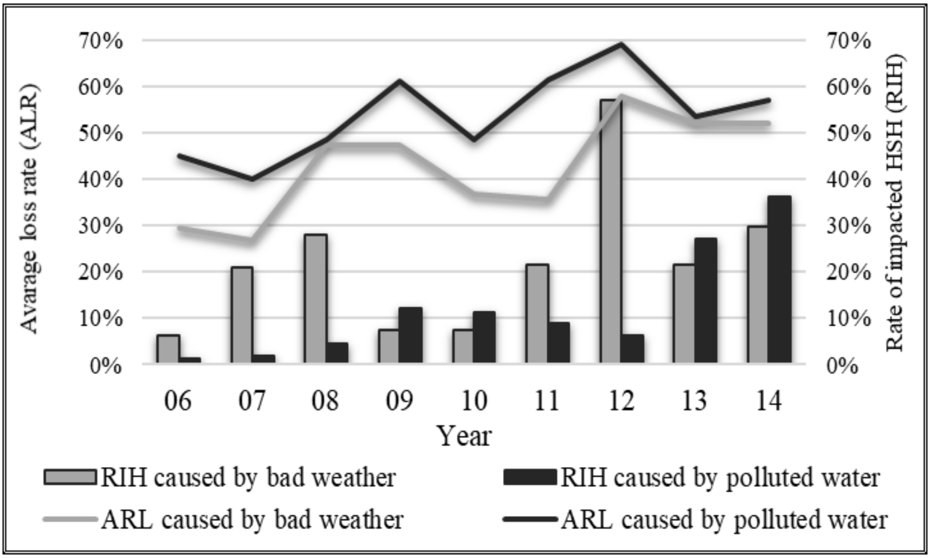


Figure 7.12: Comparison of the impacts of bad weather & polluted wastewater

The discussion of "polluted wastewater" in Chapter 5 is revisited here to consider reasons for the lack of government policies to address this issue. The farmers' evaluations of the level of impact and loss rates caused by bad weather (natural events) and polluted water (man-made events) show that the average loss rate from man-made shocks always higher than that for natural shocks. Moreover, the number of impacted households shows an upward trend over time (*figure 7.12*). Conflicts of interest among and between different groups of farmers and other people are the starting point for all explanations. Water that flows from the inland contains waste from industrial activities or rice production. Therefore, it is difficult for the local government to develop solutions that will help clam farmers without negative impact on other production activities. Although the number of clam households is not small, they account for only 25%-40% of total households in each commune. Furthermore, support for rice production is an important goal of the government because it provides "food security" for the entire community. Concerns about food security and the welfare of rice farmers constrains the ability of the government to support aquaculture risk management.

7.4. Chapter conclusions

Many factors affect the application of risk management strategies and tactics, including both internal and external factors. Internal factors that have significant impact include household financial capacity and experience of the household head, whereas the education level and job of the household head have little impact on the selection and application of household risk management strategies. External factors include policies and the enhancement of knowledge within the community. Among the activities in which clam farmers engage in their communities, “experience-sharing groups” were found to a have greater impact compared with training courses and farmers’ unions. In addition, the government influenced farmers’ clam farming practices but had little impact on risk management strategies.

Several government policy packages have been introduced in Thaibinh since 2009 to promote the clam farming sector by improving the input market and providing financial assistance. It is not easy to access the ultimate impacts of these policies in such a short period, but the results thus far indicate that the policies have failed to achieve their stated purposes. Several reasons for this failure have been discussed, including gaps between policies and farmers’ actual needs; an absence of local government intervention to connect farmers to output markets; and the difficulties of balancing various equities and efficiency objectives in government support programs.

Taking a holistic approach, there are three closely interrelated axes in clam farming in Thaibinh province: (1) clam farming risks; (2) household risk management strategies; and (3) government policies. Nearly 20 years of spontaneous investment in clam farming expanded clam raising areas to a size of 1,500 ha. In contrast, in the three years since provincial policies were introduced to expand clam farming, nearly 2000 ha of new intertidal land has been claimed for clam farming and many new (and inexperienced) farmers joined the clam farming sector. The sudden and significant increase in clam farming area has had massive consequences on farming practices and farmers’ lives. The expanded clam farming area and increased farming density have led to higher clam farming risks, i.e., a higher mortality rate. They also created higher demand for juvenile clams, which in turn caused prices to increase. Substantial investments in clam farming create risks for clam farmers. Moreover, the expanded farming area has generated a surplus of harvested clams that greatly exceeded market demand; as a result, clam prices decreased. This decrease brought chaos to the clam farming sector and to farmers in Thaibinh province shortly after the policies related to clam farming development became effective.

Given that tactics addressing capital issues, land, and clam farming techniques positively contribute to the outcomes of household risk management strategies and that experience-gaining and knowledge-sharing activities have a strong influence on the application of these tactics, government interventions and policies related to clam farming – at all levels of the government – should focus more on these issues. The government should take practice-oriented approach (and address farmers’ stated needs) by implementing not only support policies but also extension programs, training courses and farmers' union activities. Furthermore, policies/interventions related to market issues (*for both inputs and outputs*) should considered, because those risks are at the meso level, meaning that farmers can not address them alone and thus need support from government at both the local and state levels. Together with the regulation about conditions for entering the clam farming sector (in term of knowledge and experiences), the financial support from government should focus on the group of farmers who qualified, rather than equal distribution the little capital support for every farmer as present.

8

CONCLUSIONS AND RECOMMENDATIONS

8.1. Conclusions

In recent years, farming populations all over the world have experienced and suffered from multiple crises caused by climate change. As sectors that largely depend on natural conditions, agriculture in general and aquaculture in particular have been seriously impacted by various risks, both man-made and natural. The more farmers invest in aquacultural activities, the more risks they must manage. However, many farmers, especially the poor, are incapable of effectively coping with risks due to poor financial resources, limited market access, and lack of farming experience. The failure to cope effectively with farming risks can trap farmers in poverty, further exposing them to vulnerability and preventing them from pursuing other opportunities that could improve their incomes. A better understanding of the nature and scope of farming risks, based on which effective risk management strategies could be developed, is thus becoming increasingly important for farmers affected by climate change.

As an important economic subsector of Vietnam, aquaculture has significantly expanded and developed in recent years due to the country's substantial maritime resources with high aquaculture potential. At the same time that the value of aquaculture exports increased, the sector exhibited a restructuring trend: fishing practices declined due to the reduction in natural aquatic resources, whereas aquacultural production increased. As the sector moves further into aquatic production with larger outputs, Vietnamese aquaculture faces several challenges: (1) ensuring the safety of aquatic products; (2) accessing markets, both domestic and international; and (3) resolving conflicts regarding resource utilization between and among aquaculture farmers and other farming sectors.

Thaibinh is located in the Red River delta in Northern Vietnam. Approximately 26% of farmers in Thaibinh live in coastal areas and seek their livelihoods from aquacultural practices, primarily clam farming, combined with other traditional livelihood activities, such as rice and livestock production. However, the inadequate intensification of aquacultural practices has caused aquatic resources to degrade in recent years, creating greater farming risks for the millions of farmers who work in this sector. Clam farming is thus considered a gamble, one that has returned great benefits for many farmers but caused problems for others. Confirming the first hypothesis of the research, the finding shows that there are three types of risk in clam farming, namely, production risk, market risk and financial risk. Among those risks, the most serious are "high clam mortality rates", "severe fluctuations in clam prices" and "loans that exceed household solvency". Although the impacts of risks on clam production have been assessed and quantified to some extent in previous research (cf. add references here), certain causes of risk have not yet been well analyzed by the relevant actors in clam production and marketing.

Increasingly risky clam farming environments and market difficulties have had different impacts on different farmers. Although many farmers have been hit hard by risks, one-fifth of the surveyed farmers have enjoyed success in their clam farming practices. These findings are the proves for the second hypothesis of the research, which is “household risk management strategies in clam farming may vary among households, leading to different degrees of resilience to aquaculture risks”. Among the affected farmers, twenty-five percent have shown strong resilience after being hit by shocks. To gain insights into the underlying reasons for the different impacts of risks on different clam farmer groups, this study evaluated household farming risk management strategies. In general, tactics adopted by households are among the following: (1) enlarging clam farm size; (2) applying technical innovations in clam farming; (3) diversifying livelihood activities; and (4) seeking and relying on loans with no or low interest rates.

Approving for the third hypothesis of the research, the next findings have showed that the clam households’ adoption of specific risk management strategies/tactics is affected by various internal and external factors. Internal factors include farmers’ characteristics, including average annual income, average clam plot size and frequency of participation in learning and experience-sharing groups. To successfully deploy these tactics, farmers must be creative and take actions appropriate for their own farming contexts rather than simply imitating others. External factor such as “the group sharing among the farmers” have significantly impacts to farmers’ successful implementation of risk management strategies in clam farming, while “the training courses offered from extension service” have been found as no impacts. Meanwhile, “the interventions/support from government” as a role in directing farmers in clam farming practices, but not much in risk management. With the exception of local government efforts to institutionalize clam production by zoning and allocating intertidal land to clam farmers in the mid-2000s, which helped to boost local clam production, government actions have played a very modest role in supporting clam farmers. For example, the bureaucracy involved in applying for government loans has often deterred farmers from taking advantage of such loans.

Furthermore, governments have failed to effectively coordinate and mediate conflicts of interest between and among different farming groups and other actors. For instance, pollution discharged from inland agricultural and industrial practices causes serious problems for clams. Moreover, the technical support provided by the government to clam farmers is of little value. Specifically, market forecasts for clams based on clam production statistics or information regarding the clam market in China – both of which are beyond farmers’ capacity to obtain – have not been officially considered or supported by governments. In addition, there is no government support for bankrupt farmers. Instead, bankrupt clam farmers trying to repay debts have sold their assets – even their houses – or have taken out more private loans to reinvest in clam farming, hoping for positive results. In addition, self-learning of clam farming techniques by farmers through experience-sharing practices was found to have better results than training courses offered by governments through public extension systems.

8.2. Recommendations

Based on the research findings, several recommendations are made to help farmers better manage clam farming risks. These recommendations can be categorized into two groups: (1) those targeted directly at clam farmers and (2) those related to the implications of government policies on aquaculture development in particular and on rural development in general.

8.2.1. Recommendations for clam farmers

- ***Adopt strategies related to clam plot enlargement, technical innovation, and loans***

The research results show that tactics related to the expansion clam raising plots, application of technical innovations, diversification of livelihood activities, and gaining access to financial sources with no or low interest rates have yielded better outcomes for farmers and thus give farmers a greater chance to successfully raise and market clams (as reflected in the reduction of clam loss (mortality and/or drift) and other farming risks) and allow farmers to enhance their capacity to recover from encountered risks.

- ***Be more active in learning and sharing farming experiences***

Farmers encounter various and unpredictable risks. Thus, the acquisition of knowledge will help farmers to make better decisions regarding their farming practices, sources of juvenile clams, reduction of clam loss, the application of appropriate techniques and where and how to market their harvested clams. Because there is no effective government body to support these needs, it is strongly suggested that clam farmers actively seek and share farming and marketing experiences with other farmers.

- ***Be creative in the adoption of risk management strategies***

Given the differences among farmers in terms of characteristics and farming conditions, the adoption of risk management strategies/tactics by individual farmers/groups of farmers needs to be an active and creative endeavor rather than the mere imitation of others. Risk management strategies are effective only when they are applied in the proper farming context.

8.2.2. Policy Implications

- ***Improve the support system from government to household in clam farming***

Government intervention is needed to provide farmers with necessary information about clam farming and marketing practices, such as (1)better re-zoning of clam farming areas in parallel with an increase in the farm size of each household, (2) promoting sustainable linkages between the farmers and the formal financial market and output market, and (3) investing more funding into research and extension related to sustainable clam farming practices and to the improvement of farmers' skills in cooperative works and management. This research could generate information and techniques that could be taught to and adopted by farmers. Research should relate not only to clam farming and marketing practices but also to other issues, such as cooperative work arrangements, management skills, accessing loans, and strategies for negotiating with other actors. It is likely that many farmers will continue to be affected by high clam farming risks, and more farmers could be plagued by such risks in the future. However, risks related to market and financial issues can only be addressed at the meso/macro levels and thus are beyond individual farmers' capacity to control. Examples of such risks include contaminants discharged from inland activities and inflexible credit systems. Governments should play a larger role in coordinating and managing different stakeholders in order to minimize man-made risks. The role of cooperatives should also be promoted to improve farmers' links to markets, input suppliers, new technologies, and loans, as well as to provide protection from certain risks, such as unscrupulous business practices.

- ***Increasing the investment in improving the treatment of the water management issue and protect the ecosystem***

Given the factual situation about the negative impacts of wastewater from industrial zone and rice cultivation activities to the clam farming, it is necessary to have the role of government to balance the benefits among different groups including rice farmers, clam farmers and industrial sectors through increasing more investment in in improving the treatment of the water management issue, developing human livelihood activities together with protecting the ecosystem. Series of activities need to be carried out such as: (1) Mobilizing from many resources (from central government, local government and non-state budget) to invest in material facilities to support the wastewater treatment; (2) Developing the examination, inspection all of the organizations and individuals that generating wastewater from production, business and daily-life activities in the land. Discharges of treated wastewater into marine areas must ensure that the conditions related to the dynamics, environment, ecology, biodiversity, vulnerability and capacity of the marine area. Punitive sanctions should be imposed to prevent the discharge of untreated water, while at the same time can be used as providing financial investment for other technical solutions which aim to limit the harm impacts of wastewater to the community; (3) Investing in the development of high technologies for the discharge system from the inland to the coastal zone so that they can be discharged even when the tide is high, therefore minimizing the impact on the clam fields. In addition, it is also important to improve the marine environmental protection institutions as well as to enhance the awareness for businesses as well as coastal communities.

- ***Promote participatory policy formulation and enforcement***

Experienced farmers can assess the suitability of intertidal areas for clam farming. Thus, the participatory approaches adopted by certain local governments with respect to intertidal land zoning and allocation have had positive impacts on clam farming efficiency. In contrast, top-down approaches have been problematic for clam farmers.

Intertidal land allocation without consideration of farmers' preferences and abilities, as implemented by the Thaido government, created more difficulties for farmers in this commune compared with farmers in the other two communes, where farmers had more input and choices in bidding for intertidal areas. It is thus likely that with better scientific analysis – for instance, regarding the profit/cost ratios of different clam farming practices and clam market demand – and increased farmer participation in policy making and enforcement will better reduce and/or control risks in clam farming and marketing.

Greater participation of farmers in policy formulation and enforcement is essential, not only to ensure the effectiveness of policies but also to minimize clam farming and marketing risks and improve the well-being of clam farmers. However, the increased participation of farmers will undoubtedly create complications and costs in policy making and enforcement. Therefore, future studies should focus on this subject to identify not only suitable approaches to increase farmer involvement but also appropriate trade-offs between increased farmer participation and minimization of the costs involved in effective policy making and enforcement./.

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ANNEX

QUESTIONNAIRE

Interviewer		Date	
Commune		**Village**	

HSH ID:

From the 1st Survey:

BASIC INFORMATION

Name of Head of HSH: Age:

Phone Number:

Commune: Village:

Education level of the Head of HSH:

Job of the Head of HSH:

Numer of year of experience in clam farming (up to 2015):

Has been as a member of any association of clam farmer?

Has been participated in any training course about clam farming?

Has ever disscused about clam farming techniques with other farmers?

Average annual income of HSH:

The source of the family income:

Source	2006	2007	2008	2009	2010	2011	2012	2013	2014
Clam Farming									
Another Aquaculture Production									
Rice production									
Livestock									
Wages									
Business									
Other Incomes (remittances, ...)									

CLAM FARMING ACTIVITIES OF HOUSEHOLD

When HSH started clam farming:

Reason: ……………………………………………………………………

When HSH stopped clam farming:

Reason: ……………………………………………………………………

The role of income from clam farming in the household:

	2006	2007	2008	2009	2010	2011	2012	2013	2014
Role: (1= Important 2= Moderate 3=Less Important 4=No Income 5=Loss)									

Number of the clam plots the HSH have?

⇨ ***Information of each plot:***

- ✓ Total Area:
- ✓ Clam Raising Model:
  - *Juvenile Raising Model:*
  - *Adult Clam Raising Model:*
  - *Combine model:*

Number of cycles during period 2006-2014:

Information of the 1st cycle:

- ✓ *Starting time of cycle:*
- ✓ *Harvesting time of cycle:*
- ✓ *Land generating cost:*
- ✓ *Net system setting cost:*
- ✓ *Cost of constructing the guarding house:*
- ✓ *Juvenile clam size:*
- ✓ *Price of juvenile clam:*
- ✓ *Source of buying juvenile clam*
- ✓ *Total cost of juvenile clam:*
- ✓ *Labour cost:*
- ✓ *Land renting cost:*
- ✓ *Total capital invested from money of HSH:*
- ✓ *Total capital borrowing:*
- ✓ *Source of borrowing money:*
- ✓ *Interest rate:*
- ✓ *Mortality rate:*
- ✓ *Total yield:*
- ✓ *Adult clam size:*
- ✓ *Selling price of adult clam:*
- ✓ *To whom had you sold the adult clam:*
- ✓ *Any shock happened during clam cycle:*
- ✓ *Response after the loss in clam farming:*
  - Stop:
    - ➔ Reason of stopping:
  - Keep continuing:
    - ➔ Reason of continuing:
    - ➔ The source of capital used to invest in to new cycle:

Information of the 2nd cycle:

- ✓ *Starting time of cycle:*
- ✓ *Harvesting time of cycle:*
- ✓ *Land generating cost:*
- ✓ *Net system setting cost:*
- ✓ *Cost of constructing the guarding house:*
- ✓ *Juvenile clam size:*
- ✓ *Price of juvenile clam:*
- ✓ *Source of buying juvenile clam*
- ✓ *Total cost of juvenile clam:*
- ✓ *Labour cost:*
- ✓ *Land renting cost:*
- ✓ *Total capital invested from money of HSH:*
- ✓ *Total capital borrowing:*
- ✓ *Source of borrowing money:*
- ✓ *Interest rate:*
- ✓ *Mortality rate:*
- ✓ *Total yield:*
- ✓ *Adult clam size:*
- ✓ *Selling price of adult clam:*
- ✓ *To whom had you sold the adult clam:*
- ✓ *Any shock happened during clam cycle:*
- ✓ *Response after the loss in clam farming:*
    - Stop:
        - ➔ Reason of stopping:
    - Keep continuing:
        - ➔ Reason of continuing:
        - ➔ The source of capital used to invest in to new cycle:

Information of the 3rd cycle:

- ✓ *Starting time of cycle:*
- ✓ *Harvesting time of cycle:*
- ✓ *Land generating cost:*
- ✓ *Net system setting cost:*
- ✓ *Cost of constructing the guarding house:*
- ✓ *Juvenile clam size:*
- ✓ *Price of juvenile clam:*
- ✓ *Source of buying juvenile clam*
- ✓ *Total cost of juvenile clam:*
- ✓ *Labour cost:*
- ✓ *Land renting cost:*
- ✓ *Total capital invested from money of HSH:*
- ✓ *Total capital borrowing:*
- ✓ *Source of borrowing money:*
- ✓ *Interest rate:*
- ✓ *Mortality rate:*
- ✓ *Total yield:*
- ✓ *Adult clam size:*
- ✓ *Selling price of adult clam:*
- ✓ *To whom had you sold the adult clam:*
- ✓ *Any shock happened during clam cycle:*
- ✓ *Response after the loss in clam farming:*
    - Stop:
        - ➔ Reason of stopping:
    - Keep continuing:
        - ➔ Reason of continuing:
        - ➔ The source of capital used to invest in to new cycle:

Information of the 4th cycle:

- ✓ *Starting time of cycle:*
- ✓ *Harvesting time of cycle:*
- ✓ *Land generating cost:*
- ✓ *Net system setting cost:*
- ✓ *Cost of constructing the guarding house:*
- ✓ *Juvenile clam size:*
- ✓ *Price of juvenile clam:*
- ✓ *Source of buying juvenile clam*
- ✓ *Total cost of juvenile clam:*
- ✓ *Labour cost:*
- ✓ *Land renting cost:*
- ✓ *Total capital invested from money of HSH:*
- ✓ *Total capital borrowing:*
- ✓ *Source of borrowing money:*
- ✓ *Interest rate:*
- ✓ *Mortality rate:*
- ✓ *Total yield:*
- ✓ *Adult clam size:*
- ✓ *Selling price of adult clam:*
- ✓ *To whom had you sold the adult clam:*
- ✓ *Any shock happened during clam cycle:*
- ✓ *Response after the loss in clam farming:*
    - Stop:
        - ➔ Reason of stopping:
    - Keep continuing:
        - ➔ Reason of continuing:
        - ➔ The source of capital used to invest in to new cycle:

Information of the 5th cycle:

- ✓ *Starting time of cycle:*
- ✓ *Harvesting time of cycle:*
- ✓ *Land generating cost:*
- ✓ *Net system setting cost:*
- ✓ *Cost of constructing the guarding house:*
- ✓ *Juvenile clam size:*
- ✓ *Price of juvenile clam:*
- ✓ *Source of buying juvenile clam*
- ✓ *Total cost of juvenile clam:*
- ✓ *Labour cost:*
- ✓ *Land renting cost:*
- ✓ *Total capital invested from money of HSH:*
- ✓ *Total capital borrowing:*
- ✓ *Source of borrowing money:*
- ✓ *Interest rate:*
- ✓ *Mortality rate:*
- ✓ *Total yield:*
- ✓ *Adult clam size:*
- ✓ *Selling price of adult clam:*
- ✓ *To whom had you sold the adult clam:*
- ✓ *Any shock happened during clam cycle:*
- ✓ *Response after the loss in clam farming:*
    - Stop:
        - ➔ Reason of stopping:
    - Keep continuing:
        - ➔ Reason of continuing:
        - ➔ The source of capital used to invest in to new cycle:

Other Information's

Impact of the results from clam farming to the life of Households:

- ✓ **Positive Impacts**
  - *Have saving money:*
  - *Buying house/Building House:*
  - *Car/Motorbike/Other*
  - *Assets Purchasing:*
  - *Having money for health treatment:*

- ✓ **Negative Impacts:**
  - *Human damage*
  - *Over Debt*
  - *Selling house to pay the debt*
  - *Selling car/motorbike/other stuffs to pay the debt*

Perception about risks in clam farming activities:

According to your opinion, which types of below risks could happen in clam farming? And then please ranking its level in term of likelihood and loss

Type of RISK	**LIKELIHOOD**					**LOSS LEVEL**				
	Frequent	*Probable*	*Occasion al*	*Remote*	*Improba ble*	*Castrophe*	*Severe*	*Major*	*Moderate*	*Minor*
Disease										
Heat shock										
Changes in saltinity level										
Decrease of selling price										
No markets										
Deformation										
Thief										
Other risks:										

Statements to explore factors affecting the household resilience

(These statements were measured using a 5-point scale: 1- strongly agree; 2- agree; 3- not sure; 4- disagree; 5- strongly disagree):

	1	2	3	4	5
1. *Have you used your own capital or successfully borrow formal credits to restart new clam cycle?*					
2. *Do you agree that decreasing clam market price is associated with opportunity for a new clam production cycle?*					
3. *Do you agree that clam farming should be continued because its risks are tolerable?*					
4. *Do you agree that risks in clam farming are lower than those in other aquaculture activities?*					
5. *Do you agree that diversified income-generated activities help me easily to restart a new clam production cycle after disaster?*					
6. *Do you agree that loss of clam farming has no serious impact on our daily basic needs?*					
7. *Have your household received supports from governments to recover from loss?*					
8. Have you gained many practical experiences about clam farming after each failing season?					
9. Have you applied new production tools/practices (invented by other farmers) which really help us to reduce clam farming risks?					
10. Do you agree that changes in clam production techniques help our clam farming less affected by (natural and market) shocks than other households?					
11. Do you agree that new clam production cycle started after shock has higher productivity than previous one?					

Information about risk management strategies:

1. Have your household hired or purchased additional intertidal land for your clam plot?

   If yes, please give the detail information (how had you do, the result of the strategies, ...): …………………………………………………………………….

   If now, please give the reason:

   …………………………………………………………………….

2. Have your household joined any farmer's groups to contribute money and land for clam raising?

   If yes, please give the detail information (how had you do, the result of the strategies, ...): …………………………………….

   If now, please give the reason:

   …………………………………………………………………

3. Have you ever tried to choose a good place for clam plot of your household?

   If yes, please give the detail information (how had you do, the result of the strategies, ...): ……………………………………………

   If now, please give reason:

   …………………………………………………………………

4. Have your household actively controlled the point for starting & harvesting the clam cycle?

   If yes, please give the detail information (how had you do, the result of the strategies, ...): ……………………………………………………………

   If now, please give the reason:

   …………………………………………………………………

5. Have you applied techniques innovations?

   If yes, please give the detail information (name of the technics, how had you do; how often had you applied, the result of the strategies, ...):

   …………………………………………………………………….

   If now, please give the reason:

   …………………………………………………………………….

6. Have your household actively searched for good juvenile clam source?

   If yes, please give the detail information (how had you do, the name of the place you had came to buy, the result of the strategies, ...):

   ……………………………………………………………

   If now, please give the reason:

   …………………………………………………………………

7. Have your household sold the adult clam via more then one clam selling channel? (give name)

If yes, please give the detail information (how had you do, the name of the place/person you had sold your clam to buy, the result of the strategies, ...): …………………………………………………………………….

If now, please give the reason:

…………………………………………………………………….

8. Have your household carried out other aquaculture activities?

If yes, please give the detail information (how had you do, how often had you applied, the result of the strategies, ...): …………………………………………………………………….

If now, please give the reason:

…………………………………………………………………….

9. Have your household carried out rice production?

If yes, please give the detail information (how had you do, the result of the strategies, ...): …………………………………………………………………….

If now, please give the reason:

…………………………………………………………………….

10. Have your household carried out livestock activities?

If yes, please give the detail information (how had you do, the result of the strategies, ...): …………………………………………………………………….

If now, please give the reason:

…………………………………………………………………….

11. Have your household carried out other activities?

If yes, please give the detail information (how had you do, the result of the strategies, ...): …………………………………………………………………….

If now, please give the reason:

…………………………………………………………………….

12. Have your used the family/relatives saving money to invest in clam farming? (The proportion

If yes, please give the detail information (how had you do, estimated the proportion of money from your own/your relatives which you had used for clam farming; the result of the strategies, ...): …………………………………………………………………….

If now, please give the reason:

…………………………………………………………………….

13. Have you ever tried in access the formal credit market?

If yes, please give the detail information (how had you do, the result of the strategies, ...): …………………………………………………………………….

If now, please give the reason:

…………………………………………………………………….