Factors contributing to household-resilience capacity to farming risks: Case study of clam farming in Thai Binh province, Vietnam

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Abstract

Despite coastal endowment is a unique opportunity for coastal farmers it may be embedded with some risks. Vietnam was ranked 18th in world risk index in 2015 with the vulnerability index of 50.87% (Garschagen, Hagenlocher et al. 2016). In this context, Vietnamese clam farmers have been experiencing increased difficulties. This research focuses on clam production in Thai Binh province which has the largest clam area in northern and northern central coastal Vietnam. The central question of the research was "which factors contributing to farmer's resilience to clam farming risks". Results of the research indicated that there are several factors, which altogether explained 66% of variance of resilience among the households, formed three groups including (1) farmer's ability in gaining experiences from failures and harnessing new opportunities; (2) farmer's perception toward clam farming risks and its impacts; (3) farmer's confidence about financial capacity and incomes from diversifying activities which can be used to invest in clam farming. From these research results, several support strategies have been suggested to enhance this capacity of the clam farmers, in order to minimize the losses while maximizing the benefit when people seek for sustainable livelihood.

Keywords: coastal farming; clam production, risk; resilience; innovation, Thai Binh province.

1. Introduction

Vietnam is a developing country located in the southeast Asia with the area of over 3,260 km of the coastal line and 112 estuaries, which makes Vietnam being the 6th country in the world in terms of the population density living in coastal areas. This population is largely seeking livelihoods from aquaculture practices. Vietnamese aquaculture average growth rate is estimated at over 17% since 2000 with an export value of $ 6,700 million in 2015(VASEP 2016).

Coastal endowment is not only a good opportunity for farmer's clam production, but also embedded with risks. Vietnam is ranked as the 18th country in the world according to the world risk index in 2015 with the vulnerability index of 50.87% (Garschagen, Hagenlocher et al. 2016). In this context, clam farmers have been experiencing increased difficulties caused by poor development plans of governments for coastal aquaculture production, including polluted water discharged from inland agricultural and industrial activities, and increased negative impacts of climate changes, especially in terms of irregular temperature patterns. A research conducted in some coastal provinces of North and Northern Central Vietnam revealed that about 84% of farmers reported that their farms had at least one time of massive death of clam (Thuyết and Dũng 2013).

In the Thai Binh province in the early 1990s, increasing market demand for clam and experiencing a reduction of natural clam caused by increased caught, farmers started clam production with a small area (about 150 ha). The clam production area was slowly expanded in the following years. As considered a good farming sector, local government officially paid attention to clam production through zoning and bidding production areas and financial supports for clam farmers, clam production area was increased to 500 ha in 2006. After some stability in the three following years, clam production area gained a huge momentum with an exponential increase in the period of 2010 – 2012. The trend was stopped in following years.

The fast increase in the clam production area coupled with higher clam density resulted a sharp increase in clam production, especially from 2007 to 2010. However, increased natural and artificial disaster and low quality of clam breeds (see further below) had resulted a sharp reduction of clam yield in 2011. Since then, clam yield fluctuated around 18 tons/ha (*Figure 1*).

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Clam market price was on increased trend in the period of 2006-2009, and suddenly with a large jump in 2010 and 2011. In these two years, clam was considered as "golden farming" in Thai Binh as well as whole Vietnam. However, a negative jump of clam market price was happened in 2012, then keep reduced in following years *(Figure 2*).

Figure 1. Clam production area and yield (2006-2014)

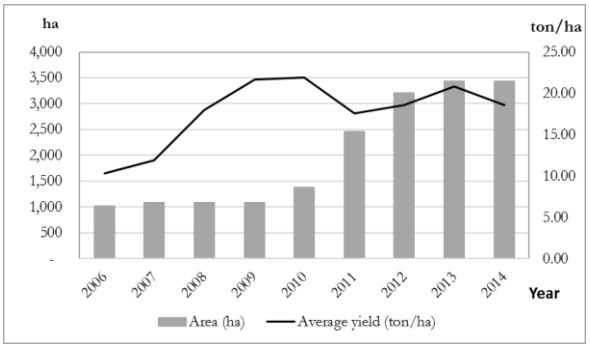
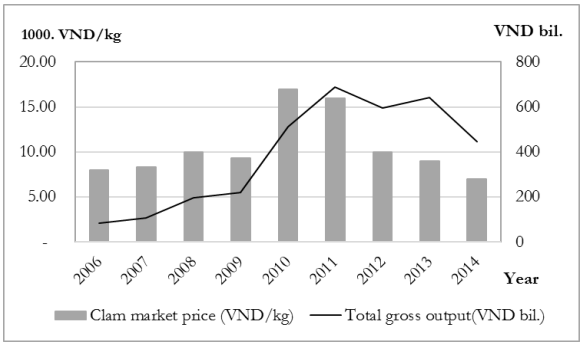


Figure 2. Total gross revenue of clam production (2006-2014)



(Source: Thai Binh Statistical Office, 2015)

The up-and-down trend of clam yield and market price reflects a fact that clam production has been suffering from risks in production and marketing. Different from other aquacultural animals like shrimp, craps, or fishes, clam full production cycle is relatively longer, i.e., two to three years, and more vulnerable to risks, both natural and artificial. At the same time, clam production is a complementary activity and all clam farmers have other income. Clam is a kind of speculation able to bring a lot but also likely to lose everything. Given these, the rate of loss of investment in the clam production in this area is estimated at 52% in Thai Binh province[3]. Despite the risk, farmers in Thai Binh were still continuing clam production which even accounted for 59% of the total provincial aquacultural outputs in the period of 2009-2014 (MaiLien 2014). In a large extent, the clam continuation reveals a kind of strong resilience capacity of some of farmers among the group of all clam farmers in Thai Binh province.

Resilience has recently become a term which is increasingly ubiquitous in scientific and policy debates (Darnhofer 2014). In a social system, resilience was defined as the ability of a system to withstand loss (Buckle 2006) by absorption external changes and shocks while maintaining its livelihoods and identity (Adger, Kelly et al. 2002, Norris, Stevens et al. 2008). With future orientation, the resilience concept is concerned with the capacity to deal with changes by renewal, restructure (Folke 2006); and creativity (Maguire and Hagan 2007). From those aspects, two distinctive approaches to understand resilience had been created: one focuses on the ability to "bounce back" while the other goes further with capability in "bouncing forward" (Davoudi, Shaw et al. 2012, Scott 2013).

There are three common features which are likely to be characteristics of resilient households (Carpenter, Walker et al. 2001). First one is about the speed of recovery after disturbance (De Bruijn 2004) that can be measured by the length of time at which the system can be restarted and recovered. The second one is the magnitude of a disturbance caused by shocks which can be absorbed before systems' changes (Berkes, Colding et al. 2008). The indicator for this property could be the level of income volatility and the consumption smoothness of households over time (WorldBank 2014). The last feature is related to the capacity for gaining experiences and create opportunity from shocks (Carpenter, Westley et al. 2005).

Many researches indicated that the internal factors affecting on resilience of household include assets base and perception or attitude of household about risks as well as the ability to learn and gain from changes. For example, researchers showed that assessing credit source, agricultural land, diversity of income sources positively influence the household resilience to climate shocks in Vietnam and Indonesia (Adger 1999, Keil, Zeller et al. 2008, Nguyen, James et al. 2013). Marschke and Berkes (2006) found that learning to live with changes and creating opportunities for self-organizations are the important factors to enhance households'

[3] Resulted from Monte Carlo Simulation by application of Crystal Ball software, based on production data's collected from household survey.

resilience in Cambodian fishing villages. In the context of Northern Australia, four perceptions were identified as the main factors which empower the fisheries household resilience: (1) perception of risk associated with change, (2) perception of ability to learn, to plan and to innovate, (3) perception of the ability to cope, and (4) level of interest in changes within an Australian context (Marshall and Marshall 2007).

Despite the fact that clam farming risks have been intensified in parallel with development of the clam production sector, which year by year increases the vulnerability of farmers, there is no study in Vietnam about clam farmer's resilience and the factors which might help them to enhance their capability to become more resilient to the shocks happen in their cultivation lands. To fill this gap, this research focuses on the clam production in Thai Binh province which has the largest amount of clam area in the northern and northern central coastal part of Vietnam. The main question of the research is that "what are the main factors contributing to farmer's resilience to clam farming risks".

Accordingly, the following section provides details about the methodology applied and briefly describes the site and sample selection of this study. The third section of the paper gives the results of research considering the three mentioned factors affecting clam household's resilience. As the rigid relation between resilience and sustainable development highlighted in the study by Folke et al. (2002), it is very important to enhance this capacity of the farmers, especially in a complex world of rapid transformation. Therefore, the last section suggests some implications based on our research findings in order to enhance the resilience capacity the clam farmers.

2. Research methodology

This study applied both qualitative and quantitative research methods to conceptualize household resilience to the shocks happened in clam farming. Firstly, subjective well-being approach which widely applied in poverty and livelihood researches in developing countries (Narayan, Chambers et al. 2000), was used in this research to identify factors contributing to the farmer's resilience capacity at household levels. Afterwards, the level of the impact of each factor/group of factors was quantified using the exploratory factor analysis.

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

Table 1: Eleven statements to explore factors affecting the household resilience

Statement 1:	I am confident that I have my own capital or successfully borrow formal credits to restart new clam cycle.
Statement 2:	In my opinion, decreased clam market price is associated with opportunity for a new clam production cycle.
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-generated activities help me easily to restart a new clam production cycle after disaster.
Statement 6:	I am confident that loss of clam farming has no serious impact on our daily basic needs.
Statement 7:	My household have received supports from governments to recover from loss.
Statement 8:	I have gained many practical experiences about clam farming after each failing season.
Statement 9:	I have applied new production tools/practices (invented by other farmers) which really help us to reduce clam farming risks.
Statement 10:	I am confident that changes in clam production techniques help our clam farming less affected by (natural and market) shocks than other households.
Statement 11:	In my opinion, new clam production cycle started after shock has higher productivity than previous one.

Exploratory Factor Analysis (EFA): Multiple-choice with Likert-scale questionnaires were utilized to weight farmers' opinion about the above mentioned statements. Data analysis was undertaken using

NVivo (QSR) to manage the qualitative data and elicit key themes; and SPSS for analyzing the quantitative data and producing a descriptive statistical analysis. Cronbach's alpha coefficient was applied to define the reliability of each variable. EFA was then carried out to combine related variables into "group of variables", which have the most impacts on the resilience capacity of households to the loss incurred in their clam farming.

Study site

As many other provinces along the coastline of Vietnam, Thai Binh has been classified as a highly potential coastal area for aquaculture. Among provinces located in the coastal line of north and northern central of Vietnam, Thai Binh has the largest clam farming areas (3,430 ha in 2013), followed by Nam Dinh (1,710), Thanh Hoa (1,200 ha) and Quang Ninh (1,000 ha) (MARD 2014). According to the Thai Binh Agriculture and Fishery Extension Center, salinity in estuary areas is just around 15-25% with a plentiful source of feeds that is very favorable for the development of aquaculture. The total estuary area having potential for aquaculture is around 17,000 ha (Nguyên 2013) of which 15,119 ha (or roughly 89% of the total estuary area) have been brought into aquaculture production. In 2013, the total aquaculture production generated a value of VND 723,227 billion (based on fix-price level in 1994) for the Thai Binh province (ThaiBinhDARD 2014).

Out of 12 communes having clam farming, located along 50 km coastal line of Thai Binh province, 3 communes were selected as the research sites since these have the largest area as well as the longest history of clam production in the province. This allows tracing the farming risks and farmer's resilience/capacity in coping with the risks in a relatively long period of time (2006-2014). There are 1,310 households raising clam in these three communes. Figure 3 presents location of Thai Binh province, and the 3 communes selected for the study.

Figure 3. Map of the research sites

Data collection: Fieldwork was carried out in Thai Binh from 8/2014 to 4/2015. In addition to secondary data obtained from local government offices and published papers/reports, various research tools were used to gather information on clam production, farming risks, farmer's capacity and strategies to recover from risks in the period of 2006-2014, such as:

- Household survey: The sample size of households for the research survey was calculated by the equation:

$$n = \frac{N*t^2*S^2}{N*\Delta_x^2+t^2*S^2} \qquad \textit{Equation (1)}$$

In which: "n" (sample size); "N"(total households in research site)=1,310; "t"(confidence interval) = 2.17 (with 97% confidence level). Sample variance and sample errors were estimated based on the trial survey (on the total loss area for each household) of 31 households from the three communes.

The statistic results of the survey showed the amount of sample variance (S^2)=194.88 and sample errors (Δ^2_x)=2.52.

The actual sample size was then needed to be increased from 137 to 157 since the sample from Thai Do commune was increased from 11 to 31 in order to have sufficient number of households to be representative of the commune.

- Key informants' interviews: 11 persons from different sectors such as three levels of local governments and clam traders. *(1 person in Thai Binh provincial aquaculture department; 2 persons in aquaculture sub-departments in 2 districts; 3 heads of communes and 3 local aquaculture officer in 3 communes in research sites; 5 clam traders)*
- Focused group discussion: 1 group of 10 farmers in a commune, made the total of 30 farmers participated in the three selected communes.
- Direct observation: Several clam field visits were taken to see farmer's practices for clam raising, loss controlling, and harvesting. In the field, farmers did also share their experience on quality of clam field (related to color of underneath soil, to sea current direction, or discharged water current). Some key informant interviews were taken during the clam-field visits.

3. Result and discussion

Clam farmer's resilience to risks

Majority of clam farmers experienced aquaculture risks (i.e., 85% of the survey households underwent at least one loss cycle during the clam farming period). The type of risks mostly happened such as high mortality rate during the production process because of unsecure quality of juvenile clam; uncontrolled water source; natural disasters such as flood, storms, drought, sea level rise; and the unpredictable fluctuation of market price (Lebailly, Bui Thi et al. 2015).

Of 87% of households suffered from clam loss, roughly 25% restarted new clam production cycle within 5 months after disasters; 30% within 6-10 months; about 23% within 11-15 months; less than 10% within 15-20 months; and the rest after 20 months (*Figure 4*). The long waiting period before restart reflects farmer's difficulties in making decision on clam production embedded with various and unpredicted risks, and farmer's financial capacity. Large percentage of farmers restarted clam production with financial debts (i.e, 70% of the investment for new cycle was financed by credit source, either from state banks or private creditors). For this, even new clam production restarted, farmers are still trapped with consequences of the previous clam loss.

Despite the efforts of the farmers, only 40% of these "re-started group" assessed that they had been recovered from the loss. Within the first 12 months after clam loss, only two percent of households said they were recovered (by raising juvenile clam which needed a shorter time but was also riskier); while 66% of households were recovered within 13 – 18 months after clam loss disasters. The rest of households were recovered after 19 months, with some even up to 60 months *(Figure 5)*. The difference in recovering time of households after clam loss reflects different "resilient capacity" of farmers in overcoming the problems they faced with and remaining their normal livelihoods (Adger, Kelly et al. 2002) and to withstand the loss (Buckle 2006).

Figure 4. Farmer's restart new clam production after disasters

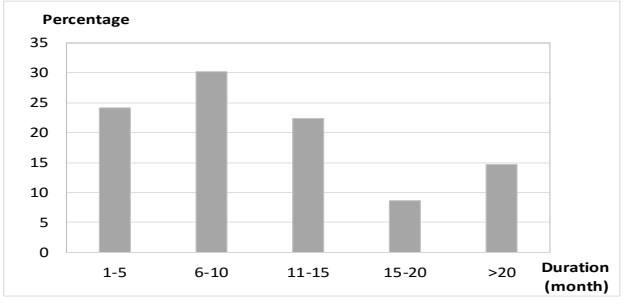
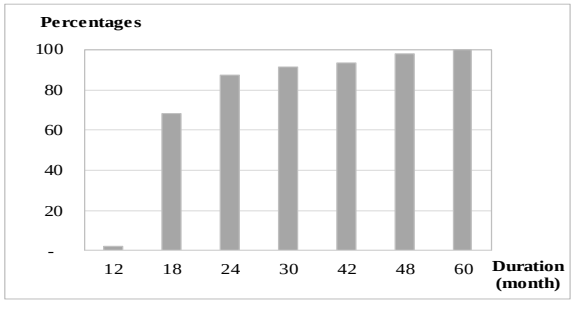


Figure 5. Farmer's recover from clam loss



Interpretation of factors affecting on households' resilience

Results of the reliability analysis showed that the index "Corrected Item – Total Correlation" for "Statement 7" is -.010 so that this statement was eliminated. The result of the second test after elimination of statement 7 indicated Cronbach's alpha coefficient equals 0.844, which means that the rest of statements reliably contribute to the level of household resilience.

The Kaiser-Meyer-Olkin (KMO) index for the sample adequacy is 0.805 and significance of Bartlett's Test of Sphericity is 0.000 (*Table 2*), revealing that factor analysis was suitable in this case (Williams, Brown et al. 2012).

Table 2: KMO and Bartlett's Test

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

The responses of interviewees for all statements are quite interesting. Clam farmers expected about high profit from clam farming but they've had to rely significantly on diversification activities to sustain their own livelihood, as with the percentage of "*agree*" and "*strongly agree*" for statement 5 is 82% and for statement 6 is 74%. More surprisingly, besides the success of some farmers in application the new innovation production tools in their clam farms, some few others said that they did not see the usefulness of those tools (i.e. 16 % chose "*disagree*" and "*strongly disagree*" for statement 9). In their opinions, clam farming risks are always "out of control", therefore they decided to rely on the luck of their fates, rather than to invest more. However, in general, the assessment of interviewees reflected the tendency that the more experiences they have and the more they feel confident about financial capacity of themselves, the better they are in resilience from the loss in clam farming. The exploitations from exploratory factor analysis, which is in below part, are the persuasive illustrations for this assessment.

Several factors were identified to contribute in farmer's resilience capacity. Results of EFA indicated that the total factors represented 66% of variance (*Table 3*) of resilience among households, which formed in three components. Component 1 represented 43% of variance, consisting of five statements (2,8,9,10,11) related to farmer's ability in gaining experiences/opportunities from failures. Component 2 explained 13% of variance with three statements (3,4,6) regarding farmer's perceptions about clam farming risks and their impacts. The last component denoted 10% of the total variance with only two statements (1 and 5) associated to the farmer's confidence about financial capacity and incomes from diversification activities which can be used to invest in clam farming. These three factors are also consistent with other studies about resilience of households in developing countries (Carpenter and Brock 2004, Marschke and Berkes 2006, Nguyen, James et al. 2013) .

Table 3: Rotated Component Matrix[a]

Statements		**Factor loading**		
		1	**2**	**3**
Component 1: *Farmer's ability in gaining experiences/opportunities from failures*	S2	.844		
	S11	.812		
	S8	.753		
	S10	.662		
	S9	.612		
Component 2: *Farmer's perception about clam farming risks and its impacts*	S6		.772	
	S4		.744	
	S3		.687	
Component 3: *Farmer's confidence about financial capacity and incomes from diversification activities which can be used to invest 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.

Component 1: Farmer's ability in gaining experiences/opportunities from failures

The component has the highest factor loading related to the interests of farmers in what they gained from the failures. Although losses and their impacts counted (90%) as the main reasons forcing clam farmers stop and leave the sector[4], many of other farmers took advantages from those shocks including practical experiences, opportunities or even chances for inventions/improvement production technics.

Risk is a burden but also an opportunity for people to explore (World Bank, 2014). The year 2013 was of serious decreases in the clam market price (*cf. Figure 2*). The clam production cycle started 18-24 months earlier with a large investment for juvenile clams, sharply decreased clam market price which caused a serious loss for farmers. All farmers were hurt by the down of clam market. However, the juvenile clam price was also reduced. This allowed a number of farmers to quickly restart new clam production cycle, as revealed by farmers:

> *In 2013, renting cost for clam production plot and juvenile clam price were cheap. In my observation, after getting a sharp down, clam market price could go up again. If farmers started new clam production when juvenile clam was cheap, a probability of success could be 80%. If a loss happened (i.e., caused by storms), then it will be less serious because of low initial investment needed (interviewed on July 18, 2015, in Dong Minh commune).*

> *I restarted new clam production cycle after the down of clam market in 2013. The first reason was a low input cost. The second reason was more food will be available for clams because many farmers stopped their clam production. The third reason was a better clam market that could be expected (interviewed on July 21, 2015, in Thai Do commune).*

Secondly, consistent with the research results about the capacity to transform and innovative mentioned in many researches (Folke 2006, Marschke and Berkes 2006, Nguyen, James et al. 2013), the pressure from risks also helped initiating some innovations associated with clam production at local level to improve clam production and harvesting practices. For instance, a "clam catching machine" (*Picture 1a*) which was invented by a high school girl whose parents have experienced serious loss partly because of high labor cost for clam harvest. The machine helps reducing cost for clam harvest from 40-50 million VND/ha to only 5-6 million VND/ha. Another example is "clam cleaning machine" invented by a local clam farmer (*Picture 1b*). It was often that many clams harvested with sands inside them. This caused clam price reduced because traders either had to submerged clams again into salty water for clams to release sands from their body, or only selling clams to cheap rural markets. This machine helps to clean harvested clams before selling. These inventions remarkably contribute to farmer's resilience capacity on continuing with clam production and recovering from losses caused by risks associated with clam production and marketing.

(1a) Clam catching machine (1b) Clam cleaning machine

Picture 1: Machines invented by farmers

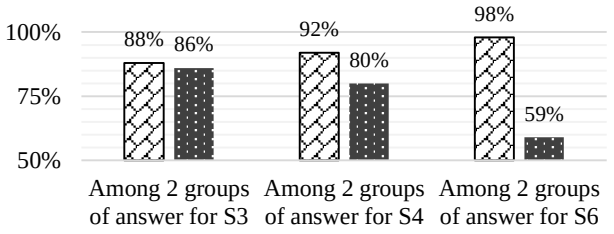
Component 2: Farmer's perception on clam farming risks and their impacts

Similar to the research findings of Marshal & Marshal (2007), farmer's perception on risk associated with clam production and marketing relatively effect on their resilience capacity. Those evaluation, decided by farmers own perceptions, related to the acceptable level of clam farming risk and its comparison within this sector to the risks of other types of aquaculture activities (which could be alternative choose for farmers' livelihoods), as well as the impact of this risk to the smoothness of the daily expenditures of their households. The more positive attitudes of farmers about clam farming risks and its impacts, the more confident they feel

[4] Result of Household Survey – April 2015

to restart and then to recover. The percentage of households who decided to restart after loss in the group with positive answers (i.e., strongly agree and agree) was always higher than the percentage of the groups with negative attitudes (i.e., disagree and strongly disagree) (*Figure 6*). Explanation for this factor, which was confirmed in many other resilient researches (Carpenter, Walker et al. 2001, Folke 2006), related to the degree to which households are capable of self-organization and less dependency on the systems containing risks potential.

Figure 6: Percentage of households decided to restart after loss



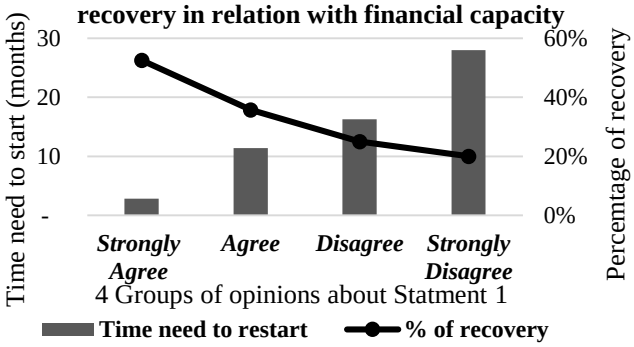
Furthermore, perceptions of farmers about the acceptability of clam farming risk, parallel with profitability of this sector affected the decision of farmers. Below is the opinion of an experienced farmer, who has more than 10-year experience in raising clams, with the idea that clam farming risk is high but it is just a trade-off for its super-profit. For the farmers thinking same as him, the investment in clam farming, more or less, has the "gambling nature" but fairer, and easier to control. In other words, the idea of "taking on risks is necessary to pursue opportunities for development and the risk of inaction may well be the worst option of all" (WorldBank 2014); together with the positive thinking about the future of clam farming creates the confident of farmers to restart a new clam production cycle.

> *Only clam can save clam farmers from loss. No local agricultural investment is more profitable than clam. One successful clam harvest like in period of 2009-2011 is sufficient for farmers to suffer from two to three harvest losses like in 2012 (interviewed on July 20, 2015, in Thai Do commune).*

Component 3: Farmer's confidence about financial capacity and incomes from diversification activities which can be used to invest in clam farming

Data on the loss of 157 households within the sample size in period 2006-2014 reflected the serious economic impacts of loss to the clam farming. Specifically, in 2012, with 67% of the clam area loss, the farmers suffered from the total loss of more than 50 billion VND. Within this group, 16% stopped their clam farms as the result of the capital bankrupt; 38% had to sell their fix assets (like houses, cars, motorbike or even clam fields) to have money to cover the debts. This explains why farmer's confidence about financial capacity and income from diversification activities affected on the length of time they need to restarted after loss (*Figure 7*). This result is in line with the discussion of Tran (2014) and Carter et al. (2007) that households need time to compensate for the asset losses balance their own financial situation. However, this point is not similar with the point in a research of Newhouse (2005) which concluded that negative shocks did not persist longer for poor house.

Figure 7: Speed of restart and Percentage of recovery in relation with financial capacity



Parallels, high investment requirement is one of the important characteristics of the clam farming; with the average total cost of 475.67 million VND/ha (Hang and Nga 2013). The results of the household survey showed that 70% of their investments as well as required financial resources to recover after shocks came from the credit system. However, the risky characteristic of the clam production makes a high barrier for the clam farmers to access formal credit market, which then force them to come to the informal credit market. Meanwhile, accessing informal credit with high interest rates is the fear of poor households (Nguyen, James et al. 2013) because once poor farmers rely on informal loans with easy access, it has been more difficult for them to escape from financial debt traps later on.

This above situation explains why farmers seemed to be reluctant to restart if they did not have confident about their financial capacity, and also had lower probability to recover the loss. In contrast, if households are confident about that they will not borrow informal credits (i.e., they have their own capital from other

diversification activities, or they may be able to borrow from their relatives, family members, and the banks with low interests), they are able to more quickly restart (i.e. 3 to 10 months with the groups chose "strongly agree" and "agree" for the statement 1, *cf. Figure 7*). Moreover, the two groups felt confident with the financial source also had higher percentage of recovery than the other remaining groups. The important of the financial issues in the ability of farmers to overcome the shocks was also the key findings of many other researches about resilience in many rural areas around the world (Marshall and Marshall 2007, Nguyen, James et al. 2013).

4. Conclusion and implication

"*Too profitable but too risky investment*" can safely explain the clam production situation in Thai Binh province for the last two decades. Attracted by good clam production and market in early 2000s, more farmers started to join the clam game. Production areas increased exponentially in late 2000s that brought farmers into more production risks such as reduced natural resources supporting clam growth, increased price and reduced quality of juvenile clams, increased labor costs, and in marketing notably reduced market price for clams. Faced with these problems, a number of farmers stopped clam production, many are in trap of debts. Only in 2012, hit of low market price for clam, 16% of survey households stopped the game. However, most of the farmers restarted raising clams after disasters with different time lags associated with their resilience capacity which is consisted into three major factors, including: (1) farmer's ability in learning and creativity from the failures; (2) farmer's perception on clam farming risks; and (3) farmer's financial capacity including their diversification of income-generated activities. These factors are embedded in specific clam production but also on social-economic situations of a rural coastal area.

Resilience capacity not only requires efforts from the clam farmers as explained by the three above factors, but also external supports such as governments and other private actors. Except efforts of local government in institutionalizing clam production through official zoning for production area in the mid-2000s which helped boosting local clam production, other efforts have played a very modest role in supporting clam farmers such as credits embedded with too much bureaucracy making farmers to be dependent on looking for their clam investments. Governments were not successful in coordinating and mediating conflicts in interests of different farming groups, for instance discharged water from inland agriculture and industry which causes serious problems for clam farmers. Technical supports provided by governments for clam farmers were also less valued by farmers. Specifically, forecasts for clam market based on clam production statistics, and possible information of clam market in China that are beyond farmer's capacity, but could be largely taken by governments, have not been officially considered. In addition, there have been no government supports for bankrupt farmers. Selling assets, even houses, or borrowing more private loans to reinvest on clam with hope for positive results were often some solutions taken by clam farmers to repay the debts.

Even though considered worse for farmers because of high interest rate, private credits have much advantages over state ones for farmers to seek for. Many of farmers have relied on private credits for their clam investments and sometimes clam traders were the money lenders to farmers. This relationship has a positive aspect that traders attempt more to seek for clam market through which farmers can sell their clams and repay the debts.

Motivated by successes, and be hurt by failures have enriched farmer's technical knowledge on selection of juvenile clams, clam production and marketing practices. Some innovations have been invented by farmers such as clam catching machine and cleaning machine in their efforts to minimize the risks. The innovation process will certainly keep going so that contribute to enhance farmer's resilient capacity in the future clam production process.

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