Farmers' Decision-Making in Relation to Rice-Based Farming Systems in the Vietnamese Mekong Delta

Hieu Hong Hua

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Declaration

I, Hieu Hong Hua, declare that this thesis, submitted in fulfilment of the requirements for the award of Doctor of Philosophy in the Environmental Management and Development programme at the Crawford School of Public Policy, College of Asia and the Pacific, the Australian National University, is wholly my own work unless otherwise referenced or acknowledged. This thesis has not been submitted for qualifications at any other academic institutions.

Hieu Hong Hua

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Abstract

Rice-based farming systems have changed in recent years in the Vietnamese Mekong Delta through an increase in crop intensity (more crops each year) and higher quality varieties than a decade ago. Although a range of policies relating to food security contributed to increasing rice productivity, it has still had a range of climatic and non-climatic constraints and threats occur in relation to how farmers decide about their rice-based farming systems. This study investigates the major decisions that farmers have to make about their rice-based farming systems through case studies from three provinces, An Giang, Can Tho and Bac Lieu in the Vietnamese Mekong Delta. The four main questions were:

1. What are the major decisions that farmers have to make about their rice-based farming systems that they wish to implement each year?
2. Which factors influence farmers' decision-making for rice-based farming systems, and how will these factors influence them?
3. How have farmers made collective and individual decisions for their rice-based farming systems?
4. What are the consequences of the major decisions about rice-based farming systems and household livelihoods?

The conceptual framework of this thesis was built around a household livelihood framework. A wide range of quantitative and qualitative data were collected, including 319 household surveys, 47 in-depth interviews and 18 focus group discussions across the six communes. The study found that in An Giang and Can Tho provinces the majority of farmers chose to implement a system of three rice crops a year with their decisions influenced by the need to retain a portion of the crop for household consumption, market price, and through agreements with neighbours regarding the flooding and draining of shared compounds within dykes. In those two provinces farmers tended to favour collective decision-making in relation to dyke construction and the drainage of their paddy fields, for deciding the seasonal calendar for planting and harvesting and for the selection of seed varieties. However, in many cases cooperation took the form of working together in time and place but did not extend to sharing economic costs and benefits. In Bac Lieu province the majority of farmers chose to implement integrated rice-shrimp systems because of saline water. In this province the pattern of individual and collective decision-making was similar to the other two

provinces but there was a greater tendency to combine for the purposes of marketing because fewer rice traders were operating in Bac Lieu. In all three provinces collective decisions through farmer organisations had declined because of increasing conflict between members and declining government support for collective organisations.

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Abbreviations

1. AC: Agricultural Cooperative
2. AEC: Agriucltural Extension Center
3. CLRRI: Cuu Long Rice Research Institute
4. CPS: Crop Protection Station
5. CPC: Crop Protection Center at Province
6. CTU: Can Tho University
7. DARD: Department of Agriculture and Rural Development
8. FC: Farmer Club
9. FU: Farmer Union
10. GDP: Gross Domestic Product
11. GSO: General Statistics Office
12. LSF: Large-sized farm model
13. MARD: Ministry of Agriculture and Rural Development
14. PG: Production Group
15. RDC: Rural Development Center
16. VMD: Vietnamese Mekong Delta
17. VND: Vietnamese dong (USD 1 = ~ VND 22,000)
18. WU: Women's Union
19. YU: Youth Union

Chapter 1

Introduction

1.1 Overview

The Vietnamese Mekong Delta (VMD) has a total area of about 3.9 million ha and in 2014 rice production accounted for 60% of the agricultural land area (GOS 2014). Rice production enables both household and national food security, and rice is also exported worldwide (Can et al. 2007). Although there are sometimes low prices, farmers can sell their rice to local traders or to traders in other provinces (Loc & Son 2011). Rice grows on most types of soil in different ecosystem zones of the VMD (Can et al. 2007), but some crops and livestock can only be produced in certain zones. For example, shrimp can only be cultured in coastal zones where saline water is available (Hoanh et al. 2003). Vegetables and beef production are more suited to locations where alluvial soil is renewed annually by flooding, such as near the Hau River (Howie 2011), and particularly suit farmers with small land size because they require large amounts of labour.

Howie (2011) also showed that in Vinh Binh, Chau Thanh, An Giang, a flooded province, farmers decided on planting two rice crops because of acid-sulphate soil zone, while farmers in the two communes of Cho Moi district planted vegetable, rice, and raised cattle after dyke construction. That was because of overpopulation in the two communes of Cho Moi, whereas the average of land size of each household was smaller than one hectare (Thanh 2009). Cho Moi is also located in the middle of Mekong River where the location is very favourable condition with good soil and access to water. In Cho Moi district, beef production could be combined with vegetable. Then, farmers used manual fertiliser from cattle to sow vegetable, and grass and sub-vegetable could be feed cattle (Thanh 2009; Howie 2011). Moreover, farmers planted vegetable in Cho Moi could access to traders from Cambodia more regularly. Obviously, rice is decided commonly to be planted by farmers in most of the different ecosystem zones in the VMD, while other crops and cattle is limited by different factors including soil condition, water condition, labours and access to market. Therefore, the thesis focuses on farmers' decision-making about rice-based farming system in different ecosystem zones of the VMD (ecosystem zones will be explained in detail in Chapter 4).

In the VMD, farmers normally decide to continue to a rice-based farming system each year, and specifically, whether to plant two or three consecutive rice crops or engage in an integrated rice-shrimp system each year. There are a range of factors influencing the process of farmers' decision-making in relation to the rice-based farming systems, and include decision about activities including accessing irrigation and draining activities, accessing rice varieties and shrimp seeds, and selecting rice varieties. The ability of farmers to make effective decision are influenced by livelihood capital, climatic conditions, flood, drought, social ecological uncertainty, and access to markets (Howie 2011; Bosma et al. 2012; Ha 2012). Also, farmers might engage in collective decisions through farmer organisations, or implement individual decisions in relation to farming activities.

There have been a few studies of how farmers make decisions relating to agricultural production or livelihoods in Vietnam. These include the choice of farming systems (Bosma et al. 2012), the selection of livelihood strategies during market downturns or social and ecological uncertainties (Ha 2012), the impact of land use decisions on the choice of crops (Trung et al. 2017), and, in An Giang province, the choice of rice cropping strategies after dyke construction for flood protection (Howie 2011). Elsewhere outside of Vietnam, relevant studies on decision-making by farmers have been conducted in Indonesia (Mathews et al. 2007; Grünbühel & Williams 2016; Robert et al. 2016), Southern Laos (Alexander & Larson 2016), Northern Thailand (Duangiai et al. 2015), and Kyrgyzstan (Zhumanova et al. 2016).

Most of these studies focused on examining factors affecting farmers' decision-making including types of livelihood capital, climatic conditions and environmental impacts associated with drought, floods and ecosystem zones, as well as market prices and access to markets (Howie 2011; Bosma et al. 2012; Duangiai et al. 2015; Grünbühel & Williams 2016; Zhumanova et al. 2016). The findings of these studies are useful in helping policy decision-makers, and domestic or international aid organisations, to identify the main threats and constraints influencing the decisions of farmers, and aid in developing suitable interventions to address them.

However, only one study has been conducted on farmers' decision-making specifically in relation to rice-based farming systems in the VMD, which is the main livelihood activity of the majority of farmers. This study (Howie 2011) examined farmers' decision-making associated with dyke construction to control flooding in An Giang province, and then how farmers decided two or three consecutive rice crops, vegetable, and cattle for farming systems, and how the pumping club controlled water during the flood season to protect the rice in two-crop rice cropping system. However, Howie (2011) only focused on analysing decision-making by farmers individually rather than collectively. Another limitation of the study was that it concentrated on An Giang province, a flooded area where farmers seems to have more advantages than farmers in coastal zones. Farmers in coastal zones in the VMD might have additional or different constraints in relation to saline water intrusion and extreme weather when considering rice-based farming systems and farming activities such as rice varieties, the seasonal calendar, and irrigation requirements.

Apart from Howie (2011), no study has examined decision-making about a particular farming activity in the VMD. Farmers decide about selecting particular rice-based farming system (in terms of two or three rice crops, or a rice-shrimp system), and decisions about farming activities (selecting rice varieties, draining water out of rice farms, setting up seasonal calendars for farming systems, etc.). Also, collective decisions associated with farming activities can be very important ways to deal with threats in relation to climate variability, flood, drought, saline intrusion, and unstable market prices. However, very few studies have discussed the role of farmer organisations with social capital as a key factor in farmers reaching agreement in collective decisions in relation to farming activities. Howie (2011) discussed social cohesion for individual relationship (farmer-farmer) when farmers in the pumping club decide time for draining water out of fallow field to beginning new season each year. However, Howie (2011) did not show the relationship of members (farmer-farmer) in a farmer organisation such as cooperative and farmer club for other farming systems or other farming activities such as selecting rice varieties. In addition, Howie (2011) did not discuss social capital between members (farmer-farmer) when they decided rice-shrimp in coastal zone to compare how difference about social cohesion between farmer organisations in different ecosystem zones in the VMD.

This thesis will examine the main questions and issues that farmers have to consider when they make decisions about their rice-based farming systems in the VMD. In particular, the study focuses on four key questions:

1. how farmers decide on particular rice-based farming systems each year,
2. which factors influence those decisions and how these factors influence them,
3. how farmers make collective and individual decisions in relation to farming activities, and
4. how the output of decision-making influences the output of each rice-based farming system.

The study will draw on three provincial case studies in the VMD including An Giang (flooding zone), Can Tho (middle zone), and Bac Lieu (coastal zone), each with different rice-based farming systems based on soil types and access to irrigation and water resources. An Giang is an upstream province which is impacted by annual floods, while Can Tho is a central province in the VMD, which has more favourable conditions than An Giang because of less severe and less frequent flooding, but still affected by acid-sulphate soils. Bac Lieu, on the other hand, is a coastal province that has limited access to fresh water from the Mekong River and is affected by saline water intrusion.

The findings of this thesis will identify constraints about how farmers make decisions relating to their rice-based farming systems and farming activities either collectively or individually. Then, the thesis will suggest solutions to address these constraints. The results of this thesis will:

- contribute to knowledge, in the social sciences, of the way farmers make livelihood choices in the face of current and likely future environmental conditions and social issues,

- help farmers and farmer organisations select the most appropriate rice farming strategies in relation to constraints imposed by specific environmental conditions (including climate change) and by social capital,

- aid local authorities in enhancing farmers' capacity to deal with these constraints in the future, and

- assist donors and international organisations to provide more focused aid to local communities in the Delta.

This introductory chapter is laid out in six main sections. The section 1.2 provides background information to highlight factors in relation to the basic information of the VMD including geographical and ecological systems, demography, and the general changes in agricultural production. The general change in agricultural production was under the support of agricultural policies of governmental organisations and international aid organisations. In section 1.3, I reveal the barriers and challenges to pressures for agricultural development of the Vietnamese central government and the global market with farmers in the VMD comprising current situations and predictions of climatic threats with changing patterns and times, and access to local markets. Section 1.4 provides the main problem statement of the study, and outlines the knowledge gap that this study helps to fill. This gap relates to limitations of previous research in understanding farmers' decision-making about rice-based farming systems. Section 1.5 provides the research questions, and section 1.6 a summary of the structure of the thesis into nine chapters. Section 1.7 outlines the significance of the study to enhance understanding of the contribution of the study in the field of social science research and points to useful documents for decision-makers from local to national governments.

1.2 Background information

The Mekong River is one of world's largest rivers (Figure 1.1 and 1.2). The river begins in China, and forms the borders between Myanmar, Thailand, and Laos. After flowing through Phnom Penh, the Mekong River divides into two main branches, the Hậu River and Tiền River, both of which later divided into multiple tributaries the spread across 12 provinces and one city in the VMD, before reaching the Eastern Sea (Ninh et al. 2007). Wet season flooding from the Mekong River brings significant benefits to the VMD including ecological support for fish spawning, aquatic products, and a flushing effect. However, flooding can also have negative impacts on people's lives by damaging crops, homes and other propert and affecting livelihoods (Kien & James 2013; Ninh et al. 2007).

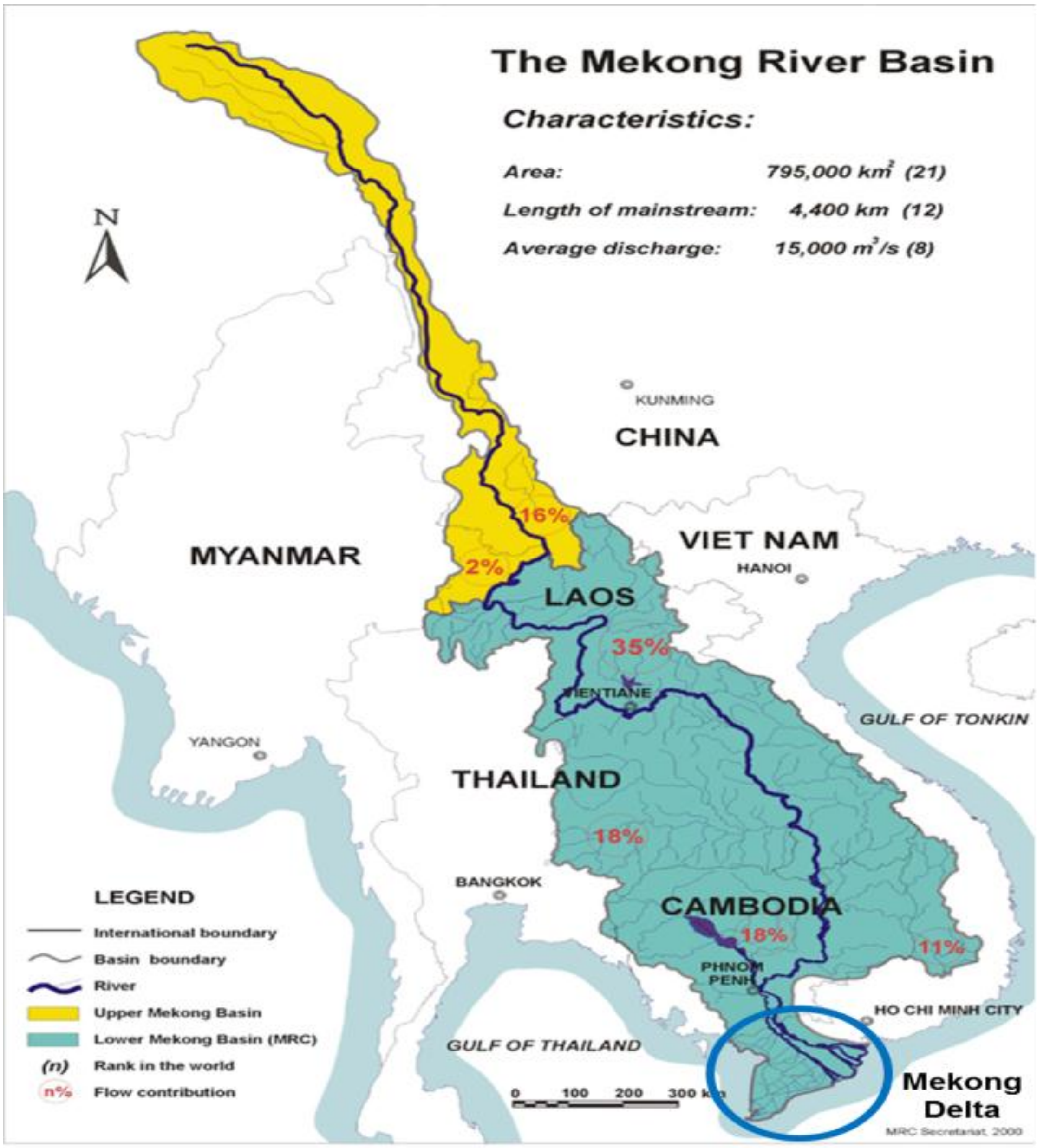

Figure 1.1: The Mekong River across the six countries including China, Myanmar, Laos, Thailand, Cambodia, and Vietnam, and the location of the Vietnamese Mekong Delta

Source: Adapted from Mekong Delta Development Research Institute

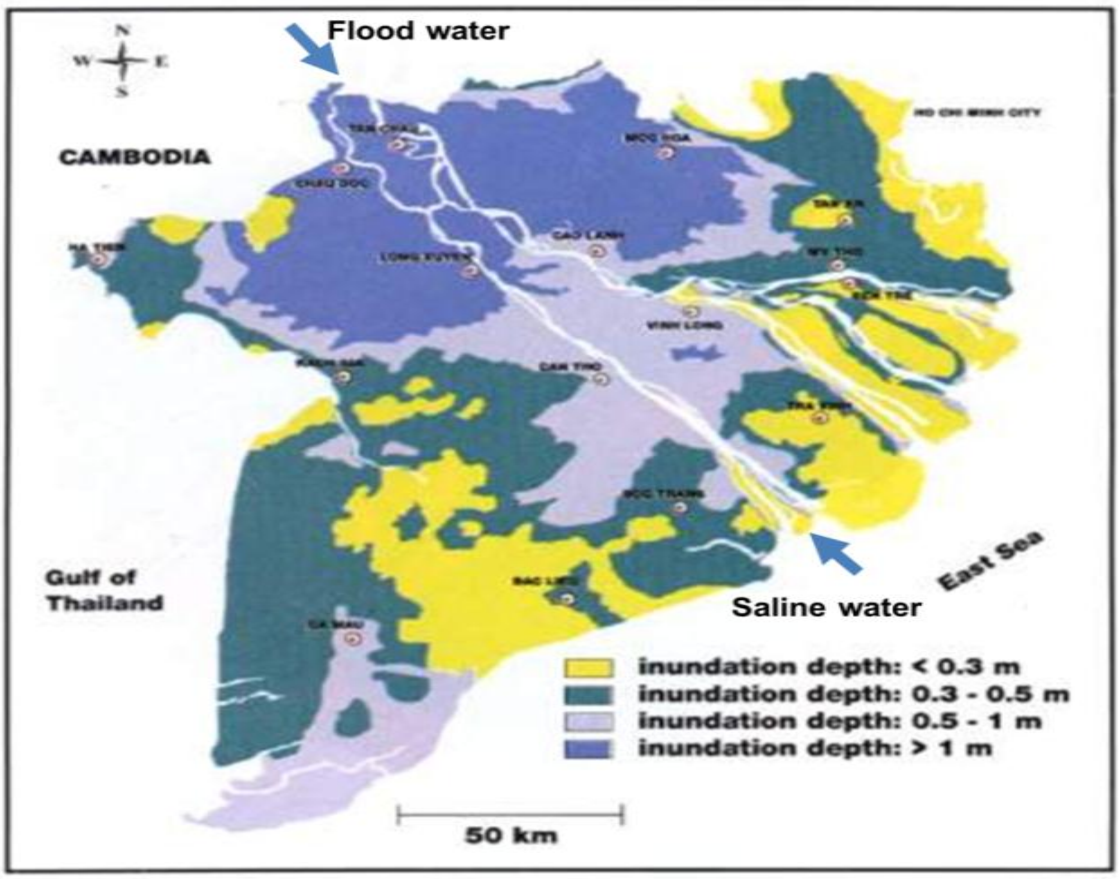

Figure 1.2: Flooding in the Vietnamese Mekong Delta
Source: Adapted from Sanh et al. (1998)

The VMD is located at the southern end of the Mekong River, in the southern part of Cambodia and Vietnam with 12 provinces and one city. The Vietnamese section of the Delta has a population of over 17.3 million people, accounting for nearly 19.6% of Vietnam's population. The population density is about 429 people per km^2. Ethnic groups in the VMD include Kinh, Chinese, Khmer and a number of Cham (Smith 2013). Most of the population in the VMD are Kinh, while other ethnic groups account for a small percentage. Over 76% of the population lives in rural areas, and their main livelihood activities are agricultural and aquaculture production.

Religion[1] is very diverse in the VMD, including Cao dai, Hoa Hao, Hiếu nghĩa, Buddhists (Bắc Tông and Nam Tông), evangelicals (Tin lành), and Catholics (Thiên chúa giáo). Data and information in relation to religious issues were not available at

[1] Religion is one of the forms of social capital of farmers in the VMD, but it will not be examined throughout the rest of the thesis because it is not a focus for the thesis.

time of writing. However, information from Vietnamese Wikipedia.org and my own observations suggest that the diversification of religions in the VMD represents social capital (in the form of relationships) in different groups of religions. Therefore, social relations in the VMD are typically diverse not only regarding ethnicity, but also in terms of religions.

The total land area of the VMD is around 3.9 million hectares and, based on the dynamics of hydrology, soil, and other ecological factors, can be divided into three different ecological zones. People in the upstream provinces (1) of the VMD such as An Giang, Đồng Tháp, and part of Can Tho city have had to adapt to flooding and acid-sulphate soils whereas people living in the downstream provinces (3) of the VMD, including Sóc Trăng, Bạc Liệu, and Ca Mau, have had to adapt to saline water intrusion (Tuan et al. 2007). The middle zone (2) of two branches of the Mekong River is favourable for agricultural production because of a fresh-water zone (Lecoq & Trebuil 2005; Can et al. 2007).

Agricultural production is considered to be the most important economic sector, making up 41% of the economy of the VMD (GSO 2011), which makes it the main "rice bowl" of Vietnam (De 2006). For example, rice production accounts for the largest area with nearly 4.2 million ha farmed[2] in 2012 (GSO 2012). Rice productivity has increased in recent years from over 18 million tonnes in 2007 to over 24 million tonnes in 2012. The VMD contributes over 50% of rice production to Vietnam, and approximately 90% of rice exported from Vietnam (Hieu 2010).

Aquacultural production is also a major economic sector in Vietnam, accounting for 4.6% of GDP. The area of aquaculture in the VMD was around 0.72 million ha between 2007 and 2012. Annually, the contribution of the VMD to aquacultural production accounted for over 71% of the total productivity of aquaculture in Vietnam between 2007 and 2012. The VMD contributed over 75% of shrimp productivity of Vietnam every year. According to Ha (2012), shrimp productivity in the VMD increased sixfold between 2000 (50,000 tonnes) and 2009 (300,000 tonnes). However, this was not published as economic data.

[2] Planted area is the total area of rice land that is cultivated with two or three consecutive rice crops each year. For example, if there is 100 ha available for rice, and if there are three rice crops per year, then the planted area is 300 ha.

A wide range of important factors contributed to the increased rice and shrimp productivity in the VMD. The Vietnamese government applied infrastructure solutions by constructing a series of dyke systems in the 1990s in order to secure rice production from flooding in the upstream zone of the Mekong River (Can et al. 2007). Dyke construction enabled farmers to intensively rotate rice crops from two to three consecutive rice crops each year. In addition, since 1990 the government has increasingly invested in constructing embankments and sluice gates in order to control salinity intrusion for rice production in part of the coastal zone (Tuong et al. 2003). Moreover, the introduction of high-yielding rice varieties, adoption of advanced technologies, and land policy reform contributed greatly to rapid development over the last several decades (De 2006).

Along with government programmes for enhancing human capacity in rice production, numerous international organisations have provided aid to rice and shrimp farmers in the VMD. These international organisations included:

- World Bank with the project VN-Mekong Delta water management for rural development (World Bank Vietnam Website),
- the southeast Asia regional initiatives for community empowerment (SEARICE) with a project on Community Biodiversity development and conservation (CBDC, 1996–2004) (Tin 2005),
- the Flemish Association for Development Cooperation and Technical Assistance (VVOB) with the Participatory Agricultural Extension Program (PAEX 2008–2010) (Diem 2010), and
- ACIAR directly to local authorities or via university networks. In recent years, ACIAR supported a partner network (Can Tho University and the Research Institutes of the Ministry of Agriculture and Rural Development of Vietnam) in the VMD conducting a project called “Climate change affecting land use in the VMD: Adaptation of rice-based cropping systems” (CLUES 2011–2015), with the overall aim to increase the adaptive capacity of rice production systems in the Mekong Delta Region (Proposal of CLUES project 2009, p. 7), and an immediate objective to provide farmers and management agencies with technologies and knowledge that would improve food security in the Mekong Delta (Proposal of CLUES project 2009, p. 7). The majority of the project activities attempted to examine and generate new rice varieties with strong

resilience to resist high salinity and flood situations, and new farming techniques, along with the adoption methods for farmers' new techniques.

1.3 What development pressures influence farmers' decision-making for agricultural development?

Agricultural production in the VMD has developed since 1990, and achieved approximately 24 million tonnes of rice in 2012. In 2013, the central government issued Decree 899_QD/TTg (10/06/2013) about agricultural restructuring (website of the Office of the Vietnamese Prime Minister). This was a key event making changes in agricultural production for the plan to 2020, because there was a range of pressures on agricultural development from this decree. The decree pressured agricultural sectors to focus more on quality and high value chains on large scale rather than on large quantity and low value chains in order to increase the value of agricultural production for export and domestic markets. For example, this goal generated strong pressure on rice production because it requires cooperation between actors in the value chain from local farmers to processing and export. However, agricultural restructuring in each crop and each region needs to be based on the advantages of each region such as climatic conditions, technology, high productivity of crops, and modern post-processing. Following Decree 899_QD/TTg, in 2015 another decree was issued to support the decree of agricultural restructuring. This is Decree 706_QD/TTg (21/05/2015) of "development of Vietnam's rice brand to 2020 and vision to 2030" (website of the Office of the Vietnamese Prime Minister).

A wide range of programmes in relation to these decrees from the central government have been implemented from the provincial level to commune levels. For example, a range of previous programmes or cooperative economic models has been promoted more strongly than before, such as large farm models (Smit et al. 2013), and cooperatives (Hai 2014), along with technical knowledge support. Technical knowledge support might be funded from Vietnamese governments or international organisations. For example, the Vietnam-sustainable Agriculture Transformation project for eight provinces in the VMD was funded by the World Bank (http://projects.worldbank.org/P145055?lang=en). These provinces include An Giang, Can Tho, Dong Thap, Long An, Tien Giang, Hau Giang, Kien Giang, and Soc Trang.

Although the central government and local governments had new policies to develop agriculture until 2020 and a vision for 2030, there have been a wide range of pressures and challenges for local communities in the VMD in terms of climatic and non-climatic constraints. Climatic conditions include the changing time of the rainy season, its intensity and patterns, and changing temperatures, changing time and level of floods, changing salinity. For example, when the projection of average temperatures at the end of the 21st century is compared to 1980–1999, the average temperature in Vietnam was predicted to increase by 0.4 °C (2020) to 3.7 °C (2100) for most regions in Vietnam (Ministry of Natural Resources and Environment–MONRE 2012). However, the increase in temperature in provinces of the north is higher than in the south of Vietnam.

Sea level rise is also predicted to increase in the VMD by about one metre by the end of this century, which would flood more than 15,000 square kilometres, or around 38% of the VMD's current land area with salt water (ICEM 2009). Long before that, however, the VMD will experience more intense natural disasters, loss of biodiversity, and progressively serious saline water intrusion leading to declining agricultural productivity (90% of the Delta could be soaked in salt water) (ICEM 2009). A household's agricultural and livelihood systems are considered to be vulnerable if there is a high probability of loss or damage from climate change (ADB 2013), so, future climate change, sea level rise, and flood are threats that will most likely influence farmers' decision-making in relation to rice-based farming systems.

Farmers are also challenged by non-climatic threats such as market access and prices. For example, the market price of shrimp dropped by nearly one third due to the global economic downturn in 2008, whereas the production costs of shrimp increased by 20–40% due to increasing prices for fuel and feed. Farmers reported that the price of one kilogram of shrimp decreased from VND[3] 105,000 to VND 65,000 in six months in 2008. NACA (2010) reported that, during 2008, the price of shrimp decreased from VND 109,670 to VND 106,110 per kilogram (Ha 2012).

There are different forms of contract farming between rice farmers and rice companies to overcome unstable market prices; these forms include the large field model, contract farming, and cooperatives, or added groups in the VMD. In fact,

[3] USD 1 = ~ VND 22,000

contract farming models between farmers and companies have been a common model not only in Vietnam, but also in other countries such as in the North of Thailand (Songsak & Aree 2008) and Southern Laos (Alexander & Larson 2016). Normally, under contract farming in Vietnam, Thailand, and Laos, companies supply seed, input supplies (fertiliser and pesticide), and technical knowledge to farmers. Then, farmers sell their product directly back to the contracting companies (Songsak & Aree 2008; Nhan et al. 2013; Can 2014; Alexander & Larson 2016). Besides, farmers in Thailand have also received a range of support from government in terms of transferring technology (Songsak & Aree 2008).

Each case of contract farming is more or less unique because there are many factors, often beyond a farmer's control, that can determine success or failure. Common external factors that can affect performance in contract farming for crop production include weather conditions, flood and disease. In addition, trust-building between the various actors in contract farming is also very important for success (Songsak & Aree 2008). In the VMD, conflicts between companies and farmers often arise when a farming contract is broken due to unstable market prices, disagreement between companies and farmers over product quality, or the time a farmer has to wait to receive payment from the contracting company (Roberts & Khiem 2005; Nhan et al. 2013). Therefore, farmers have to decide whether to participate in farmer organisations for collective contract rice farming, which is one of the important decisions a farmer has to make in rice-based farming systems.

1.4 Problem statement of the study

It is important to examine how farmers make collective and individual decisions in the context of current policies, and adapt to marketing and climatic uncertainties across different ecosystem zones in the VMD. Livelihood assets and access are amongst a number of fundamental factors that influence a farmer's decisions on livelihood strategies and land use (Bruijn and Van Dijk 2005; Trung et al. 2017). Livelihood assets or capital include such things as human capital (i.e., education level, age, skills, and knowledge), social capital, natural capital (e.g., land and water), physical capital, and financial capital (Scoones 1998; DFID 1999). Livelihood access refers to the capacity of households to access external materials and services (DFID 1999). Furthermore, how farmers collaborate with each other, with farmer organisations and with government organisations is also an important factor in the process of making decisions on rice-based farming system under conditions of climate variability and market issues. These kinds of collaboration are likely to improve the resilience of farmers and facilitate their adaptation to change.

In the diffusion of innovation approach (Rogers 2003), decision-making has three main types for adopting innovation including (1) "*optional innovation-decisions* are choices to adopt or reject an innovation that are made by an individual independent of the decisions of other members of the system", (2) "*collective innovation-decisions* are choices to adopt or reject an innovation that are made by consensus (collective) among the members of a system", and (3) "*authority innovation-decisions* are choices to adopt or reject an innovation that are made by a relatively few individuals in a system who possess power, status, or technical expertise" (Rogers 2003, p. 29; emphasis in original). Authority decisions have always applied in authority unit, in a village council for example. Decision of these organisational units was made via unanimity, not by majority vote (Popkin 1979, p. 106). Therefore, "decision-making units may range from an individual to much larger units such as village, regions, states and even international organisation" (Bruijn & Van Dijk 2005, p. 5).

Relevant studies on decision-making by farmers have been conducted elsewhere outside of Vietnam. For example, Alexander and Larson (2016) found that in Southern Laos, the main factors influencing farmers' decision-making about crops for their livelihood include lack of funds, disease, lack of water, lack of labour, low prices, and seed varieties. Similarly, in case studies in Indonesia presented by Grünbühel and Williams (2016), land size and lack of labour directly impacted farmers' decision-making when they considered adopting new cattle management practices. In Northern Thailand, Duangiai et al. (2015) examined farmers' land use decision-making in the context of changing land and conservation policies. Duangiai et al. (2015) found that farmers changed decision-making from rice to commercial crops because of the increase in population, conservation policies, and markets. In Kyrgyzstan, Zhumanova et al. (2016) explored farmers' decision-making and land use changes in Kyrgyzstan agropastoral systems. Zhumanova et al. (2016) found that farmers' decision-making about the increase of livestock number depended on climate change condition and environmental capacity of pasture. In addition, farmers' decision-making about crops was also reviewed by Matthews et al. (2007), and Robert et al. (2016). Matthews et al. (2007) showed that in a case study in Indonesia, farmers and their neighbours had to decide collectively about an irrigation timetable to produce a high yielding crop because there was not enough water available if all fields were irrigated at the same time. Decision-making about farming activities depended on ecosystem condition (Matthews et al. 2007).

A few studies have investigated farmers' decision-making for selecting livelihood pathways (strategies) and adopting innovation of farming systems in the VMD (Bosma et al. 2012; Ha 2012), or land use decision-making of farmers in another part of Vietnam and in Northern Thailand (Trung et al. 2017). Farmers in the coastal zone of the VMD individually decided on organic shrimp systems or intensive shrimp systems under social and ecological uncertainties (Ha 2012). In contrast, Bosma et al. (2012) determined factors influencing farmers' decision-making for individuals adopting rice-fish systems including high income and quality low land, among other things. However, these studies applied quantitative data to determine elements influencing farmers' decisions for farming systems and land uses. For example, Bosma et al. (2012) determined that market price was one of the main factors influencing farmers' decision-making in relation to rice-fish-garden systems in the VMD. In contrast, Ha (2012) focused on how shrimp households decided their livelihood under market uncertainties. Farmers decided that they should not sell shrimp during a period of market downturn, and instead they stored shrimp in the shrimp fields during the market downturn to wait for improvement in market prices. They also protected mangroves, and did not use chemicals on their fields in order to maintain good environmental conditions for shrimp. However, there are no studies applying formal and informal collective[4] and individual decision-making for the specific livelihood activities of farmers in the VMD. My study will apply both qualitative and quantitative data to explore farmers' decision-making regarding rice-based farming systems, and farming activities to enhance understanding of farmers' capacity and strategies for responding to threats such as climate variability and markets.

Thus far, no studies have investigated the importance of farmer organisations (such as agricultural cooperatives, farmer clubs, large-sized farms, and agricultural extension clubs) in formal collective decision-making in the VMD. Farmer organisational units in the VMD, including agricultural cooperatives (ACs) *(Hợp tác xã*

[4] Formal collective decision-making is a form of decision with members of farmer organisations or participation of local authorities, while informal collective decision-making is a group of farmers, who decide farming activities by themselves without participation of farmer organisations and local authorities.

nông nghiệp), farmer clubs (FCs) *(Câu lạc bộ nông dân)* and large-sized farm models (LSFs) *(Cánh đồng lớn)*, are important potential decision-making unit. However, in the past, rice farmers in the VMD have preferred to operate and make decisions individually, rather than as part of a cooperative (Miller 2003, p. 235). Neverthess, this behaviour is changing and farmers are now able and encouraged to be more involved in farmer organisations as a result of government and international aid programmes. Accordingly, members of farmer organisations and even general farmers (who are non-members) are more likely to engage in collective and individual decisions for their rice-based farming systems and farming activities than in the past.

The resilience of farmer organisation units with strong social capital of members in organisations might influence the frequency of collective decision-making because members might decide to work closely on rice-based farming systems. Social capital is viewed as a key factor in linking factors that Borda-Rodriguez and Vicari (2014) discussed, including membership, collective skills and networks, in a local organisation. Previous studies on local organisations such as ACs, FCs and LSFs in the VMD were implemented by several authors (De 2006; Ha 2013; Hai 2014). However, there is very little research on the role of farmer organisations in adaptation to changes of climate and constraints on rice-based farming systems at the same time. Moreover, only a few studies have applied the social capital concept to measure a variety of relationships between different actors in and outside farmer organisations in different networks, especially regarding social trust and cohesion of relations among members and actors. For example, Ha et al. (2013) applied collective actions and upgrading of value chains as the main concepts to analyse the shrimp farming of farmer clusters in the VMD. Vertical and horizontal co-ordinations were also applied so as to discuss the relationships between different farmers, between farmers and traders, and between farmers and companies. The study found that farmer clusters *(tổ hợp tác)* were successful owing to receiving support from local government such as in electricity supply, credit, and farming techniques. However, the study did not find such relationships between relatives, neighbours, and friends in a cluster.

Tuan et al. (2014) investigated changes in social capital of farmers over two periods, from 1858 to 1954 and from 1975 to1990. The study found that the social capital of farmers has decreased because of a decline in the exchange of labour, more access to technical knowledge, and greater access to irrigation. Nowadays, farmers only share technical knowledge, and they tend to work more individually regarding hired labour and machines due to labour shortages.

However, these studies did not measure and discuss social trust, cohesion, and social commitment in a specific group, which are three important social ties of horizontal relations also known as bonding social capital. Meanwhile, different forms of both formal and informal social capital might lead to an increase or decrease in the number of farmer organisations, as well as bring other advantages, opportunities, or constraints to the success of farmer organisations. Last but not least, social capital relates to collective decision-making because it helps farmers or members of farmer organisations to more easily reach agreement in relation to collective decision-making about rice-farming activities.

Generally, farmers' decision-making about rice-based farming systems and the activities of each farming system is a process, where farmers need to consider a number of factors to reach decisions. Accordingly, the output of rice-based farming systems must be examined to understand the interaction between components in the decision-making process. These components include (1) decision-making for the main rice-based farming systems (two rice crops, three rice crops, or rice-shrimp system), (2) factors for specific farming activities (climate variability, access to markets, and livelihood capitals), (3) decision-making for rice-farming activities (selecting rice varieties, setting up seasonal calendars for farming system, etc.), and (4) output of rice-based farming systems (rice yield and income).

1.5 Research questions

Main question

What are the main questions that farmers have to consider when they make decisions about their rice-based farming systems in the VMD?

Specific questions

1. What are the major decisions that farmers have to make about their rice-based farming systems that they wish to implement each year? (Chapters 5, 6, and 7)

This is a large-scale question about what decisions farmers have to make about a range of farming systems including,

- Choosing two rice crops, three rice crops, or a rice-shrimp system
- Choosing production of seed or normal rice (rice for consumption)
- Setting up seasonal calendars for a particular farming system
- Access to irrigation and draining activities
- Selecting rice varieties and shrimp seed for each crop
- Access to rice varieties and shrimp seeds
- Access to labourers for showing seeds, transplanting nursery, spreading fertiliser, spraying pesticide, and harvesting rice.
- Access to combine harvesters for harvesting rice.
- Access to local market and selling rice to traders

In order to respond to this question in detail, the study is also necessary to consider why farmers decide to choose a particular rice-based farming system (two rice crops, three rice crops, or rice-shrimp system) through a farming systems lens (see Chapter 2). In contrast, the detail in farmers' decision-making about farming activities of a particular farming system will be discussed in response to research question 3. The farming activities include choosing production of seed or normal rice, setting up seasonal calendars for a particular farming system, accessing irrigation and draining activities, selecting rice varieties and shrimp seed for each crop, plus other.

2. Which factors influence farmers' decision-making for rice-based farming systems, and how will these factors influence them? (Chapters 5, 6, and 7)

   This is a smaller-scale question about exploring a range of factors such as how agricultural production policies, livelihood capitals, markets and climate variability influence farmers' decisions on an ongoing basis. What are the sorts of decisions farmers need to make on a day-to-day basis throughout the season? The study therefore presents and explores how these factors influence the process of farmers' decision-making.

3. How do farmers make collective and individual decisions for their rice-based farming systems? (Chapters 5, 6, and 7)

Farmers might make decisions collectively for different farming activities via organisations and informal farmer groups. Farmers also make individual decisions for a range of farming activities. Farmer organisations include ACs, FCs, and LSFs, while informal groups are created around similar “interests” such as land field conditions, informal social capital (i.e., kin and neighbours), but they might work collectively for some farming activities. Generally, farmers’ decision-making for rice-based farming systems or specific farming activities is based on the above factors, so these will be explored and analysed.

4. What are the consequences of the major decisions about rice-based farming systems and household livelihoods? (Chapters 5, 6, and 7)

   Farmers’ decision-making about rice-based farming systems and detailed activities with rice-farming activities link the factors for decision-making (causes) with the output of rice farming (effects). Rice yield and income from rice production and shrimp farming are outputs of rice-based farming systems. Those are also the consequences of farmers’ decision-making about rice-based farming systems.

The main question and these sub-questions will be considered in the context of three provincial case studies in the VMD: An Giang, Can Tho, and Bac Lieu. These three provinces are located in different regions of the VMD and each has different rice-based farming systems based on soil type and access to irrigation and water resources. An Giang is an upstream province which is impacted by annual floods, while Can Tho is a central province in the VMD with more favourable conditions than An Giang because of less severe and less frequent flooding. Bac Lieu is a coastal province that is affected by saline water intrusion. Rice-shrimp is one of the rice-based farming systems in Bac Lieu, and also a crucial livelihood activity. Different modes of farmers’ decision-making for rice-based farming systems are used in the research sites of the three provinces.

1.6 The structure of the thesis

Chapter 1 introduces general background information, the problem statement of the study, research questions, and the significance of the study. Chapter 2 reviews the main concepts used in each case study, including decision-making for agricultural intensification, integrated farming systems, a number of factors influencing farmers' decision-making in relation to rice-based farming systems and farming activities including farmer organisations with social capital as a linkage between members, livelihood assets and access, climate variability, and access to local market, and livelihood outcomes as a result of rice-based farming systems, which are affected by farmers' decision-making.

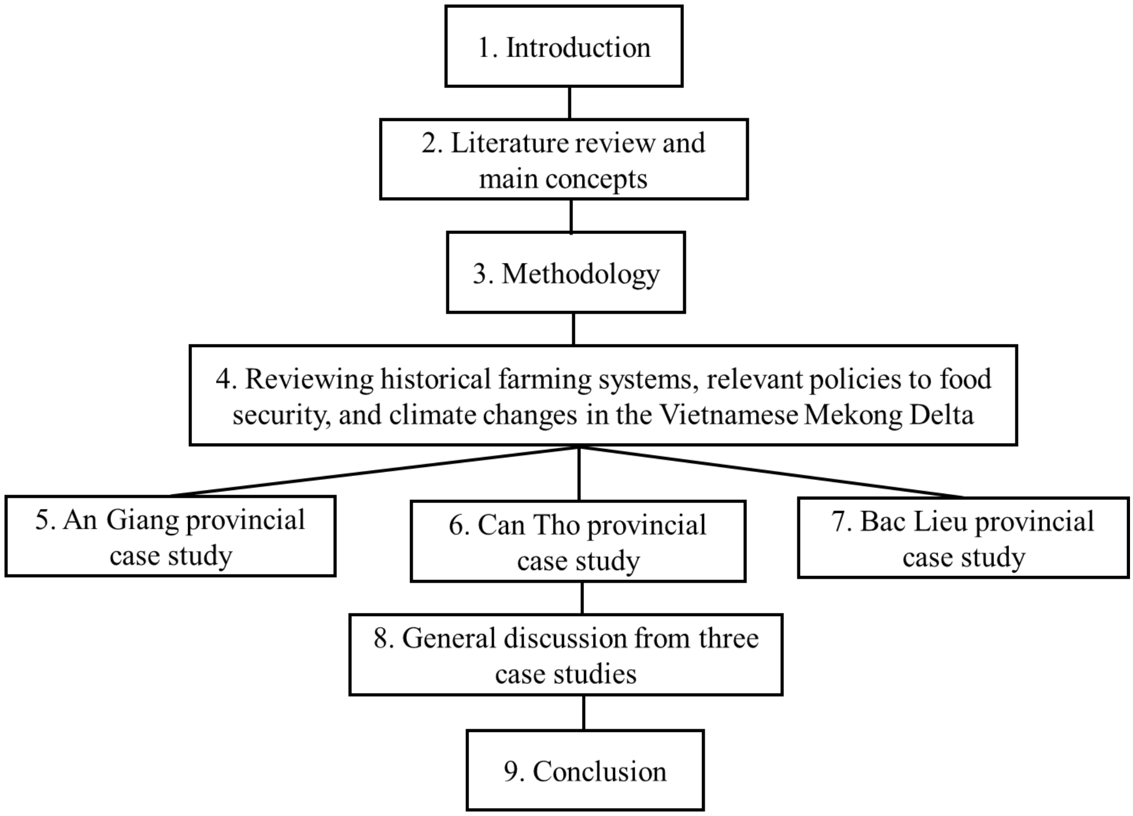

Figure 1.3: The relationship between chapters in the thesis

Chapter 3 describes the methodology applied in the study including the how and why of selecting research sites, methods of data collection, and analysis. Firstly, the study describes the research sites in the six communes located in the three provinces (Can Tho, An Giang, and Bac Lieu). Secondly, the study presents three primary methods of data collection comprising focus group discussions, semi-structured interviews, and household surveys. Secondary data and information were also collected from local and provincial authorities during the fieldwork. The chapter discusses the method of analysis consisting of descriptive statistics with quantitative analysis and narratives with qualitative analysis. These quantitative and qualitative data are presented to respond to the four main research questions.

Chapter 4 reviews agricultural transformation and farmer organisations in the VMD. In particular, this chapter will discuss the general, changing process of agriculture in different ecosystem zones in the VMD under state policies, including policies and programmes relating to infrastructure such as excavating or improving canals, constructing high dykes to secure the third rice crop in the flood season in the upstream region of the VMD, and constructing sluice gates to control saline water for cultivating rice or raising shrimp in the coastal zone of the Delta (relating to Questions 1 and 2). Additionally, the chapter reviews non-infrastructure policies for contributing to increasing agricultural productivity, comprising supporting credits to farmers to buy combine harvesters, and enhancing farmer capacity in seed production to improve rice variety quality in normal rice farming (relating to Question 1, 2, and 3). General results and challenges of agricultural production in the VMD are also reviewed in the chapter. Typically, the majority of these policies in relation to agricultural production might influence current farmers' decision-making about rice-based farming systems, and farming activities.

Chapter 5 (the An Giang case study) provides general background information and the agricultural policies of An Giang, which expriences severe flooding annually, including land use, water conditions (flooding), and the evolution of farmer organisations and dyke construction. The main section of this chapter highlights findings and discussion on what members of the FC and general farmers decide about rice-based farming systems in the two communes of An Giang province (Question 1). Decision-making for rice-based farming systems is a process and has different factors influencing crucial farming systems and specific farming activities. Accordingly, the study presents and discusses the results of a number of main factors influencing farmers' collective and individual decisions for farming activities (Question 2). Then, it presents and discusses the process of farmers' collective and individual decision-making for rice-farming activities (Question 3). Finally, the results and discussion of the case study focus on the effect of collective and individual decision-making on the output of farming systems (Question 4). The outputs of rice-based farming systems such as rice yield and rice income are considered significant parameters to understand the influence of decision-making on farming systems as an interaction between decision-making and results.

Chapter 6 (the Can Tho case study) presents general background information and the agricultural policies of Can Tho province, an annual small-flood area, including land use, flooding conditions, and the evolution of farmer organisations and dyke construction. The main section of this chapter highlights findings and discusses what members of ACs and LSFs, and general farmers, decide about particular rice-based farming systems in the two communes in Can Tho (Question 1). The study presents and discusses the results of a number of main factors influencing farmers' collective and individual decision-making for farming activities (Question 2). Then, it presents and discusses how members of ACs and LSFs, and general farmers make collective and individual decisions for rice-farming activities (Question 3). Finally, the results from and discussion of the case study focus on the influences of collective and individual decisions on the result of farming systems (Question 4). The outputs of rice-based farming systems such as rice yield and rice income are considered a group of significant parameters to present the consequences of decision-making.

Chapter 7 (Bac Lieu case study) presents general background information and the agricultural policies of Bac Lieu province, a coastal province where the farming system has been affected by saline water intrusion. The factors in relation to the background information include land use, saline and fresh–water conditions, sluice gates, and the evolution of farmer organisations. The chapter highlights findings and discussions on what members of FC and AC, and general farmers, decide about particular rice-based farming systems in the two communes in Bac Lieu province (Question 1). The study demonstrates the results from the case study and discusses a number of main factors influencing farmers' collective and individual decisions for farming activities (Question 2). Then, the thesis presents and discusses the process of farmers' collective and individual decision-making for rice-farming activities (Question 3). Finally, the results from and discussion of the case study will figure out the effect of collective and individual decisions on the output of farming systems (Question 4). The outputs of rice-based farming systems such as rice yield and rice income are considered significant parameters that reveal the relation between decision-making and the result of farming systems.

Chapter 8 will discuss the main findings across the provincial case studies of An Giang, Can Tho, and Bac Lieu in order to compare the similarities and differences between multiple case studies at the commune level in the three provinces. The topics of discussion include similarities and differences relating to farmers' decisions about the main rice-based farming systems (Question 1), factors influencing farmers' decision-making for rice-farming activities (Question 2), farmers' collective and individual decision-making for farming activities (Question 3), and the effect of decision-making on rice-based farming systems (Question 4).

Chapter 9 is the conclusion chapter, which summarises findings to answer the research questions from multiple case studies across the three provinces. The chapter will provide reflections on and suggestions for local authorities and farmers to consider when they conduct cooperation programmes. The chapter also suggests future research in the field of collective adaptation to climatic risk, environmental risk, and access to markets across different provinces in the VMD as there have been a range of aid projects from the World Bank (http://projects.worldbank.org/P145055?lang=en), and other organisations to improve the capacity of local farmers and local authorities in different farming systems such as rice and rice-shrimp systems.

1.7 The significance of the study

Previous studies of farming communities in the VMD have been conducted from many different perspectives (Ha 2012; Bosmas et al. 2012; Trung et al. 2017). Ha (2012) highlighted how shrimp and fish households decide livelihoods and pathways under social and ecological uncertainties, while Bosmas et al. (2012) and Trung et al. (2017) conducted studies on what factors influence farmers' decisions about rice-fish-garden systems, and about land use (for crops). However, very few studies have discussed the process of how factors influence farmers' decision-making about rice-based farming systems.

In recent years, a range of studies have typically highlighted farmers' perceptions and behaviours in adapting to climate change, or farmers' perceptions and behaviour in decision-making for farming systems in the VMD. These studies have largely focused on individual households' adaptation strategies rather than collective actions (Hoa et al. 2013; Binh 2015). For example, Hoa et al. (2014) identified 22 adaptive strategies that were grouped into seven categories, including adjusting the planting calendar, adjusting planting techniques, crop and variety diversification, water use management, diversifying income sources, reinforcing safety for humans and assets, and other measures. In contrast, Binh (2015) determined that farmers adjusted their seasonal calendar (i.e., the time for beginning and harvesting rice and sugarcane) as a common solution to adapt to rising salinity. Generally, these studies discussed how factors in relation to climate variability influence livelihood strategies and adaptive capacity. However, these studies have not explored in more detail how issues of climate variability influence the process of farmers' decision-making about rice-based farming systems and farming activities, especially collective decision-making by farmer organisations at the commune level. In addition, these studies only used social capital to discuss the relationship between individuals of farmers rather than looking in detail at farmer organisations and collective decision-making.

Among the factors influencing farmers' collective decision-making about rice-based farming systems and farming activities, social capital (a full review of social capital will be undertaken in Chapter 2) is considered to be a significant factor. Social capital links members of farmer organisations and enables them to make collective decisions. This is especially important for decisions affecting seasonal calendars, selecting rice varieties, harvesting, and selling products because these farming activities might contribute to coping with current climatic threats and access to markets.

Therefore, this study provides a full picture of detailed decision-making of practical farming activities of farmers in the VMD. The study typically focuses in detail on a deeper understanding of what farmers do for farming activities, and why they do it. The study contributes to research not only in the social sciences but also in planning for farmers' rice farming and the planning of local authorities in supporting infrastructure and other policies to enhance farmers' capacity to deal with a range of climatic and non-climatic threats (including market access). Also, it is useful for donor and international aid organisations providing funds for local communities in the Delta. In particular, the study provides findings relating to farmers' behaviour in decision-making for rice-based farming systems, factors influencing collective and individual decision-making for farming activities under promoting farmer organisations by local authorities and different policies (both infrastructure and non-infrastructure) in increasing in rice production. The study applies interdisciplinary approaches to the social sciences including those based on human geography, human ecology, and sociology to understand the interaction among members of organisations and general farmers, and other associated actors in the farming activities of farmers in a specific rice community. Furthermore, this thesis attempts to determine the interaction between farmers' decision-making and the output of farming systems to enhance understanding of the important role of collective decision-making in rice-based farming systems. The study further contributes to identifying farmers' perceptions and behaviours in collective decision-making for working together or in cooperation under a range of support from aid organisations and governmental programmes.

This thesis is built on the foundations provided by the CLUES project, so the relationship between the Thesis and CLUES project that is briefly reviewed in the section of background information of this chapter and will be presented in the detail in chapter 3 (i.e., chapter of methodology). This thesis is designed to add value to Objective 4–Theme 4 of the CLUES project because it builds on information and data found by the studies of the project. In particular, this thesis uses several maps in relation to land use and water control in Bac Lieu province for the case study of Bac Lieu. Moreover, the thesis also uses published papers that are the results of studies conducted by research activities of the CLUES project, such as the financial capacity of rice-based farming households in the Mekong Delta, Vietnam (Dung et al. 2017). Again, in chapter 3 of this thesis, the relationship between this thesis and the CLUES project will be discussed in detail in the section on research site selection.

1.8 Conclusion

In conclusion, this chapter introduced farmers' decision-making in relation to rice-based farming systems, along with factors regularly influencing the process of their decision-making. These factors included types of livelihood capital, climate variability, flood, drought, and rising salinity, and access to markets. The chapter showed that a few studies have been conducted in relation to farmers' decision-making about rice-based farming systems. However, most of these studies were limited to discussing the detailed process of farmers' decision-making for rice-based farming systems and for farming activities. In addition, these studies did not discuss specific farmers' collective decision-making in relation to farming activities of rice-based farming systems. In particular, farmers might become involved in farmer organisations to make collective decisions about farming activities, or they might decide individually on farming activities for their rice faming. The objective of the thesis will be to examine the main questions that farmers have to consider when they make collective and individual decisions about their rice-based farming systems in the VMD.

Chapter 2

Literature review and main concepts

2.1 Introduction

This study sets out to examine issues relating to how farmers make decisions about their rice-based farming systems. In particular, the main question is: What are the main questions that farmers have to consider when they make decisions about their rice-based farming systems in the VMD? The four sub-questions include:

1. What are the major decisions that farmers have to make about their rice-based farming systems each year?
2. Which factors influence farmers' decision-making for rice-based farming systems, and how will these factors influence them?
3. How do farmers make collective and individual decisions for their rice-based farming systems?
4. What are the consequences of major decisions about rice-based farming systems and household livelihoods?

In Chapter 1, the thesis discussed the problem statement of the study, covering a range of concepts in relation to farmers' decision-making around rice-based farming systems. These concepts include decision-making, livelihood strategies, agricultural intensification, integrated farming systems, climate change or climate variability and adaptation, types of livelihood capital, and social capital in the resilience of farmer organisations, and access to local markets. In this chapter, these underlying concepts are explored and reviewed in greater detail.

Typically, the rural livelihoods framework has been used to examine various issues around how farmers make decisions and implement their livelihoods such as rice-based farming systems. The livelihood framework was first described by Chambers and Conway (1991), and has since been modified for specific purposes (Scoones 1998; DFID 1999; Ellis 1998). Based on these approaches I selected a framework with components from Chambers and Conway (1991) (see Figure 2.1), and from the sustainable rural livelihoods framework (Scoones 1998) (see Figure 2.2) to develop the conceptual framework of the current study. This approach enabled an analysis of issues relevant to the research questions of this study, particularly agricultural intensification.

In addition, the study also considers decision-making for livelihoods as described by Burijn and Van Dijk (2005). Therefore, the final conceptual framework for the current study combines a number of different approaches, as illustrated in Figure 2.3.

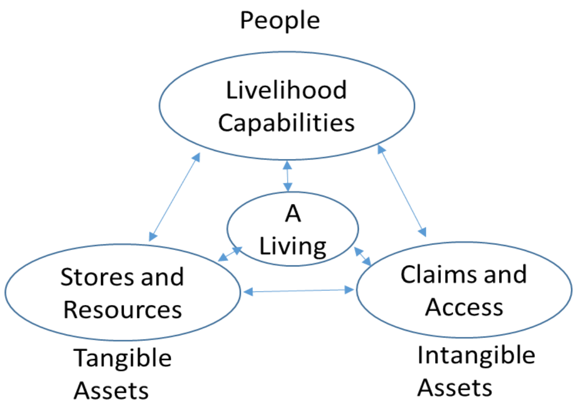

Figure 2.1: Linkage of components and flows in a livelihood including livelihood capabilities, tangible assets (stores and resources) and intangible assets (claims and access) across a living in the middle.
Source: Adapted from Chambers and Conway (1991)

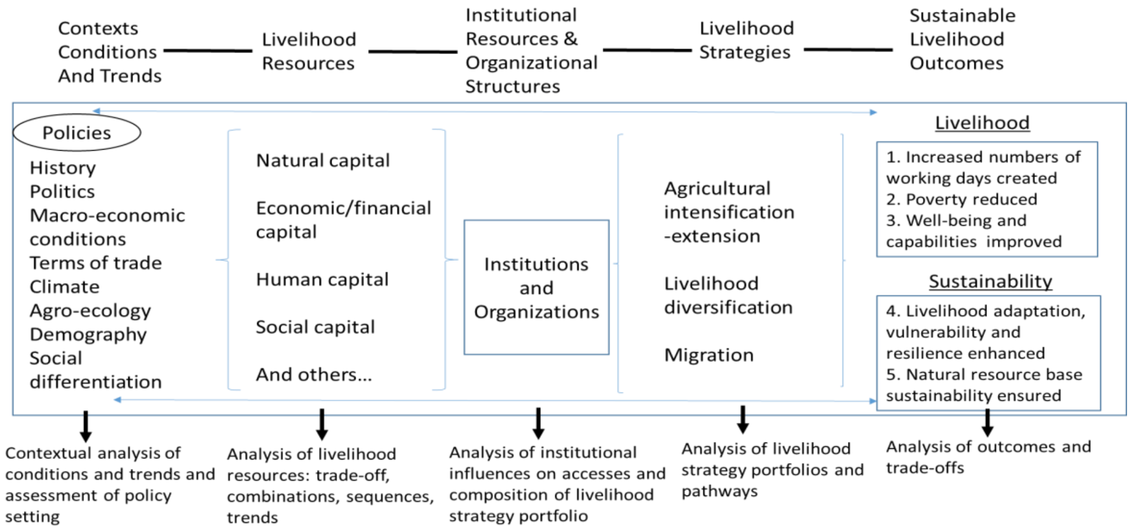

Figure 2.2: Sustainable rural livelihoods: a framework for analysis including different groups of components from contexts, conditions, and trends for sustainable livelihood outcomes
Source: Adapted from Scoones (1998)

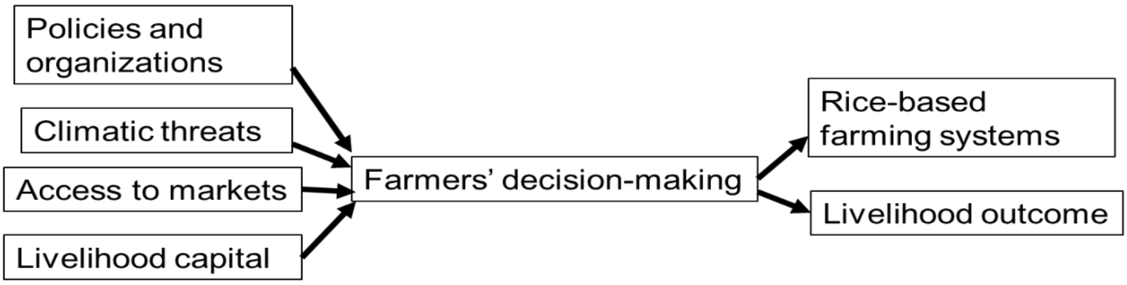

Figure 2.3: Conceptual framework of the study
Source: Modified from Chambers and Conway (1991), Scoones (1998), and Bruijn and Van Dijk (2005)

In order to focus on sections relevant to the study, the conceptual framework for this study (see Figure 2.3) shows the linkages between farmers' decision-making for rice-based farming systems, and (1) four factors including policies and organisation, climate and market threats, and livelihood assets and access, (2) conducting decision-making about rice-based farming systems, and (3) livelihood outcomes.

Based on the conceptual framework (see Figure 2.1), the study reviews farmers' decision-making about rice-based farming systems as livelihood pathways with two options, agricultural intensification and integrated farming systems. Secondly, the study demonstrates factors including influence of social capital on the resilience of farmer organisations, climate variability and negative impact of climate variability on agriculture, local people's responses to the impacts of climate variability, and main livelihood capitals. Finally, the study reviews the effects of decision-making on pathways such as farming systems through exposing livelihood outcomes with the outputs of farming systems.

2.2 Review of concepts relating to farmers' decision-making for rice-based farming systems in the Vietnamese Mekong Delta

2.2.1 Farmers' decision-making for main rice-based farming systems

Decision-making

There is a wide range of studies from different fields in relation to decision-making such as in business (García-Peñalvo & Conde 2014; Majumda 2014), in health (Darteh et al. 2014), in the military (Maclean & Vandepeer 2014), and in agriculture (Öhlmér et al. 1998; Nicholson et al. 2015), as well as in other fields. Across all these fields, there are some common elements such as identification of a problem, consideration of alternatives, implementation and review. In health decision-making, Darteh et al. (2014) found that decision-making passes through different steps including determination of a problem, collecting data for analyses, evaluating alternative solutions, selecting appropriate solutions, implementing the solution and evaluating the results. In military decision-making, Maclean and Vandepeer (2014, p. 78) stated that "decision-making has been understood as an event, a pause in the flow of a situation where the decision-maker selects a course of action from alternatives, after which the flow restarts".

There have been a number of studies of decision-making in farming. For example, in Sweden, Öhlmér et al. (1998) applied models of decision-making to analyse farmers' decision-making behaviour with eight functions or elements of farmers' decision-making. These elements were values and goals (relating to good or bad results), problem detection, problem definition, observation, analysis, development of intentions, implementation, and bearing responsibility after implementation. The study identified four main phases of the decision-making process and four sub-processes. The four main phases included problem detection, problem definition analysis and choice, and implementation. This study focused on farmers' individual decision-making, and more on the principles of the decision-making behaviour of farmers in each phase of individual decision-making.

More recently, Nicholson et al. (2015, p. 1) clarified the concept of a decision to "imply a conclusion or resolution reached after consideration. It is the result of processing a situation and deciding what action to take. Choosing to do nothing is a decision and may be a good decision given the circumstances". Nicholson et al. (2015) categorised decision-making into three types including simple decisions, complicated decisions, and complex decisions. A simple decision has few variables and an obvious right or wrong answer, while complicated decisions are considered to be when there are a number of variables involved, but the interaction between them is clear and well-documented. A complex decision is viewed as being when many complicated decisions come together and interact, and there is a range of variables and trade-offs, making it difficult for people to weigh up and decide (Nicholson et al. 2015).

In the field of diffusion of innovation, Rogers (2003, p. 29) argued that decision-making has three main types when adopting innovations: (1) "*optional innovation-decisions* are choices to adopt or reject an innovation that are made by an individual independent of the decisions of other members of the system"; (2) "*collective* *innovation-decisions* are choices to adopt or reject an innovation that are made by consensus (collective) among the members of a system"; and (3) "*authority innovation-decisions* are choices to adopt or reject an innovation that are made by a relatively few individuals in a system who possess power, status, or technical expertise" (Rogers 2003, p. 29, emphasis original). Pannell et al. (2006) also showed that many decision makers will engage and re-engage with their personal support network and with other information sources when there are more difficult decisions. A series of small decisions (e.g., time and money) will be made to support a main decision.

Different types of decision-making operate at different levels and units both collectively and individually: "Decision-making units may range from an individual to much larger units such as village, regions, states and even international organisations" (Bruijn & Van Dijk, 2005, p. 5). According to Bruijn and Van Dijk (2005), risk events might produce different arrays of responses by individual and collective decision-making units because each unit interacts with environmental contexts and other factors in relation to psychological, institutional and cultural processes. Decision-making units may not be maintained as the same unit in the long term; they might change according to a wide range of factors, especially in high-risk environments (Bruijn & Van Dijk 2005).

According to Bruijn and Van Dijk (2005), individuals decide on the basis of a wide range of past experiences rather than on a vision of the future. Ha (2012, p. 17) also contended that "decision-making is a step-by-step process, guided by the past decisions that shaped the individuals' character and contribute to her/his mental attitude in the present". Generally, "different actors, or groups of actors have experienced different conditions over time, their knowledge, experiences and understanding of their environment vary systematically between them" (Bruijn & Van Dijk 2005, p. 9).

Bruijn and Van Dijk (2005) classified the three main elements influencing different decision-making units. These elements are "resources", "capital" or "assets", and can be used for decision-making. Adapting Bourdieu (1986), Bruijn and Van Dijk (2005) distinguished different forms of capital for decision-making units, including economic capital, social capital, and cultural capital. Using a similar approach, Trung et al. (2017) categorised forms of capital according to a livelihood approach presented by Carney (2002) and Scoones (2009), to examine factors around farmers' land use decision-making (livelihood capitals appears in section 2.2.2). He determined which factors or categories influenced farmers' decision-making for land use models. Similarly, Bosma et al. (2012) categorised more specific factors relating to farmers' decisions about integrated farming systems of fish-rice-vegetables-fruit-pig-cattle models or irrigated rice models. These include considerations such as water use, finance and labour, among other things. Furthermore, when a study sets up elements or resources for farmers' decision-making, it should consider the interaction between resources, risks and livelihood strategies (Grunbuhel & Williams 2016). Generally, decision-making units are based on livelihood pathways, strategies, even specific livelihood activity, and other relevant factors.

There is a distinction between pathways and strategies. According to Bruijn and Van Dijk (2005, p. 9), a pathway is "the strategies arising out of the decisions actors, households and groups of people take to deal with risk in an unstable environment". In contrast, a strategy has the connotation of trying to attain a pre-set goal, which is established after a process of conscious and rational weighing-up of the actor's preferences. Although there are distinctions between pathways and strategies, it is not easy to clarify precisely the two terms in the specific context of case studies, and the researcher has to use the two terms in parallel (Ha 2012).

Livelihood strategies are a component in rural livelihood frameworks that has received considerable attention (Chambers & Conway 1991; Scoones 1998; Ellis 1998; DFID 1999). According to Scoones (1998), livelihood strategies encompass agricultural intensification and extensification, livelihood diversification and migration (Figure 2.2). In this study, agricultural intensification and aquaculture are the main development pathways for the improvement of farmers' livelihoods in the VMD, whereas other livelihoods may be considered to be simply additional income sources contributing to a households' financial capital for investing in rice-based farming systems (Dung et al., 2017). Therefore, decisions relating to the selection and adoption of a main farming system play a vital role in the livelihood strategy of farmers.

Agricultural intensification

Agricultural intensification has been defined as "increased average inputs of labour or capital on a smallholding, either cultivated land alone, or on cultivated and grazing land, for the purpose of increasing the value of output per hectare" (Tiffen et al. 1994, p. 29). According to Carswell (1997), "agricultural intensification might occur as a consequence of (a) an increase in the gross output in fixed proportions due to inputs expanding proportionately, without technological changes, (b) a shift towards more valuable outputs or (c) technical progress that raises land productivity". In other words, agricultural intensification is identified by the increase of outputs when investing more inputs or technology into agricultural production. Agricultural intensification will be applied depending on a specific context.

There are a wide range of factors leading to agricultural intensification including falling or declining capital (i.e., land, water, and soil), increased demands of population growth, increased market demand in a country or region, and demands for higher value products (Pingali & Binswanger 1988, cited in Carswell 1997). In recent times, agricultural production has been transformed from small-scale, with most inputs for production coming from biological components of the agro-ecosystem, to a system of modern intensification, in which artificial chemicals (fertiliser) of agriculture are used to substitute for functional ecological processes (Tilman et al. 2002, cited in Lin 2008). However, there have been adverse environmental impacts such as over-use of water and reliance on artificial chemicals and pesticides. Agricultural intensification allows the development of large-scale monocultures with little resemblance to the natural system around them (Lin 2008).

Rice intensification is an agricultural intensification pattern in the VMD where rice cultivation has shifted from one crop to two consecutive crops, even three consecutive crops, each year because of the demands of food security and national exports (Can et al. 2007). Numerous previous studies have applied the approach of cost, benefits and environment to estimate the effectiveness of rice intensification by comparing two consecutive rice crops and three consecutive rice crops (Dan 2016). These studies also show sustainability of this system and constraints in production. Hieu (2012) found that the greater the intensity, the greater reliance on fertiliser usage, and then intensification reduced soil quality.

An Giang and Can Tho provinces are located in the upstream and middle of the VMD respectively, and rice intensification is one of the main livelihood pathways of local farmers (Kono 2001; Can et al. 2007). Similar to the upstream and middle region of the VMD, in spite of being located in the coastal zone of the VMD, after 1995 farmers in some parts of Bac Lieu province gradually changed rice farming from two rice crops to three rice crops for 10% of the land area in Bac Lieu province. The reason for the change was infrastructure development comprising embankments, sluice gates, and techniques of seed production and farming systems (Ut 2004; Can et al. 2007). However, to date very few studies have discussed how farmers make decisions about rice-based farming systems with agricultural intensification such as two rice crops and three rice crops under a wide range of factors and threats in relation to climate and water issues in An Giang, Can Tho, and parts of Bac Lieu province.

Integrated farming system

El Titi (1992) describes an integrated farming system as a multi-goal approach aimed at sustaining agricultural production, maintaining farm incomes (i.e., yield, costs and benefits) and safeguarding the environment such as caring for the ecosystem. The objective of an integrated farming system is "a holistic pattern of land use which integrates natural regulation processes into farming activities to achieve maximum replacement of off-farm farm inputs and to sustain farm income" (El Titi 1992, p. 34).

An integrated farming system was applied in the coastal area of VMD (Hoanh et al. 2003) in the upstream area and middle area of the VMD (Ha et al. 2013). More specifically, farmers in several ecological zones in Bac Lieu province employed integrated rice-shrimp farming as their main livelihood strategy in order to adapt to food security and water policies (Ut 2004). Integrated farming systems are discussed in more detail in Chapter 4 of this thesis. Very few studies have discussed farmers' decision-making for rice-shrimp farming under a wide range of factors and threats. Therefore, this study will also determine what decisions farmers make and how they make decisions about multiple farming systems with rice-shrimp in Bac Lieu province.

2.2.2 Factors influencing farmers' decision-making for rice-based farming systems

In recent years, several studies have been conducted on factors influencing decision-making for livelihood activities, farming systems, and land use (Bruijn & Van Dijk 2005; Bosma et al. 2012; Rogers et al. 2012; Alexander & Larson 2016; Trung et al. 2017). For example, Bruijn and Van Dijk (2005) classified three main resources, or capital, that affect decision-making for reducing environmental risk. They include economic capital, social capital, and cultural capital. Roger et al. (2012) examined the influence of cognitive processes on rural landholders' decision-making about responding to climate change. The finding showed that landholders' decision-making in relation to responding to climate change risk should be based on sound knowledge of their value and worldwiews. Alexander and Larson (2016) determined ten factors influencing farmers' decisions about rice, crops, or livestock when they conducted a project, called, "Smallholder farmer decision-making and technology adoption in southern Laos: opportunities and constraints". These factors include finance, disease, irrigation, labour, technical knowledge, weather, flood, drought, market, and seed varieties. Similarly, Trung et al. (2017) adopted livelihood capital (human, natural, physical, financial, and social) from the livelihood frameworks of Carney (2002) and Scoones (2009) to select factors influencing land use decision-making in two provincial case studies, one in Vietnam and one in Thailand. In contrast, Bosma et al. (2012) applied bottom-up approaches by classifying a range of different detailed factors that affected farming systems. Later on, these factors were also grouped into main elements including land and water resources, finance, labour, climatic conditions, and market price. Although previous studies mentioned climate change or climate variability and factors related to climatic conditions such as floods, drought and weather conditions, these studies did not detail how climate change influences farmers' decision-making about farming systems, land use, or crops. In addition, except for the study by Bruijn and Van Dijk (2005), other studies applied quantitative data to determine the influences of these factors on individual farmers or households' decision-making for farming systems or land use.

Based on work conducted by Carney (2002) and Scoones (1998), this study adopts livelihood capital as the internal factor, and climate and access to local markets as external factors for identifying factors impacting on farmers' collective and individual decision-making about rice-based farming systems in the three provincial case studies in the VMD. According to Miller (2003, p. 235), rice farmers in the VMD worked both individually and cooperatively on several farming activities such as land preparation, seed procurement, and water management. However, they typically worked more individually than collectively. Therefore, this study will review factors relating to collective and individual decision-making for farming activities. As discussed earlier, farming activities of agricultural intensification and integrated farming systems might be based on livelihood capital.

As reviewed earlier, Bruijn and Van Dijk (2005, p. 9) referred to a pathway as "the strategies arising out of the decisions actors, households and groups of people take to deal with risk in an unstable environment”. In the context of the VMD, farmer organisational units with strong social capital in a relationship between members might play a significant role in collective decision-making for farming activities. In particular, the link between decision-making in relation to the various decision items is that in a region with high degree of social capital (i.e., good relationship), farmers will be able to reach agreement faster on questions such as whether they should work together, in parallel or separately on a particular activity (i.e., draining of water out of large rice fields during the flood season, selection of seed) than they would be in areas with a low degree of social capital (i.e., poor relationship). Accordingly, social capital might be conceived as a group of parameters relating to the resilience of farmer organisations because it is a relationship between members through different activities. Therefore, social capital will be reviewed in the next section to understand different forms of social capital, and to understand how social capital influences the resilience of farmer organisations in decision-making.

Influence of social capital on farmer organisations for collective decision-making

Social capital

Social capital is a theory and concept that emerged several decades ago. Bourdieu (1986), Coleman (1988), and Putman (1993) are considered to be three of the first scholars who discussed the theory of social capital. According to Bourdieu (1986, pp. 248–249), social capital is considered to be an actual and potential resource which is formed by durable networks of formal or informal relationships. These relationships can be built and guaranteed by different applications such as the names of formal and informal organisations, and institutional relationships are ongoing. The relationship needs to exist in a practical state to maintain and develop social capital, which can involve the exchange of resources (both materials and symbolic). Bourdieu (1986, p. 249) argued that the sum of social capital exists in people, which depends on the size of the network of connections of some people and allows them to encourage the sum of other forms of capital such as economic, cultural, and symbolic.

Coleman (1988, p. 98) stated that, “social capital is not a single entity, but a variety of different entities having two characteristics in common: they all consist of some aspects of social structures, and they facilitate certain actions of individuals who are within that structure". Social capital can be understood as a relationship of individuals within a social structure, and which provides advantageous conditions for individuals in the structure. In contrast, Putnam et al. (1993) defined social capital at an organisational unit. Particularly, social capital is referred to as "features of social organisation, such as networks, norms, and trust that can improve the efficiency of society by facilitating coordinated actions" (Putnam et al. 1993, p. 167).

Social capital is developed in different forms. For instance, an original form of social capital is analysed as the relationship of horizontal and vertical connections in organisations and communities (Putnam et al. 1993, pp. 163–185). Horizontal network refers to "bringing together agents of equivalent status and power", while vertical network refers to "linking unequal agents in asymmetric relations of hierarchy and dependence" (Putnam 1993, p. 173).

Later on, social capital was classified into three forms, bonding, bridging, and linking social capital (e.g., Coleman 1998; Putnam 2000, pp. 22–24; Woolcock 2001). Bonding social capital refers to the relationship of connections of similar people, or the cohesion of groups with homogenous people such as relatives and internal groups or organisations, whereas bridging social capital is described as the relationship of connections between heterogeneous people. Woolcock (2001) contends that linking social capital is the capacity of people to have access to resources, ideas and information from formal institutions beyond their community.

In contrast to previous scholars, Grootaert and Van Bastelaer (2001) indicated that a result of the interaction between two distinct forms of social capital, including structural and cognitive, has influences on development at different levels: "Structural social capital facilitates information sharing, collective action and decision-making through established roles, social networks and other social structures supplemented by rules, procedures, and precedents whereas, cognitive social capital refers to shared norms, values, trust, attitudes, and beliefs" (Grootaert & Van Bastelaer 2001, p. 5). Social capital is dynamic in different forms, and is not complementary between structures and cognition. For instance, the interaction between neighbours can be based on a personal cognitive bond that is not necessarily reflected in a formal, structural arrangement (Grootaert & Van Bastelaer 2001).

In relation to social capital, social cohesion, trust, and commitment are also important relationships among individuals and members in a group or in a society. According to Chan et al. (2006), “Social cohesion is a state of affairs concerning both the vertical and the horizontal interactions among members of society as characterized by a set of attitudes and norms that include trust, a sense of belonging and the willingness to participate and help, as well as their behavioural manifestation”. Social cohesion is presented through the levels of social cohesiveness or people repeated interactions in groups in a society. That implied that the degree of social cohesion depends on the repeated interactions among people in a group.

Trust was defined by different scholars. According to Moorman et al. (1993, p. 82) “Trust is defined as a willingness to rely on an exchange partner in whom one has confidence”. Then, Moorman et al. (1993, p. 82) viewed trust is as a belief, confidence, expectation, about exchange partner’s trustworthiness that results from the partner’s expertise, reliability, or intentionality. This means that people are confident and believe their partners or members when they interacted with them.

Commitment was reviewed by Morgan and Hunt (1994, p. 23), and they defined “relationship commitment as an exchange partner believing that an ongoing relationship with another is so important as to warrant maximum efforts in maintaining it, that is, the committed party believes the relationship is worth working on to ensure that it endures indefinitely”. This is understood that someone attempts to maintain relationships with their partners or other members in their organisation by working on to commit to their organisation.

Social capital is commonly identified as having positive and negative effects. They can be called positive and negative social capital or dark side of social capital (Pillai et al. 2017). According to Baiyegunhi (2014), although social participation in collective activities of a group allows members positively to access and adopt new technologies, social capital can negatively influence economic and environmental outcomes due to the existence of inequalities. Putnam (2000) observed that someone may not belong to particular social entities, and so might be excluded by the social capital of small groups. Similarly, Arneil (2006) noted that an important role of social capital is the enabling of dominant groups to protect self-interest in a particular large group. At national level, Collier (1998) mentioned that in the modern labour market with strong labour competition, job seekers and workers used their bonds of obligation to extract patronage from managers. In Ghana, Collier and Garg (1998) found that there is a 25% wage premium for those workers who are members of the locally dominant kin groups. Collier (1998) also noted that a very high degree of ethnic diversity contrained collective action. Besides, Cloete (2014) argued that if there is no reciprocity in the use of social capital it could be easily destroyed and is difficult to rebuild in the future. After reviewing relevant literature on social exclusion and social capital, Daly and Silver (2008) also concluded that social inclusion and social capital can have negative outcomes, that depend on time, place, and most importantly, inequalities in power and resources. Although positive and negative social capital exists in particular organisations, Woolcock (1998) showed that a group can harness positive aspects of social capital to produce public good for their group, and negative aspects of social capital might be overcome. Therefore, positive aspects of social capital should be nurtured and maintained in a formal organisation.

Social capital application in previous studies in the Vietnamese Mekong Delta

Social capital has been considered in different studies of the agricultural production, climate change, and hazards in Vietnam in general, and the VMD in particular (Thuy 2007; Hieu 2010; Howie 2011; Kien 2012; Ha 2012; Tuan 2014; Tuan 2015). However, the majority of these studies focused on social capital in individual units (i.e., individual farmers), while there have been very few studies on social capital in organisational units (e.g., farmer organisations such as agricultural cooperatives, large-sized farms, and farmer clubs). Thuy (2007) examined the role of social capital in forest conservation in Cat Tien National Park in Vietnam. She built indices of social capital throughout community activities in relation to forest conservation issues. These conservation activities can be based on relationships in the community such as farmer organisations, neighbours, relatives, and friends. For example, Thuy (2007) constructed social cohesion, social trust, and social commitment throughout these activities to examine the role of social capital in natural resource conservation at Cat Tien National Park in Vietnam. Her study found that most forms of social capital had a score around average levels. Thuy (2007) found that social bonds (i.e., attachments to neighbours) are more important than bonds to local organisations.

Howie (2011) used social cohesion to examine the relationship between farmers in the same village in An Giang province. Farmers shared their experience in relation to agricultural production. They also helped each other by lending money without charging interest. Social cohesion was also presented through a pumping club, with working together to overcome threats from floods, for example by collectively pumping water out of large field to minimise production cost. However, Howie (2011) did not use social cohesion, trust, and commitment to examine the relationship among members in large size farms (LSFs) *(Cánh đồng lớn)*, agricultural cooperatives (ACs) *(Hợp tác xã)*, and farmer clubs (FCs) *(Câu lạc bộ nông dân)*. The pumping club was a club in which farmers worked together to address threats from flood, while LSFs and ACs had a range of collective activities. In addition, LSFs, ACs, and FCs were developed after the model of pumping club. Howie (2011) assumed that social cohesion among farmers in a club would be developed when a farmer organisation developed from a pumping club to a cooperative organisation to help farmers access to good markets in the future. Therefore, my study will examine all these aspects of social capital among members of farmer organisations.

Regarding the supply chain approach, horizontal coordination is interaction between members within a farmer organisation (Ha et al. 2013). Vertical coordination is the connection between farmer organisations, households, and other agencies including the private sector and extension agencies. In order to maintain and increase social capital between actors with high trust and cohesion, regular social interactions and exchange activities are required through conducting agricultural services, and participation in diffusion of innovation and business in farmer organisations. Ha et al. (2013) found that farmer clusters *(tổ hợp tác)* were successful owing to support received from local government such as electricity supply, credit, and techniques. However, the study presented by Ha et al. (2013) did not show any special relationship between members such as relatives, neighbours, and friends in a farmer cluster. Social capital might influence the sustainability of a farmer organisation, and a farmer organisation with strong social capital is able to be diffused to other communes in the VMD.

Social networks or social capital are applied in this research to measure social cohesion, social trust, and social commitment among members of agricultural cooperatives, large-sized farms, and farmer clubs. As reviewed earlier, social cohesion, trust and commitment play an important role for examining the level of relationships or interactions among members in ACs, LSFs, and FCs. Strong social cohesion, trust, and commitment help members in an organisation quickly achieve agreement when they conduct collective decision-making. In addition, these forms of social capital were used by Thuy (2007) and Howie (2011) for examining the relationship of farmers in a group and a community. In my study, forms of social capital are built through activities of farmer organisations in relation to rice production and shrimp farming, which will be discussed more specifically in Chapter 3. In addition, social capital also explores the relationship between ACs, LSFs, and FCs and outside agencies such as companies, institutes, and local services. For example, farmers who are members of agricultural cooperatives have had contract farming for seed production. They have also received technical training from organisations of the Department of Agriculture and Rural Development in the provinces.

There are often relatively small groups of farmers inside a cooperative. These farmers regularly obtain benefits from sharing finance in an AC, and they tend to exclude other members from participating in the AC (Rankin & Russell 2014). This is considered to be negative social capital. However, Rankin and Russell (2014) did not explore the detail in social relations among members by neglecting social cohesion, trust, and commitment among members of the cooperative. In my study, although I use social capital to explore the positive relationships between members in farmer oraganisations, I also examine the negative social capital that might occur in different farmer organisations. For example, leaders of farmer organisations might prioritise their kin and neighbour when signing contracts with a rice company or they might prioritise colleagues or local officials to obtain benefits before other members in their organisation. These forms of social capital exclude a member without a good relationship with the leaders of farmer organisation. Therefore, social capital can negatively affect farmers' decision-making, and the cooperation or resilience of a farmer organisation when a local authority wants to increase capacity of farmer organisation to cope with market constraints in a value chain approach.

Resilience of organisation

The concept of resilience has been defined in many ways by different scholars from different fields, but there are some common elements, such as the ability of individuals or systems to adapt to or resist change. From an ecological perspective, Holling (1973, p. 17) defined resilience as a means to "determine the persistence of relationships within a system and is a measure of the ability of these systems to absorb changes of state variables, driving variables, and parameters, and still persist". Moreover, resilience is considered to be "the buffer capacity or the ability of a system to absorb perturbations, or the magnitude of disturbance that can be absorbed before a system changes its structure by changing the variables and processes that control behaviour" (Holling et al. 1995, cited in Adger 2000, p. 349). Building on these previous definitions, Walker et al. (2004) contend that resilience is the capacity of a system to absorb disturbance and reorganise while undergoing change so as to retain essentially the same function, structure, identity, and feedback.

From an organisational perspective, Borda-Rodriguez and Vicari (2004, p. 44) determined organisational resilience as a means "to develop a set of dynamic capacities so as to adjust to shocks, mitigate its effects and cope with the consequences while simultaneously taking advantage of opportunities emerging from a crisis". According to Birchall (2004, cited in Borda-Rodriguez & Vicari 2014), ACs in developing countries have to deal with the perspectives of economic, political and climate crises more than their counterparts in the developed world. They also face a number of challenges such as accessing financial capital and commodity markets at national and international levels, and enhancing capacity building (Borda-Rodriguez & Vicari 2014). Resilience of organisational structure is very important in coping with challenges in difficult circumstances, while the organisation still provides services and meets the needs of its members.

Membership, collective skills, networks, innovation, and the role of government are five main factors that are able to influence cooperative resilience (Borda-Rodriguez & Vicari 2014). Firstly, membership elements associated with cooperative resilience include identity, commitment, cohesion, loyalty, trust and reciprocity because resilient cooperation belongs to the degree of these elements (e.g., strong or weak cohesion, trust, and commitment) (Borda-Rodriguez & Vicari 2014; Münkner 2012). Secondly, collective skills are clarified as the abilities and capacities developed by members and learned from each other in organisations and by external actors via training courses (Busemeyer & Trampusch, 2012, cited in Borda-Rodriguez & Vicari 2014, p. 44). Collective skills will help members improve their production process by learning processes within production, along with encountering challenges and limitations (Busemeyer & Trampusch 2012, cited in Borda-Rodriguez & Vicari 2014, p. 45). Thirdly, innovation enables individuals or organisations to upgrade products by rearranging existing and new resources because this facilitates organisations to improve their technological and economic performance not only internally in an organisation but also in cooperation with outside agencies (Borda-Rodriguez & Vicari 2014).

More generally, Borda-Rodriguez and Vicari (2014) built a concept of cooperative resilience or organisational resilience based on cooperation in and outside of organisations in order to increase the capacity of organisations and achieve the needs of members. This thesis will adopt cooperative elements comprising members, networks, collective skills and innovations to determine the resilience of ACs, LSFs, FCs, and general farmers (non-members). These factors will be classified in relation to collective farming activities. For example, ACs, LSFs, and FCs in the VMD might provide technical innovation, and assist members to access input services via cooperation with outside agencies. I will explore the extent to which these activities might contribute to assisting members or organisations to adapt to constraints from climate variability or other negative factors.

Application of social capital to measure organisational resilience

This study will use social capital (in the form of social cohesion, commitment, and trust) to measure collective skills, networks, and innovation within ACs, LSFs, and FCs because the social capital concept is the linkage between members in terms of bonding social capital, which is portrayed by cohesion, trust, and the commitment of members in organisations, and between members and management boards of organisations. In addition, the social capital concept is also applied to examine the relationship between organisations, communities, and external agencies or companies based on bridging and linking social capital or horizontal and vertical coordination.

The concept of social capital in this study is based on previous studies such as those by Krishna and Uphoff (1999), Thuy (2007), and Kien (2011) for measuring social capital in ACs, LSFs, and FCs. However, the social capital indices in this study are constructed via collective activities that might be cooperated with and shared in the farmer organisations or communities. These activities are training and sharing knowledge and experiences, exchanging seed varieties of rice or shrimp, coordinating with machine owners to harvest efficiently, sharing money to build dykes, and working together activities (i.e., working at the same time in irrigation or upgrading dykes, or sharing money to build dykes). The construction of indices of social capital through activities of agricultural and aquaculture production will be discussed in more detail in the methodology of this study (Chapter 3).

Climate change, increased climate variability, and other hazards

In this thesis I use the IPCC definition of climate change: "a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity" (IPCC 2007, p. 30). Additionally, climate change has been observed through changes in temperature, rainfall patterns, and extreme climate events, such as floods, typhoons, droughts, storms, and sea level rise (Apata et al. 2009; Deressa et al. 2011). In contrast, climate variability refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all spatial and temporal scales beyond that of individual weather events. Generally, in a particular location, climate variability was considered a significant issue and climate change was likely to be a problem in the future (Cruz et al. 2007; Yusuf and Francisco 2009).

Countries in Southeast Asia also experience frequent and intensive environmental hazards. There are various types of natural hazards and natural extreme events, which vary across country and locality (Francisco et al. 2008). Cyclones, floods, storm surges, forest fires, and drought were the most common extreme climate events in the Philippines, Indonesia, and Vietnam, whereas drought and flood are considered to be extreme events in Thailand, Laos, and Cambodia (Francisco et al. 2008). Climate change is predicted to continue on the same trend with higher frequency and intensity in the future. For instance, temperature in Cambodia is projected to increase from the 2008 temperature by 0.3, 0.7 and 2.0°C in 2025, 2050, and 2100 respectively (Francisco et al. 2008). Rainfall in Cambodia is predicted to increase by 6% compared to current rainfall with the magnitude of change varying with time and location (Francisco et al. 2008). The increase in projected rainfall will probably be higher in lowland regions compared to highland and coastal zones.

Studies on climate change or climate variability and hazards relevant to climate have been undertaken in the Nile Basin of Ethiopia (Deressa et al. 2011), in Southwest Nigeria (Apata 2011), and in Vietnam (Adger 1999; McElwee 2010; Binh 2015; Hoa

2013 & 2014). For example, Deressa et al. (2011) reported that 51% of farmers perceived that temperatures in the Nile Basin of Ethiopia had increased, and 53% of farmers said that rainfall had decreased compared to the past 20 years. In Vietnam, people experienced a range of climate change threats including storms, typhoons, flooding, and drought across multiple regions from the north to the south in Vietnam (McElwee 2010). In the VMD, Kien (2011) and Tuan (2014) applied a number of concepts encompassing resilience, vulnerability, exposure and sensitivity to explore how floods in the VMD influence farmers' livelihoods in the flood zones, while Binh (2015) used these same concepts to explore how saline water intrusion affects local farmers' livelihoods in the coastal zones of the VMD. Regarding flooding, the change of flood regime in the VMD has been affected by climate, intervention from infrastructure projects on the upstream of the Mekong River, and by embankments inside the VMD (Tuan 2014). According to Binh (2015), the maximum salinity concentration in most of the dry months in Tra Vinh, a coastal province in the VMD, over the period 1995–2002 was 19.7 grams/litre higher than in the period 2003–2010 with 16.1 grams/litre. Hoa (2013) conducted a study on farmer perceptions of climate changes and variability, and their influence on farmers' livelihoods and barriers to farmers' adaptation in the VMD. The result of the study indicated that farmers had enhanced their understanding of the climate variability. However, they still had limited knowledge of the significance of adaptation to climate variability for their livelihoods.

In this thesis, the impact of climate variability (i.e., the variations in pattern of temperature and rainfall) and extreme climate events or events relevant to climate change such as flood, drought, and saline water intrusion, is examined across multiple case studies in the three provinces. For example, changing patterns of flood, or abnormally heavy rains might usually occur in An Giang province, while saline water intrusion and drought might regularly appear in the coastal province of Bac Lieu. Additionally, other elements such as increasing risks posed by diseases and pests might be consequences of climate variability in different crop seasons.

Relationship between livelihoods and climate variability[5] and other constraints

According to Ellis (2000, p. 60), there were high correlations between rural livelihoods in developing countries, and risks such as market collapse, climate variability, floods,

[5] Climate variability is suitable in this study, but the majority of the literature refers to climate change rather than climate variability.

and drought. In particular, the impact of climate change on households relying on income from a single crop is higher than for those with livestock (Francisco et al. 2008). This implies that farmers focusing their strategies on agricultural intensification could be more vulnerable to climate change. In the case of rice production that is because of the high cost of using a large amount of chemical fertiliser and the risk that one or two abnormal events could have a severe adverse impact on yield, and thus farm income. In addition, climate variability (e.g., abnormal rains) or extreme weather (e.g., droughts or floods) could have indirect effects on agricultural production by increasing the incidence of pest and disease outbreaks, and reducing soil fertility leading to increased production costs. These could also reduce the quality and quantity of crops in the area, which in turn might decrease market prices. Besides, the impact of climate change is a concern because agricultural products such as rice, maize and wheat are sensitive to the reduction of water availability (Biggs et al. 2013).

In the VMD, there is a range of types of climate variability, flood, and salinity that impact agricultural production, especially rice production (De & Tuan 2012). For example, Hoa (2014) shows that factors of climate variability such as typhoons, tornados, and unseasonal rains, and floods had direct or indirect impacts on different crops for agricultural production. More specifically, climate variability was reported to reduce the yield of rice by 30% and fruit production by 20% in Soc Trang province, a coastal province in the VMD (Hoa 2014). Farmers in this province could not cultivate their third rice crop due to late rains. Unseasonal rains also stimulated an increase in diseases in fruit and rice at Long An and Dong Thap provinces (Hoa 2014).

The current study will identify the impacts of hazards associated with from climate change or climate variability and other factors such as flood, saline intrusion, insects, diseases, and pests on each rice crop or rice-shrimp farming system. For instance, high temperatures might increase salinity in a shrimp pond, and damage the shrimp. Abnormally heavy rains might facilitate advantageous conditions for diseases or insects affecting rice; thus farmers need to spend a good deal of money on pesticides or on applying other strategies to deal with this hazard. Generally, there are a wide range of impacts of climate or other hazards on agricultural production.

Adaptation, adaptive capacity, vulnerability, exposure, and sensitivity have been variously defined according to the needs different disciplines and approaches to specific studies (Adger 1999; Smit & Wandel 2006; Birkmann 2006; Pelling 2011). A series of concepts, including adaptation, vulnerability, exposure, and sensitivity, have been regularly applied in studies in relation to assessing local people's vulnerability in adapting to changes such as climate and hazards (Adger 1999; Birkmann 2006; Pelling 2011). However, in the scope of this thesis, local adaptation to climate variability and hazards is one group of threats considered by farmers when they decide on rice-based farming systems. In this study, climate threats are climate variability (e.g., abnormal rains) or extreme weather (e.g., droughts or floods) which is considered to be one of the external factors influencing farmers' decision-making when farmers decide between two or three rice crops, as in the case study in Bac Lieu (Chapter 7). The study is narrowed down to examine how farmers decide to respond to threats of climate variability, flood, rising salinity, drought, and other hazards (i.e., insect, diseases, and pests) in the VMD. These threats have impacted the rice-based farming systems of local communities in Southeast Asian countries (Brown et al. 2018). Therefore, the study has only reviewed the concept of local adaptation more in relation to agricultural production, which is one of the important livelihoods of local people (Scoones 1998).

According to Smit and Wandel (2006, p. 282), "adaptation in the context of human dimensions of global change usually refers to a process, action or outcome in a system (household, community, group, sector, region, and country) in order for the system to better cope with, manage or adjust to some changing condition, stress, hazard, risk or opportunity". In the climate change context, Smit et al. (2000, p. 225, cited in Smit & Wandel 2006, p. 282), define adaptation as "adjustments in ecological-socio-economics in response to actual or expected climatic stimuli, their effects or impact".

In terms of the climate change issue, adaptation is referred to as "initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects. Various types of adaptation exist, e.g. anticipatory and reactive, private and public, and autonomous and planned. Examples are raising river or coastal dykes, the substitution of more temperature-shock resistant plants for sensitive ones, etc." (IPCC 2007, p. 76).

According to Smit and Skinner (2002), there are various adaptation options in agriculture, and these are grouped into four main options: (1) technological developments, (2) government programmes and insurance, (3) farm production practices, and (4) farm financial management. Firstly, technological development refers to a variety of farming technologies including new rice varieties, information systems, and water resource management (Smit & Skinner 2002). Secondly, government programmes and insurance are able to respond to economic risks in the process of adapting to climate change and may influence strategies of risk management at the farmer-level. Programmes, including subsidies and support from government, or private insurance in agricultural production, may help farmers to mitigate the impacts of climate change such as drought, flood and other types of changes (Smit & Skinner 2002). Thirdly, adaptation of farm production also includes various factors such as farmer-level decisions with respect to farm production, land use, land topography, irrigation, and operation time, which are able to reduce exposure to climate-rated risks (Smit et al. 1996). Finally, farm financial adaptation options are farm-level responses applying farm income strategies to reduce the risk of climate-related income loss (Smit & Skinner 2002).

As discussed earlier, after making decisions about two crops, three rice crops, and rice-shrimp, farmers in the VMD might have different decision-making processes for farming activities (e.g., setting seasonal calendars, selecting rice varieties, harvesting, selling rice to traders, among other things) as they encounter the threats of climate variability in relation to variations in patterns, timing, and intensity of high temperatures, drought, high salinity, unseasonal rainfall, and flood. For example, in the VMD, local people had different adaptive strategies to floods such as growing floating vegetables or fishing in An Giang province (Kien 2011) and in Dong Thap, another upstream province of the Delta (Tuan 2014), and migration due to flood in the VMD (Dun 2011). Farmers in Tra Vinh, a coastal province, make individual decisions when they encounter saline water intrusion by adjusting seasonal calendars, changing to other rice varieties, or getting more input investments for their rice farming (Binh 2015). Hoa et al. (2013) determined that there were seven groups of adaptive strategies to adapt to climate change including adjusting the planning calendar, adjusting planting techniques, crop and variety diversification, water use management, diversifying income sources, reinforcing safety for humans and assets, and other measures. However, there has been very little research discussing collective decision-making for farming activity that deals with specific threats such as saline intrusion, drought, and flood in the VMD. Therefore, this study will examine local individual and collective adaptation to threats of climate variability and hazards through collective decision-making in relation to rice-based farming systems. In the next section, the study will discuss approaches to accessing local markets.

Access to local markets

There are different approaches to understanding how farmers access markets to sell their products. The majority of economists use value chains to enhance insights into the interactions between different actors from the inputs and outputs of production, and chains until they reach the final consumers (DFID 2008). Therefore, in order to gain insight into farmers' perceptions of access to markets to sell their rice or other crops outside the farm gate, I adopted a "value chain" approach to understand several actors across the study sites. However, due to the scope of the research, I sought to understand how and why farmers perceive and access good market prices because it is also possible that this is a significant factor influencing farmers' decision-making for rice-based farming systems in the VMD.

According to DFID (2008), there are eight tools for analysing a value chain: (1) prioritise value chains, (2) mapping the value chain, (3) governance (i.e., coordination, regulation, and control), (4) relationship, linkages and trust, (5) analysing options for demand-driven upgrading: knowledge, skills, technology and support services, (6) analysing costs and margins, (7) analysing income distribution, and (8) analysing employment distribution. Depending on the different purposes of studies, researchers might select suitable tools for their studies. For example, using a governance analysis is aimed at understanding how the value chain is coordinated. In particular, the analysis of a governance tool will identify key firms (actors) and mechanisms (i.e., contracts, agreements, services), and provide insight into the coordination structure that has arisen and evolved. In addition, the analysis of governance as a tool also maps formal and informal rules, regulations, and standards that influence the value chain. Furthermore, this tool helps a study assess the impacts of rules on different actors. Accordingly, the study is able to identify advantaged and disadvantaged groups of people who are impacted by rules. Another important tool for analysing a value chain is the combination of analysing relationships, linkages and trust in a study. The general aim of this tool is to examine the trust in the linkage between two parties, particularly company and suppliers or traders and suppliers. Using relationship analysis helps a study in relation to the value chain examine the social capital between two parties in the business linkage (DFID 2008).

There is a wide range of studies on analysing the value chain in agricultural products in the VMD, and authors have integrated different tools such as mapping the value chain and governance (Loc & Son 2011; Ha 2012). In their study, Loc and Son (2011) mapped the value chain systems between different actors who participated in the rice value chain in the Mekong Delta. They also showed that more than 93% of rice from farmers was sold via collectors (traders), instead of via rice companies and other actors. In contrast, Ha et al. (2013) used governance tools to understand how farmers change the quality and standard of shrimp from domestic markets to global markets by adopting organic farming to comply with environmental certificates in the global value chain. The result of this study shows that farmers had to upgrade the quality of shrimp to meet global demand, instead of depending on domestic markets or previous standards of global markets.

In this study, I have adopted a qualitative tool with governance (i.e., coordination, regulation, and control) and a group of social relations (i.e., relationships between actors, and linkages between actors in value chain with different degrees of trust) to obtain insight into how farmers' access to local markets is an important factor in how farmers decide on farming activities such as rice variety in rice-based farming systems. Through the network and interaction between members of farmer organisations and individual farmers and other actors in the local markets, the study might find key collectors (i.e., a business person buying rice directly from farmers) such as contract farming between companies or seed organisations and farmers. The linkage is also between brokers or traders and farmers at the commune level. Brokers might control the local market, and negatively affect access to good market prices for farmers. As Bosma et al. (2012) showed, market price affected farmers' decisions to practise a rice-fish system in the VMD.

Livelihood capitals

There are five types of capital used to cope with or adapt to shocks and stress, these being human, social, physical, natural and financial capital (Chambers & Conway 1992;

Scoones 1998; DFID 1999). The five assets play significant roles for farmers' decision-making with rice-farming activities.

Social capital in the livelihood context was clarified by DFID (1999) as the social capital developed through networks and connections between individuals. People increases their trust and ability to work together and expand their access to wider institutions. Additionally, a member of groups commonly accepts rules, norms and sanctions. Moreover, a relationship of trust, reciprocity and exchanges facilitate cooperation and reduce the cost of transactions. According to DFID (1999), social capital is very important for an individual because it directly influences other forms of capital in livelihoods. For example, individual with strong social capital might have access to credit for improving financial capital to invest in livelihood activities. In this thesis, social capital is used for examining the relationship between members of farmer organisations that was mentioned ealier.

Human capital represents the knowledge, skills, ability of labour and good health that together enables people to pursue different livelihood strategies and achieve their livelihood objectives. At the household level, human capital is a factor in the amount and quality of labour available, which varies according to household size, skill levels and health status. The current study highlights age, education of the household head, and household size to understand how labour capacity influences the use of labour in rice farming activities.

Natural capital includes natural resources such as land, water, forest and pastures, and so is vitally important to those who derive all or part of their livelihoods from resource-based activities, such as farming, fishing, gathering in forests and mineral extraction. The study focuses on discussing land and water for rice-based farming systems of households. Out of the resources, access to water is viewed as one of the most important factors in relation to farmers' decision-making in the VMD, especially for farmers in the coastal provinces.

Physical capital is comprised of the basic infrastructure and goods needed to support livelihoods. Infrastructure consists of the physical environment that helps people to meet their basic needs and be more productive. Goods are the tools and equipment that people use to function more productively, such as food stocks, livestock, jewellery, equipment, tools and machinery. Access to physical capital is an essential element of strategies to reduce household poverty (DFID 1999). The research concentrates on classifying significant agricultural tools for rice-farming activities.

Financial capital has three main sources, these being available stocks, resources and regular inflows of money. Available stocks include savings, remittances, pensions and credit, all of which provide people with different livelihood options (Carney 1998). The study utilises three main financial sources including savings, bank credit, and buying agricultural materials by credit payments after finishing the crop season.

In the current study, these livelihood capitals will be used to enhance insights into basic household resources so that farmers can successfully implement rice-based farming systems. In addition, the critical issue that the study will identify is how these factors influence farmers' decision-making about rice-based farming systems.

2.2.3 Farmers' decision-making for farming activities

Similar to the approach of decision-making for main rice-based farming systems, farmers might make collective and individual decisions about rice-farming activities according to a wide range of factors discussed earlier. For example, farmers, who are members of farmer organisations (i.e., ACs, FCs, and LSFs), are able to make collective decisions in relation to selecting rice varieties if they have contract farming for seed production or commercial rice production. Also, they make individual decisions about accessing finance from credit organisations such as government banks or private banks. According to Miller (2003, p. 235), farmers in the VMD preferred working together *(làm cùng nhau)* rather than cooperatively *(hợp tác)* because farmers working together in the VMD means working at the same time and in the same field. In contrast, a cooperative requests that members share economic benefits. However, under a wide range of interventions from government organisations such as the Department of Agriculture and Rural Development and international organisations from 2000 to 2014, the cooperation among members in ACs, LSFs, and FCs might be improved for making collective decisions.

Collective decision-making was used in a case study in Dogon village, Somali (Beek 2005), where farmers worked together by establishing different groups linking labourers who had land located next to each other. Their group was decided and coordinated by leaders (i.e., old men) in the village for conducting farming activities such as clearing fields and weeds. However, in this context, Dogon village is different from the context of the VMD in terms of market and geographical conditions. Under the market economy policy in Vietnam, farmers in the VMD had rights to access materials and services for land preparation and to harvest easily (LeCoq & Trebuil 2005).

Another lens of understanding for the levels of collective decision-making in farming systems is the participation approach, where there is a wide range of rungs to clarify the meaning of farmers' participation into a farmer organisation, project, or a programme. Aref (2011) adopted a method of a ladder of citizen participation presented by Arnstein (1969) to describe farmers' participation in agricultural development in Iran. He discussed formal decision-making with empowerment of farmers' participation in planning and implementing government agricultural projects in Iran. I adopted the participation ladder described by Aref (2011) to clarify farmer organisational units in different provincial case studies for this study. There are three rungs of participation in Table 2.1. The first rung is manipulation of non-members. These farmers are not members of any formal organisation in the communes. The second rung is symbolic interaction. FCs and LSFs are the two main organisations in this study. Farmers who engage in the two organisations might obtain and share technical knowledge. The third rung is the highest level of participation with ACs. Members of ACs share benefits and economic value in tasks in relation to farming activities.

Table 2.1: The rungs of members' participation in the organisations in the VMD

Rung	Type	Organisation	Characteristics
3	Genuine participation	Agricultural cooperative	Sharing benefit/economic value
2	Symbolic Interaction	• Farmer club • Large-sized Farms	• Working together at the same large farm and time • Farmers participate to collect technical knowledge, but they are not interested in sharing benefit/economic values.
1	Manipulation	Non-member or individual farmer	No formal participation

Source: Adapted from Aref (2011); and modified by author

According to Miller (2003, p. 235), farmers decided and worked more individually with rice activities including sowing, applying fertiliser and spaying pesticide, while cooperation mainly involved land preparation, seed procurement, and water management. However, after more than one decade, it is possible to increase farmers' collective decision-making for farming activities, even though they only worked at the same time and on the same farm. They might decide more collectively and work together to cope with threats in relation to climate variability and access to local markets in the local areas of the VMD. Miller (2003) did not further discuss how farmers make collective and individual decisions related to significant farming activities. Therefore, farmers' collective and individual decision-making will be identified and discussed in the provincial case studies in the VMD.

To further explore farmers' individual decision-making, the thesis also considers whether and how people follow detailed government instruction or whether they have a significant degree of freedom to decide for themselves what they will do in the context of the VMD. The degree of freedom to decide for themselves what they will do is a large issue and relates to different fields such as business, health, the military, and agriculture, plus others. The relevant literature was reviewed earlier. A good example of individual autonomy is Khan's (2014) study of women's autonomy in Pakistan. Khan (2014) found that women with high educational levels and high independent income were more autonomous of their husbands. However, social and cultural norms of society have still played an important role in shaping women's decision-making power within the household (Khan 2014).

In order to scope the content of this thesis, the thesis focuses on detailed farmers' decision-making about rice-based farming systems in the VMD where farmers' individual autonomy is in relation to local authorities. In particular, examples will be presented in the context of farmers' individual autonomy to institutional arrangements of the Vietnamese government in clarifying the degree of individual autonomy of farmers' decision-making about rice-based farming systems in Chapter 8. In addition, the findings from collective and individual decision-making about farming activities in relation to particular rice-based farming systems will present the farmers' individual autonomy to their local authorities in the context of VMD. However, to limit the scope of this thesis, the thesis will not analyse and discuss in detail concepts and approaches in relation to individual autonomy.

2.2.4 Effects of decision-making on output of rice-based farming systems

There are few studies on the effects of decision-making on farming systems, farming activities, and livelihoods. Decision-making is involved in the process of selecting livelihood pathways (Bruijn & Van Dijk 2005, p. 9). Therefore, effects of decision-making on farming systems encompass different farming activities such as timing of crops, whom farmers sell rice to, and which rice variety farmers decide upon. In addition, productivity of crops and income from crops were important parameters to present the effect of decision-making on rice-based farming systems. For example, different rice varieties are able to bring out similar or different rice productivities. The result of farming systems or livelihood activities possibly influences the next crop season or coming years.

On-farm income is one of the income sources of livelihood diversification (Ellis 1998). On-farm income includes livestock, and crop income, and also comprises both consumption-in-kind of on-farm output and cash income from output sold. Agricultural income is a consequence of decision-making. In addition, good decision-making for rice-farming activities might contribute to strong household resilience. This study also estimates the ratio of the output of farming systems that contributes to household incomes by comparing income from rice or shrimp to other income sources such as off-farm and non-farm income sources.

2.3 Conclusion

In conclusion, the chapter reviewed and analysed the main concepts related to farmers' decision-making around rice-based farming systems, which were built around the four research questions of this thesis.

Firstly, decision-making, agricultural intensification, and integrated farming systems are three main concepts to responding to the first research question. Growing more rice crops each year (rice intensification) is a form of agricultural intensification, while rice-shrimp systems are types of integrated farming systems in the VMD. These two rice-based farming systems are also the main strategies of farmers' livelihoods. The thesis will identify farmers' decision-making about rice-based farming systems and rice-farming activities in case studies in An Giang, Can Tho, and Bac Lieu.

Secondly, the chapter discussed the main factors influencing farmers' decision-making in relation to rice-based farming systems and farming activities (i.e., setting up seasonal calendar, selecting rice varieties, and drainage of water out of large-sized farms). Other studies discussed organisational social capital, but did not show in detail how social capital between members helps maintain organisational resilience, nor help them rapidly reach agreement about farming activities in the VMD. A review of the literature showed that climate variability and hazards including floods, drought, changing rainfall, and salinity of water influenced agricultural production and farmers' decision-making about land use, crops, and farming systems. The concept of value chain with tools of governance and social relation were reviewed. These tools will be applied to further understand how rice and shrimp farmers access local rice markets, which also affects agricultural production and farmers' decision-making about land use, crops, and farming systems. The thesis will use these concepts to further explore impacts of climate variability and access to local markets on farmers' decision-making around rice-based farming systems in case studies in three provinces in the VMD.

Thirdly, the literature review showed the importance of working together or participation in agricultural production. Very few studies discussed the benefits of collective decision-making about rice-based farming systems and rice farming activities in the VMD. This thesis will apply collective decision-making to further understand farmers' collective decision-making around rice-based farming systems and rice-farming activities in case studies in the VMD.

Finally, the concept of livelihood outcome was reviewed to enhance the understanding of the outputs of farming systems such as rice yield and rice income. In this thesis, key outputs of rice-based farming systems, including rice yield and rice income, will be presented as the consequence of farmers' decision-making about rice-based farming systems. Rice yield and rice income will be analysed and discussed in case studies of this thesis.

Chapter 3

Study methodology

3.1 Introduction

In accordance with the four research questions in Chapter 1 and the conceptual framework in Chapter 2, this thesis focuses on farmers' decision-making about rice-based farming systems. The study has adopted a range of theories and concepts from different previous studies and theoretical reviews relating to decision-making for livelihoods, land uses, and farming systems (Scoones 1998; Bruijn & Van Dijk 2005; Bosma et al. 2012; Ha 2012). The conceptual framework of this study is the linkage between factors (farmer organisations, climate threats, access to markets, and livelihood assets and access), farmers' decision-making about rice-based farming systems, and the outputs of rice-based farming systems. These provide a group of indicators to describe the effects of farmers' decision-making to farming systems.

There have been a few studies relating to the combination of farmers' decision-making for livelihood pathways, livelihood strategies, and livelihood activities (Bruijn & Van Dijk 2005; Bosma et al. 2012; Ha 2012). In practice, decision-making for pathways, livelihood strategies, and livelihood activities are the process of farmer's livelihood decision-making. The process starts by identifying values or problems to consider solutions in relation to making decisions so that farmers might achieve a goal or value (Ha 2012). It is unclear, from livelihood conceptual frameworks, if the process is separated into different sections. However, this depends on the specific research question so that an investigator can select suitable research methods to conduct a study. Bosma et al. (2012) applied quantitative analysis to determine the main factors that possibly influence farmers' decision-making in relation to the choice of farming systems. This study used a bottom-up approach by examining a range of specific factors in relation to rice-fish systems such as market prices, land size, distance from rice field to house, among other things (Bosma et al. 2012). Then, Bosma et al. (2012) ran a model to explore the main elements (i.e., land size, access to finance, market prices, labour) influencing farmers' decision-making, and showed that market prices of rice, fish and their main inputs were the main factors affecting farmers' decision-making to practise a rice-fish system. In contrast, Ha (2012) investigated farmers' livelihood decision-making during social and ecological uncertainties and market uncertainties, using data from semi-structured interviews and focus group discussions (FGDs), and quantitative data from household surveys. More recently, Trung et al. (2017) used a quantitative model to identify factors affecting farmers' decision-making in relation to land use, employing a top-down approach to design factors for the model. The majority of factors in their model were categories of the five types of livelihood capital (Trung et al. 2017).

This chapter is organised into three main sections. Firstly, the chapter discusses general information about the study sites, the differences between these research sites, and how farmer organisations were selected in each commune. Secondly, methods for data collection were applied by a mixed methods approach encompassing quantitative and qualitative data. Qualitative methods were conducted in local communes via FGDs, semi-structured interviews, and observations. In contrast, quantitative methods were mostly implemented via household surveys and secondary data collection. Thirdly, the chapter discusses how these data were analysed and categorised to illustrate the results of the study to answer the four main research questions through the three provincial case studies.

3.2 Study site selection and farmer organisations

The relationship between this study and the CLUES project

This PhD study is based on the research sites of the project "Climate change affecting land use in the Mekong Delta: adaptation of rice-based cropping systems" (CLUES) (ACIAR 2016), a four-year project funded by the Australian Centre for International Agricultural Research. The overall aim of the project was to increase the adaptive capacity of rice production systems in the VMD, and its specific objective was to provide farmers and management agencies with technologies and knowledge that would improve food security in the VMD. The CLUES project had six themes, each with a specific objective, and was implemented from 2011 to 2015. The project was conducted in four provinces in the VMD including An Giang, Can Tho, Hau Giang, and Bac Lieu (ACIAR 2016). My thesis is built on Objective 4 (Theme 4) of CLUES, which will be discussed in detail in the next section.

The summary of main findings from annual reports of the CLUES project

Theme 1: The annual report of Theme 1 showed variation in the seasonal structure of crops and shrimp in different years in Bac Lieu province. In addition, it discussed how different scenarios such as the amount of sea level rise expected in 2030 and 2050, together with low or high salinity, might impact rice areas and rice-shrimp areas at different areas of Bac Lieu province (Annual report of Theme 1 in 2014).

Theme 2: The results of this study showed appropriate rice varieties that can be planted in spring–winter (December–February) in Bac Lieu province. These rice varieties include OM 4900, OM 3536, OM6162, and OM 6677. These rice varieties are able to resist acid-sulphate soils, salinity, drought, insects and diseases. Rice varieties grown in the season from summer to autumn (March–June) include OM 4900, OM 2517; OM 10041, and OM 8108 (Annual report of Theme 2 in 2014).

Theme 3: The results of research activities of Theme 3 showed that irrigation using a process of alternating wetting and drying of rice fields saved water and was more effective than traditional techniques with prolonged flooding of rice fields. In addition, the results of activities of this theme showed solutions for reducing salinity in soil before beginning rice cultivation in areas of Bac Lieu province that experiences saline water intrusion (Reports of Theme 3 in 2014).

Theme 4: Theme 4 examined livelihoods, hazards impacting on rice farming, and private responses to hazards. It also examined issues in agricultural production such as irrigation, access to credit, labour, and markets. In addition, activity 4.2 of Theme 4 investigated farmers' adaptive capacity and constraints associated with livelihood capital such as social, financial, human, natural, and physical capital.

Theme 5: The result of research activities in Theme 5 were maps of land use, maps of soils, maps of irrigation areas, and maps of operation and regulation of sluice systems of Bac Lieu province. These maps will contribute to future plans for Bac Lieu province in adaptation to climate change. In addition, the result of the social economic study in Theme 5 also showed community challenges in relation to cultivating rice-shrimp systems and two or three rice crops. These challenges included localised and external water pollution by poor management and poor quality of shrimp seed and rice variety supply.

Theme 6: The research activities of Theme 6 highlight different farming techniques that might influence production of green-house gases (GHG) such as different rice varieties, fertiliser use, and water. The results of these activities showed that cultivating three consecutive rice crops each year generated considerable quantities of methane and that this was much higher than by cultivating a rice-shrimp system. In addition, short-time cultivated rice OM 4900 generated more methane than the 1 Bụi Đỏ variety (Annual report of Theme 6 in 2014).

Generally, farming technologies to prevent saline water intrusion, drought, flood, and to promote good rice varieties should be transferred to local communities. Theme 4 had plans to cooperate with other themes to undertake training activities in relation to technical knowledge of farming. Farmer organisations in different research sites in this project might facilitate these training activities. However, the time of the project was limited, and the theme could not conduct this step in the local community. In addition, Theme 4 did not conduct research on farmer organisations in more detail in relation to their role in rice-farming activities, although these organisations might play an important role in diffusing new rice varieties or farming techniques to a local community. Finally, these activities in Theme 4 have not considered relationships between farmers in farmer organisations, and relationships between farm organisations and general farmers (i.e., non-members of farmer organisations) in communities.

This thesis was designed to add value to Theme 4 of the CLUES project because it built on information and data found by the studies of the project. In addition, it also adds value to the project by applying theories and concepts to conduct research on how farmers make decisions in relation to rice-based farming systems. The thesis also selected the same research sites at the CLUES project. Although the research sites for this thesis were built on research sites of the CLUES project, the research sites of the CLUES project also had background information and farmer organisations relevant to the research questions of this thesis.

The study sites of the research

Similar to the CLUES project, I selected three provinces in the VMD to implement the research including An Giang, Can Tho and Bac Lieu provinces (there were four provinces used in the CLUES project, but three were used in this thesis). This is because the aim of the study was to enhance our understanding of farmers' decision-making about rice-based farming systems across the three provinces in the VMD (Figure 3.1). The research sites are located across different ecosystem zones of the VMD, where farming systems have been affected by a range of different threats such as climate variability, floods, high tidal movement, and saline intrusion, which impact on the main livelihoods of the majority of the farmers in these provinces, especially rice production and rice-shrimp farming (Tuong et al. 2003). An Giang is extensively flooded annually with high water levels, while Can Tho experiences less extensive flooding with lower water levels than An Giang (Huu 2011; Kien & James 2013). Bac Lieu, however, is located in the coastal zone, and has acid-sulphate and saline soils, as well as a diversity of water sources (Hoanh et al. 2003). Within Bac Lieu, I selected a commune with intensive rice, and another with rice-shrimp systems as the two main rice-based farming systems.

Figure 3.1: Research sites of the study including location of An Giang, Can Tho, and Bac Lieu in the Vietnamese Mekong Delta

In each province I selected two communes, each with different conditions, namely favourable and unfavourable conditions. According to the CLUES project (2011–2015), favourable conditions were defined as a environmental condition with good soil quality (i.e., alluvial, less acidic), moderate flood levels, and good infrastructure such as permanent dykes or sluice gates to protect rice in rice-based farming systems from floods or saline intrusion, or access to irrigation. In contrast, unfavourable conditions means a commune with slightly poorer environmental conditions consisting of more acidic soil or subject to saline intrusion, and no permanent dykes or sluice gates to secure rice and rice-shrimp farming systems.

Selecting a suitable farmer organisational unit was another criterion for selecting research sites (i.e., communes) because it relates to farmers' collective decision-making for farming activities in rice-based farming systems. According to the current political structure of a commune in the VMD, most communes in the VMD have a wide range of mass organisations comprising farmer unions (FUs), women's unions (WUs), youth unions (YUs), agricultural extension clubs (AECs), agricultural cooperatives (ACs), farmer clusters, farmer clubs (FCs), and large-sized farms model (LSFs). After running FGDs with heads of farmer organisations and local authorities in 2015, I discovered that only FCs, ACs, and LSFs had collective farming activities in rice production, consisting of contract farming for seed production or commercial rice (i.e., rice for consumption), irrigating and draining water out of rice fields in the rainy season and flood season, providing training and sharing activities, supplying rice varieties, and other activities. Typically, communes were selected according to rice-based farming systems, the condition of environment, infrastructure, and farmer organisational unit.

An Giang Province: In An Giang province, the two communes selected by the CLUES project were Vinh Trach of Thoai Son district, and Ta Danh in Tri Ton district. Vinh Trach commune was viewed as a favourable commune, whereas Ta Danh commune was an unfavourable site. Vinh Trach had permanent dykes (i.e., high dykes, Figure 3.2). The high dykes were constructed to secure rice fields damaged by annual floods (August–November). The high dykes also function as roads to assist with transportation. The high dykes in Vinh Trach were constructed more than ten years ago. In contrast, the majority of the land area of Ta Danh only had small dykes (i.e., low dykes, Figure 3.3) that could not secure the third rice crop during the flood season (i.e., August–November) in the VMD. Consequently, most rice land areas in Ta Danh have been cultivated with two consecutive rice crops each year. However, since 2013 a small amount of rice land area in Ta Danh has been cultivated with three consecutive rice crops owing to the construction of permanent dykes. Although the two communes had slightly different environmental conditions, the FC model was a common farmer organisational unit, having collective decision-making about rice-based farming systems.

Figure 3.2: High dyke in An Giang (i.e., dyke is >3 metres high and 12 metres wide)
Source: Author (2015)

Figure 3.3: Low dyke in An Giang province (i.e., dyke is <2 metres high and 3 metres wide)
Source: Author (2015)

Can Tho Province: Thoi Tan and Truong Xuan A are the two communes selected in Can Tho. The two communes are located in a moderate flood zone (i.e., smaller flood levels than in An Giang) of the VMD (Huu 2011). Annually, the combination of flood and high tide movement has impacted farmers' rice production in Can Tho because floods from An Giang province can cause additional inundation for the majority of rice farming fields in Can Tho (Huu 2011; CCCO 2015). Farmers and government in the two communes also constructed small dykes to secure the third rice crop.

The dykes[6] (Figure 3.4) in the two communes in Can Tho are less than half the height of those in An Giang (Figure 3.2) because the flood levels in Can Tho are around half those in An Giang (Huu 2011; the data in the Can Tho case study), but farmers were able to cultivate three consecutive crops a year, which will be explored in the case study of Can Tho (Chapter 6) to understand how farmers can use low dykes to prevent low floods to cultivate three rice crops.

Figure 3.4: Low dyke in Can Tho (i.e., dyke is <2 metres high and 4 metres wide)
Source: Author (2015)

In general, the two communes in Can Tho had similar ecosystem conditions and threats in relation to climate variability and access to local markets. However, Thoi Tan was considered a favourable location, whereas Truong Xuan A was unfavourable

[6] Dyke systems help farmers secure rice for all farmers having land parcels inside the same field in the flood season in Can Tho province (Figure 3.3). Dyke systems also assist as local roads for transportation.

because it is located in an area with a slightly deeper inundation level than that in Thoi Tan. In addition, farmers in Thoi Tan changed from two rice crops to three rice crops each year, three years earlier than in Truong Xuan A. Last but not least, an AC was a representative for farmer organisational units in Thoi Tan, whereas LSFs dominated farmer cooperation models in Truong Xuan A. Although ACs and LSFs are both cooperative models, they might have similarities or differences that affect collective decision-making for farming activities in rice-based farming systems.

Bac Lieu Province: In Bac Lieu, two communes located in different ecosystem zones were selected for the study. A part of Hoa Binh commune was considered a favourable area with a sluice gate controlling saline water intrusion permanently, and this area was able to extract fresh water from the Mekong River by a canal system of the Delta so that farmers were able to cultivate the three rice crops each year. In contrast, Phuoc Long was an unfavourable commune without permanent sluice gates controlling saline water, and rice-shrimp dominated rice-based farming systems of the majority of farmers in this commune. Annually, saline water appeared from February to August to allow farmers in Phuoc Long to raise shrimp, and then farmers reply by using fresh water from rain and the Mekong River to cultivate rice from September to February. Last but not least, a FC was a representative farmer organisation in Hoa Binh, while an AC was identified in Phuoc Long because they have had collective activities in relation to rice-based farming systems. Relevant background information will be discussed in more detail in the case studies of Bac Lieu (Chapter 7).

3.3 Methods of data collection

In this thesis, I applied a mixed-methods approach to collect data for the six communes including FGDs, semi-structured interviews, and household surveys, and I collected both qualitative and quantitative data. Qualitative data were used to explore the results from the FGDs and the household surveys, and quantitative data were used to assess respondents' perceptions. In the case studies, I present both the quantitative and qualitative data and analyses to respond to each of the research questions. The main methods used were FGDs, semi-structured interviews, and household surveys, and these were used in slightly different ways for each research question of the thesis according to their relative advantages in addressing each question (Table 3.1).

Table 3.1: Data collection methods applied for each of the four research questions and target stakeholders

Research question	Focus Group Discussions	Semi-structured interviews	Household surveys
1. What are the major decisions that farmers have to make about their rice- based farming systems each year?	• Members of farmer organisations • General farmers • Local officials	• Members of farmer organisations • General farmers	• Members of farmer organisations • General farmers
2. How have different factors influenced farmers' decision-making for rice-based farming systems?	• Members of farmer organisations • General farmers	• Members of farmer organisations • General farmers	• Members of farmer organisations • General farmers
3. How have farmers made collective and individual decisions for their rice-based farming systems?	• Members of farmer organisations • General farmers	• Members of farmer organisations • General farmers	• Members of farmer organisations • General farmers
4. How have these decisions affected the farmers' rice-based farming systems and household livelihoods?			• Members of farmer organisations • General farmers

Focus group discussions (FGDs) are a useful research method to facilitate a greater depth of knowledge about the participants, data, and local community in relation to the content of the study. The interaction between participants of FGDs makes it easy to generate a range of new data and information for studies (Rice & Ezzy 1999). The semi-structured interviews method is also useful for qualitative data collection because it allows researchers to discover the subjective meanings and interpretations that people give their experiences via interaction between interviewers and interviewees during conversation (Rice & Ezzy 1999). Household surveys are an important method for collecting quantitative and qualitative data. That is because household surveys are a face-to-face survey method, which allows researchers to collect data when there are a wide range of detailed questions in relation to who, what, where, how many, and how much (Yin 2009, pp. 8–9). In addition, the survey results help researchers to easily summarise, compare, and generalise issues of the study.

The three data collection research methods typically have advantages and disadvantages in practice, which will be discussed in more detail in the following sections. However, they are complementary to each other during data collection. Therefore, the current study used these methods for suitable cases to answer the research questions. For example, farmers' decision-making for main farming systems and farming activities relate quantitative data to the number of households making decisions in relation to conducting the same farming systems such as two rice crops, three rice crops, or rice-shrimp. Then, I explored how and why farmers decide on these farming systems by using FGDs and semi-structured interviews. The FGDs help interviewers identify key informants, and explore key factors in relation to farmers' decision-making through different interactions between different participants. However, in my research experience (10 years) of interviewing farmers in the VMD, farmers sometimes feel shy, and they do not engage in discussions when responding to questions in FGDs. Accordingly, semi-structured methods helped me explore information so that farmers found it easy to talk independently. This could then be used to check the group responses from the FGDs. The data and information in relation to the first three research questions were collected by FGDs, semi-structured interviews and household surveys (Table 3.1). In contrast, in research question 4, I used household surveys to collect data because the question needed quantitative data to present evidence of the relation between farmers' decision-making and outputs of farming systems such as rice yield, and net income of rice production (Table 3.1).

Setting up methods of data collection in the fieldwork in Vietnam

My fieldwork was conducted over three sessions in Vietnam. Firstly, FGDs with heads of farmer organisations and local officials in each commune to identify main farmer organisations at commune level having activities in relation to rice-based farming systems. I conducted this activity at Ta Danh and Vinh Trach commune in An Giang, in March 2015. FGDs were also conducted at Thoi Tan and Truong Xuan A commune in Can Tho, and at Hoa Binh and Phuoc Long commune in Bac Lieu in April (Table 3.2). Secondly, household surveys were implemented after the FGDs with heads of farmer organisations and local officials in each of the two communes of the three provinces. Household surveys were conducted in the two communes in An Giang in May 2015, in Can Tho in July 2015, and in Bac Lieu in July (Table 3.2). Thirdly, FGDs with members of farmer groups and general farmers, and semi-structured interviews were implemented after the household surveys were completed. The FGDs with members of farmer groups (ACs, FCs, and LSFs) and general farmers, and semi-structured interviews with different interviewees (i.e., detail in semi-structured interviews method) were conducted over one week at the same commune. I implemented FGDs with members of farmer organisations before conducting them with general farmers at each commune level (Table 3.2).

Table 3.2: Timing of activities for data collection in Vietnam

Methods	**An Giang** (Vinh Trach and Ta Danh)	**Can Tho** (Thoi Tan and Truong Xuan A)	**Bac Lieu** (Hoa Binh and Phuoc Long)
1. FGDs with heads of farmer organisations	March 2015	April 2015	April 2015
2. Household surveys	June 2015	May 2015	June 2015
3. FGDs with members of farmer organisations	August 2016	February 2016	September 2016
4. FGDs with general farmers	August 2016	February 2016	September 2016
5. Semi-structured interviews	August 2016	February 2016	September 2016
6. Secondary data collection	August 2016	February 2016	September 2016

Note: Contents for each method are presented in more detail in the following sections

3.3.1 Focus group discussion

The focus group technique is a form of qualitative research method. However, the number of participants involved in a focus group is more than one, usually from six to twelve participants. The discussion is based on topics, and the researcher takes the role of a moderator. The use of group interaction for specific topics produces data and insights (Morgan 1997).

According to Rice and Ezzy (1999), a focus group interview has a wide variety of different significant features. Firstly, a relatively small number of people are involved in an in-depth discussion. Secondly, the success of a group discussion depends on the interaction between different participants on the same issues, rather than individuals answering the moderator's questions. Interaction is a unique feature of focus group interviews, which distinguishes the method from individual, in-depth interviews. The process of interaction assists participants to explore and clarify their points of view and bounce ideas off each other. Thirdly, the moderator plays an important role in FGDs. They introduce the topic and guide the participants to discuss it, encouraging interaction and guiding the conversation.

FGDs are also able to be utilised in a variety of ways for different purposes. According to Rice and Ezzy (1999), FGDs can be used as a "self-contained" method, a "supplementary" source of data, or in "multi-method" studies. A self-contained method is applied to obtain primary data so as to examine research questions from the perspectives of participants as well as to explore new research areas. Supplementary sources of data can be used as a source of preliminary data in qualitative research. More frequently, FGDs are applied to generate survey questionnaires. They may be used for developing a programme or intervention. Finally, FGDs are used in "multi-method" studies, where a combination of several approaches is used to collect information.

There is a wide range of research using FGDs in various studies in the VMD. For example, studies examining the impact of changes of water policies on farmers' livelihoods in the coastal zone in the VMD used FGDs (Hoanh et al. 2003), and applying FGDs to enhance understanding of the livelihood resilience of people living in flood zones in the VMD (Kien & James 2013).

Applying focus group discussion to the study

FGDs in this study were undertaken across six communes with three mini-workshops in each commune. The first included representatives of mass organisations and local authorities such as FUs, WUs, AECs, ACs, FCs, and LSFs. The purpose of working with these organisational units was to determine suitable farmer organisations that had collective farming activities comprising selecting the same seasonal calendar, pumping water, operating internal credit, implementing services of input supply or output supply, and having contract farming. Most of the collective farming activities were relevant to adapting to threats or constraints in relation to climate variability, flood and saline conditions, and markets for rice or shrimp.

After conducting the first FGDs with heads of mass organisations and local authorities, I undertook two more FGDs in each commune. A first focus group was conducted with members of ACs, LSFs, or FCs (Table 3.3). The second was general farmers (non-members) who had not engaged in these farmer organisations. FGDs had from 6 to 11 participants (Table 3.3), and the time for discussion was around one hour and 30 minutes. The majority of members of ACs, LSFs, and FCs who participated in the workshops of FGDs were men, and less than 40% of general farmers attending workshops of FGDs were women.

Table 3.3: Number of participants engaged in focus group discussions in each of the six communes

Group	An Giang		Can Tho		Bac Lieu		Total
	Vinh Trach (FC)	**Ta Danh (FC)**	**Thoi Tan (AC)**	**Truong Xuan A (LSFs)**	**Hoa Binh (FC)**	**Phuoc Long (AC)**	
Head of mass organisations & local authorities	10	11	8	8	9	5	51
Members of farmer organisation	6 (1)	8	6	11	6	5	42
General farmers	8	8	7 (4)	10 (3)	8 (1)	6	47
Total	24	27	21	29	23	16	140

Source: Focus group discussion in 2015 and 2016

Note: AC: Agricultural cooperative; FC: Farmer club; and LSFs: Large-sized farms model. Numbers in brackets are the number of females in each FGD

Based on the usage of focus groups by Rice and Ezzy (1999), multi-methods were used in FGDs in this present study. The data and information from the first FGDs with representatives of mass organisations were utilised to clarify questions in the questionnaires of household surveys. In contrast, the two later FGDs were "self-contained" with members of farmer organisations (ACs, FCs, and LSFs) and general farmers (note that FGDs with members of farmer organisations were conducted before those with general farmers). Additionally, FGDs confirmed the results of household surveys for each research site, and provided deeper insights for a wide range of different factors relevant to decision-making for farming activities, and threats such as climate variability and access to local markets.

The FGDs were conducted at the homes of farmers, communal houses in villages, or in meeting rooms of the People's Committee of the commune. The process of the FGDs followed a range of steps. Firstly, the moderators introduced themselves and the research objectives. In FGDs we used a large sheet of paper stuck on the wall to record on all the information and data so that it was easy for visualisation and discussion. We implemented different tools for different general questions to discuss with participants such as seasonal calendars, timelines, webs of networks of farmer organisations, and cause and effect analysis. During the discussion, the moderator in this study relied on perspectives of the research sites and participants' perceptions of perspectives so as to suggest key questions for the majority of participants to be able to engage in the discussion. The tools and questions for discussion were arranged in the following sections.

Question 1 enabled me to attain an understanding of the seasonal calendar of farming systems in each of the three provinces, and factors influencing paddy in each rice and shrimp crop (Table 3.4). Then, the information and data enabled me to understand the process of farmers' decision-making for rice-based farming systems because farmers in the VMD are not familiar with the term, "decision-making". They regularly use: "What did they do?", "Why did they do it?", and, "How do they select or do this or that activity?".

Question 2 in Table 3.4 allowed me to identify factors affecting the process of farmers' decision-making to change farming systems and farming activities in each farming system such as the improvement of rice varieties, technical knowledge, and combine harvesters for harvesting rice. In addition, infrastructure development was also a key element including canals and dykes for protecting rice from floods, sluice gates controlling saline water, and irrigation.

Question 3 in Table 3.4 helped me explore the main threats such as high temperature, drought, flood, abnormally heavy rains, and access to markets. In addition, through the interaction between members, I could identify more detail in social relations between members of farmer organisations, and between farmer organisations and general farmers (i.e., non-members) in communities.

Question 4 in Table 3.4 enabled me to obtain insights into the process of farmers' collective and individual decision-making for farming activities in each rice crop of members of farmer organisations and general farmers.

Question 5 in Table 3.4 allowed me to be able to understand the main solutions that farmers used to overcome barriers from threats in cultivating farming systems.

Generally, these questions are typically abstract questions with farmers. Therefore, depending on the context of the local area, I had to use specific questions in order to help farmers understand and discuss (see appendix 1).

Table 3.4: List of main guide questions for the FGDs

Question	Description of the questionnaire
Q1	How regular was the seasonal calendar? How have climatic factors, floods, saline intrusion, common insects, diseases, pests, and crops varied in different months in recent years?
Q2	How did farmers change rice-based farming systems? What are the relevant factors in the development process of increasing from one to three rice crops or other farming systems in a commune?
Q3	What were the main constraints for farmers in rice crop farming?
Q4	How do farmers make collective and individual decisions for farming activities?
Q5	How did farmers regularly solve barriers in adapting and coping with threats such as climate variability, market access, and shortage of labour?

3.3.2 Semi-structured interview

Semi-structured interviews were set up with a set of single and open questions with important topics that the interviewer asks, and the interviewee is then allowed to respond freely, with the interviewer simply responding to points that seem worthy of being followed-up (Bryman 2012; McCraken 1988, p. 25, cited in Rice & Ezzy 1999, p. 52). In other words, un-structured interviewing or semi-structured interviewing can be seen as quite similar to conversation (Burgess 1984, cited in Bryman 2012, p. 471). The interviewers should not be passive and distanced, but actively involved in encouraging the respondent to talk, and to converse about the research issues under discussion. The interviewer is considered to be a co-participant in narratives (Rice & Ezzy 1999). In addition, "The key to asking questions during in-depth interviewing is to let them follow, as much as possible, from what the participant is saying" (Seidman 1991, p. 59, cited in Rice & Ezzy 1999, p. 59).

Semi-structured interviews are used for different research issues in relation to the adaptive capacity to climate variability and to flooding, as well as the resilience of ACs (Kien 2011; Hoa 2014; Borda-Rodriguez & Vicari 2014). For example, interviews were conducted with representatives of relevant actors in ACs, contributing to insights into how ACs have faced challenges. Additionally, the results of the interviews also showed participants' perceptions of whether their knowledge and skills had improved after engaging in ACs. Generally, the consequences of semi-structured interviews enable interviewers to have more understanding of interviewees' perceptions of issues in the study area.

Applying semi-structured interviews to the study

For this thesis, I interviewed key informants including local government staff of communes and villages (9 respondents), and members of farmer organisations (14 respondents from ACs, FCs, and LSFs). In addition, the semi-structured interviews were conducted with general farmers (6 respondents) who had experience and knowledge of events and changes in farmer organisations, and the agricultural development of communities. Furthermore, key informants included owners of combine harvesters (5 respondents), brokers (5 respondents), and owners of agricultural material shops (8 respondents). The activities of these actors are relevant to harvest activities, market prices of rice, and climatic conditions in relation to hazards (pests, insects, and diseases). These factors relate to farmers' decision-making about rice-based farming systems and farming activities. Most of the interviewees were men because it was difficult to find women who could remember the narratives of changes relating to policies and activities of agricultural production (i.e., land use, changing crops, markets, and agricultural services), and farmer organisations, namely ACs, FCs, and LSFs. Finally, key informants have also perceived responses of local farmers to changes of agricultural production and the influence of other factors on changes.

The questions in the FGDs and semi-structured interviews were designed to be complementary during the fieldwork. Factors relating to farmers' decision-making were regularly located in FGDs and questionnaires of household surveys, but they were used to understand and interview interviewees in semi-structured interviews. Complementary information is linked between household surveys, FGDs, and semi-structured interviews. For example, interviewers or moderators (facilitators) need to understand the process of farmers' decision-making in relation to rice-based farming systems and specific farming activities so that interviewers are able to interview and confirm data from interviewees through information and data collected by different methods. This is one of the reasons the study had to use mixed methods.

Question 1 allowed me to obtain an understanding of the process of farmers' decision-making about rice-based farming systems (Table 3.5), but with more individual perceptions than discussions in FGDs, because farmers in local areas in the VMD sometimes do not talk much in public.

Question 2 in Table 3.5 enabled me to gain insights into the main factors or reasons for farmers engaging in the collective decision-making of a farmer organisation, or individual decision-making for selecting and conducting farming activities. This enhanced my understanding of the level of farmers' participation and the social capital between farmers in their farmer organisations via decision-making for farming activities.

Question 3 in Table 3.5 helped me identify specific levels of participation such as working together *(i.e., làm cùng nhau)* or cooperation *(i.e., hợp tác)*, and the degree of social capital (i.e., cohesion, trust, commitment) between members in organisations. These qualitative data support the explanation for the data collected by household surveys such as measuring social capital in the organisational resilience of farmer organisations.

Question 4 in Table 3.5 enabled me to gain insights into farmers' perceptions of the degree of cooperation and working together in their communities because farmer participation or their social relations might influence collective decision-making about rice-based farming systems and farming activities.

Table 3.5: Main questions of semi-structured interview with farmers

Question	Description of the questionnaire
Q1	How does a farmer or a group of farmers make collective and individual decisions for rice-based farming systems or agricultural production?
Q2	What are the main factors influencing collective and individual decision-making for rice-based farming systems and farming activities?
Q3	How did they share benefits from cooperation in collective farming?
Q4	How did farmers perceive working together or cooperation in cultivating rice farming?

As with the FGDs method, I based questions on the specific cases of interviewees to ask appropriate questions. Besides the main questions above, there was a wide range of specific questions relating to changing farmer organisations because they relate to reasons, or factors influencing the levels of current cooperation or working together for collective decision-making (see Appendix 2).

The majority of interviews were carried out at the homes of interviewees or at their private offices. Each conversation lasted a maximum of one and a half hours. I and my research assistant took notes of the information provided and managed time and the content of the conversation. Most questions were open-ended. The author followed the theme list, and encouraged interviewees in having more ideas. However, interviewees also felt comfortable to tell us their stories, or stories of communes or their farmer organisations. In addition, the author also asked specific questions to clarify ideas or perceptions of interviewees of narratives. In general, the semi-structured interviews provided me with enhanced insights into the process of rice development as well as farmer organisations, and associated elements with changes in relation to climate variability, flood zones, saline water intrusion zones, and markets, among other things.

3.3.3 Household surveys

In household surveys, I focused on a methodological approach for exploring how farmers make decisions about rice-based farming systems. In addition, the household survey was also used to collect quantitative data in relation to outputs of rice-based farming systems. These outputs are the results of farmers' decision-making for rice-based farming systems and farming activities.

Sampling strategies for quantitative research

Similar to FGDs, the process of selecting farmer organisations involved in collective activities was undertaken via the results of FGDs of local staff and heads of mass organisations as mentioned earlier. Through the first FGDs, secondary data, and key informants, the study identified activities and the relationships between different mass organisations. Farmer organisations including ACs, FCs, and LSFs had collective rice-farming activities. In contrast, most of the activities of other unions had vertical relationships, or were not relevant to rice-farming activities. However, most of the farmers involved in ACs, FCs, and LSFs were able to be members of FUs, WUs, or other mass organisations in communes.

Different sampling methods were applied in this study. Firstly, a stratified sample was applied to divide the total population of the research site into two sub-populations of the six communes. The distinction between the two sub-populations was based on farmers engaging or not engaging in FCs, ACs, and LSFs. In this research, farmers involved in each of the three forms of farmer organisation were called members, while farmers who have not participated in these farmer organisations were called general farmers (i.e., non-members). Secondly, around 30 households were selected by using a stratified random approach. However, if farmer organisations had fewer than 30 members, the study tried to conduct the interview with all members. In particular, Table 3.6 illustrates the sample size of the household surveys in 2015. The number of respondents of the AC at Thoi Tan engaging in the household surveys was 35, while the AC at Phuoc Long was 11 because of the limitation of the number of members in this AC (Table 3.6). There were more details in clarifying males, females, and couples (i.e., husband and wife) when I conducted the household surveys (Table 3.7).

Table 3.6: Number of households that participated in household surveys

Province	**Commune**	**Farmer organisations**	**Members**	**General farmers**
An Giang	Vinh Trach	Farmer club	26	30
	Ta Danh	Farmer club	24	28
Can Tho	Thoi Tan	Agricultural cooperative	34	24
	Truong Xuan A	Large-sized farms model	35	27
Bac Lieu	Hoa Binh	Farmer club	21	27
	Phuoc Long	Agricultural cooperative	11	32
Total			**151**	**168**

Source: Household surveys, 2015

Table 3.7: Number of participants (male, female and couple) for the household surveys for members of each different farmer organisation and for general farmers (non-members)

Research sites and farmer organisations			**Male**		**Female**		**Couple**	
			n[1]	**%**	**n**	**%**	**n**	**%**
An Giang	Vinh Trach	Member of FC[2]	25	96.2	1	3.8	-	-
		General farmers	27	90.0	2	6.7	1	3.3
	Ta Danh	Member of FC	24	100	-	-	-	-
		General farmers	23	82.1	1	3.6	4	14.3
Can Tho	Thoi Tan	Member of AC[3]	28	82.4	3	8.8	3	8.8
		General farmers	13	54.2	4	16.7	7	29.2
	Truong Xuan A	Members of LSF[4]	34	97.1	1	2.9	-	-
		General farmers	23	85.2	-	-	4	14.8
Bac Lieu	Hoa Binh	Members of FC	20	95.2	1	4.8	-	-
		General farmers	23	85.2	1	3.7	3	11.1
	Phuoc Long	Member of AC	9	81.8	-	-	2	18.2
		General farmers	26	81.3	1	3.1	5	15.6

Source: Household surveys, 2015

Note: 1. n is the number of participants

2. Farmer club

3. Agricultural cooperative

4. Large-sized farms model

Undertaking household surveys

Designing questionnaires

The questionnaires of this study were combined from different sources. Research questions provide important guidance that a questionnaire has to follow. However, the structure of a questionnaire needs to make sense to the local community. The questionnaire was based partly on the CLUES project to generate suitable questions with local language and local logical understandings in the community. Additionally, qualitative data from the first FGDs with local officials and leaders of farmer organisations, and secondary data also contributed to the design of this questionnaire. Moreover, the data obtained in household surveys was not only used for analysing and writing this thesis, but was also used for discussions in FGDs with members of farmer organisations and general farmers. For example, a wide range of factors affect farmers' decision-making about rice-based farming systems and farming activities. The study selected important factors through the results of household surveys to discuss with farmers in FGDs to clarify why these factors influence their decision-making. Factors were identified by using descriptive statistics for analysis. Last but not least, the questionnaire was reviewed by the panel of supervisors before conducting the pre-test and surveys. Table 3.8 lists the main sections in the questionnaire for household surveys of this study and detailed questions in the Appendix 3.

Table 3.8: List of main sections used in the household surveys

Section	Description of the questionnaire
A.1	Household identification and location
A.2	Human resources of respondents and household members including age, education, gender, ethnicity, social network of members in household
A.3	Household assets comprising house conditions, land uses of agricultural production, equipment of rice production and household daily activities, financial access.
B.1	Location of the most important livelihood activities
B.2	Sources of information about weather condition
B.3	Sources of information about rice varieties
B.4	Where rice varieties are accessed
B.6	Estimates of output and costs of production activities including each rice crop, vegetable, fruit, livestock, and aquaculture.
B.7	Household (non-farming/paid) activities that generated direct cash income (including pensions and subsidies from the government)
C.1	Perceived hazards experienced in the household within ten years, and measured the scale of its impact on main livelihoods
C.2	Experiences impacting on rice or shrimp production
C.3	Solutions of households responding to hazards
C.4	Measurements of the scale of factors including water access, input access, credit access, information access, labour access, and output markets that have influenced rice and shrimp production
D	Respondents who were members of farmer organisations were asked to measure the scale of forms of social capital of farmer organisations through collective activities of rice farming, and factors of organisational resilience
F	Suggestions for improving working together in enhancing capacity of climate variability adaptation

Training interviewers

The interviewers for the household surveys in this study consisted of four graduate students from the engineering programme of rural development, and researchers and research assistants at the Mekong Delta Development Research Institute (MDI) of Can Tho University (CTU). All the students involved in this survey have studied research methods in the rural development programme. They have experience in interviewing farmers in the VMD because they have been involved in many research projects, along with participating in a wide range of small research projects with social scientists of MDI. The questionnaires were sent to all interviewers one week before training so that the interviewers had time to read, and were able to gain insights into the content of the questionnaires before training. During the training period, the interviewers had a chance to practise and ask about the questions if they did not understood sections of the questionnaire.

Survey pre-test

A pre-test of the questionnaire was undertaken across the six communes so as to determine any problems with misunderstanding in order to provide suitable questions in the questionnaire. Each interviewer in this survey had to interview one or two households in the pre-test period so that they were able to understand farmers' perceptions of questions in the questionnaire and the ability of respondents to answer these questions, or if the questions would suit the local language of the respondents. In addition, the pre-test found difficulties that interviewers faced when they interviewed respondents because this study was undertaken in different ecosystem zones of the VMD. Different communes had specific issues encompassing farming systems, water condition, and local words. Similar to using a Likert scale to measure forms of social capital presented by Thuy (2007) and to measure types of livelihood capital presented by Brown et al. (2010), the questionnaire in this study also had sections using a Likert scale to measure the scale of factors influencing livelihood activities or statements of social capital of farmer organisations. This was a challenge for respondents to select a scale of assessment. The interviewers had to spend time explaining to respondents how to measure.

3.3.4 Secondary data collection

A range of secondary data needed to be collected to support each of the research questions. The majority of data and information were collected from documents and annual reports from the local People's Committees of communes and centres and offices of Department of Agricultural and Rural Development (DARD) of provinces. The data and information related to areas of land use size, rice yields, number of rice crops cultivated by farmers each year, other crops, livestock, population, number of households, and number of mass associations.

The secondary data enabled me to implement more advantages when conducting interviews with local officials about historical background information in relation to rice production. These included location or the process of developing rice-based farming systems, and advantages and disadvantages or main constraints of rice intensification and constraints of developing farmer organisations at commune levels and province levels. The secondary data helped the investigator to have more understanding of the general context of rice production development and shrimp production in communes and provinces of the VMD.

3.3.5 Research ethics

I conducted the fieldwork in Vietnam in accordance with the requirements of the office of human research ethics of the Australian National University. The protocol number was 2014/741, which was approved on the meeting date, 22 January 2015. There were a range of rules of research ethics that I had to follow when I conducted the fieldwork for my thesis in Vietnam. For example, before I began to conduct each interview, I had to ensure participants involved in different activities of my fieldwork such as FGDs, semi-structured interviews, and household surveys were completely voluntary by showing and reading out an oral consent script for participants. If they felt uncomfortable with any questions or issues during interviews, they could withdraw at any time. If participants withdrew during the interviews I would not use the information and data that they provided me for my thesis and future papers. In addition, I also told participants that if they thought their information and data that they provided me might harm them in the future, they should not provide it to me because my thesis will be published in the future. Moreover, I would not use the real name of interviewees and participants in my thesis and future papers.

3.4 Data analysis

3.4.1 Farmer organisation and unit of analysis

The unit of analysis for most of the sections of the study primarily included members of farmer organisations such as ACs, FCs, or LSFs, and general farmers (non-members). Households of respondents comprising members of farmer organisations and general farmers are units for analysing all data in the study, but they are followed by farmer organisations (members of ACs, FCs, or LSFs) and general farmers. The household was applied for livelihood capital, adaptation of individual households in rice and shrimp production to hazards, social capital through collective activities, and organisational resilience. Additionally, the unit of household was also used in the output of rice-based farming systems and household income of members of farmer organisations and general farmers so that the study indicated the consequences of farmers’ decision-making for responding to threats in relation to rice production or shrimp farming.

3.4.2 Quantitative data and qualitative studies for farmers' decision-making about main rice-based farming systems

Descriptive statistics are used for quantitative data such as the number and percentage of members of farmer organisations or general farmers making collective or individual decisions about rice-based farming systems. Narratives or opinions collected from individual farmers and by FGDs were used qualitatively. The study combines thematic and narratives analysis. I did not use thematic analysis with texts because of the limitation of number of interviewees for each type of interviewee (i.e., local authorities, brokers, or advanced farmers). I relied on relevant themes to make short narratives to support research issue. For example, the study revealed factors that might influence farmers' decision-making about rice-based farming systems. They include income, household consumption, markets, dyke construction, collectively draining water out of rice fields in the rainy season, and sluice gates, among other things. Narratives relating to themes of factors support farmers' collective and individual decision-making about rice-based farming systems.

3.4.3 Quantitative and qualitative studies for factors influencing rice-based farming systems

Applying quantitative methods for measuring social capital of farmer organisations

Social capital was measured in this study based on studies by Krishna and Uphoff (1999), Thuy (2007), and Kien (2011). For example, Thuy (2007) applied the method of social capital measurement by constructing indices in a case study of social capital and forest conservation in Vietnam. Social capital was divided into eight main items such as social trust, cohesion, and social commitment. Each item had several statements, for example, for Trust, "Most people in this community can be trusted?". Thuy (2007) used a Likert scale to measure indices of forms of social capital by scoring from strongly disagree (1) to strongly agree (5). The results of the first FGDs of this thesis with heads of ACs, FCs, and LSFs indicated which factors and activities were associated with collective rice farming activities. Therefore, the study did not use a factor analysis method.

The data illustrated in this section were collected from household surveys. Descriptive statistics were applied to estimate the average score of the measurement from members of farmer organisations. All indices of forms of social capital include social cohesion, social trust, and social commitment. An example of social trust was, “I believe that group members are willing to spend their time to upgrade dykes, prevent salinity, and help each other when it rains in harvest seasons”, which can be scored: 1 = completely disagree; 2 = disagree; 3 = neutral; 4 = agree; and 5 = completely agree (Appendix 3). The average score was 3.3 for all households of the sample in this study.

The study also uses narratives from members of farmer organisations and general farmers about their perceptions of members’ relationships and relationships between members and leaders via their collective farming activities. Through this I was able to better understand the reasons why members measured social capital indices with high or low scores. Then, I was able to obtain insights into how farmer organisations influence collective and individual decision-making for farming activities, and who participates in collective decision-making for farming activities.

Local authorities and relationship between members in farmer organisations as a factor influencing farmers’ decision-making in rice-based farming system

Local authorities play an improtant role in encouraging farmers’ decision-making about rice-based farming systems or dyke construction, especially cases of contract farming in An Giang and in Can Tho. In Can Tho, local authorities encouraged LSFs in Truong Xuan A to sign contracts with a food company to produce common rice, while the cooperative in Thoi Tan signed contracts with Cuu Long Rice Research Institute to produce improved rice varieties (i.e., seed). Actually, local authorities of village and commune are also the members of LSFs and ACs. According to Howie (2011), local authorities are a long hand of local government. They did not directly work as position of local authorities, while their position is a farmer in communes. They are involved in activities of farmer organisation such as LSFs, ACs, or FCs. In the result section of each case study An Giang, Can Tho, and Bac Lieu, I did not analyse in detail in the procedures of local authorities who encouraged farmers’ decision-making about rice-based farming systems. That is because it is difficult to recognize the influence of them on farmers’ decision because they are also farmers. The study examines the role and position of local authorities when they participated in LSFs, ACs, and FCs. They might be prioritised for obtaining benefit from rice contract farming before other members who is not local authorities.

The relationship between members in a farmer organisation influencing collective and individual decision-making is explored, and there is a section on measuring social capital of members in farmer organisation, and how the relationship between members in an organisation influences farmers' decision-making. For example, an individual might engage in contract farming for producing seed rice or normal rice (i.e., rice for consumption) when they are members of farmer organisations, and have a good relationship with the leader of farmer organisations.

Climate variability, flood, saline intrusion, and salinity as a group of external factors influencing farmers' decision-making for farming systems

Secondary data are used to illustrate how spatial and temporal patterns of temperature, rainfall, flooding, and salinity changed over time between the period 1996–2016 and over the three years of 2014, 2015 and 2016. The data are illustrated by figures which helps us understand how climate variability is affecting farming systems in different provinces.

Qualitative data in the seasonal calendar from FGDs is presented in tables in the three provincial case studies to describe and explain farmers' perceptions of the relationship between different rice crops and different weather seasons. For example, the first rice crop is in the dry season, but at a low temperature. The second rice crop is also in the dry season, but at a high temperature. However, the cultivation of each rice crop typically belongs to the communal seasonal calendar of each province.

Climatic conditions and episodic events floods, drought, and salinity intrusion are uncertain factors so that members of farmer organisations and general farmers in the rice community make collective or individual decisions for conducting farming activities such as when to irrigate, when to sow or transplant, and when to harvest for each rice crop. In addition, seasonal calendars also contain information on when drought, salinity of saline water, or abnormally heavy rain is likely to affect rice in the second or third rice crop in a commune.

Farmers' perception of access to local rice markets

Qualitative data collected from semi-structured interviews and FGDs was used to assess farmers' perceptions of access to local rice markets, and the positive and negative effects of markets for different rice crops. The advantages and disadvantages of access to local markets also affect collective and individual farmers' decisions for farming activities such as farmers' decision-making for selecting rice varieties to cultivate the first, second, or third rice crop. In addition, the qualitative data were used to show which farmer organisations are able to access better market prices than others. For example, members of farmer organisations regularly access better market prices than general farmers (i.e., non-members).

Household assets and access

Quantitative data in the household surveys were used to evalute livelihood capital in terms of the basic resources available to farmers. Descriptive statistics were employed to estimate the number of households, percentages, and averages of variables. The data on livelihood assets allows us to determine how farmers use their resources to decide their farming activities. For example, general farmers with small land sizes were not engaged in farmer organisations; accordingly they were also rarely involved in collective decision-making for farming activities. Besides, qualitative data, such as narratives, are useful to clarify the factors influencing livelihood access of households, factors such as the causes of reducing labour supply in rural areas or scarcity of water in the dry season in Bac Lieu province. These factors indirectly impact farmers' decision-making in relation to changing rice-based farming systems or changing strategies of farming activities. Moreover, the livelihood capital of households enables more understanding of the adaptive capacity of households in rice and shrimp production to threats from climate variability, drought, salinity, and markets.

3.4.4 Quantitative and qualitative study of farmers' collective and individual decision-making for farming activities

Qualitative data collected through FGDs was used for the majority of collective and individual decision-making for farming activities to respond to this question. However, data for collective or individual decisions on selecting rice variety was collected through household surveys. In addition, numbers and percentages of households are illustrated as the results of farmers' decision-making about selecting rice varieties for each rice crop. To support the reasons why farmers decided on a particular rice variety, instead of other rice varieties, the study used qualitative data from semi-structured interviews to explain it. Generally, this section combined quantitative and qualitative data to illustrate the results of the study.

3.4.5 Quantitative data for outputs of rice-based farming systems

The outputs of rice-based farming systems include outputs of rice crops and raising shrimp. The descriptive statistics in the study included averages of yield, gross income, cost, and net income, as well as the number of households, and percentages of households. Net income of different crops, either rice or shrimp was calculated by gross income minus the cost of rice varieties, pesticide, fertiliser, irrigation fees, land preparation services, combine harvesters, labour, and fees for rented rice land. Net income from off-farm and non-farm sources was collected directly through estimates by respondents. The off-farm sources encompassed agricultural services and agricultural labour. Agricultural services consist of combine harvesters, tractors for land preparation, and transport services. Agricultural labour comprised associated rice production activities such as sowing rice varieties, transplanting, and sprayers. Non-farm income was generated by different members in a household, and consisted of activities such as local officials, teachers, traders, and workers in local companies. The limitation of the study was that I did not use Independent Samples T-Test to compare means of parameters (i.e., rice yield, cost and income of rice and shrimp) between two groups (i.e., members of farmer organisation and non-members) to test for the significant differences statistically. That is because most of members of farmer organisation produced rice varieity (i.e., rice seed), while most of non-members (i.e., general farmers) produced normal rice (i.e., rice for consumption).

3.5 Case study method for structuring provincial case study

According to Yin (2003, p. 4), "a case study is the method of choice when the phenomenon under study is not readily distinguishable from its context. Such a phenomenon may be a project or programme in an evaluation study. Sometimes, the definition of this project or programme may be problematic, as in determining when the activity started or ended – an example of a complex interaction between a phenomenon and its (temporal) context". The case study method enables the investigator to retain the holistic and meaningful characteristics of real-life events including individual life cycles, small group behaviour, organisational and managerial processes, neighbourhood change, school performance, international relations, and the maturation of industries (Yin 2009). There are six different types of case study, which depend on a single case study or multiple case studies, and then a single case study or multiple case studies can be used in exploratory, descriptive, or explanatory ways to conduct research. For this study, the exploratory method was used in semi-structured interviews and FGDs, and description and explanation were used in household surveys and secondary data to investigate answering the four main research questions in Chapter 1. Descriptive and explanatory case studies are used to present and discuss in the results and discussion chapter. According to Yin (2009 p.28), the investigator sets the boundaries of the case study relying on research questions, time, relevant social groups, organisations, or geographic areas, types of evidence to be collected, and the priorities for data collection and analysis.

In this study, I used the case study method to structure the main contents of the study. The study is organised with three provinces into three chapters including case studies for An Giang province (Chapter 5), Can Tho province (Chapter 6), and Bac Lieu province (Chapter 7). The reasons for using a provincial case study for each chapter are that there is a wide range of factors relating to farmers' decision-making about main rice-based farming systems, and about farming activities in each province. Following the research questions and literature reviews in Chapter 1 and 2 respectively, factors included farmer organisational units, geographical conditions, climatic conditions, and households' resources. However, I used multiple case studies at the commune level with two communes for each provincial case study because I want to compare the similarities and differences between multiple groups of the two communes, and two groups in the same commune to enhance the understanding of farmers' perceptions and behaviours in decision-making processes in relation to rice-based farming systems in the VMD.

3.6 Conclusion

In conclusion, this methodology chapter reviewed and discussed the research sites, methods of data collection, and data analysis.

Firstly, two communes were identified to be research sites in each province (An Giang, Can Tho, and Bac Lieu). Each commune was divided into favourable and unfavourable communes with conditions relating to land, water use, dyke construction for protecting rice crop in flood season, and sluice gates for controlling saline water intrusion.

Secondly, the study used a mixed-method approach including FGDs, semi-structured interviews, and household surveys to collect data. The chapter described benefits for using each method because the list of questions and guidelines in three methods were complementary to respond to the four main research questions of this thesis. The participants engaging in each approach included farmers, local officials, brokers of local rice market, and owners of combine harvesters.

Finally, the main methods of analysis consisting of descriptive statistics with quantitative data, and narratives with qualitative analysis were used in three provincial case studies in chapter 5, 6 and 7. These quantitative and qualitative data were described and used for discussion in responding to the four research questions. The chapter also showed the importance of using case study for setting three main provincial case studies in three chapters 5, 6, and 7 of this thesis.

Chapter 4

Reviewing historical farming systems, policies relevant to food security, and climate variability in the Vietnamese Mekong Delta

4.1 Introduction

The VMD is located in the monsoon tropical region where a variety of crops such as rice, vegetables, and fruit are grown each year (Sanh et al. 1998). The VMD also possesses a long coastal area where a variety of fish are able to be raised, especially shrimps (Tuong et al. 2003). Generally, farming systems in the VMD are very diverse, owing to advantageous natural conditions. Rice still dominates a large amount of the planted area[7] (approximately 4,274,000 ha) in the VMD by reason of policies relevant to commercial and national food security. In the fresh-water zones of the VMD, farmers have shifted gradually from two to three consecutive rice crops each year since about 2000 (Nha 2006). To enable this intensification, local government and farmers have constructed dykes to control flooding which occurs annually between August and November. In coastal provinces of the Delta, for example Bac Lieu and Ca Mau, shrimp is a common aquatic species (Ha 2012). In addition to mono-rice farming systems, rice is still a priority crop for integrated farming systems, especially rice-fish and rice-vegetable in fresh-water areas, whereas shrimp-rice systems are practised in provinces having brackish water including Bac Lieu, Ca Mau, and other coastal provinces. Such integrated farming systems were considered to be an innovative approach for the sustainable adaptation to natural conditions as well as improving income for farmers in the VMD (Ut 2004).

Rice and shrimp farmers in the VMD have achieved positive results from intensive and diversified farming systems, especially rice in the fresh-water area and shrimp in the coastal area, but there might still be threats from climate change and factors related to climate variability (Binh 2015). In recent years, the pattern, timing and intensity of rainfall, temperature, and saline water intrusion has changed (ICEM 2009). Both rice and rice-shrimp farming systems are likely to be affected by continuing variations in the pattern, timing and intensity of temperature, rainfall and saline

[7] Planted area is the total area of rice land that is cultivated with two or three consecutive rice crops each year. For example, if there is 100 ha available for rice, and if there are three rice crops per year, then the planted area is 300 ha.

intrusion. In addition, rising sea level is predicted to raise flood levels in the provinces of the VMD in the future (Wassmann et al. 2004).

This chapter reviews and discusses specific factors and policies in relation to the process of agricultural development in the VMD. It also summarises the major farming systems in the VMD, and how they have changed over time in response to environmental factors, social conditions and policy decisions, including policies relating to agricultural development during the change from a collective economy to a commercial economy, investment mechanisms, and especially farmer organisations. These farmer organisations might contribute to improve capacity as well as the supply of agricultural services such as input and output supplies. Additionally, the study highlights climate variation such as temperature, drought, and rainfall in the VMD in recent years. These changes and variations in climate comprising high temperature, drought, and high salinity of saline water have directly and indirectly influenced rice-based farming systems in recent years. Many factors might influence farmers' decision making about rice-based farming systems. Most data and information provided in this chapter are collected from references, general statistics books of Vietnam and provinces, and secondary data and documents from provinces.

4.2 Geography of the Vietnamese Mekong Delta

4.2.1 Topography and soil characteristics

The VMD is a flat and low-lying region, which was created through slow alluvial depositions. Only a few hills are located in Kien Giang and An Giang province where hard rocks are exposed (Figure 4.1). The average elevation of the Delta is 2 m above mean sea level, but parts of Dong Thap province are 0.5 m below mean sea level (Sanh et al. 1998, p.19).

The soils of the VMD are mostly deposited with a large amount of alluvium carried by different floods, and combined with exited soils over thousands of years to generate the complexity of types of soil in the VMD (Figure 4.1). Soils in the VMD are classified into three main types including alluvial soils, acid-sulphate soils, and saline soils. In the VMD, different types of soil are combined with hydrology patterns from tidal movement of the sea through rivers constituted by characteristics of different agro-ecological zones in the Delta. As a consequences, the VMD can be classified into seven sub-regions including the fresh-water alluvial zone (900,000 ha), the Plain of Reeds (500,000 ha), the Long Xuyen-Ha Tien Quadrangle (400,000 ha), the Trans-Bassac Depression (600,000 ha), the coastal zone (600,000 ha), Ca Mau Peninsula (800,000 ha), and the hills and mountains (< 200,000 ha) (Sanh et al. 1998, p. 21).

In the VMD, alluvial soils are located along the Tien River (Mekong River) and Hau River (Basac river) and comprise about 28% (1,100,000 ha) of the VMD. These suits rice cultivation, upland crops, and fruit trees. Acid-sulphate soils are found in the Long Xuyen-Ha Tien Quadrangle and the Plain of Reeds which are located in the upper parts of the Delta, and account for 13% (510,000 ha) of the VMD. In addition, potential acid-sulphate soils can be found in flooded saline areas along the coastline, this soil covers an area >1,080,000 ha (28% of the Delta). Saline soils are located along the coastal zones which account for 21% (over 808,000 ha) of the VMD (Sanh et al. 1998, p. 21).

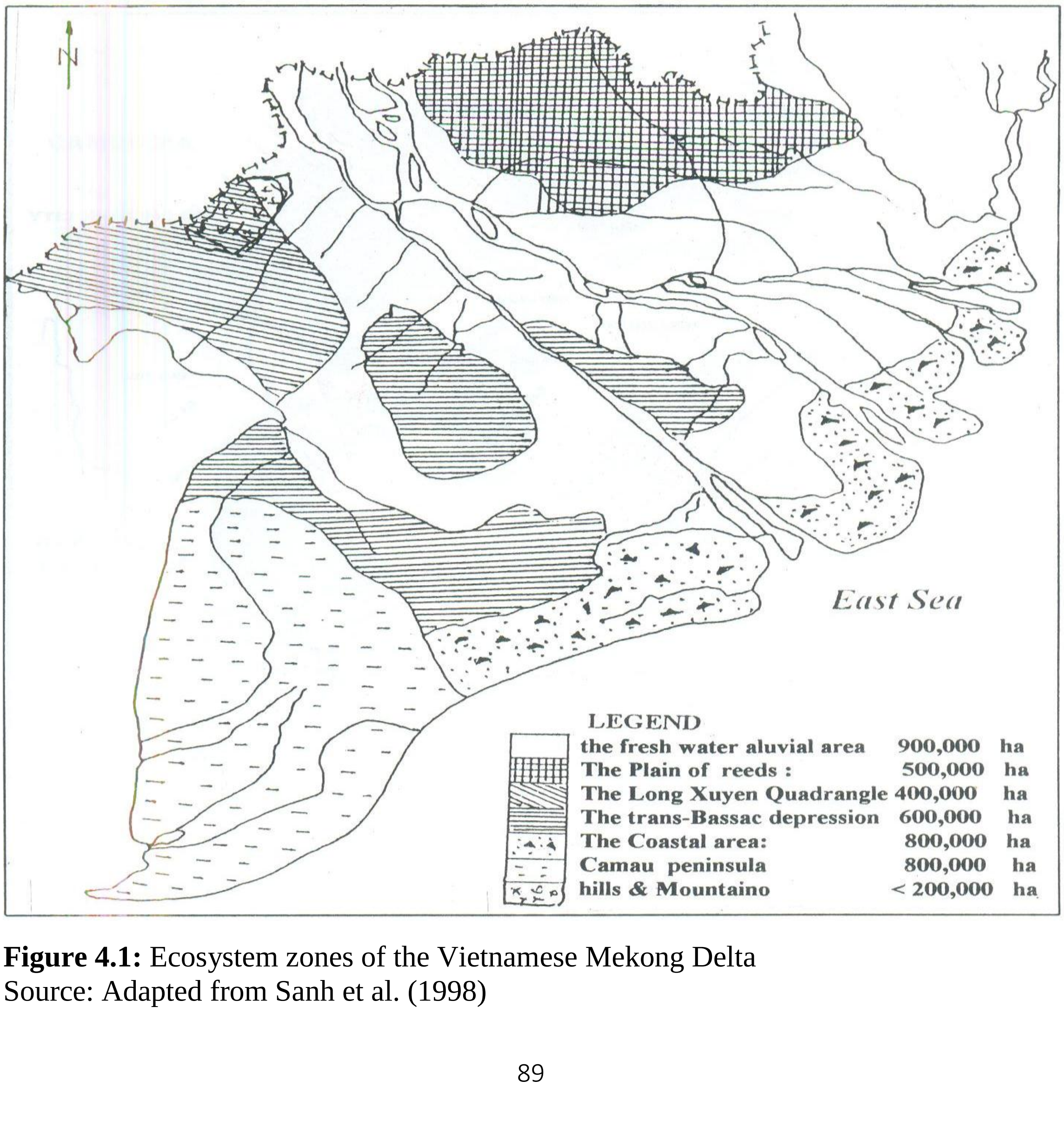

Figure 4.1: Ecosystem zones of the Vietnamese Mekong Delta
Source: Adapted from Sanh et al. (1998)

4.2.2 Climatic conditions and hydrology in the Vietnamese Mekong Delta

The VMD has a semi-equatorial, monsoon tropical climate which is characterised by a dry season from December to April, and a rainy season from May to November. The average temperature varies between 26–27 °C. The temperature in the coolest months (December to January) varies between 23–25 °C, and in the warmest month (April) between 32–33 °C. Temperature conditions will be discussed in more detail in the section on climate variability in this chapter. The rainfall distribution in the VMD varies geographically and seasonally. The average annual rainfall is approximately 1,600 mm. Annual rainfall can reach 1500 and 2500 mm in the Western part and Central part of the Delta, respectively. More than 90% of the total annual rainfall occurs in the rainy season (Sanh et al. 1998, p. 20).

The variation in water levels on the Mekong River is influenced by a combination of three main factors which usually occur at the same time including the flow of the Mekong River, the diurnal tidal movement of the East Sea, and the semi-diurnal tidal movement of the gulf of Thailand which is also called West Sea of the VMD (Smajgl et. al. 2015). Annual flooding occurs in the upper and middle parts of the VMD (Miller 2003) due to the combination of annual rainfall and a high flow of around 40,000 m^3/sec of the Mekong River, resulting in regular floods of 0.3 to 3 m during the rainy season in poorly drained, depressed areas. Serious floods (i.e., big floods) usually damage crops, housing and other infrastructure in upstream parts of the Delta (Kien & James 2013). The coastal zone and the Ca Mau Peninsula are regularly exposed to intrusion by saline and brackish water in the dry season (Tuong et al. 2003; Ut 2004).

4.3 Farming system development and relevant policies in the Vietnamese Mekong Delta

Farming systems in the VMD range from monocultures of rice, vegetables, fruit, livestock, and aquaculture, to integrated farming systems usually consisting of rice-fish, rice-vegetable, or rice-shrimp (Bosma et al. 2012). Additionally, fruit trees may also be integrated with livestock, and fish (VAC: vườn, ao, chuồng: garden, pond, and livestock) (Nhan et al. 2005). Fruit, rice intensification, integrated rice-fruit-fish system, aquaculture (i.e., raising fish) and other crops or livestock are frequently undertaken in the fresh-water alluvial zone and Hau River (a branch of the Mekong River) depression zone where irrigation water can be guaranteed because such zones are next to the Mekong River (Can et al. 2007).

Historical changes in farming systems can be analysed through a timeline which helps to identify an increase in rice production and other farming systems, including the emergence of integrated systems and intensive mono crops. A wide range of factors have influenced the development of rice and other farming systems, including canal excavation, dyke construction, high yield rice technology, agricultural mechanisation, and especially economic policy, which embedded and stimulated the development of high-yield rice and mechanisation (Table 4.1).

Table 4.1: Summary of agricultural changes in the Vietnamese Mekong Delta

Year	Major events (contribute to changes of agricultural production)
10,000 years ago	• Formation of the Mekong Delta • Oc-Eo stage and pioneer Vietnamese settlements: rice collection for food and rice cultivation. The Delta is covered by forest
1705–1858	The early stage of the exploitation of the Mekong Delta under the Nguyen dynasty, three main canals are excavated, land reclamation and development of floating rice cultivation
1858–1954	Colonial regimes • Many canals were excavated • People settle following the canal systems • Land reclamation: increase cultivated area for rice • Double transplanting and single transplanting rice • Rice plantation establishment by French colonists • Fruit tree development
1954–1975 1966–1974	Years of war Many canals were excavated, but they are not useful for the agricultural production in the rural areas and on the acid-sulphate soils in the flood plain area Introduction of High Yielding Rice varieties (IR5 and IR8) • Shift from single rice cropping to double rice cropping on alluvial soils and high topography areas • Brown plant-hopper outbreak in 1972
1975	End of war; liberation and reunification
1976–1981	Collective farm establishment • Many primary and secondary canals were excavated • Double rice cropping increased gradually • Took land of land-holder and redistributed previous land holders and landless • Many frontier area exploited (including forests & acid-sulphate soils) for rice production • Cooperative and Production group • Dyke construction was begun, but very small scale
1981–1987 1981 1988	Processing of government policy reforms Contract system policy *(Khoán 100)* Policy reform in Vietnam • De-collectivisation of farms and redistribution of land to farmers • Shifting from central-planning economics to market-oriented economics • Free market

1988–2000 1994 1996	Vietnam became the world's second rice largest exporter Sluice gates for controlling saline in coastal zones operated Dyke construction began to develop
2000-date	• Dyke construction has been gradually increased in the upstream provinces • Agricultural mechanisation • Mono-rice intensification in most provinces in the VMD • Integrated farming systems: rice and vegetable; rice-fish or rice-shrimp • Fruit in provinces nearby to Hau and Tien Rivers (two main branches of the Mekong River)

Source: Adapted from Sanh et al.(1998, pp. 31–32); Tuong et al. (2003), Ut (2004), Can et al. (2007)

4.3.1 Canal excavation and land reclamation

Most of the land area in the VMD was shaped by saline and acid soils which account for two thirds of the land area. The saline and acid soils are commonly located in the frontier zones (i.e., more natural, relatively undeveloped areas converted in new economic zones with high intensity rice rotations), and were reclaimed by leaching acids through canal excavation. According to Sanh et al. (1998, pp. 32–34), the primary canals, which directly connect to the Mekong River, are located in the three zones (Figure 4.2). The first is the Long Xuyen quadrangle which is between the left bank of the Hau River and the Gulf of Thailand. The second area is the flood plain on the right side of the Tien River (the Mekong River), the Vam Co Tay River and the old alluvial terrace near the Cambodian border (Figure 4.1). Lastly, canals in the Ca Mau Peninsula were dredged.

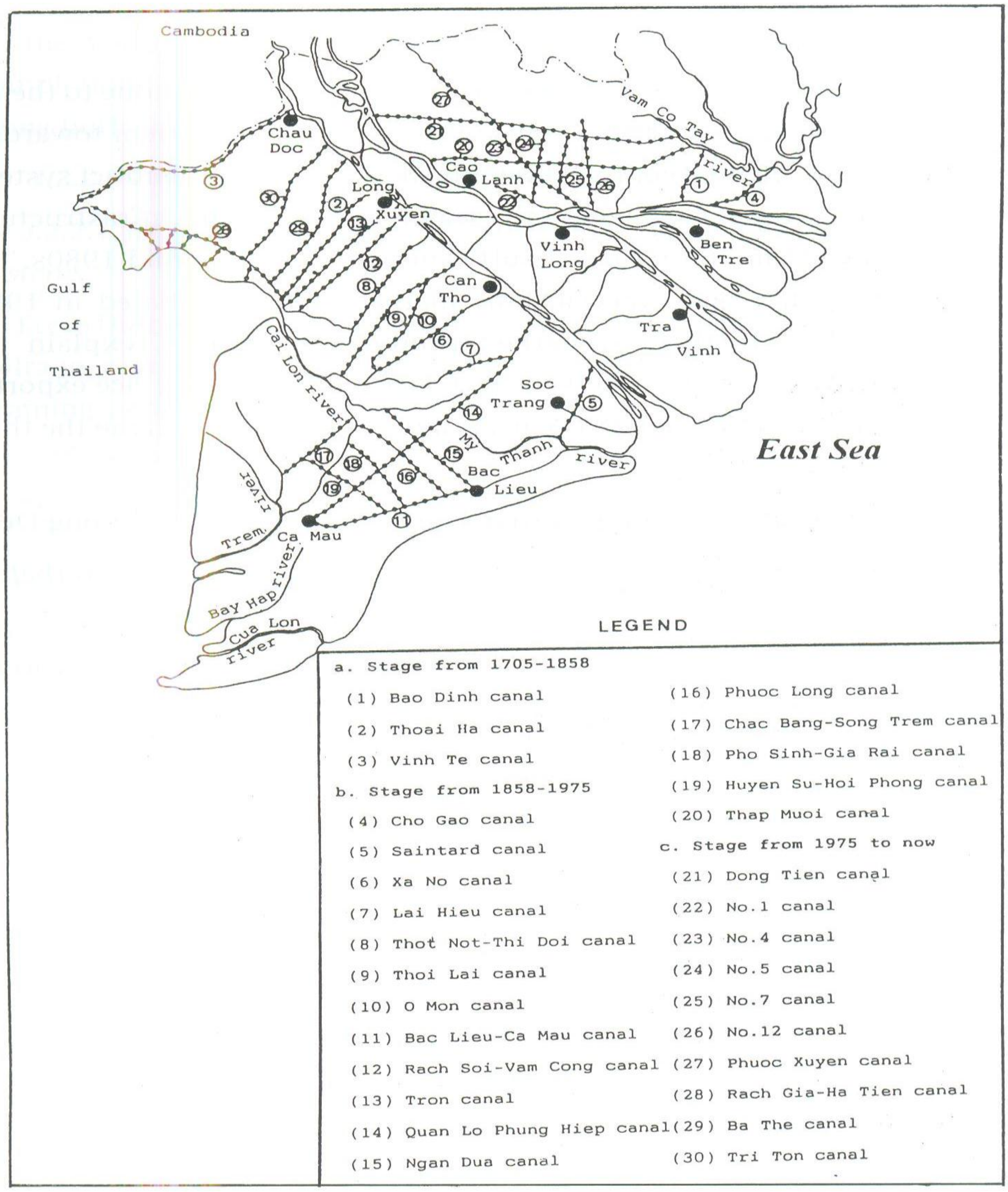

Figure 4.2: Canals excavation in the Vietnamese Mekong Delta
Source: Adapted from Sanh et al. (1998)

The canal excavation in the VMD was undertaken in four major stages. The Nguyen dynasty (1705–1858) was the early stage of canal excavation. Vinh Te was one of the first three canals in the VMD excavated to mark the border between Vietnam and Cambodia. Such a canal also strengthened national defence and exploited land for settlement and rice cultivation (Sanh et al. 1998, pp. 36–37). Under the French colonial regime (1958–1945) and other stages including 1945–1975 and after 1975, a series of canals was excavated for a wide range of purposes consisting of waterways, roads on banks of canals, and irrigation which enabled farmers to extract water from the Mekong River to be delivered to fields, and to wash away salts and acid to improve the ability to cultivate rice in acid-sulphate soil areas (Sanh et al. 1998; Miller 2003; Bigg 2010).

4.3.2 Dyke construction in the Vietnamese Mekong Delta

Dyke construction for rice production has actually existed in the VMD for more than three decades, but was mentioned in a slogan, "living with flood" *(sống chung với lũ)*, especially after historically significant floods in 1978, 1984, 1996 and 2000 (Kien 2011). According to Nha (2006, p. 34), one village in Cho Moi, a district of An Giang, was the first village in the VMD to construct permanent dykes (3.8 m high) after the high flood of 1978. At that time, permanent dykes in this village were able to prevent the peak of the annual flood, while most other communes in Cho Moi, An Giang had low dykes (i.e., 1–2 m; dykes only to prevent flood levels in August according to the lunar calendar, the so-called August dyke). The low dykes only allowed farmers to cultivate two rice crops because the second rice crop would finish in August according to the lunar calendar. A third crop was not possible because of persistent flood water. Then, farmers and the governments of other provinces recognised that dyke construction was the most important solution to protect rice and other crops from floods. According to Can et al. (2007), dyke construction is a key condition that lets farmers decide to change rice-based farming systems from two crops to three consecutive rice crops each year. The dyke construction programme in each province will be discussed in more detail in the case studies of An Giang and Can Tho.

4.3.3 Development of high-yield varieties in rice production in the Vietnamese Mekong Delta

Rice varieties also developed in different periods according to a variety of environmental conditions and food security needs in the VMD and Vietnam. For instance, before 1972, IR5 and IR8 varieties were adopted by many farmers in southern Vietnam (Ut & Kajisa 2006). In order to reduce the length of the growing season, and to avoid high floods at harvest-time in the VMD, rice scientists at the Cuu Long Rice Research Institute (CLRRI) developed varieties OM1490 and OMCS96 with super-short ripening times (85–90 days). In the coastal zones, new rice varieties might be also utilised under conditions of saline intrusion, which will be discussed in the case study of Bac Lieu province.

Since 1999 rice varieties have been transferred from scientists to farmers via a variety of pathways, including through provincial seed centres that established contract farming with local organisations to diffuse new rice varieties (Tin 2009). These local organisations consisted of agricultural extension clubs and seed producer clubs. International cooperative projects were introduced by different institutes such as Can Tho University and CLRRI for building the capacity of extension staff and seed farmers (Cuc et al. 2008). Ninety-five percent of the seed which have been sold in free markets in the VMD were produced by the networks of farmer clubs, seed production groups, and seed clubs at the commune level (Cuc et al. 2008).

4.3.4 Harvesting machine as a mechanisation in rice production

After 2000, the Ministry of Agriculture and Rural Development (MARD) and DARD of Vietnam encouraged farmers to use combine harvesters for the rice harvest. This is because agricultural scientists, as well as the Government, recognised that post-harvest rice losses in the VMD were a major element in the loss of productivity. According to Can (2004), annual average post-harvest losses made up 11.1% of total rice productivity in the VMD. Out of the post-harvest activities, losses during the harvest activity itself made up 2.9% of total rice productivity in the Delta. Therefore, policies and programmes were introduced to encourage service suppliers and farmers to invest in and use post-harvest technologies. In particular, combine harvesters were demonstrated in rice fields, through the work of agricultural extension centres in provinces across the VMD. In addition, provincial governments in the VMD also supported special policies of credit for farmers who bought combine harvesters. By 2015, there were 11,000 rice combine harvesters in the VMD (Tan 2014).

4.3.5 Development of farmer organisations in the Vietnamese Mekong Delta (1976–1986)

One year after reunification in 1976, Resolution No. 4 of the 4th National Convention of the Communist Party encouraged all southern provinces to transform gradually towards collectivisation (De 2006, p. 25). A collective economy was created in the south of Vietnam, especially in the VMD, where around 75% of people worked in rural areas. There were two models of collective organisation, including collective cooperatives and organisational teams, which existed in parallel during this period. Old models of agricultural cooperatives *(ACs: hợp tác xã kiểu cũ)* in the south were similar to the high-ranked cooperatives in the north (Keikvliet 2005). It was compulsory for farmers to work on collective farming land, and they received outputs from rice farming according to their working hours each day. In contrast, production group *(PG: tập đoàn)* were considered as low-ranked cooperatives. PG was defined “as a traditional form aimed at getting the individual peasants to exchange labour, to help each other in production, to begin to produce according to the guideline of the plans of the central government and to achieve economic relation with the central government” (Long 1988, p. 164). Nonetheless, it might have differed from one commune to another, which will be explored more specifically in the following case studies. By 1980, in the entire south of Vietnam, there were 1,158 agricultural cooperatives and 9,350 production groups established. Around 35.6% of households in the south were involved in one of the two models (i.e., 24.5% in ACs and 11.1% in production groups) (GSO 1989, p. 35). The average farming size of each AC was 312 ha, which was 1.5 times larger than in the north. Most of the ACs in the south were high-ranked cooperatives.

The number of households in southern Vietnam involved in ACs and PGs was higher than 30%, but the VMD had only 1.7% of households and approximately 8% of households joining ACs and PGs respectively, because collectivisation was not supported by a large number of people in the VMD, and they protested in different ways. For example, before being involved in cooperatives, many people uprooted fruit trees, sold their livestock, and destroyed crops, instead of giving away these crops, animals and machines to cooperatives (Kerkvliet 2005, p. 177; De 2006, p. 26). In an unexpected result after establishing cooperatives, by 1986 only 5.9% of peasants in the VMD participated in the low-ranked ACs (De 2006, p. 26).

Current model of agricultural cooperatives in the Vietnamese Mekong Delta

After 1986, the economy shifted from a collective economy to a market economy, ACs in Vietnam did not operate until 1996. ACs were operated under the cooperative laws which were reconstructed according to basic principles of the International Cooperative Alliance (ICA). The legal framework for ACs was completed in 1997, which was called the new model of AC *“hợp tác xã kiểu mới”*. The new mode of an AC is voluntary for farmers (Cooperative Law 2003 in 18/2003/QH11). Members of ACs worked on their private land, bought shares of ACs, and paid lower fees for agricultural services from ACs than non-members (Hai 2014). In contrast, the old mode it was compulsory for farmers to be involved in ACs in the period 1976–1985, as explained earlier (Kerkvliet 2005). The old mode of cooperatives will be discussed in more detail in Vinh Trach commune in the case study of An Giang (Chapter 5) and Phuoc Long commune in the case study of Bac Lieu (Chapter 7), while the new mode of cooperatives will be discussed in Thoi Tan commune in the case study of Can Tho (Chapter 6) and Phuoc Long commune in the case study of Bac Lieu (Chapter 7). Generally, both old and new modes of cooperatives have been implemented in the three provinces, although not all communes have been involved.

In 2015, there were 18,169 cooperatives in Vietnam, including 1,091 in the VMD (VCA 2015). In the VMD, ACs have been used to undertake a wide variety of service activities including irrigation, marketing, electricity, extension and credit, and supplying fertilisers, pesticide and seeds to their members and communities. However, according to Cox and Viet (2014) and Hai (2014), Vietnam has a large number of ACs with new models, but farmers have not been interested in being involved with them. This is because of negative impacts of the institutional arrangement (i.e., institution of high-ranked cooperative) of ACs with old models on farmers' perceptions and cooperative behaviours. Therefore, the role of ACs might affect farmers' collective decision-making about rice-based farming systems in multiple case studies across three provinces. The study will explore the resilience of ACs in more detail via measuring social capital between members in ACs to understand how leaders and members cooperate and work together in decision-making about farming activities

Large-sized farm model in the Vietnamese Mekong Delta

In 2002, the central government issued Decree 80/2002/QD-TTg of the Prime Minister with guidelines for contract farming between rice companies and farmers (Du & Tung 2012). This model of farming contracts has been applied frequently since 2012, after the central government issued a new Decree and guideline book for contracts and linkages between different actors involved in a contract. These actors include companies and farmers under the support of centres of the Department of Agriculture and Rural Development (DARD) of provinces; with activities comprising transferring new farming techniques to farmers, reducing tax for companies, and prioritising export rice with companies (Du & Tung 2012). This model is the large-sized farms (LSFs) model. LSFs have different sizes from 50 ha to 300 ha, sometimes even larger than 300 ha, and a number of households will have land parcels in the same LSF. LSFs are considered to be a potential model of working together *(làm cùng nhau)* at the same time and in the same large field (Miller 2003, p. 235). However, we need to identify the resilience of this model to understand how the model affects farmers' collective decision-making about rice-based farming systems and farming activities in the case study in Can Tho province.

4.4 Periods of farming systems changes in the Vietnamese Mekong Delta

4.4.1 Farming systems development (1976–1987)

After the war in southern Vietnam, the population of the Delta was slightly greater than ten million people, and over 90% of them worked in agricultural production (Sanh et al. 1998, p. 44). Fruit and rice dominated most of the land area in the Delta, with around 2,062,600 ha of rice producing up to 4,000,000 tonnes per year. The area of fruit was estimated at 50,000 to 60,000 ha. In this period, farmers in the Delta faced two threats, namely a serious outbreak of brown plant hoppers on traditional rice crops in 1977, and a serious flood in 1978. Fruit, aquaculture and rice production were seriously damaged by this flood (Sanh et al. 1998, p. 44).

4.4.2 Evolution of rice-based farming systems (1988–2016)

Rice intensification

After the transformation from a collective economy to a commercial economy, the farming systems in the Delta have completely shifted rice production from traditional cultivated patterns to intensive and diverse patterns. Rice production increased remarkably from 6,900,000 tonnes in 1985 to 12,800,000 tonnes in 1995 (Sanh et al. 1998, p. 50). Then, the development of dyke construction since 2000 enabled farmers to intensify further from two rice crops to three rice crops each year. As a result, the total area planted with rice increased from 3,946,000 ha to 4,247,000 ha between 2000 and 2014. An Giang was the leading province in the shift to three rice crops, with an increase in the planted area from 464,500 ha in 2000 to 625,800 ha in 2014 (SOAG 2014). Can Tho also shifted from two rice crops to three rice crops, with the planted area of rice increasing from 209,000 ha to 232,000 ha between 2000 and 2014 (SOCT 2000; 2005).

Rice yield in An Giang, Can Tho and Bac Lieu province

The annual rice yield of the VMD rose from just over 4 tonnes/ha/crop in 2000 to 6 tonnes/ha/crop in 2014 (Figure 4.3). Rice yield in An Giang was the highest of the three provinces from 2000 to 2014, reaching 6.5 tonnes/ha/crop in 2014. In contrast, rice yields in Bac Lieu were the lowest of the three provinces between 2000–2014, reaching nearly 6.0 tonnes/ha/crop in 2014.

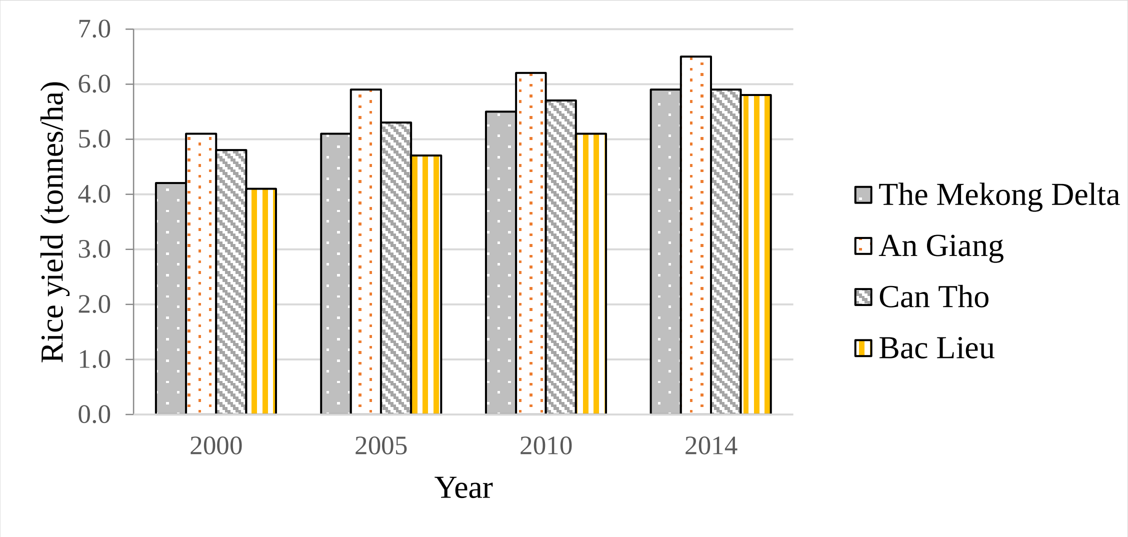

Figure 4.3: Average yields of rice (tonnes/ha/crop) from the Vietnamese Mekong Delta, An Giang, Can Tho and Bac Lieu from 2000 to 2014
Sources: GSO 2005, 2010, and 2014, Statistical offices of An Giang, Can Tho and Bac Lieu (2000, 2005, 2010, & 2014)

Rice productivity in An Giang, Can Tho and Bac Lieu

Rice productivity (i.e., the total quantity of rice) in An Giang rose from around 2,400,000 tonnes in 2000 to 4,000,000 tonnes in 2014 (Figure 4.4). In contrast, rice productivity in Bac Lieu dropped to 700,000 tonnes in 2005 from 900,000 tonnes in 2000 because some farming land areas in brackish water areas of Bac Lieu were converted from rice to shrimp in the dry season. Rice productivity in Bac Lieu increased again in 2010 (800,000 tonnes) and 2014 (1,000,000 tonnes) because the areas completely protected from saline shifted from two rice crops to three rice crops. Can Tho increased in rice productivity from 1,000,000 tonnes in 2000 to 1,300,000 tonnes in 2014. This increase in rice productivity was a result of dyke construction and other solutions, especially improving rice varieties.

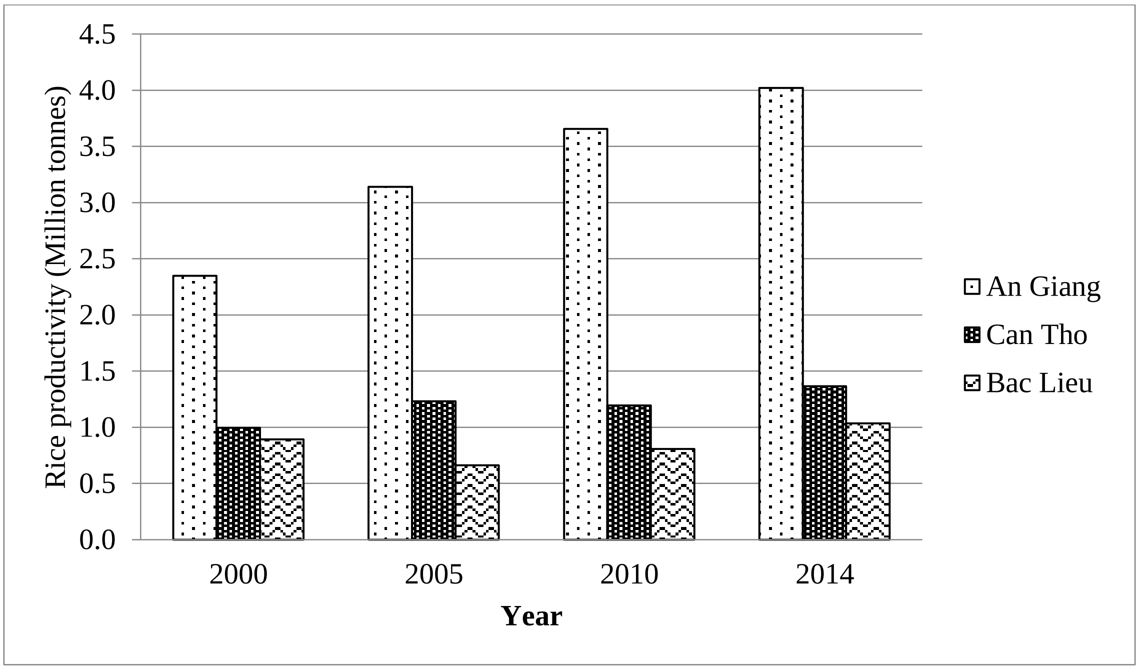

Figure 4.4: Rice productivity (million tonnes/year) of An Giang, Can Tho and Bac Lieu in the VMD from 2000 to 2014
Sources: Statistical offices of An Giang, Can Tho and Bac Lieu (2000, 2005, 2010, and 2014)

Integrated farming systems

After dyke construction in almost all provinces in the VMD, and especially in the upstream provinces, farmers began development of an integrated farming system by combining rice with other crops. For example, Cho Moi, a district of An Giang province is located in the middle of the area between the Hau River and the Tien River (two branches of the Mekong River), in the fresh-water alluvial zone of the VMD (Ha et al. 2013). According to SOAG (2014) the rice-planted area declined from 51,000 ha in 2000 to 42,000 ha in 2014, while the area planted with vegetables increased from 7,000 ha in 2000 to 27,000 ha in 2014. Farmers in this district applied the VAC system (i.e., V: garden, A: pond, C: cattle) along with baby corn on the rice land (Ha et al. 2013).

In brackish-water coastal areas, farmers adopted rice-shrimp farming systems (Hoanh et al. 2003). Until 2014, rice, intensive shrimp, and rice-shrimp were the three main farming systems in Bac Lieu province. The planted area of rice declined from 217,300 ha in 2000 to 179,000 ha in 2014 due to less rain for cultivating rice in winter (July to December) in the brackish-water areas. The area of shrimp in Bac Lieu increased from 52,129 in 2000 to nearly 124,000 ha in 2014. Out of the raised areas of shrimp, more than 80% of the area had integrated rice-shrimp systems (SOBL 2014).

4.5 Increased climate variability[8], other hazards, and impacts on the Vietnamese Mekong Delta

The VMD is expected to experience severe adverse impacts from a changing climate and sea level rise, particularly through changes in annual flooding, saline intrusion, increasing temperatures, and abnormally heavy rains. For example, according to projections by the Ministry of Natural Resource and Environment (MONRE 2009, p. 66), compared to 2009, the temperature in the south of Vietnam could increase by 1.1 ºC and 1.5 °C in 2050 and 2070 respectively. On a decadal basis, it is forecast that the temperature in the south of Vietnam could rise by 1.4, 1.6, and 1.9 °C in 2050, 2070, and 2100 respectively (MONRE 2009).

Rainfall patterns and intensity are also expected to change during this century. For example, compared with the period 1980–1999, the annual rainfall in the south of Vietnam is predicted to increase by 2–10% from 2020 to 2100, but it varies between different years in each region from the north to the south of Vietnam (MONRE 2012). Sea level rise is also a serious issue for Vietnam, especially the VMD (MONRE 2012). In high emission scenarios for future decades, compared with the period of 1980–1999, sea level rise may be 12 cm by 2020, 30 cm by 2050, 46 cm by 2070, and 100 cm by 2100. According to ICEM (2009) around 38% of the current land area of the VMD could be inundated by sea water.

Annual slow-onset floods in the Mekong River occur regularly from late July and last until December, peaking in late September or mid-October because of Cambodia's Great Lake (Tonle Sap) which functions as a large natural water retention pond. In the early part of the flood season, water from the upstream area of the Mekong River is naturally stored in the Tonle Sap Lake because of its low topography, and afterwards flood water is gradually released to the downstream basin. The VMD area that experiences slow-onset floods consists of eight upper provinces, including Long An, Dong Thap, Tien Giang, Vinh Long, Can Tho, Hau Giang, An Giang and Kien Giang, accounting for 53% of the natural area and over 50% of the population of the VMD (Xe & Dang 2007). Flood water mainly discharges from the Mekong and Bassac Rivers across the Cambodian floodplains. During high flooding, flood water comes mainly from the Mekong and Bassac Rivers, accounting for 83% to

[8] Increased climate variability is suitable in this study, but the majority of the literature refers to climate change rather than climate variability.

91% of total discharge, and the rest of the flood water overflows across the rural floodplains from Cambodia to the Plain of Reeds and Long Xuyen Quadrangle (Tuan 2014). The flooding situation in upstream areas will be discussed in more detail in relation to impacts on rice production and how farmers adapt to flooding situations in the case study of An Giang (Chapter 5).

The downstream of the Delta experienced a major threat of saline water intrusion in 2016. According to WRD (2016), due to the rainy season beginning late in 2015 along with lack of water from upstream of the Mekong River coming to the Delta, the flood in 2015 had the lowest level in the last 90 years. As a result, saline water intruded two months sooner and in a larger area than in previous years. In particular, saline water with a salinity of 4 grams/litre intruded approximately 60 km from the river mouth of Hau River inland, compared to previous years when saline intruded 20 km inland (Figure 4.5). As a result, some rice area was damaged, and this issue will be discussed more specifically in the Bac Lieu case study.

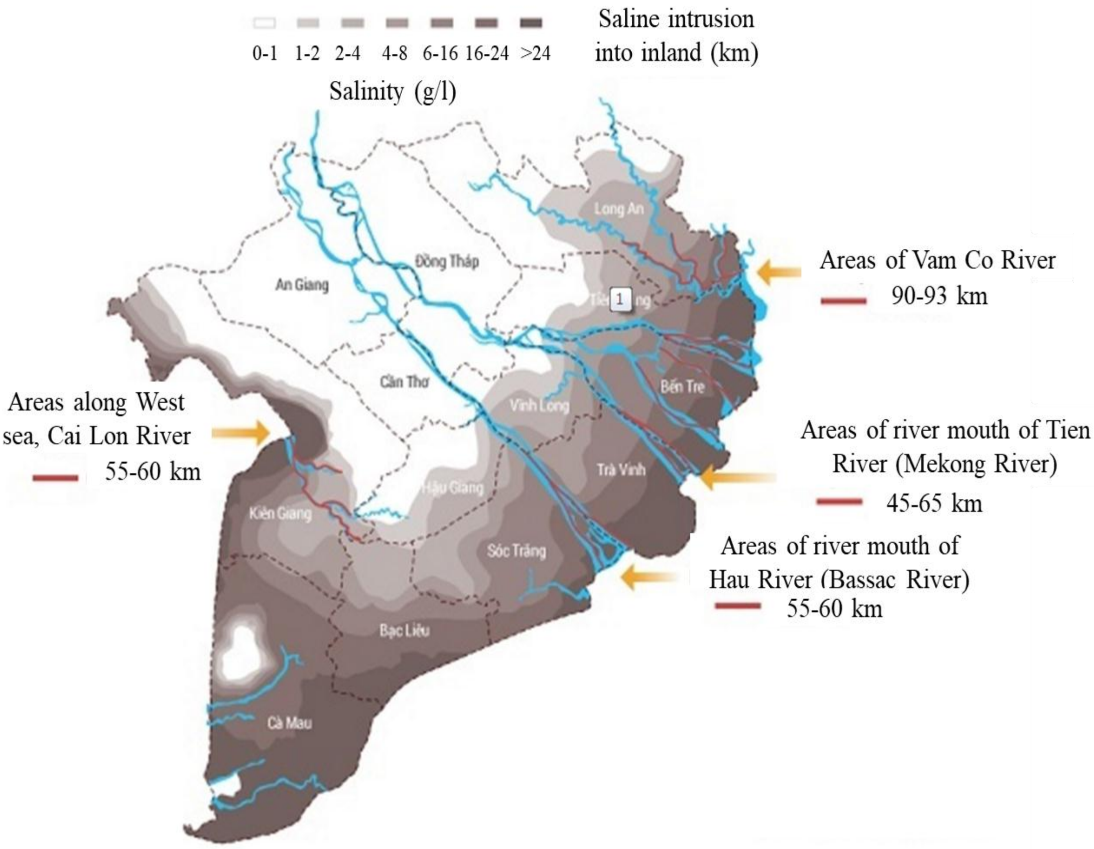

Figure 4.5: Map of saline water intrusion in the Vietnamese Mekong Delta in 2016
Source: Modified by author from adapted by website of Water Resource Directorate (WRD) of MARD (2016).

Typically, farmers in the VMD have experienced a range of constraints relating to climate variability and other hazards including flooding, high temperature, drought, saline intrusion, and high salinity. These threats might directly and indirectly influence farmers' decision-making about rice-based farming systems and farming activities. Therefore, the study will identify how these factors affect farmers' decision-making about rice-based farming systems and farming activities across multiple case studies of the three provinces.

4.6 Conclusion

In conclusion, farming systems in the VMD have seen large changes, from growing the one rice crop to three rice crops in rotation and multiple farming systems with different integrated crops, livestock, and aquaculture in different ecosystem zones. Diverse soil and water conditions in different ecosystem zones led farmers to decide on suitable rice-based farming systems for their livelihoods. Additionally, a wide range of policies relating to food security, particularly infrastructure (i.e., canal excavation, dyke construction, and sluice gates) was a key factor affecting farmers' decision-making about rice-based farming systems. Farmer organisations also changed across different periods with different names and institutions including old modes of ACs, new modes of ACs, PGs, and LSFs. Old modes of cooperatives were viewed as having negative effects on the development of rice production as well as farmers' perceptions of collective action with current farmer organisations because farmers had low trust in old modes of cooperative. These constraints might have influenced farmers' decision-making to participate in farmer organisations. Social capital is one group of indicators to understand the resilience of farmer organisations and collective decision-making. Accordingly, we are able to understand the causes of why farmers might prefer to decide on farming tasks individually rather than in collective action. This study will explore barriers in relation to farmers' collective decision-making about rice-based farming systems and farming activities.

The market economy, along with increasing climate variability (pattern, timing, and intensity) in recent years has led to uncertainty, threats and risks for farmers in the VMD. Market prices may be unstable because they depend on global and domestic market prices. In addition, variation in climatic attributes can cause regular negative impacts that influence rice-based farming systems in different ecosystem zones in the VMD. These include variations in rainfall patterns, timing and levels of flooding, duration and scale of drought, and extent and scale of saline water intrusion. Climate variability and other hazards will be discussed in more detail in the different case studies that follow.

Due to uncertain negative factors from unstable prices and factors of climate variability, current farmer organisations might be expected to help farmers make good decisions in their rice-farming systems to adapt to and cope with these threats via collective decision-making for farming activities. Therefore, the study will identify farmers' collective and individual decision-making for farming activities across case studies of An Giang, Can Tho, and Bac Lieu, particularly in relation to a range of external drivers, that are sometimes highly variable.

Chapter 5

Farmers' decision-making for rice-based farming systems in the flood zone province of the Vietnamese Mekong Delta: A case study of An Giang

5.1 Introduction

An Giang is an upstream province in the VMD and an important rice producer. Although it is extremely flood-prone due to its location (Figure 5.1), An Giang produced approximately four million tonnes of rice in 2014, accounting for 16% of the 13 provinces in the VMD and 9% of Vietnam's total rice output (GSO 2014). The total rice output in the province increased rapidly from approximately 2.3 million tonnes in 2000 to 4 million tonnes in 2014. According to Can et al. (2007), the increase in productivity of rice in recent decades has resulted from the contribution of a wide range of policies and programmes of agricultural production including dyke construction, and improvements in rice varieties and the technical knowledge of farmers. Dyke construction has enabled farmers to increase their farming intensity from two to three consecutive rice crops per year. While farmers have been able to adapt to various constraints, including climatic and non-climatic constraints and challenges, the impact of climate change is projected to become more serious over time (ICEM 2009). In addition, market prices have been unstable in recent years, and this could present more constraints for farmers in the future (Nhan et al. 2013; Can 2014). Therefore, collective farming is being considered by the Government of Vietnam as a potential agricultural model for securing better markets for farmers, and to increase adaptive capacity to respond to climate-related environmental changes, whilst meeting rice production targets. Consequently, a range of models are being considered to supporting collective decision-making in rice farming in An Giang province.

There have been few studies conducted on the role of farmer clubs (FCs) in rice production in An Giang province; most have been grey literature reports produced by donor-led projects (e.g., Can 2014). Diem (2010) worked with the Flemish Association for Development Cooperation and Technical Assistance (VVOB) with the Participatory Agricultural Extension Program (PAEX 2008–2010). The project focused on enhancing capacities of group members in terms of participation technology development (PTD) via technical knowledge in agricultural production, and the skills of participation and management in FCs. Projects to develop new rice varieties by Tin (2005) in An Giang and elsewhere in the Delta also focused on enhancing the technical knowledge of farmer organisations (via seed clubs) in rice varieties for improved seed production.

Building upon previous research in An Giang province, this chapter examines whether FCs might provide a useful organisational structure for enhancing local responses to individual and collective challenges via collective decision-making. In the view of the national government, farmer organisations could become reliable local institutions to build collective skills and capacities to improve technical knowledge, and to promote understanding of new state policies. Moreover, seed companies view advanced farmers, who are usually also members of FCs, as important conduits and influential representatives for promoting commercial sales of their products in VMD communities. Some FCs in An Giang have internal credit groups to help members meet the expenditures of rice production. In addition to these formal FCs, informal farmer groups also work together *(làm cùng nhau)* in An Giang (Miller 2003, p.235), which means that farmers work at the same time and in same place (e.g., when organising collective irrigation). In An Giang, participants might have strong traditions of collective action in rice farming, both formally and informally, for example in terms of coordinating seasonal calendars for planting and harvesting. Supporting these formal and informal collective organisations might help local farmers to improve their rice output and productivity. Generally, farmers have different choices to decide collectively and individually on rice-based farming systems under a wide range of factors including conditions of climate variability, hazards related to climate threats, and access to markets.

The aim of this chapter is to examine the decision-making orientations of rice farmers (including through formal FCs, informal collective action, and individually oriented decision-making) for rice-based farming systems. The specific objectives in this chapter are to determine the major decisions that farmers have to make about their rice-based farming systems each year, figure out factors influencing farmers' decision-making for rice- based farming systems, understand how farmers make collective and individual decisions for their rice-based farming systems, and identify decisions affecting farmers' rice-based farming systems and household livelihoods.

5.2 Research questions

Main question

What are the main questions that farmers have to consider when they make decisions about their rice-based farming systems in An Giang province?

Specific questions

1. What are the major decisions that farmers have to make about their rice-based farming systems each year?
2. Which factors influence farmers' decision-making for rice-based farming systems, and how will these factors influence them?
3. How do farmers make collective and individual decisions for their rice-based farming systems?
4. What are the consequences of the major decisions about rice-based farming systems and household livelihoods?

5.3 Concepts and methods

5.3.1 Concepts

The case study of An Giang has been developed from the livelihood conceptual framework which is synthesised from different authors (Chapter 2). Chapter 5 briefly mentions these concepts before illustrating and discussing the results of the study.

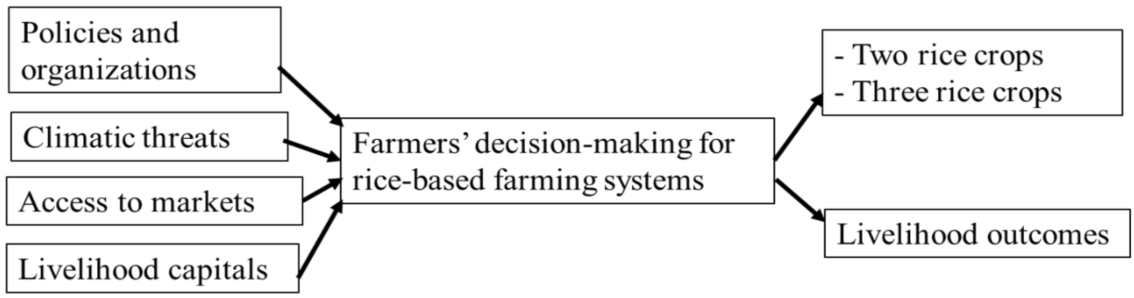

Figure 5.1: Conceptual framework of study with linkages between livelihood capitals, policies, farmer organisations, farmers' decision-making, climatic threats, access to markets and livelihood outcomes.
Source: Adapted from Chambers and Covey (1991), Scoones (1998), and Bruijn and Van Dijk (2005)

According to the conceptual framework (Figure 5.1), a number of factors might influence farmers' decision-making for rice-based farming system livelihoods (see

Chapter 2). Factors largely external to households include policies and institutions, climate, and access to markets. Factors largely internal to the household include livelihood capitals (namely, human capital, social capital, physical capital, natural capital and financial capital), and these represent a significant factor influencing the collective decision-making of FCs (Scoones 1998; DFID 1999). These concepts formed the basis for data collection and analysis, as discussed in Chapters 2 and 3.

The main rice-based farming systems in An Giang are formed through the intersection between agricultural intensification (two and three rice crop farming systems), collective and individual decision-making for strategies of farming activities, and adaptation to outside factors including agricultural policies, geographical conditions, climate and market conditions (Carswell 1997; Morris & Winter 1999; Scoones 1998; Smit 2000; Bosma et al. 2012). The outputs of rice-based farming systems (two rice crops and three rice crops) being the households' livelihood outcome presents the consequences of farmers' decision-making on rice-based farming systems (Scoones 1998; DFID 1999).

5.3.2 Research methods

Research sites

Vinh Trach commune[9] of Thoai Son, and Ta Danh commune in Tri Ton district were selected as comparative case study research sites in An Giang province (Figure 5.2). Vinh Trach is considered to be a "favourable" (or more advanced) commune by CLUES project, where three rice crops have dominated rice farming because of protection by big dykes. Vinh Trach has permanent dykes, constructed with government assistance more than ten years ago, to support farmers cultivating three consecutive rice crops each year. Here, annual flood water has been blocked from entering into the farmers' fields, and this has negative implications for the ecological reinvigoration of the rice paddy. In contrast, Ta Danh is viewed as being an "unfavourable" commune by CLUES project and most of the land area remains under a two rice crop system. Ta Danh has small dykes which are unable to block flood water, and so cannot support a third rice crop. Located upstream in Tri Ton district, close to the Vietnam-Cambodian border, Ta Danh commune experiences a stronger seasonal flood pulse than does Vinh Trach commune,

[9] Clarification of commune level is presented at the beginning of section of 5.4 regarding background to policies relating to rice development in An Giang.

and this has created obstacles for three cropping in the former commune. These issues will be elaborated upon in the next sections.

Although the two communes have slightly different environmental conditions, they have had similar activities of farmer organisations, based around the sharing of technical knowledge of rice production. In addition to the commune FC, Vinh Trach also had an agricultural cooperative *(Hợp tác xã nông nghiệp)* (AC) and a seed producer group *(Tổ sản xuất giống)*. Many commune participants in the FC in Vinh Trach are also involved in these other farmer organisations such as an AC and a seed producer group. However, this chapter focuses upon the FC as the main institution of study.

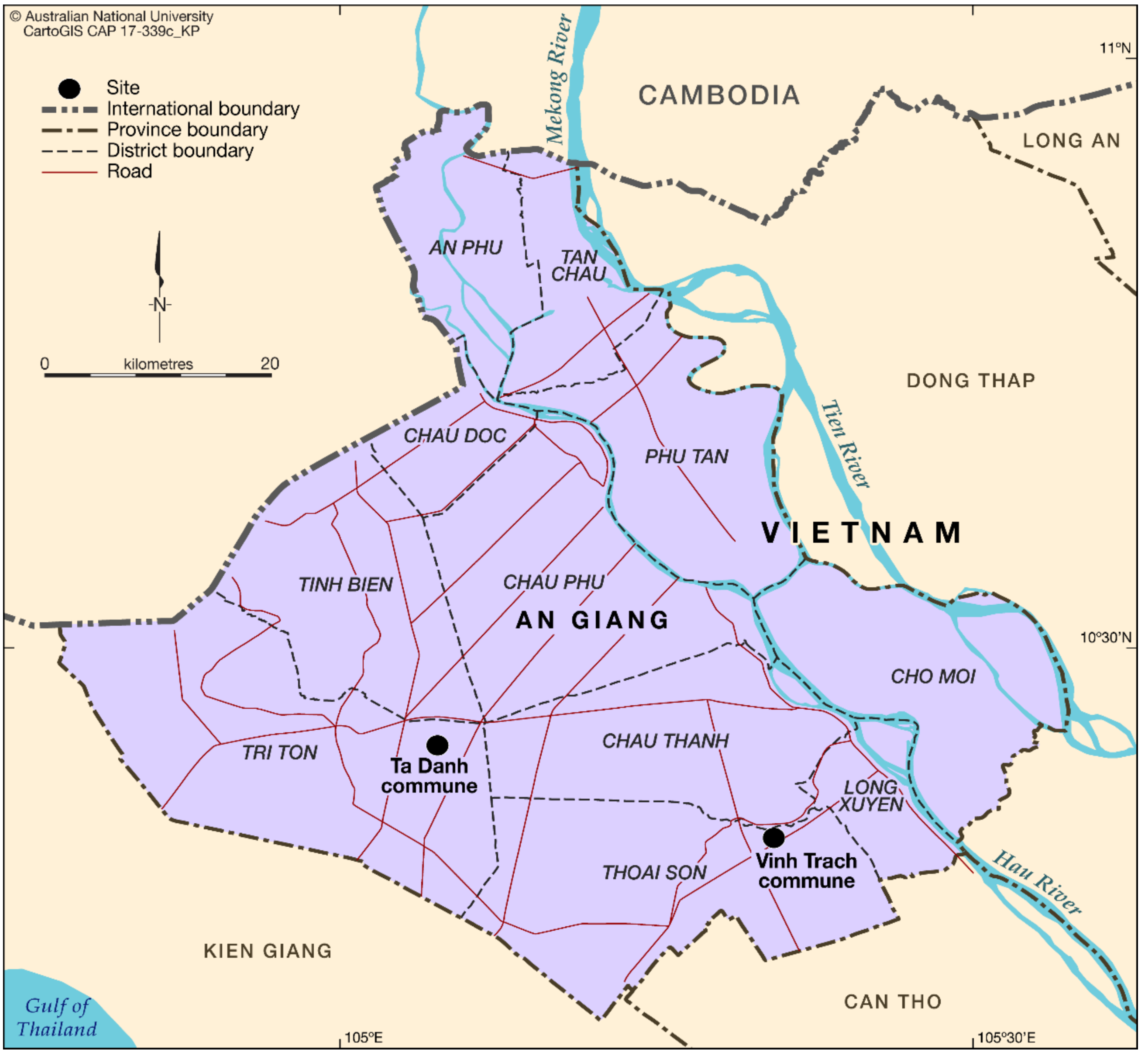

Figure 5.2: The location of Vinh Trach and Ta Danh communes in An Giang province

Data collection and analysis methods

As mentioned in Chapter 3, household surveys, semi-structured interviews, and focus group discussion (FGDs) were the three methods of data collection. A household survey with quantitative and qualitative data was conducted in Vinh Trach commune with 56 households (26 members of FC and 30 general farmers) and in Ta Danh commune with 52 households (24 members of FC and 28 general farmers). The majority of respondents to the household surveys were male (Table 3.3 in Chapter 3). The semi-structured interviews were undertaken in the two communes with 15 key informants including members of the FC, general farmers, brokers (middle people between farmers and traders), owners of combine harvesters and owners of agricultural materials (90% males). These interviews enabled the interviewers to obtain deeper insights into the networks between farmers and other actors when farmers decide their rice-farming activities. FGD was undertaken with two groups in each of the two communes: (1) the group of households having participated in FCs, and (2) the group of general farmers who had not been involved in FCs. In Vinh Trach, there were six participants in the FC and eight participants who were general farmers, and in Ta Danh there were eight participants in the FC and eight participants who were general farmers. The majority of the quantitative and qualitative data in this study will be illustrated through descriptive statistics on data and narratives.

5.3.3 General information about the Vinh Trach and Ta Danh communes of An Giang Province

The natural land area of Vinh Trach (2,078 ha) is less than half of Ta Danh (5,040 ha), of which agricultural land occupies 83% in Vinh Trach, and 70% in Ta Danh. Three consecutive rice crops a year are produced on 69% of the agricultural land in Vinh Trach, but only occupy 13% of that in Ta Danh, where two consecutive rice crop system accounts for 57% of the agricultural land (Table 5.1). The population is approximately 17,000 people in Vinh Trach and only around 7,000 people in Ta Danh. Accordingly, the number of households in Ta Danh (1,809 HHs) was less than half of that in Vinh Trach (4,105 HHs). The majority of households were of Kinh ethnicity in both Vinh Trach and Ta Danh. According to FGDs conducted in 2016, Vinh Trach was a commune with a high population density in An Giang, while Ta Danh developed later than Vinh Trach in terms of population, rice production and infrastructure. Owing to being a new commune (i.e., on a frontier area) in 1987, having an abundance of rice land area, and being a famous commune for seed production, Ta Danh attracted a large number of small land farmers and poor people from other districts of An Giang who came to Ta Danh to buy rice land, and to work as agricultural labourers in rice-farming activities including transplanting, sowing fertiliser, and spraying pesticide.

Table 5.1: Different land types (ha[1]), ethnicity distribution, and number of households in Vinh Trach and Ta Danh, An Giang province

Indicator	Vinh Trach		Ta Danh	
	Number	%	Number	%
Total land area (ha)	**2,078**	**100**	**5,040**	**100**
Agriculture (ha)	1,730	83	3,521	70
Three rice crops (ha)	1,424	69	667	13
Two rice crops of rice (ha)	0	0	2,854	57
Other types[2] of land (ha)	348	17	1.519	30
Population	**17,083**	**100**	**7,066**	**100**
Kinh ethnicity	16,691	98	7,052	100
Khmer ethnicity	384	2	4	0.1
Chinese ethnicity	8	0	0	0
Total households (HHs)	4,105	100	1,809	100
Poor households (HHs)	144	4	165	9

Source: Collected from People's Committee of Commune
Note: Poverty rate of Vietnamese government officials
1. Ha is hectare
2. Other types of land are land for homesteads, markets, schools, forests, and public land

5.4 Background to policies relating to rice development and the results in An Giang

5.4.1 Background to policies relating to rice production in An Giang

There are five levels of authority in Vietnam, national, provincial, district, commune, and village. The lowest level with a stamp is the commune authority, and they undertake policies relating to rice production, and follow policies from national, provincial, and district authorities. The village authority has very little power, they just implement policies. Under a macro market economy, there is a wide range of agricultural policies at different levels. However, due to the limited scope of the study, I reviewed policies and programmes relating to the process of the development of rice-based farming systems of Vinh Trach and Ta Danh. These policies include production groups, and dyke construction to secure third rice crops. These policies directly affected rice farming, especially more intensification with rice crop rotation from two to three consecutive crops each year. Another set of policies was related to a liberalised economy, which allowed farmers to access a wide variety of inputs comprising seeds, fertilisers, pesticides, and agricultural services such as tractors and combine harvesters.

Revolution of farmer organisations in Vinh Trach and Ta Danh

The study viewed the production group as a main organisational unit in Vinh Trach and Ta Danh in the period 1976–1986. Participants of FGDs with members of the FC in Vinh Trach responded that this cooperation model has influenced farmers' perceptions of participating in current FCs.

Production groups coincided with land reform policy in 1976: Vinh Trach had 13 production groups, with 50–60 ha per group. Production groups operated according to two crucial institutions. The first was applied in Vinh Trach in 1979, and it was similar to the old institutional arrangement of agricultural cooperatives in the North of Vietnam (Kerkvilet 2005). Farmers compulsorily worked on collective farming land, and they received outputs of rice farming according to their working hours each day. However, this model disintegrated in 1981 due to low transparency and the unfair sharing of benefits (field interview with a 68-year-old farmer in Vinh Trach in 2016), and then changed to the second model of production group.

The second model of the production group dominated the majority of collective models in rice farming in An Giang province from 1976 to 1986. Farmers readily accepted this model although they were not happy with such models because farmers had a right to work and own all outputs of rice farming on private land after paying money for inputs received from heads of production groups and submitting taxes to commune authorities. However, farmers were forced to sell to local government companies. After 1986, the second model of the production group also disintegrated because the Vietnamese economy was transformed from a collective economy to a liberalised economy. After that, farmers in Vinh Trach were able to widely access agricultural materials comprising fertilisers, pesticide, and petrol, and after producing rice, farmers could sell their grains to traders. Although production groups finished three decades ago, this cooperative institution has still had negative effects on farmers' perceptions of new institutions of farmer organisations, especially agricultural cooperatives (ACs). Consequently, only a small number of farmers are engaged in ACs. For example, there were 45 members of the Vinh Trach AC, but nearly 80% of members were local officials because they were farmers (FGDs with officials in Vinh Trach, 2015).

The production group in Ta Danh worked up until 1994 because the private supply of agricultural materials and agricultural services was scarce in Ta Danh. Nevertheless, production groups had different institutions from that in Vinh Trach. The production group in Ta Danh was viewed as being an organisation of the commune authority. Annually, the management board of the production group contracted tractors to prepare land for farmers, and distributed agricultural materials for farmers by credit. Then, after finishing the rice crop, farmers paid costs to the management board of production group in rice, but without interest. Farmers were able to sell the rest of the rice outside in free markets. After 1994 farmers were able to widely access agricultural materials as individuals because several private agricultural shops opened in Ta Danh market (FGDs in 2016).

Dyke construction for implementing the three rice crops in An Giang (2000 to 2016)

Vinh Trach was one of the communes in An Giang province with early construction of dykes to secure a third rice crop. According to the FGDs (2016), dykes not only blocked floods from entering rice fields but also transported and protected settlements. The majority of dykes in Vinh Trach were constructed nearly 15 years ago. In the first three years of dyke construction, farmers and local officials had to deal with big floods because although the dykes had been already constructed they were not strong enough to block floods entering rice fields, and farmers faced this risk annually. By 2016 such dykes were stable.

The land area used for three rice crops in Ta Danh was around 700 ha, and dykes securing the third rice crop were constructed from 2011. In order to conduct construction of dykes to secure the third rice crop, commune authorities sent letters to farmers who had land parcels in a large farm to ask their opinions on constructing the dyke. Then, the representative of the authority of the commune and village had a meeting with such farmers to decide on the cost of dyke construction and time of payment. In the first model of three rice crops in Ta Danh, the provincial government subsidised the construction of dykes with VND 2 million (USD 90) per ha. Farmers paid the rest of the construction costs with approximately VND 10 million (USD 450) per ha, according to each rice crop, and this was paid within two years.

Commercialisation of rice varieties in An Giang

According to documents from the provincial agricultural extension centre (AEC) of An Giang province, production and commercialisation of rice varieties (i.e., seed) was issued by the Department of Agriculture and Rural Development (DARD) of An Giang in 2000. The Community Biodiversity Development and Conservation (CBDC) project of Can Tho University cooperated with AEC of An Giang to diffuse technical knowledge of seed production to farmers through networks of FCs in communes in An Giang because most members of FCs were advanced farmers who had good technical knowledge of rice production. After that, staff of AEC and advanced farmers annually continued to diffuse this technical knowledge to their organisations and other communes. In 2014, An Giang had more than 8,000 ha producing seed per crop. Seed production and commercialisation contributed to an increase in the quality and quantity of normal rice. For example, if farmers used a good rice variety from seed production by FCs or seed producer groups, then the rice yield was able to be increased by 5–10% compared to normal rice varieties. Seed production in Vinh Trach and Ta Danh developed at the same time at provincial levels because the FCs of the two communes are in the networks of seed production of AEC of An Giang.

5.4.2 The consequences of the process of rice intensification in Vinh Trach and Ta Danh

Between 1976 and 1980, most farmers in Vinh Trach cultivated one floating rice crop a year, and the yield was approximately 2 tonnes/ha/crop (Table 5.2). From 1981 to 1986, all farming land area in Vinh Trach was cultivated with two rice crops each year. The rice yields of the first and second crops were approximately 6 tonnes and approximately 4 tonnes/ha/crop respectively. Vinh Trach began the three rice crops in 2003, and by 2005 the model had completely expanded to all land areas in the commune because the land areas had big dykes to secure the third crops from flooding. The ouput of each rice crop also increased gradually. For instance, the yield of the first crop increased from 6 tonnes/ha/crop in 2000 to 9 tonnes/ha/crop in 2014 (Table 5.2).

Table 5.2: Relevant policies of rice production and rice yield (tonnes/ha/crop) in Vinh Trach

Year	Policies	Change in rice-based farming systems	Farmers' responses	Rice yield
1976–1980	• Control/planning economy • Land conversion • Canal development(by hand) • Production group	Floating rice crop each year	Followed government policies but not interested in land conversion and this cooperative model, and then changing policies	~ 2 tonnes/ha/crop
1981–1986	• Contract farming with government in the planned economy • Production group • Improved and opened canals (by hand)	2 rice crops	Followed government policies but was not interested in land conversion and this cooperative model	• 1st crop: ~6 tonnes/ha/crop • 2nd crop: ~4 tonnes/ha/crop
1987–2000	• Market economy • Land conversion • Improved canals (by machine) • Technical knowledge via agricultural extension and farmer associations (farmer clubs, seed production groups)	2 rice crops	Followed government policies but low productivity of rice because of technical knowledge and input supply	• 1st crop: ~8 tonnes/ha/crop • 2nd crop: ~6 tonnes/ha/crop
2003	• Cooperative (update) • Technical knowledge • Improved canals • Controlling insects • Seed production • Dyke construction • Contract farming	3 rice crops a year on rice land	Followed government policies but some arguments due to considering costs and benefits (cost of dyke construction and soil quality degradation)	• 1st crop: ~8 tonnes/ha/crop • 2nd crop: ~6 tonnes/ha/crop • 3rd crop: ~6.5 tonnes/ha/crop
2007–2013	• Cooperative • Technical knowledge • Improved canals • High seed quality • Dyke construction • Contract farming • Combine harvester (Decree 65 of Prime Minister	3 rice crops a year with high quality rice variety on the rice land		• 1st crop: ~9 tonnes/ha/crop • 2nd crop: ~6 tonnes/ha/crop • 3rd crop: ~6.5 tonnes/ha/crop

Source: combined from DARD and FGDs in 2016, and household surveys in 2015

In Ta Danh, the majority of land area had still been cultivated with one floating rice crop a year between 1987 and 1990 (Table 5.3). The annual yield of this model was approximately 1.4 tonnes/ha/crop. After 1991 almost all rice land areas in Ta Danh were changed from one floating rice crop to the two rice crop pattern a year. The rice yield of each rice crop increased gradually from approximately 8 tonnes/ha/crop in 2000 to approximately 9 tonnes 2011 (Table 5.3). After 2011, nearly one-fifth (20%: ~ 667 ha) of rice land area in the commune continued to be shifted from two rice crops to the three rice crop system. The rice yield of each crop from first to third crop was respectively 9, 6, and 7 tonnes/ha/crop.

Table 5.3: Relevant policies of rice production and rice yield (tonnes/ha/crop) in Ta Danh

Year	**Policies**	**Changes in rice farming systems**	**Farmers' responses**	**Rice yield**
1987–1990	• Market economy • Canal development • Production group	Floating rice crop each year	Followed the policies	~1.4 tonnes
1991–2000	• Market economy • Production groups • Improved and opened canals (by hand)	2 rice crops	Followed the policies	• 1st crop: ~8 tonnes/ha/crop • 2nd crop: ~5 tonnes/ha/crop
2001–2007	• Seed production • Combine harvester • Technical knowledge via agricultural extension and farmer associations • Farmer Clubs	2 rice crops	Followed the policies	
2011–2015	• Market economy • Technical knowledge via agricultural extension and farmer associations • Seed production • Informal contract farming	• 2 rice crops • 3 rice crops	Followed the policies	• 1st crop: ~9 tonnes/ha/crop • 2nd crop: ~6 tonnes/ha/crop • 3rd crop: ~ 7 tonnes/ha/crop

Source: Collected from DARD, FGDs in 2016, and household surveys in 2015

Generally, members of FCs and individual farmers in Vinh Trach and Ta Danh have accumulated knowledge of rice production over many years. Therefore, their decision-making in relation to rice-based farming systems was typically to opt for two or three rice crops a year. In the first question in the results and discussion, I will present and discuss how farmers decided on two and three rice crops a year.

5.5 Results and discussion

As reviewed in Chapter 2, according to Nicholson et al. (2015), decision-making is a process, and it is also essential to consider decision items or tasks. There are simple, complicated or complex decisions to make. Nicholson et al. (2015, p. 2) also explained that, "there are a range of explanations about how people make decisions. A commonly accepted approach involves conducting logical, rational analysis, often with the support of calculators, tools or models to determine various outcomes. These outcomes are compared and the most favourable results accepted as the best. Financial and management tools are commonly used in agriculture to provide these types of outputs". A range of studies was likely to support the approach that decision-making is not simply rational and not always methodically thought through. For example, Öhlmér et al. (1998) used models of decision-making to analyse farmers' decision-making behaviours with eight steps of farmer's decision-making such as value and goals (i.e., good or bad results), problem detection, problem definition, observation, analysis, development of intention, implementation, and bearing responsibility after implementation. Therefore, value was a first step for farmers' decisions about their crop or farming items.

In this study, decision-making approaches in relation to rice-based farming systems have only depended on the characteristics and scale of decision tasks. When presenting and discussing how farmers decide rice-based farming systems, it is essential to consider which rice-based farming systems farmers choose and why they decide on a particular farming system. As explained in Chapter 3 (i.e., research methods), farmers could not answer how they decided on a particular rice-based farming system directly because it is a complicated decision for them. However, they responded about what crop they decided to cultivate, and why they chose this crop. The narratives for the clarification of the factors affecting farmers' decision-making described the process of how farmers decide upon a particular rice-based farming system each year.

Farmers have a wide range of decision-making tasks in rice-based farming systems. Farmers have to decide on a particular rice-based farming system such as two rice crops, or three rice crop each year. Then, they have to make decisions in relation to different farming activities for each rice crop including choosing production of seed or normal rice (rice for consumption), setting the seasonal calendar, selecting rice varieties, draining water outside rice fields, harvesting, accessing labour for spraying pesticide, and accessing agricultural services (see Tables 5.10 & 5.11 in section 5.5.3 in this chapter). Furthermore, they make both collective and individual decisions when deciding on different farming activities. In section 5.5.1, the study will present and discuss what, how and why farmers decide on two rice crops or three rice crops for the case study in An Giang, while various specific farming activities in each crop will be presented and discussed in detail in section 5.5.3 of this chapter. Section 5.5.3 will present and discuss more specific tasks of decision-making, not only collective and individual, but also explain why and how they decide on various farming activities.

5.5.1 Farmers' decision-making for two and three rice crops (Research question 1)

This section will show the results and discuss what farmers decide on a particular rice-based farming system, and why they decide to choose this farming system. As mentioned above, the study will discuss what farmers decide on two or three rice crops in the case study of An Giang with Vinh Trach and Ta Danh communes. The reasons for making presentations and discussions on why farmers decide on two or three rice crops are that two rice-based farming systems dominated most of the land area in Vinh Trach and Ta Danh (Table 5.1). In addition, rice cultivation was one of the main rice-based farming systems and a main income source for farmers in the two communes. After farmers in Vinh Trach and Ta Danh decide on whether to cultivate two or three rice crops, they continue with making decisions about a wide range of farming activities (see Tables 5.10 & 5.11 in section 5.5.3 of this chapter), which will be discussed in detail in section 5.5.3 because Tables 5.10 and 5.11 present particular farming activities that farmers make decision about and how they make collective and individual decisions on two and three rice crops systems.

All members of the FC and general farmers in Vinh Trach typically made individual decisions about whether to grow three consecutive rice crops in 2014. By comparison, in Ta Danh, 67% (16 households) of members and 71% (20 households) of general farmers decided on two consecutive rice crops, while 33% (8 households) of members of the FC and 29% (8 households) selected three rice crops (Table 5.4).

Table 5.4: Number and percentage of households cultivating two rice crops and three rice crops each year of members of farmer club (FC) and general farmers in Vinh Trach and Ta Danh, An Giang province

Indicator	Vinh Trach				Ta Danh			
	Members of FC		General farmers		Members of FC		General farmers	
	HHs	%	HHs	%	HHs	%	HHs	%
Two rice crops	0		0		16	67	20	71
Three rice crops	26	100	30	100	8	33	8	29
Total	**26**	**100**	**30**	**100**	**24**	**100**	**28**	**100**

Source: Household surveys in 2015
Note: HHs is number of households

My results identified that farmers (both FC members and non-members) who engaged in three rice crops were mostly located within the high-dyke systems, whereas two rice crops farmers were mostly located in the low-dyke systems. According to the respondents, there are four crucial factors influencing farmers' decision-making (both members of FCs and general farmers) for cultivating two rice crops or three rice crops in the two communes. They included household consumption, access to markets, dyke construction, and farmers' perceptions and behaviours with "safety first" (Scott 1976, p. 18) via estimating costs and benefits of rice production.

First, farmers (both members of the FC and non-members) decide on rice-cropping strategies not only in relation to commercial considerations, but also in relation to different household consumption requirements. Normally, farmers with normal rice production preserve enough rice to consume for the next three months or longer according to the time of harvesting for the next season. According to the respondents, if they sell their total harvest to traders, then they have to buy other rice at a high price for household consumption. Moreover, with the perception of "safety first", farmers with normal rice production also perceived that they were not able to predict the productivity of the next season. In contrast, farmers producing seed crops (rice variety) sold their total production to seed companies because the seed companies do not allow seed farmers to preserve for consumption (personal field note in August 2016).

Secondly, access to good markets is considered to be an important factor in farmers' decisions to cultivate rice, instead of other crops. According to respondents, rice has an unstable market price, but is easier to sell than other "high value" crops (e.g., baby corn) because it is consumed in both domestic and international markets. They stated that local brokers (i.e., a middle person connecting traders and farmers) contacted them when rice crops were nearly harvestable. In contrast, if they change to other crops, they do not always know how to sell their products. Moreover, they have to rely on a monopoly trader or a company for selling. For example, Mr L., a member of the FC in Vinh Trach, is a small farmer with approximately 0.5 ha for seed production, and stated:

> I had a small land area, then I rented 0.3 ha in 2014 from other farmers in the commune to cultivate baby corn to improve family income because I do not have a large land area. However, I had to rely on a company for selling the product because this company supplied seed for my production. If I did not sell to this company, they will not supply seed for the next season. In addition, it is difficult to sell in the local

market because baby corn is not a daily item of food for local people, and very few local traders buy it.

(Field interview Mr L. in August in 2016)

In this case, the farmer was reluctant to change from a rice-farming system to other high value crops because of problems with access to local markets. According to Mr L., it was also difficult to select suitable land for renting to cultivate other crops because the majority of farmers in the same area cultivate rice. If one farmer switches to other crops, then conflicts with other farmers over irrigation water might occur because of different seasonal calendars and demands for water use. In the above case, Mr L. had to select a suitable land location with irrigation such as an adjacent canal for his crop. He also informed me that the quality of soil in his commune is more suitable for rice than for other crops. This information is also confirmed by the head of the commune agricultural office. The officer responded that it is challenging for farmers to make decisions to select other crops because they rely on access to water, suitable soils, and facilitative markets.

Thirdly, as mentioned earlier, dyke construction is a key factor in helping farmers secure a third rice crop. In Vinh Trach, all farmers decided to cultivate three consecutive rice crops, while in Ta Danh only 33% of members of the FC and 28% of general farmers decided to cultivate three rice crops because only a smaller area of land in Ta Danh is secured by large dykes. Most other farmers in Ta Danh decided to cultivate two rice crops because their land was located in an area protected by a small dyke which was not able to block high floods from entering the rice fields.

Fourthly, in Ta Danh, the majority of farmers (both members of the FC and general farmers) decided to limit their farms to two rice crops due to their low-dyke system and for other reasons. For example, some members of the FC informed me that they are rice seed farmers and have a large area, and they preferred to cultivate two rice crops each year. They released farming land for fallow in order to accumulate alluvium (a kind of natural fertiliser from floods) for their land in the flood season, instead of cultivating a third rice crop. In addition, some farmers also have off-farm activities such as agricultural services (such as tractors and combine harvesters). According to their perceptions, the net return (profit) of three rice crops is not higher than for two rice crops, because of high production costs in the third rice crop, and a resulting lack of alluvium from flood water, leading to soil degradation. This perception was also referred to as a “safety first” system by Scott (1976, p. 18). This implies that farmers rejected certain innovations or changes because they considered them in relation to overall livelihood and economic effectiveness.

Some members of the FC and general farmers in Ta Danh would actually prefer to cultivate three rice crops, but it was impossible to do that because their land was located inside the land area with small dyke systems, which could not secure the third crop from floods. They responded that they would prefer to cultivate a third rice crop because market prices for rice in this season are higher than other crops due to the small land area for a third rice crop in Ta Danh. However, in order to construct dykes to cultivate three rice crops, they need the support of money from the provincial government.

More generally, farmers in Vinh Trach and Ta Danh depended on different factors to decide on two rice crops and three rice crops for their main rice-based farming systems. Farmers have always made decisions on rice-farming systems based on common practices and past experience. The next section will present the results and discussion of the study about factors influencing the farming activities of each rice crop in rice-based farming systems.

5.5.2 Factors influencing farmers’ decision-making for rice intensification in Vinh Trach and Ta Danh (Research question 2)

There are a range of factors influencing farmers’ livelihoods or related to farmers’ decision-making about livelihood strategies, farming systems, and land use including environmental, physical and social risks (Miller 2003; Bruijn & Van Dijk 2005), climatic conditions, land, water conditions, access to market (Bosma et al. 2012), livelihood capital and resources (Trung et al. 2017), and market or social ecological uncertainties (Ha 2012). Different groups of household (better-off, middle, and poor income) typically had a range of pressures on their livelihoods in the VMD. For example, Thong and James (2017) determined pressures on households’ livelihoods, finding it was more challenging for the poor households if there was a decrease in fish and other aquatic resources (i.e., due to high dykes for securing three rice crops in the flood season) in the flooding zone of the VMD. The poor households have also lost their labouring jobs in the agricultural sector due to the mechanisation of agriculture (combine harvesters for rice production). As a result, they migrate to the city to find jobs (Thong & James 2017). However, through literature reviews in relation to farmers' decision-making, and the present results from the research sites, this study will focus on factors that might affect farmers' decision-making on rice-farming activities and tasks. In particular, as reviewed in Chapter 2, factors influencing farmers' decision-making about rice-based farming systems include policies and organisations, climate threats and access to local markets, and livelihood assets and access.

According to farmer organisation selections in relation to collective decision-making, a FC were selected as the key farmer organisation to examine their influence directly on farmers' formal collective decision-making about farming activities. Social capital is a main group of indicators to evaluate not only the resilience of FCs, but also collective decision-making for rice-farming activities. That is because the link between decision-making in relation to the various decision items is that in a region with a high degree of social capital, farmers will be able to reach agreement faster on questions such as whether they should work together, in parallel or separately on a particular activity (i.e., draining of flooding the dyke area, selection of seed, etc.) than they would in areas with a low degree of social capital.

Social capital as a crucial factor influencing resilience of current farmer clubs for collective decision-making in rice farming systems

Farmer clubs applied into Vinh Trach and Ta Danh

Vinh Trach has applied FCs since 2000 with 54 members. According to a 62-year-old male farmer, a member of an FC, the FC had a monthly meeting on the 23rd of each month to share their experience and situation of rice crops such as insects, diseases, pests, and irrigation conditions. Also, they received projects to enhance farmers' capacity from Can Tho University and higher-level authorities. According to a 68-year-old male farmer, a head of the FC at Vinh Trach commune in the period 2000 to 2013, the FC contributed to building technical knowledge in seed production for rice and normal rice (market rice) for farmers in Vinh Trach, not only for members of the FC but also general farmers in and outside Vinh Trach commune.

The FC of Tan Thuan village, a main FC in Ta Danh commune, was established in 2002, but they have worked more regularly since 2008, after they were supported by funding and training in participatory technology development and credit models from an agricultural extension project of Can Tho University. Similar to the FC in Vinh Trach, the FC in Ta Danh had monthly meetings to share technical knowledge of seed and normal rice production, or to set up a seasonal calendar (FGDs with members of the FC in Ta Danh in 2016). According to a 44-year-old man, a previous head of this FC, the FC had a reliable model of internal credit. All members participating in this model contributed money (i.e., shares) to the FC to support members with constraints to get a small loan from these funds to buy agricultural materials, or conduct other livelihood activities such as buying fertilisers, or raising cows or ducks.

Social capital as a crucial factor influencing on resilience of current farmer club

The method of measuring social capital indices (i.e., statements) in this study was adopted from Krishna and Uphoff (1999), Thuy (2007), and Kien (2011). These studies focussed on relationships between individual farmers, and between farmers and the community, whereas this present work is measuring social capital indices for FCs so as to understand the resilience of FCs in Vinh Trach and Ta Danh. The indices of social cohesion, social trust, and social commitment were drawn from collective rice-farming activities (FGDs with heads of FCs in 2015). Social capital indices (i.e., statements) provided more understanding of the degree of relationships between members, and between members and the leaders of FCs. If relationships between different members, and members and leaders, were maintained and developed, then the FC contributed to enhancing technical knowledge for members of the FC in rice production, and to having good networks with their customers, such as contract farming for seed production. In household surveys, participants of the AC and LSFs were asked to select from completely disagree (1) to completely agree (5) from a wide range of statements (i.e., indices) that were built via a variety of collective rice farming activities.

Statements of social cohesion of the FC in Vinh Trach attained a higher mean score than those of the FC in Ta Danh. For example, the statement, “People are friendly in the organisation” of the FC in Vinh Trach obtained a mean score of 4.2, while that of the FC in Ta Danh gained a score of 4 (Figure 5.3). In addition, members of the FC in Vinh Trach attained a higher score (3.9) than members of the FC in Ta Danh (2.3) with the statement, “Members usually agree to begin crops at the same time”. That is because the majority of members of the FC and general farmers in Vinh Trach cultivated three rice crops each year. The seasonal calendar for each crop was the same for land parcels at the same large field so that farmers drained water out of large field collectively when there was the combination of flood and rain. In contrast, more than half of the members of the FC in Ta Danh cultivated two rice crops each year. Farmers selected seasonal calendar more individually. They finished the second rice crop before floods could inundate fields and damage the rice.

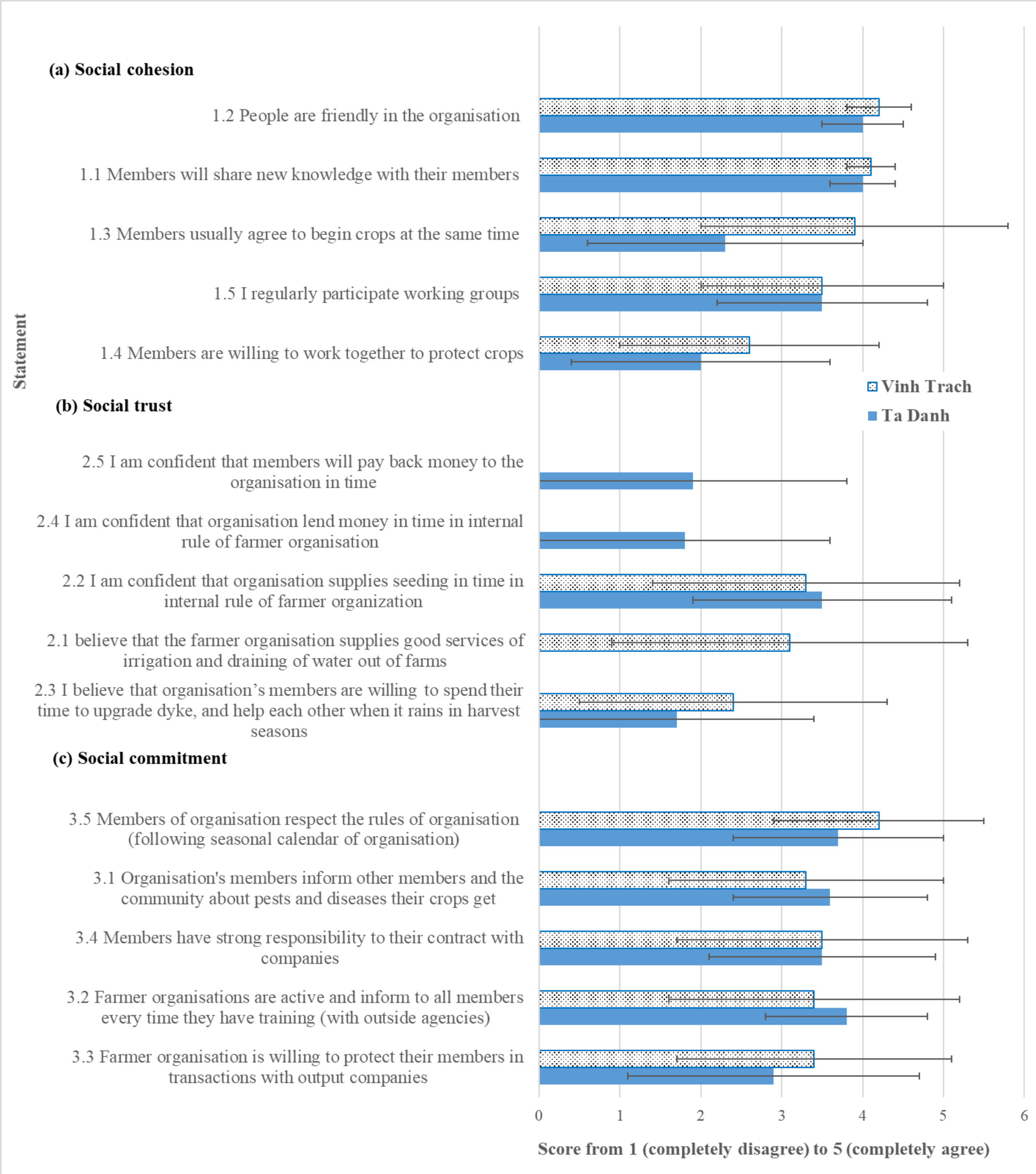

Figure 5.3: Comparison of social cohesion (a), social trust (b), and social commitment (c) of members between two farmer clubs in Vinh Trach (n = 26 households) and Ta Danh (n = 24 households), An Giang by members' perceptions. Score measured from 1 = completely disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = completely agree, and the bar shows the mean and the error bars present 1 standard deviation.
Source: Household surveys in 2015

Social trust of members of the FC at Vinh Trach commune frequently obtained a lower score (3.3) than members of the FC at Ta Danh (3.5) with the statement, “I am confident that the organisation supplies seeding in time in internal rule of farmer organisation” (Figure 5.3). That is because the majority of members of the FC at Ta Danh produce seed, while many members in Vinh Trach did not participate in the seed producer group to produce seed. In contrast, members of the FC at Vinh Trach obtained a higher score (2.4) than that of the FC at Ta Danh (1.8) with the statement “I believe that the organisation’s members are willing to spend their time to upgrade dykes, and help each other when it rains in harvest seasons”.

For the FC in Ta Danh, credit activity was considered to be important. The index score of this activity was 1.8 with, “I am confident that organisation lends money in time in internal rule of farmer organisation”, and 3.7 with, “I am confident that members will pay back money to the organisation in time” (Figure 5.3). According to a current leader of the FC, some members in the FC had an average income level. They had volunteered to be involved in the FC to obtain loans from the FC to overcome financial constraints in livelihoods such as spending on the costs of rice production, or raising pigs, or cows. However, it was impossible for them to sell products to be able to return money to the FC in time. These cases caused some members not to trust previous borrowers. In addition, the FC lent money to new borrowers using credit from previous members who returned previous credit to the FC.

The social commitment of the FC in Vinh Trach, measured with the two statements, “Farmer organisation is willing to protect their members in transactions with output companies” and, “Members have strong responsibility to their contract with companies” attained scores of 3.7 and 3.5 respectively (Figure 5.3). The score of the two statements implied that there was a good commitment between members and seed companies. However, some members withdrew from the seed producer group. According to Mr N., a member of the FC in Vinh Trach, numerous members did not agree with the coordination methods of the leader of the FC. They argued that the leader prioritised collecting their seed from rice fields after harvesting earlier than other members. Companies usually complained about the output quality of seed production of several members. According to Mr N., seed companies require high quality seed, and some members in the seed producer group could not meet that need.

Figure 5.3 also reveals that members of the FC in Vinh Trach had stronger social cohesion than those of the FC in Ta Danh. That is because the FC in Vinh Trach developed earlier than that in Ta Danh. The FC in Vinh started in 1996 with another name, that is, IPM club (Integrated Pest Management). In addition, a long-term skills programme (i.e., attending training) allowed members of this organisation to have strong cohesion. This type of social capital has also existed over many years in local areas in An Giang (De 2006; Tuan 2014). In contrast, the FC in Ta Danh began to work as an FC in 2008, and more formally in 2010. However, there were no differences in social trust between the two FCs in Vinh Trach and Ta Danh. That is because they did not have all the same collective activities for comparison. In contrast, the social commitment of members in the FC in Vinh Trach and Ta Danh has nearly similar scores from different activities. That is because these activities relate to collective activities with seed production of members of the FC in Vinh Trach and Ta Danh. Therefore, if members in an organisation did not have strong commitment, then they might not trust each other because the commitment of someone to another is able to create conditional trust from this member to another (Tuan et al. 2014).

Although social cohesion, trust and commitment of members of the FC in Vinh Trach and Ta Danh had high scores for some collective activities, these forms of social capital of members of the FC in the two communes declined after the advanced farmers withdrew from their leader positions at the end of 2015. That is because these leaders were busy with their seed company and seed production, and members of the FC were also busy with their rice production. Leaders of the FC in Vinh Trach and Ta Danh were advanced farmers. They were pioneers in rice evolution in their communes. They also contributed to the local community by volunteering to pioneer innovations such as using new seed, and applying new technical knowledge on their farms so that other farmers could adopt it. Although formal social capital declined gradually in both FCs in Vinh Trach and Ta Danh, informal social capital has existed for years in rice production in Vinh Trach with bonding social capital between farmers. Therefore, formal social capital and formal farmer organisations have reduced in importance in farmers' collective decision-making about rice-farming activities. This is because strong social capital between members of an FC is able to reach agreement faster in collective decision-making associated with farming activities. The study will explore more specifically decision-making for rice-farming activities.

Climate variability as a threat affecting farmers' decision-making for three rice crops

Climate change, flooding, sea level rise, salinity, and drought have been large global issues (IPCC 2007), and their effect has already been felt in Vietnam as well as in the VMD (McElwee 2010; 2017; MONRE 2003; 2009; 2012). The VMD is one of the regions impacted by changing temperature, floods, drought, sea level rise, and salinity as a consequence of climate change (McElwee 2010; Kien 2011; IMHEN & ADB 2013; Tuan 2014; Binh 2015). For example, floods annually damaged humans, houses and crops in An Giang province between 1991 and 2006 (Kien 2011).

Following the literature review in Chapter 2, "adaptation in the context of human dimensions of global change usually refers to a process, action or outcome in a system (household, community, group, sector, region, and country) in order for the system to better cope with, manage or adjust to some changing condition, stress, hazard, risk or opportunity" (Smit & Wandel 2006, p. 282). In the VMD, local people have employed different adaptive strategies to floods such as growing floating vegetables or fishing in An Giang province (Kien 2011) and in Dong Thap, a neighbouring upstream province of An Giang (Tuan 2014), and migration (Dun 2011). However, very few studies have been conducted on how climate threats directly influenced farmers' decision-making about rice-based farming systems. This needs to be built on farmers' perceptions and behaviour at the research sites of the study. The next section of the study presents how farmers perceive and experience climate threats in relation to temperature, rainfall, and flooding for a case study in An Giang. This is because these changes influence farmers' decision-making for farming activities in each rice crop.

Climate variability and other hazards in An Giang province

Some climate data in this chapter were collected from 1996 to 2016 to gather background information on climate variability, and this chapter compares these climatic variabilities regarding maximum temperature, minimum temperature, rainfall, and flood levels to 2014, 2015, and 2016.

Mean monthly maximum temperature (1996–2016) in An Giang province follows a pattern with the highest maximum temperature in April (36.5 °C) and lowest maximum temperature in January (32.8 °C; Figure 5.4). The observed monthly values for maximum temperature were roughly similar to the mean maximum temperature in 2014, higher in 2015 (i.e., very hot) and variable in 2016 (some months very hot). The highest recorded maximum temperature was 37.8 °C in April 2015, and there was a run of 10 consecutive months with higher-than-average maximum temperatures (from April 2015 to January 2016). These high temperatures caused an increase in irrigation costs for farmers for the second rice crop in Ta Danh and Vinh Trach.

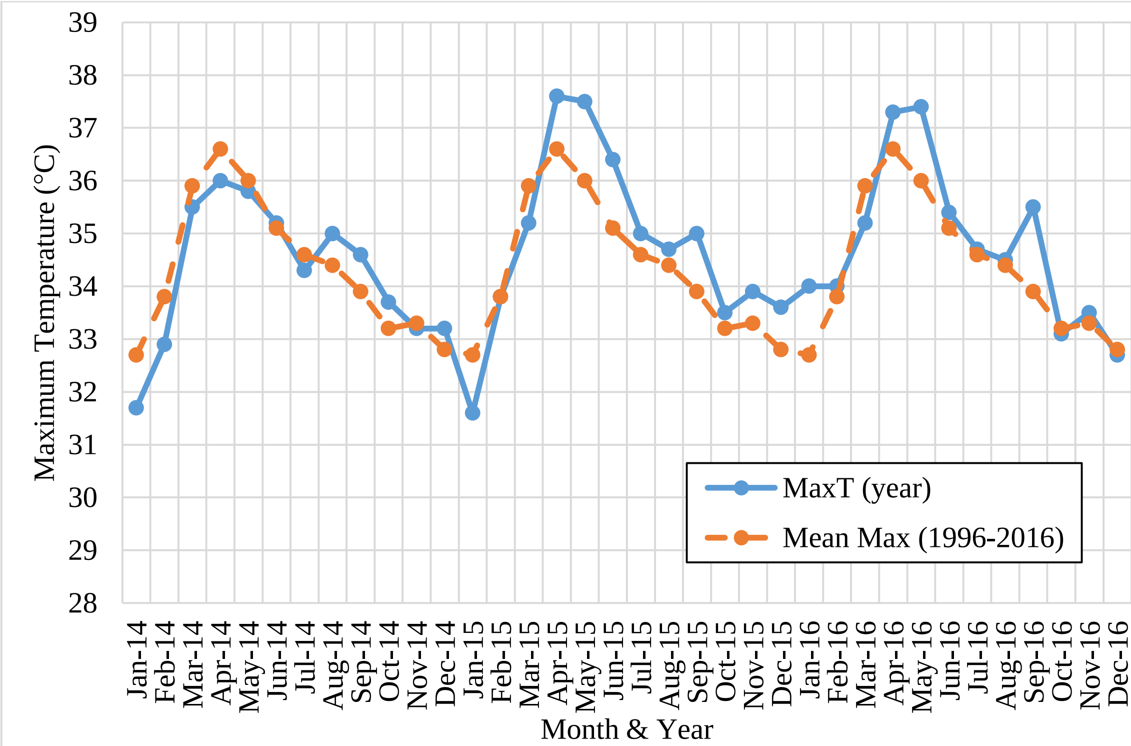

Figure 5.4: Comparison of monthly maximum temperature (°C) in 2014, 2015 and 2016 with mean monthly maximum temperature from 1996 to 2016 from An Giang province.
Source: National Hydro-Meteorological Service of Vietnam

The highest minimum temperature usually occurs in May (25 °C) and lowest minimum temperature in January (17 °C; Figure 5.5). The lowest recorded minimum temperature during the period 1996 to 2016 was typically similar to the monthly minimum temperature in 2014, slightly lower in 2015, and variable in 2016 with the coolest in February. In contrast, the observed monthly values for the highest mean minimum temperature (1996 and 2016) were lower than in May 2014 (25 °C) and in May 2015 (27 °C), and August 2016 (25 °C). Along with maximum temperature, minimum temperature was also recorded to indicate the hot temperature in 2015, and it contributed to an increase in costs for irrigation for the second rice crop of farmers in both communes of An Giang province.

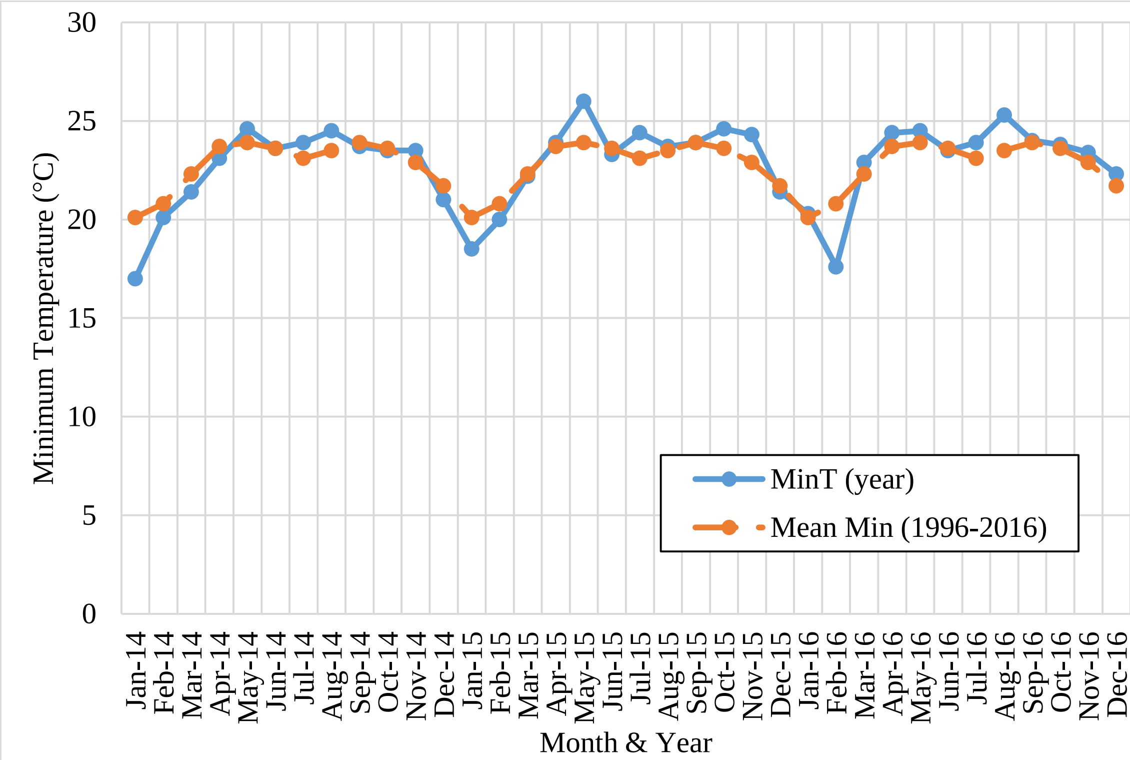

Figure 5.5: Comparison of monthly minimum temperature (°C) in 2014, 2015 and 2016 with mean monthly minimum temperature from 1996 to 2016 from An Giang province.
Source: National Hydro-Meteorological Service of Vietnam

The annual rainfall in An Giang is 1331 mm. An Giang receives a typical tropical rainfall distribution with the wet season staring in April and going through to November or December with a peak in rainfall normally in October (270 mm; Figure 5.6). The monthly rainfall in 2014 (908 mm) and 2015 (917 mm) was mostly lower than the mean rainfall (1996–2016), it peaked later in the wet season than the normal rainfall distribution (1996–2016); with a peak value of 200 mm compared to 270 mm (Figure 5.6). Very high rainfall occurred in October 2016 (1476 mm) causing localised inundation and affecting third rice crop, while 2015 was a year with high temperature, and less rain than previous years.

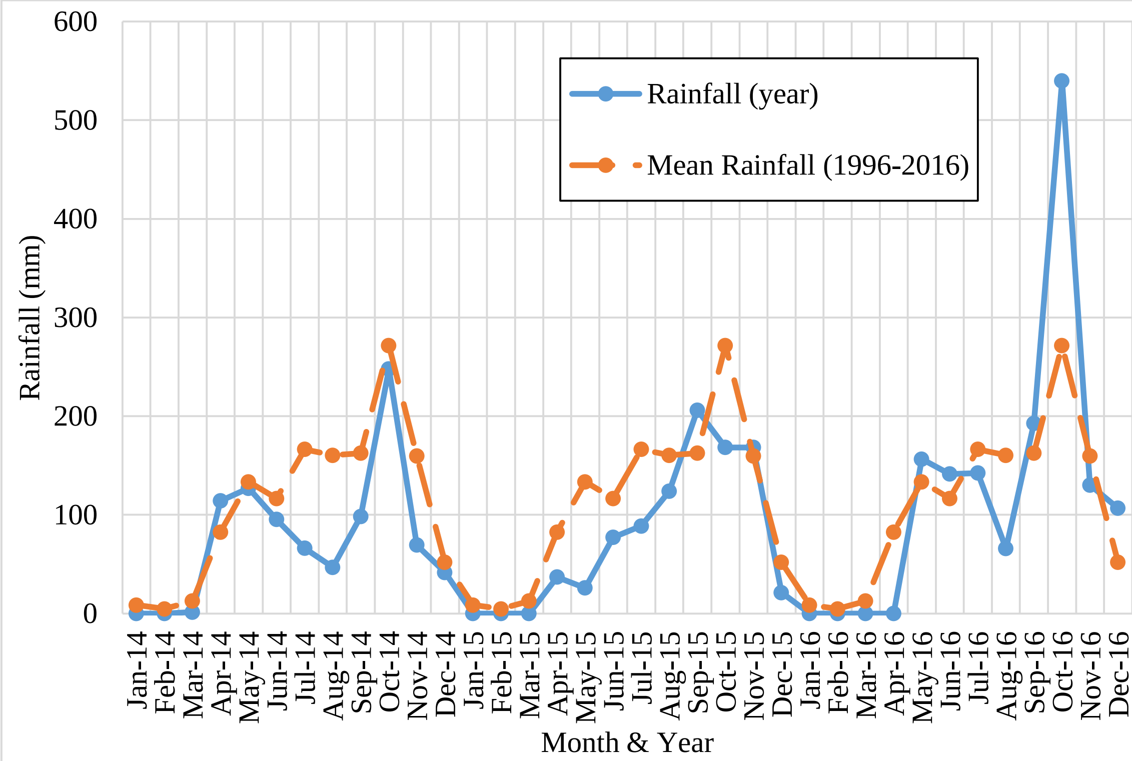

Figure 5.6: Comparison of monthly rainfall in 2014, 2015 and 2016 with mean monthly rainfall from 1996 to 2016 from An Giang province.
Source: National Hydro-Meteorological Service of Vietnam

Monthly flood levels mostly follow a pattern with the highest level in October (350 cm) and lowest in April (120 cm; Figure 5.7) in the period between 1996 and 2016. The highest flooding level was in October with 250 cm in 2014, 240 cm in 2015, and 280 cm in 2016, all lower than the mean flooding levels of the period from 1996 to 2016 (Figure 5.7). Low flood levels from 2014 to 2016 caused the reduction of alluvium supporting rice farming with the three crops in Ta Danh, while all farmers in Vinh Trach conducted three rice crops, and low flood levels did not influence rice fields.

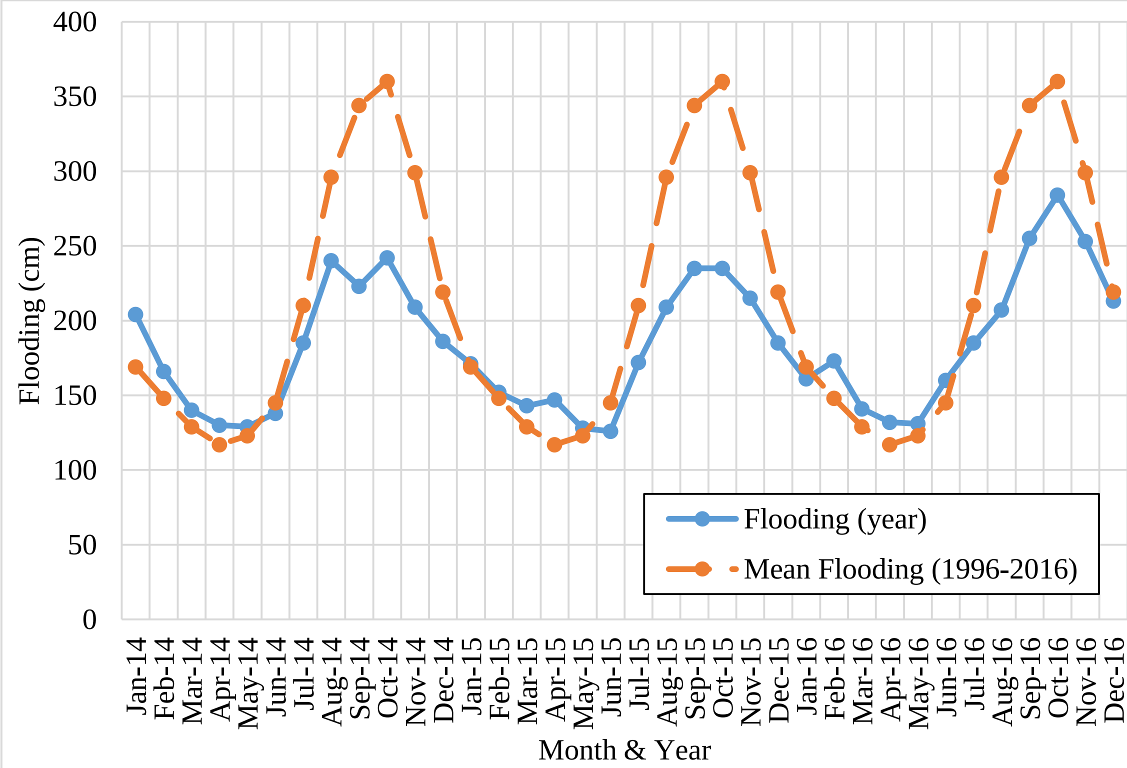

Figure 5.7: Comparison of monthly flooding level in 2014, 2015 and 2016 with mean monthly flooding level from 1996 to 2016 from An Giang province.
Source: National Hydro-Meteorological Service of Vietnam

Farmers' perception of climate variability in the first rice crop (November-March)

Members of the FC and general farmers in Vinh Trach and Ta Danh perceived the weather during the first rice crop to be generally suitable for paddy, when the climate was not too hot and less rainy than in other months (Figure 5.8); thus farmers' perceptions are similar to the data in Figure 5.4 and Figure 5.5. In addition, water levels in the canals in both communes were higher than the rice fields so pumping water for irrigation is unnecessary, and thus farmers did not spend money on irrigation as in the second crop (FGDs in 2016).

Crops and weather	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Three rice crops	First crop				Second crop				Third crop			First
Two rice crops		First crop				Second crop			Fishing and non-farm			
Dry season (hot)	*	**	***	***	**							
Abnormal rains						**	***	***	***	***	**	
Flood season							*	**	***	**	**	*

Figure 5.8: Seasonal calendar of rice farming and relevant factors to rice farming in Vinh Trach and Ta Danh, An Giang
Source: FGDs with members collected in Ta Danh in 2015 and 2016
Note: * less frequent, ** frequent, ***very frequent

Insects, diseases, and pests regularly occur in each rice crop. Participants could not clarify the details of frequency of these insects, diseases, and pests.

Farmers' perceptions of climate variability in the second rice crop (April-July)

Farmers amongst the members of the FC and general farmers in Vinh Trach and Ta Danh perceived that very hot weather was a negative climatic condition for cultivating a second rice crop (Figure 5.4; Figure 5.8). However, located in the upstream zones of the VMD, the two communes had favourable geographical conditions. Farmers had adequate water to irrigate rice fields. In difficult times, water could not be guaranteed during both the day and night time for irrigation, and then farmers had to wait for water levels elevating from tidal movement which pushes water back up the Mekong River from the ocean.

Abnormally heavy rains naturally occur at the end of the second rice crop when paddy is nearly at harvesting season (Figure 5.8); thus farmers' perceptions were also similar to the data in Figure 5.6. Heavy rains usually make wet and dirty grains due to paddy falling on the ground, and then rice traders usually ask farmers to reduce rice prices lower than previous contract prices (i.e., traders have contracts with farmers two or three weeks before harvesting rice). Also, the cost of the harvest increased because combine harvesters increased the price of harvest from VND 1.8 million to VND 2 million per ha (~ USD 100). Typically, abnormally heavy rains cause reduced prices of rice and high harvest costs of rice production. In order to minimise paddy falling on the ground, farmers had to use fertiliser such as kali (i.e., Kali Clorua, a fertiliser with potassium chloride) to make stems of rice plants stronger. Farmers also changed rice varieties to suit climatic conditions and collective drainage of water out of large rice farms, which will be discussed in detail in section 5.5.3.

Farmers' perceptions of climate variability in the third rice crop (August-November)

Abnormally heavy rains continued occurring during the period of the third rice crop (Figure 5.8). Members of the FCs and general farmers in Vinh Trach and Ta Danh did not spend much money on irrigation. However, if abnormally heavy rains occurred more frequently, they created a good chance for insects and diseases to damage paddy in the field. According to the result of the FGDs (2016), it was difficult to spray pesticide to kill insects if abnormal rains occurred because if farmers sprayed pesticide to kill insects, the rain would wash the pesticide out of the paddy. Besides, rain regularly made water levels inside a large field elevate; then the collective pumping service in the two communes need to operate to reduce water levels.

Generally, very hot weather and abnormally heavy rain created adverse conditions for cultivating the second rice and third rice crops. Climate variability encouraged farmers to engage in collective decisions about collective drainage of water out of large-sized farms through pumping services at the two communes, which will discussed further in section 5.5.3. Next section discusses the main constraints of access to rice local markets so that farmers make decisions for adapting to these constraints in each rice crop.

Access to local rice markets

Access to local rice markets by farmers differed from one commune to another. However, in the VMD, Loc and Son (2011) reported that the 93.1% of total rice productivity of farmers was sold to traders (through local brokers) at the farm gate, 2.7% was sold to local factories, and 4.2% was sold directly to rice companies. Similarly, in Vinh Trach and Ta Danh, except for members of the FCs, who had contract farming for seed production, or for common rice production with companies, the general farmers (i.e., non-members) sold rice immediately after harvesting at the farm gate to traders (through local brokers). In section 5.5.3, collective and individual decision-making will be discussed in more detail in the process of farmers' decision-making for selling rice. The following section presents and discusses the main constraints in access to markets that farmers have to respond to.

Local markets in the first rice crop. A fall in the price of rice regularly occurred in the first rice crop with members of the FC who did not engage in seed production and general farmers, for several reasons. Owing to good climate, the first rice crop regularly yielded 8–9 tonnes/ha/crop (Table 5.19). In addition, a large area of rice production in An Giang was harvested over a period of one month. As a result, a large amount of rice was produced in An Giang during the same month, with supply exceeding demand. However, in recent years general farmers signed contracts to sell rice to traders through brokers two or three weeks before harvesting; this issue will be discussed further in the section on farmers' decision-making for selling rice.

Local markets in the second rice crop. The low prices of rice for the second rice crop were because of the low quality of rice due to wet conditions instead of market downturns in the local market when market demand is lower than supply. The factor influencing the low quality of rice is abnormally heavy rains, as presented in the section on climate variability factors (FGDs in 2016).

Local markets in the third rice crop. Farmers in Ta Danh perceived that they accessed higher market prices for the third rice crop compared to the other crops, with approximately VND 6 million/tonne for the third rice crop compared to VND 5.5 million/tonne for the first rice crop in Ta Danh (data from household surveys). According to the FGDs, the area of rice production in the third crop is smaller than other crops because of a lack of high dykes for securing paddy from flooding. For example, in Ta Danh, the area suitable for three crops was around 660 ha, while that suitable for two rice crops was approximately 2,800 ha in 2014 (Table 5.1). Then, demand for rice was higher than supply. Accordingly, although rice cultivation in the third rice crop caused environmental degradation (Dan 2016), a large number of farmers still decided on cultivating because of the high price of rice. Therefore, the local market price is also an important factor in promoting farmers' decisions for cultivating a third rice crop.

Livelihood capitals

Following the literature review of concepts in Chapter 2, livelihood capitals include human, social, physical, natural, and financial capital (Scoones 1998; DFID 1999). Formal social capital is used to measure relationships between members of the FC above; thus the study only selected categories that might be considered advantageous and disadvantageous for farmers' decision-making in the following discussion. These categories were analysed by descriptive statistics as shown in the following results.

Human capital in rice production

Human resources in this study include age, gender, and education of the head of a household and the number of labourers in the household. The mean age of the household heads in Vinh Trach and Ta Danh ranged between 48 and 54 years (Table 5.5). The education levels of household heads in Vinh Trach were higher than those in Ta Danh. Of household heads in the FC of Vinh Trach, 42% finished secondary school (to year 9) and 19% finished high school (to year 12), whereas 33% and 13% of household heads of the FC in Ta Danh had achieved the same education levels, respectively. A small percentage of household heads of the FC in Vinh Trach had college (8%) or university degrees (4%), compared to none in Ta Danh. The farmers with the highest education levels in Vinh Trach were typically under the age of 40, and were recently engaged in forming new households. Education can contribute to improving the technological knowledge of farmers, although not all advanced or highly skilled farmers have high levels of formal education.

Table 5.5: Age, gender and education of head of households, and labourers of households of members of farmer clubs (FCs) and general farmers in Vinh Trach and Ta Danh, An Giang province

Indicator	Vinh Trach		Ta Danh	
	Members of FC[1] (n=26 HHs[2])	General farmers (n=30 HHs)	Members of FC (n=24 HHs)	General farmers (n=28 HHs)
Age of head of household (mean ± sd)	48 (±11)	54 (±13)	48 (±11)	50 (±9)
Gender (%)	100	100	100	100
Male	88	87	100	100
Female	12	13	0	0
Education (%)	100	100	100	100
Illiterate	0	0	4	4
Primary school	27	37	50	32
Secondary school	42	43	33	50
High school	19	20	13	14
College	8	0	0	0
University	4	0	0	0
Total members/hh (mean ± sd)	4 (±1)	5 (±1)	4 (±1)	4 (±1)
Total labour (mean ± sd)	3 (±1)	3 (±1)	3 (±1)	3 (±1)

Source: Household surveys in 2015

Notes: 1. FC is farmer club

2. HHs is number of households

Land and water as crucial natural resources

Natural resources are a significant source of livelihoods in flooded rice areas, where fish and floating vegetables have occurred regularly in the last few years (FGDs in 2016). This study focuses on land ownership and irrigated water access for rice farming activities in Vinh Trach and Ta Danh. The mean total land area of households in the FC in Ta Danh (3.37 ha) was approximately 50% larger than that in Vinh Trach (2.34 ha) (Table 5.6). Accordingly, the agricultural area of *households* in the FC in Ta Danh (3.14 ha) was also approximately 50% larger than that in Vinh Trach (2.20 ha) (Table 5.7). The standard deviation is very high for some values because of the wide range of land areas of some farmers compared to those of farmers in Vinh Trach and compared to other farmers in the same commune (Table 5.6 and 5.7). For example, numerous households owned a large area of land (>6 ha) compared to others (Table 5.7). In contrast, there were numerous households with a small farming area (<1 ha) in Vinh Trach.

Table 5.6: Summary of different types of land area (mean ± sd) for each household of members of farmer clubs (FCs) and general farmers in Vinh Trach and Ta Danh, An Giang province

Land type	**Vinh Trach**				**Ta Danh**			
	Members of FC[1] (n=26 HHs[2])		**General farmers (n=30 HHs)**		**Members of FC (n=24 HHs)**		**General farmers (n=28 HHs)**	
	ha[3]	**%**	**ha**	**%**	**ha**	**%**	**ha**	**%**
1. Homestead	0.02 (±0.01)	1	0.02 (±0.01)	2	0.02 (±0.02)	1	0.02 (±0.02)	1
2. Agriculture	2.20 (±1.82)	93	1.89 (±1.23)	92	3.14 (±2.89)	92	2.32 (±1.73)	92
3. Leased	0.10 (±0.36)	4	0.01 (±0.04)	1	0.19 (±0.94)	6	0.16 (±0.54)	6
4. No work	0.04 (±0.05)	2	0.08 (±0.19)	5	0.04 (±0.07)	1	0.03 (±0.06)	1
Total land	**2.34 (±2.07)**	**100**	**1.98 (±1.23)**	**100**	**3.37 (±3.04)**	**100**	**2.52 (±1.83)**	**100**

Source: Household surveys in 2015
Note: 1. FC is farmer club
2. HHs is number of households
3. ha is hectare

Table 5.7: Summary of different types of agricultural land (mean ± sd) for each household of members of farmer clubs (FCs) and general farmers in Vinh Trach and Ta Danh, An Giang province

Types of agricultural land	**Vinh Trach**				**Ta Danh**			
	Members of FC[1] (n=26 HHs[2])		**General farmers (n=30 HHs)**		**Members of FC (n=24 HHs)**		**General farmers (n=28 HHs)**	
	ha[3]	**%**	**ha**	**%**	**ha**	**%**	**ha**	**%**
1. Rice	2.03 (±1.80)	93	1.84 (±1.22)	97	3.11 (±2.87)	97	2.28 (±1.73)	98
2. Orchard	0.08 (±0.20)	3	0.04 (±0.07)	2	0.01 (±0.02)	1	0	0
3. Other	0.09	4	0.02 (±0.02)	1	0.02 (±0.01)	2	0.03 (±0.04)	2
Total	**2.20 (±1.82)**	**100**	**1.89 (±1.23)**	**100**	**3.14 (±2.89)**	**100**	**2.32 (±1.73)**	**100**

Source: Household surveys in 2015
Data from Table 5.7
Note: 1. FC is farmer club
2. HHs is number of households
3. ha is hectare

Agricultural tools as main physical assets of farmers in Vinh Trach and Ta Danh

Households in Vinh Trach and Ta Danh had a large range of rice-farming equipment. For instance, 85% of members of the FC and 87% of general farmers in Vinh Trach had pumping machines, while in Ta Danh, 71% of households in the FC and and 68% of general farmer households owned this property (Table 5.8). Nearly 100% of households in Vinh Trach and Ta Danh had a television (Table 5.8). Television was important for farmers in terms of accessing technical knowledge, through weekly programmes sponsored by private fertiliser and pesticide companies in association with provincial governments in the VMD. One advanced farmer in Vinh Trach, Mr N. said he was a fan of programmes providing technical knowledge (field interview in September 2016). New technical knowledge from these programmes helped him improve his rice farming.

Table 5.8: Farming machines and communication devices of members of farmer clubs (FCs) and general farmers in Vinh Trach and Ta Danh, An Giang province

Machine and tool	**Vinh Trach**				**Ta Danh**			
	Members of FC[1] (n=26)		**General farmers (n=30)**		**Members of FC (n=24)**		**General farmers (n=28)**	
	HHs[2]	**%**	**HHs**	**%**	**HHs**	**%**	**HHs**	**%**
1. Farming machine								
1.1 Tractor	3	12	5	17	1	4	5	18
1.2 Hand tractor	4	15	4	13	2	8	2	7
1.3 Rice combine harvesters	0	0	2	7	0	0	1	4
1.4 Pump machine	22	85	26	87	17	71	19	68
1.5 Sprayer for pesticide and herbicide	20	77	25	83	15	63	21	75
2. Communication device								
2.1 Television	26	100	30	100	23	96	26	93
2.2 Radio	3	12	5	17	3	13	7	25
2.3 Mobile phone	26	100	30	100	24	100	27	96
Total	**26**	**100**	**30**	**100**	**24**	**100**	**28**	**100**

Source: Household surveys in 2015

Note: 1. FC is farmer club

2. HH is number of households

Access to sources of farmers' financial capital

Surveys focused on the two main financial sources for informants in Vinh Trach and Ta Danh, namely household savings from their livelihoods, and access to formal credit. Firstly, 31% of households in the FC and 43% general farmer households in Vinh Trach had finance through household savings, whereas 67% of households in the FC and 32% of general farmer households in Ta Danh had finance from this source (Table 5.9). Secondly, the majority of households of the FC and around one-half of general farmers in Vinh Trach and Ta Danh had access to credit from different local banks (Table 5.9). In summary, while households in the FC of Ta Danh tended to have a higher savings rate, access to formal credit was quite prevalent in both communes.

Table 5.9: Saving and debt of households of members of farmer clubs (FCs) and general famers in Vinh Trach and Ta Danh, An Giang province

Financial source	**Vinh Trach**				**Ta Danh**			
	Members of FC[1] (n=26)		**General farmers (n=30)**		**Members of FC (n=24)**		**General farmers (n=28)**	
	HHs[2]	**%**	**HHs**	**%**	**HHs**	**%**	**HHs**	**%**
1. Saving	8	31	13	43	16	67	9	32
2**. Credits**	17	65	14	47	15	63	15	54
2.1 Local agriculture bank	6	23	6	20	7	29	6	21
2.2 Policy bank	3	12	1	3	0	0	2	7
2.3 Women's union	8	31	7	23	7	29	8	29
2.4 Commercial banks	8	31	13	43	16	67	9	32
Total	**26**	**100**	**30**	**100**	**24**	**100**	**28**	**100**

Source: Household surveys in 2015
Note: 1. FC is farmer club
2. HH is number of household

Vinh Trach was considered a favourable commune compared to Ta Danh regarding bio-physical factors such as soil conditions and high dykes for protecting third rice crops from flooding (as identified through the CLUES project). Accordingly, the majority of farmers in Vinh Trach cultivated three rice crops each year, while more than 70% of farmers in household surveys in Ta Danh cultivated two rice crops each year. In addition, the land area for cultivating two rice cops occupied 70% of the total agricultural land area of Ta Danh. In contrast, farmers in Ta Danh owned a larger land area than farmers in Vinh Trach because Ta Danh is one of the communes in a new economic area of An Giang province. The population of Ta Danh is smaller than that of Vinh Trach. However, social capital of members of the FC in Vinh Trach was stronger than in Ta Danh regarding social cohesion, while social trust and commitment was similar between the two communes. Moreover, farmers in Vinh Trach had similar constraints in terms of climate variability, floods, and abnormal rains to farmers in Ta Danh because the rice crop seasons of both communes were similar to one another. That is because farmers in the two communes followed the general seasonal calendars of the provincial government. Also, general farmers in both Vinh Trach and Ta Danh were usually constrained in accessing good prices for selling rice in the local area, while members of the FC in the two communes did not have challenges in accessing markets because they had farming contracts for seed production.

Finally, the livelihood capitals presented above are fundamental factors, and the study found that members of FCs and general farmers of the two communes did not have many constraints with livelihood capital because they owned basic resources. Compared to factors including climate variability, flood, abnormal rains, and access local markets, livelihood capitals have not been a key factor directly influencing farmers' decision-making for rice-farming activities. Other factors related to farmers' decision-making might occur in the two communes when the study shows the results and discusses on how farmers make collective and individual decisions for rice-farming activities, such as characteristics of rice variety, informal social capital (kinship and neighbours), land locations, among other things.

5.5.3 Decision-making of members and general farmers for farming activities of three and two rice crops (Research question 3)

Decision-making in a livelihoods context is the process for selecting between different farming systems (Bruijn & Van Dijk 2005; Ha 2012). However, except for studies on the adoption of innovations (Huan et al. 2008; Bosma et al. 2012), very few studies have provided discussion on how farmers decide on particular management choices within farming systems (e.g., selecting rice varieties, decisions for seasonal planting and harvesting calendars, irrigation management, marketing). This section will present findings and provide a discussion of the collective and individual decisions for different rice-cropping rotations. In the VMD, there are multiple forms of collective decision-making, tailored for (or specific to) each planted rice crop, and these decisions are related to factors such as land location, seed production, or kinship, as explained below.

Multiple forms of collective decision-making of members of the farmer clubs and general farmers in relation to farming activities of the first rice crop in Vinh Trach and Ta Danh

The FC of Vinh Trach had 54 members, 39 of whom were members of a seed producer group, and eight of whom were involved in an AC. The seed producer group regularly had contracts with a wide range of seed organisations to produce seed each season.

Organisations and agencies included staff of Cuu Long Rice Research Institute (CLRRI), the Rice Centre of An Giang, Loc Troi Group, and seed agencies in An Giang and other provinces of the VMD. Members of this group produced seed according to the demand of customers. The members' farms are located in the same field with general farmers (i.e., non-members) in different villages in Vinh Trach commune. Members in FCs perceived that they could decide whether or not to be involved in the seed producer group because the seed producer group was required to follow the contract with seed companies for seed production and apply a higher level of technical knowledge than for normal rice production (i.e., rice for consumption). This enabled them to sell seed with a higher market price and gain a higher income than for normal rice.

In Ta Danh, members of the FC also produced seed, but they had a contract between the leader of the FC and their members. However, not all members are involved in seed production. Members could produce normal rice to sell in the free market or produce seed for other seed companies. The FC in Ta Danh had collective activities including credit, collective skills, and sharing information in relation to the situation of rice farming in the commune. Members of the FC and general farmers in Vinh Trach and Ta Danh considered a wide range of factors when making collective decisions (Tables 5.10 & 5.11). Tables 5.10 and 5.11 summarise what and how farmers make collective and individual decisions about farming activities for each of two or three rice crops.

Table 5.10: Summary of decision-making of members of farmer club (FC) and general farmers for each rice crop in Vinh Trach

Farming activities	**Members of farmer club**		**General farmers**	
	Crop 1	**Crop 2 and 3**	**Crop 1**	**Crop 2 and 3**
Collective decision-making for farming activities				
Setting up a seasonal calendar of rice farming	Members of FC[1], general farmers, and local authorities	Members, general farmers, and local authorities	Members, general farmers, and local authorities	Members, general farmers, and local authorities
Draining water out of rice fields during the rainy season	NA[3]	Cooperative, village authorities, and farmers in large rice fields	NA	Cooperative, village authorities, and farmers in large rice fields
Contract farming to sell seed or sell normal rice (rice for consumption)	Members, leaders of seed producer group, CLRRI[2], and seed companies	Members, leader of seed producer group, CLRRI, and seed companies	General farmers and rice companies with **informal collective action** (selling normal rice)	General farmers and rice companies with **informal collective action** (selling normal rice)
Selecting sources of rice varieties	Members of FC, leader of seed producer group and seed companies	Members of FC, leader of seed producer group and seed companies	General farmers and rice companies with **informal collective action** (selling normal rice)	General farmers and rice companies with **informal collective action** (selling normal rice)
Selecting rice varieties	Members of FC, leader of seed producer group and seed companies (Described data in Table 5.12)	Members of FC, leader of seed producer group and seed companies	General farmers and rice companies with **informal collective action** (selling normal rice)	General farmers and rice companies with **informal collective action** (selling normal rice)
Accessing combine harvesters	Members	Members	NA	NA
Training farming techniques	Member and management board of FC	Member and management board of FC	NA	NA
Accessing farming labour for harvesting and porter	Owners of combine harvester	Owners of combine harvester	Owners of combine harvester	Owners of combine harvester
Selling seed to seed companies	Members, leader of seed producer group	Members, leader of seed producer group	NA	NA
Selling normal rice to traders	NA	NA	Informal farm group in the same a rice field and brokers	Informal farm group in the same a rice field and brokers

Individual decision-making for farming activities				
Selecting sources of rice varieties	Members without producing seed (Described data in Table 5.12)	Members without producing seed	General farmers (Described data in Table 5.14)	General farmers
Selecting rice varieties	Members without producing seed	Members without producing seed	General farmers (Described data in Table 5.13)	General farmers
Preparing land	All Members	All Members	General farmers	General farmers
Method of sowing seed	Members ***(transplanting)***	Members ***(transplanting)***	General farmers ***(sowing by hand and machine)***	General farmers ***(sowing by hand and machine)***
Irrigation activity	All Members	All Members	General farmers	General farmers
Accessing financial capital (access credit, saving, buy materials paid at the end of crops) for investing rice production	All Members	All Members	General farmers	General farmers
Accessing farming materials (fertiliser, pesticide, petrol, etc)	All Members	All Members	General farmers	General farmers
Applying fertiliser and pesticide	All Members	All Members	General farmers	General farmers
Accessing farming labour for transplanting, sowing seed and sprayer pesticide	All Members	All Members	General farmers	General farmers
Selling rice to traders	Members without producing seed, and brokers (via traders)	Members without producing seed, and brokers (via traders)	General farmers and brokers (via traders)	General farmers and brokers (via traders)
Accessing combine harvesters	Members without producing seed and brokers	Members without producing seed and brokers	General farmers and brokers	General farmers and brokers
Accessing farming labour for harvesting and porter	Owner of combine harvester (cost included in harvest price)	Owner of combine harvester (cost included in harvest price)	Owner of combine harvester (cost included in harvest price)	Owner of combine harvester (cost included in harvest price)

Source: Focus group discussion in 2016

Note: 1. FC is farmer club
2. CLRRI is Cuu Long Rice Research Institute
3. NA is not available
There are different small informal groups of general farmers and members of FC (without producing seed) making informal collective decisions for different activities

Table 5.11: Summary of decision-making of members of farmer club (FC) and general farmers for each rice crop in Ta Danh

Farming activities	**Members of farmer club**		**General farmers**	
	Crop 1	**Crop 2 and 3**	**Crop 1**	**Crop 2 and 3**
Collective decision-making for farming activities				
Setting up seasonal calendar of rice farming	Informal collective action of members of FC[1] and general farmers have land parcels in the same rice fields (dependent on flood levels)	Informal collective action of members of FC and general farmers have land parcels in the same rice fields (dependent on flood levels)	Informal collective action of members of FC and general farmers have land parcels in the same rice fields (dependent on flood levels)	Informal collective action of members of FC and general farmers have land parcels in the same rice fields (dependent on flood levels)
Draining water out of rice fields during the rainy season (apply for three rice crop model)	NA[2]	Members, general farmers, and private company (leader of FC)	NA	NA
Draining water out of fields after the flood season for the beginning of first crop (the two rice crops model)	NA	NA	Informal collective action of all general farmers have land parcel at the same rice field (dependent on flood levels)	Informal collective action of all general farmers have land parcel at the same rice field (dependent on flood levels)
Contract farming to sell seed to seed companies	Members and leader of FC	Members and leader of FC	NA	NA
Selecting rice varieties	Members and leader of FC (Describled ata in Table 5.12)	Members and leader of FC	NA	NA
Training farming techniques	Members and leader of FC	Members and leader of FC	NA	NA

Individual decision-making for farming activities				
Selecting sources of rice varieties	Members without producing seed	Members without producing seed	General farmers	General farmers
Selecting rice varieties	Members without producing seed (Described data in Table 5.12)	Members without producing seed	General farmers (Described data in Table 5.13)	General farmers
Preparing land	All members	All members	General farmers	General farmers
Method of sowing seed	Members ***(transplanting by labour)***	Members ***(transplanting by labour)***	General farmers ***(sowing machine)***	General farmers ***(sowing machine)***
Irrigation activity	All members	All members	General farmers	General farmers
Accessing financial capital (access credit, saving, buy materials paid at the end of crop) for investing rice production	All members	All members	General farmers	General farmers
Accessing farming materials (fertiliser, pesticide, petrol, etc)	All members	All members	General farmers	General farmers
Applying fertiliser and pesticide	All members	All members	General farmers	General farmers
Accessing farming labours for sowing seed and sprayer pesticide	All members	All members	General farmers	General farmers
Selling rice to traders	NA	NA	General farmers and broker (via traders)	General farmers and brokers (via traders)
Accessing combine harvesters	All members	All members	General farmers	General farmers
Accessing farming labour for harvesting and porter	Owners of combine harvesters (cost included in harvest price)	Owners of combine harvesters (cost included in harvest price)	Owners of combine harvesters (cost included in harvest price)	Owners of combine harvesters (cost included in harvest price)

Source: Focus group discussion in 2016

Note: 1. FC is farmer club

2. NA is not available

Setting up a seasonal calendar in Vinh Trach and Ta Danh. Members of the FCs and general farmers in Ta Danh and Vinh Trach informally and collectively decide upon a seasonal calendar (Tables 5.10 and 5.11). They do this in relation to the provisions of a coordinated, hierarchical seasonal calendar produced through the provincial, district and commune authorities, which are set to minimise the risks of attacks from rats, brown plant hoppers, and golden apple snails.[10] All members of the FC participating in the seed producer group in Vinh Trach also need to report the timing of their rice production to the leader of the FCs due to signing contracts with companies. The leader of the FC in Ta Danh (who is also the head of a seed and fertiliser company) distributes information on the seasonal calendar to participants regularly via monthly meeting. Thus, there are multiple actors, from both formal and informal institutions, involved in establishing these complex seasonal rice calendars in both communes.

Selecting sources and rice varieties for seed contract farming in Vinh Trach and Ta Danh (Tables 5.10 and 5.11). These activities of the FC in Vinh Trach were decided by the management board of a seed producer group, and involved members and customers including the representative of the CLRRI and seed organisations in the VMD. According to a leader of the seed producer group, selecting rice varieties was dependent on customers. Similarly, decision-making for these activities of the FC in Ta Danh were also conducted by a leader of the FC and members who had signed contracts for seed production for the leader's own company.

Rice varieties for seed production of the FC in Vinh Trach were supplied by companies (65% of households) and seed organisations who signed a contract with them (Table 5.12). Similarly, the majority (67%) of members who participated in seed production through the FC in Ta Danh received rice varieties from companies to produce seed, while some other members could produce seed for other organisations.

[10] Seasonal calendars need to be coordinated at the provincial level in the VMD because if farmers plant their crop at different times, pests could move across a landscape and affect larger areas (FGDs).

Table 5.12: Source of seed collected for the first rice crop of members of farmer clubs (FCs) in Vinh Trach and Ta Danh, An Giang province

Source of rice varieties	Members of FC[1] in Vinh Trach		Members of FC in Ta Danh	
	HHs[2]	**%**	**HHs**	**%**
1. Seed company	17	65	16	67
2. Seed production centre	2	8	1	4
3. Neighbour	1	4	0	0
4. Family	1	4	0	0
5. Seed production club	1	4	1	4
6. Research institute	2	8	3	13
7. Member of farmer organisations	1	4	3	13
8. Farmer organisations	1	4	0	0
Total	**26**	**100**	**24**	**100**

Source: Household surveys in 2015

Note: 1. FC is farmer club

2. HHs is number of households

There were eight different rice varieties used by the members of the FC in Vinh Trach, but the main one was IR 50404 (62% of respondents) (Table 5.13). Varieties of both seed and normal (market) rice in Ta Danh were more diversified than those in Vinh Trach. 29%, 25%, and 21% of respondents decided to use IR 50404, OM 6976, and Jasmine 85 respectively for the first rice crop. Participants in the FGDs in Ta Danh in 2016 indicated that their commune was crucial for seed production in An Giang province. Seed is produced according to the demands of the seed market, not only from An Giang, but also for other provinces of the VMD.

Table 5.13: Rice varieties[11] for seed and normal rice production used for the first rice crop of members of farmer clubs (FCs) in Vinh Trach and Ta Danh, An Giang province

Rice Variety	Members of FC[1] Vinh Trach		Members of FC Ta Danh	
	HHs[2]	%	HHs	%
1.IR 50404	16	62	7	29
2.OM 6976	3	12	6	25
3.Jasmine 85	0	0	5	21
4.OM 7347	1	4	3	13
5.OM 4218	1	4	1	4
6.OM 4900	1	4	1	4
7.Nang hoa 9	1	4	0	0
8.OM 5451	2	8	0	0
9.OM 10636	1	4	0	0
10.OM 576	0	0	1	4
Total	**26**	**100**	**24**	**100**

Source: Household surveys in 2015
Note: 1. FC is farmer club
2. HHs is number of households

Contract farming between general farmers and a rice company for cultivating normal rice in Vinh Trach commune (Table 5.9). Vinh Trach had an informal farmer group which had a contract for cultivating normal rice with the Loc Troi group, one of the major rice companies in An Giang province. General farmers and this company did informal collective decision-making by themselves without the participation of local authorities. However, their contract is also a formal contract following the law of the Vietnamese government. Farmers in this group received rice varieties, pesticides, and technical knowledge support from Loc Troi. Then, farmers at the same field sold rice collectively to the company. In 2016, there were strong social bonds between members in this informal group, and between a leader of this group and representatives of the company. The majority of members in this group had land located in the same field and kinship relations. Besides, the large field of this group is located near the company’s warehouse. The success of this informal group was because strong social capital made members of the group able to reach agreements in collective decisions about contract farming because of high trust between members, the leader, and the company (field notes during household surveys in 2015).

[11] Rice varieties discussed in this thesis include rice varieties for producing seed and normal rice (rice for consumption). This thesis does not separate the two types of rice varieties for two purposes because it becomes complicated. In addition, analysis of seed production in the Delta was presented by Tin (2009; 2011). Finally, this thesis focuses on decision-making issues.

Selecting rice varieties collectively for normal rice production with members of the FC and general farmers in Vinh Trach (Table 5.10). Selecting rice varieties, selling rice and harvesting grain were viewed as being the general farmers' informal collective decision-making in Vinh Trach because numerous land parcels of farmers in the same field had a geographical relationship. Farmers with farming land located near large canals would individually decide rice varieties for growing, while farmers with land located behind other rice farms and far from main canals had to depend on farmers with land located next to large canals. This is because harvesting time relied on the duration of rice varieties or the seasonal calendar of each rice crop. For example, IR 50404 has a duration of 85 days, compared to 110 days for Jasmine 85. Accordingly, farmers with land located far from large canals were unable to ask owners of combine harvesters operating combine harvesters for their services because the timing between paddy fields was always different, and it was difficult to arrange times for scheduling harvesting machines.

General farmers in the household surveys chose three main rice varieties for the first rice crop, the major one being IR 50404 (90% of respondents) (Table 5.14). They decided to grow IR 50404 because of a range of factors. Firstly, selecting a rice variety relied on farmers with land located next to a large canal, because other farmers located behind their land had to follow what they grew. For example, Mrs Q. a farmer in Vinh Trach, responded that,

> I had two rice land parcels locating in various places in Vinh Trach commune. These two land parcels are located far from large canals, thus I had to rely on farmers having land next to large canals. My first land parcel is located in the large farm with many farmers growing IR 50404. I had to follow them because if I changed other rice varieties, OM 6976 for example, I had to harvest later than them. Then, I could not harvest by combine harvester because the paddy field was harvested before my land, and their land was being prepared for next rice crop, and then combine harvester could not drive across their land. Additionally, after harvesting their paddy, they would burn straws (body of paddy) on the rice field to prepare their land for new rice crop. At that time, this situation might damage my paddy because my paddy was in the ripe period and it was nearly the harvesting time.
>
> (Field interview Mrs Q. in August in 2016).

Secondly, respondents decided on IR 50404 because they perceived that IR 50404 was well adapted to local climatic conditions, so farmers were able to reduce the costs of fertiliser and pesticide. For example, using IR 50404 enables farmers to use up to two fewer applications of fertilisers and pesticide than other rice varieties (six times compared to eight times). Thirdly, traders still buy IR 50404 at reasonable prices, VND 0.5 million (USD 25) per tonne lower than high quality rice varieties such Nang Hoa 9, Jasmine 85, and other varieties.

Table 5.14: Rice varieties used for the first rice crop of general farmers in Vinh Trach and Ta Danh, An Giang province

Rice variety	**General farmers of Vinh Trach**		**General farmers of Ta Danh**	
	HHs	**%**	**HHs**	**%**
1. IR 50404	27	90	1	4
2. AG 103	2	7	3	11
3. OM 7347	1	3	1	4
4. Jasmine 85	0	0	10	36
5. OM 6976	0	0	7	25
6. OM 4218	0	0	3	11
7. OM 2517	0	0	1	4
8. Nang Hoa 9	0	0	1	4
9. OM 5451	0	0	1	4
Total	**30**	**100**	**28**	**100**

Source: Household surveys in 2015
Note: HHs is number of households

Selling rice collectively to traders, and accessing combine harvesters and labour for harvesting in Vinh Trach commune (Table 5.10). In many cases, informal groups of farmers who had land parcels in the same field made collective decisions by discussing rice prices, harvest times, and renting combine harvesters before contacting and negotiating with brokers and owners of combine harvesters. Continuing with the case of Mrs Q., she had another land parcel in another large rice field where farmers regularly discussed and used the same high quality rice varieties such as Nang Hoa Chin to substitute for IR 50404 to obtain higher prices (personal field note in August 2016). This case implies that there were diverse instances of collective action for making decisions, which exist in the rice community not only in the formal form organised by commune authorities or stamped by authority, but also in informal forms implemented by farmers who trust each other by themselves.

Generally, farmers' collective decision-making for different farming activities for the first rice crop in Vinh Trach and Ta Danh depended on a wide range of factors. These include preventing threats (insects and pests), accessing good market prices, saving pumping costs, informal social capital (kinship and neighbours) and being at the same land location. Out of these factors, strong social capital enabled farmers to reach agreement in collective decision-making in relation to a range of farming activities faster than with weak social capital, particularly contract farming. However, this collective decision-making for farming activities was only presented via working together *(làm cùng nhau)*, such as working at the same time and on large farms; they did not have more cooperation to share economic value.

Individual decision-making of the members in the farmer clubs and general farmers in Vinh Trach and Ta Danh for farming activities of the first rice crop

The members of the FC also had individual decision-making on a range of farming activities for the first rice crop including preparing land, sowing seed and transplanting nursery of paddy, irrigation, financial sources, applying fertiliser and pesticide, accessing farming labour for sowing seed and transplanting nursery of paddy, sprayer, and harvesting (Tables 5.10 & 5.11). The study selected some significant activities to present and discuss because farmers in the two communes perceived that they were able to rent agricultural services (e.g., land preparation), and to buy materials (i.e., fertiliser, pesticide, oil) from local markets.

Accessing sources of rice variety of general farmers (Table 5.10). In Vinh Trach, the Loc Troi company supplied seed to general farmers (37% respondents) who signed contract farming directly to them. General farmers who did not participate in any organisation were able to access various seed sources. The percentage of general farmers accessing seed was 27% from neighbours, 10% from seed production, and 7% from seed stations (Table 5.15). In Ta Danh, 54% of general farmers bought seed from companies and 14% of farmers bought from seeding stations. In Vinh Trach and Ta Danh, farmers perceived that they were able to access rice varieties more easily than before, especially in Ta Danh, because there was a wide range of rice seed companies and numerous small seed agencies of seed companies in Ta Danh (FGDs with local officials in Ta Danh held in 2015). The provincial policy of commercial rice seed, and international organisations created good opportunities for farmers to access good rice varieties from different sources.

Table 5.15: Sources of seed collected for the first rice crop of general farmers in Vinh Trach and Ta Danh, An Giang province

Source of rice varieties	General farmers in Vinh Trach		General farmers in Ta Danh	
	HHs	**%**	**HHs**	**%**
1. Seed company	11	37	15	54
2. Seed production centre	3	10	3	11
3. Neighbour	8	27	1	4
4. Family	3	10	2	7
5. Seed production club	1	3	1	4
6. Member of farmer organisation	1	3	1	4
7. Seeding station	2	7	4	14
8. Seeding agency	1	3	0	0
9. Farmer organisation	0	0	1	4
Total	**30**	**100**	**28**	**100**

Source: household surveys in 2015
Note: HHs is number of households

Irrigation activity (Tables 5.10 and 5.11). Farmers in Vinh Trach and Ta Danh individually decided on accessing irrigation water in the commune. The majority of farmers (85%) in Vinh Trach had pumping machines (see the physical capital section and Table 5.7). They bought petrol to pump water in the field any time they thought that was necessary for their rice field (Figure 5.10). That is because their rice field was next to internal canals where water was extracted from the Hau River (one of the main branches of the Mekong River).

Figure 5.9: Private irrigation from a public canal into a rice field through a high dyke in the dry season at Ta Danh commune
Source: Author (2015)

Accessing traders for selling normal rice (i.e., rice for consumption) (Table 5.10 and 5.11). Numerous general farmers (both in Vinh Trach and Ta Danh) made transactions with brokers at their houses or farmers' fields. In this business, the broker was a representative of traders in the local area to negotiate with farmers in relation to prices and the quality of rice because traders frequently came from other communes in An Giang and other provinces in the VMD. The broker also decided activities of hiring labour, if harvesting activities needed labour, namely carrying rice across the road to load onto a large boat. Normally, 5–10 days before harvesting, brokers contacted farmers to ask them to sell rice to them, or farmers called brokers to inform them of the situation of their paddy, and to ask rice prices, and then the transaction and decision-making occurred at the homes of farmers. General farmers regularly received a bond (i.e., money from brokers) to secure the price of rice. The bond was commonly VND 1–2 million (USD 50–100) per ha (field interview, Mr X., a broker in Vinh Trach).

Decision-making of the members of the farmer clubs and general farmers for farming activities of the second and third rice crops in Vinh Trach and Ta Danh

The second rice crop and third rice crop had similar farming activities to the first rice crop in the case of members of FCs. Members of the FC in Vinh Trach who were involved in the seed group maintained contracts with seed companies, CLRRI, and the seed centre of DARD of other provinces in the VMD to produce seed. Similarly, members of the FC in Ta Danh also continued to produce seed for the company of the FC's leader. Other members of the FCs in Vinh Trach and Ta Danh who did not engage in seed production and general farmers in Vinh Trach also continued to make informal collective decisions for selecting rice varieties and selling normal rice. Therefore, decision-making for a wide range of rice-farming activities was separated into collective and individual decision-making, similar to the case of the first rice crop, except for draining water out of rice fields (Figure 5.10).

There were two times for draining water from rice fields, that is (1) draining water out of rice fields at the end of the second rice crop to enable harvesting of rice at the beginning of the rainy season, and (2) draining water out of the rice fields in the first two months of the third rice crop when flooding can occur. The combination of heavy rains and floods can occur at the same time, and abnormally heavy rain leads to the height of water in canals being higher than in the fields. Accordingly, abnormal rains could damage young rice plants. In Vinh Trach, the draining of water outside the rice fields was decided in combination by the management board of the AC, the commune authority, general farmers, and members of the FC. The price of pumping was around VND 1.8 million/ha (data from household surveys in 2015). This activity was invested in and operated by the AC of Vinh Trach, and the AC annually works around four months in the rainy season (FGDs with members of the FC in Vinh Trach, in 2016). Similarly, the three rice crops area in Ta Danh also needed to have water drained out of rice fields during the period of the second and third rice crops, but this activity was operated by the leader of the FC, and then farmers with land parcels inside this large field had to pay money to the FC's leader. Similar to a case study by Miller (2003), the water draining service is run by the ACs and the private sector.

Figure 5.10: Collective draining water from a large rice farm to a public canal in the rainy season in Vinh Trach commune
Source: Author (2016)

Throughout the interaction between farmers' decision-making for rice farming activities and factors, the study identified farmers' collective and individual decision-making about rice-farming activities. Members of FCs and general farmers depended on their perception and previous behaviour in relation to factors and activities including weather conditions, access to markets, and characteristics of different rice varieties and farming tasks to make decisions.

5.5.4 Effects of farmers' decision-making on the outputs of rice production and other livelihood patterns (Research question 4)

Farmers' decision-making about rice-based farming systems and farming activities is linked to factors for decision-making (causes) and to outputs of rice farming (effects). The decision-making for rice farming presented earlier affected the results of different rice-farming activities as well as the final output of rice production. Farmers' decision-making in relation to rice-based farming systems also contributed to household income for enhancing household resilience. According to DFID (1999), livelihood outcomes are regularly considered to reduce risks and enable more challenges. Therefore, rice yield, cost and income of rice production, and other livelihood income sources are viewed as being a significant output of rice-based farming systems that will now be discussed.

In Vinh Trach all farmers planted three consecutive rice crops a year, while in Ta Danh 16 households (67%) in the FC and 20 general farmers (71%) cultivated two crops, and only eight households (33%) in the FC and eight general farmers (29%) cultivated three rice crops (Table 5.16). In Vinh Trach, the mean yield of the first rice crop of members of the FC (8.8 tonnes/ha/crop) was similar to that of general farmers (9.0 tonnes/ha/crop). The mean net income for members of the FC (26.8 million VMD/ha) was higher than that of general farmers (VND 19.3 million/ha) (Table 5.16). Numerous members involved in the FC obtained higher profits than general farmers because they produced seed. Rice seed usually has higher prices (approximately VND 6.5 million/tonne) than normal rice (i.e., rice for consumption; < VND 5 million/tonne) (data collected from household surveys in 2015). The standard deviation is very high for some values because of a wide range of net income by household of some farmers compared to that of other farmers in Vinh Trach (Table 5.16).

The mean yield of the second and third rice crop of members of the FC (6.4 tonnes/ha/crop) was higher than that of general farmers (6.1 tonnes/ha/crop) (Table 5.16). The mean net income per ha of the second rice crop of members of the FC (VND 14.9 million) was also more than double that of general farmers (Table 5.16). That is because rice seed had higher prices than normal rice as explained earlier.

In Ta Danh, the mean yield of the first (9.5 tonnes/ha/crop), second (6.7 tonnes/ha/crop), and third rice crop (7.5 tonnes/ha/crop) of the members of the FC was higher than that of the first (8.5 tonnes/ha/crop), second (6.3 tonnes/ha/crop), and third rice crop (6.1 tonnes/ha/crop) of general farmers. Similarly, the mean net income per ha of the first (VND 31.6 million/ha), second (VND 14.9 million/ha) and third rice crop (VND 24.9 million/ha) of members of the FC was a higher than that of the first (VND 24.3 million/ha), second (VND 12.2 million/ha), and third rice crop (VND 13.4 million/ha) of general farmers (Table 5.16).

The mean net income of rice production from members of the FC was higher than for general farmers because more than 50% of members of the FC have cultivated seed, while general farmers cultivated normal rice (i.e., rice for consumption). The price of seed is regularly higher than normal rice. The price of seed fluctuated from VND 5.2 million/tonne to VND 11 million/tonne. In contrast, the price of normal rice varied from VND 4.5 million/tonne to VND 6 million/tonne (data from household surveys in 2015). However, it is difficult to identify the accuracy of prices of seed because there are three degrees of seed (intensive original seed, original seed, and certified seed) in Ta Danh and Vinh Trach (FGDs in 2016). The original seed is used to produce certified seed, while certified seed was regularly used by farmers to plant normal rice (for consumption). In addition, there is a wide range of rice seed varieties (Table 5.14). Each rice variety has different prices. However, seed production requires high technical knowledge of seed production. In addition, the cost of seed production is much higher than that of cultivating normal rice due to the high cost of hiring labour for transplanting seed (VND 3–5 million/ha), and testing the quality of seed on the field before harvesting.

Table 5.16: Mean (± sd) rice yield, gross income, cost, and net income (VND million = ~ USD 45.5) for each of the three rice crops by household and by hectare (ha) of members of farmer club (FC) and general farmers in Vinh Trach and Ta Danh, An Giang province

Indicator	Vinh Trach				Ta Danh			
	Members of FC[1]		General farmers		Members of FC		General farmers	
	HH[2]	Ha[3]	HH	Ha	HH	Ha	HH	Ha
First rice crop	**n=26**		**n=30**		**n=24**		**n=28**	
Yield 1 (tonnes)		8.8 (±1.0)		9.0 (±0.9)		9.5 (±1.4)		8.5 (±1.3)
Gross income[4] 1	147.2 (±118.8)	50.8 (±8.6)	87.3 (±76.7)	40.4 (±5.9)	243.4 (±217.2)	53.6 (±10.0)	125.1 (±150.6)	46.6 (±10.4)
Cost 1	67.4 (±56.3)	23.9 (±7.7)	43.5 (±35.6)	21.1 (±6.9)	102.5 (±96.3)	21.9 (±5.2)	62.7 (±83.5)	22.1 (±6.5)
Net income 1	79.7 (±66.6)	26.8 (±8.7)	43.8 (±45.3)	19.4 (±6.1)	140.8 (±123.5)	31.6 (±8.6)	62.3 (±70.4)	24.3 (±9.1)
Second rice crop	**n=26**		**n=30**		**n=24**		**n=28**	
Yield 2 (tonnes)		6.4 (±0.7)		6.1 (±0.6)		6.7 (±1.3)		6.3 (±1.0)
Gross income 2	113.0 (±97.9)	38.8 (±7.7)	60.1 (±53.8)	27.1 (±3.3)	181.8 (±177.7)	37.6 (±10.7)	92.4 (±109.2)	33.5 (±7.7)
Cost 2	67.1 (±57.3)	23.9 (±7.3)	44.1 (±36.1)	21.1 (±6.7)	102.8 (±82.9)	22.7 (±4.8)	58.7 (±76.0)	21.3 (±5.9)
Net income 2	45.8 (±46.2)	14.9 (±8.0)	16.0 (±24.1)	6.0 (±6.1)	78.9 (±103.5)	14.9 (±9.9)	33.6 (±38.7)	12.2 (±7.4)
Third rice crop	**n=26**		**n=30**		**n=8**		**n=8**	
Yield 3 (tonnes)		7.0 (±0.8)		6.8 (±1.1)		7.5 (±1.8)		6.1 (±1.2)
Gross income 3	125.7 (±107.7)	43.8 (±7.2)	72.1 (±61.7)	32.3 (±5.2)	208.3 (±318.4)	50.2 (±21.2)	182.3 (±232.7)	36.4 (±13.7)
Cost 3	70.1 (±61.0)	24.8 (±7.6)	47.1 (±37.7)	22.7 (±6.9)	89.2 (±110.4)	25.2 (±7.9)	118.5 (±160.5)	23.3 (±9.6)
Net income 3	55.5 (±51.3)	19.0 (±7.7)	24.9 (±29.8)	9.6 (±8.2)	119.1 (±210.5)	24.9 (±18.5)	63.8 (±73.2)	13.4 (±7.1)

Source: Household surveys in 2015

Notes: 1. FC is farmer club

2. HH is household

3. Ha is hectare

Household income included on-farm, non-farm, and off-farm (Ellis 1998). The on-farm income of members of FC and general farmers in Vinh Trach and Ta Danh comes from rice production, vegetables, and livestock, while off-farm income was typically from activities of agricultural services and labour. For example, several farmers in Vinh Trach and Ta Danh owning tractors or hand tractors were able to work on their farm and also perform services for other farmers (Table 5.7). Non-farm income encompassed petty trades (e.g., small shops), official salaries, local services, and remittances.

The majority of household income was generated from on-farm activities in Vinh Trach and Ta Danh, especially rice production. For instance, the majority of household income was on-farm income for members of the FCs in Vinh Trach and Ta Danh, 94% (VND 193.9 million) in Vinh Trach and 88% (VND 278.7 million) in Ta Danh (Table 5.17). Household income of members of the FC in Vinh Trach at VND 206.4 million was lower than in Ta Danh at VND 318.4 million, because farmers in Ta Danh had a larger area of land than those in Vinh Trach, and rice accounted for the majority of household income.

Table 5.17: On-farm, off-farm and non-farm income (mean ± sd) (VND million = ~ USD 45.5) of members of farmer club (FC) and general farmers in Vinh Trach and Ta Danh, An Giang province

Income source	**Vinh Trach**				**Ta Danh**			
	Members of FC[1] (n=26 HHs[2])		**General farmers (n=30 HHs)**		**Members of FC (n=24 HHs)**		**General farmers (n=28 HHs)**	
	Mean	**%**	**Mean**	**%**	**Mean**	**%**	**Mean**	**%**
1. On-farm	193.9 (±159.1)	94	90.2 (±93.8)	76	278.7 (±328.7)	88	114.9 (±142.9)	80
2. Off-farm	4.5 (±11.1)	2	19.1 (±48.1)	16	16.8 (±48.7)	5	11.5 (±26.1)	8
3. Non-farm	8 (±19.5)	4	9.8 (±24.6)	8	22.9 (±56.1)	7	16.4 (±58.9)	11
Total	**206.4 (±165.2)**	**100**	**119.2 (±111.1)**	**100**	**318.4 (±344.3)**	**100**	**142.8 (±200.6)**	**100**

Source: Household surveys in 2015
Notes: 1. FC is farmer club
2. HHs is number of households

5.6 Conclusion

In conclusion, the case study reviewed the main findings in responding to the overall research questions that farmers in An Giang have to consider when they make decisions about their rice-based farming systems in An Giang province.

In terms of research question one, the major decisions that farmers have to make about their rice-based farming systems each year, members of the FC and general farmers in Vinh Trach decided to pursue three rice crops for rice-based farming systems, while the majority of farmers (members of the FC and general farmers) in Ta Danh decided to remain with the two rice crop system in 2014. The latter based their decision upon issues of household consumption, markets, and particular dyke conditions for securing paddy. Members of the FC and general farmers also relied on a different series of factors to decide their rice-farming activities.

Regarding research question two, various factors influenced farmers' decision-making for rice-based farming systems. Of these factors, social capital played a significant role in the resilience of both formal decision-making in the FCs, and in informal collective decision-making. The social capital of members of the FC in Vinh Trach was generally stronger than that of members of the FC in Ta Danh. Members of the FC in Vinh Trach had worked together through training activities over many years, as also noted in the studies presented by De (2006) and Tuan (2014). However, social capital of the two FCs in the two communes had reduced due to issues of lack of social cohesion, trust and commitment. The finding on social capital in the FCs of Vinh Trach and Ta Danh also indicates that their relationship relied on collective knowledge rather than economic activities. Similar to Miller (2003), farmers still prefer to work together at the same time and the same place, but do not necessarily seek to cooperate in the realm of economic organisation. However, local governments continue to maintain these organisations so they can conduct new projects in the future because the majority of members in the FCs are advanced farmers. Advanced farmers play an important role in collective decision-making for rice-farming systems.

Climate was shown to affect the two communes through very hot weather at the beginning of the second rice crop and abnormally heavy rains which occurred annually at the end of the second rice crop. Farmers in An Giang made individual decisions for farming strategies to cope with the hot temperature and heavy rains, as well as collective decision-making in draining water out of the rice fields to cope with abnormal heavy rains. Collective decision-making in draining water out of fields was supported by the AC in Vinh Trach and the leader of the FC in Ta Danh.

Local market access was one of the most important factors affecting farmers' decision-making for farming activities for rice production. This was closely aligned with local climatic conditions, characteristics of rice varieties, and accessing suitable prices for rice which encouraged farmers in making decisions to use IR 50404 for rice varieties in the three rice crops. I agree with Bosma et al. (2012) that access to suitable prices for the outputs of a farming system influenced farmers' decision-making in the VMD.

In terms of research question three, farmers made collective and individual decisions for their rice-based farming systems. Members of FCs and general farmers in both communes individually decided on a wide range of farming activities (i.e., draining water out of fields, selecting rice varieties, and access rice varieties) for each rice crop in the two and three rice crops each year. In contrast, they made collective decisions for farming activities including pumping water, the seasonal calendar, and the same rice varieties, and especially a focus on seed production. The requirement for collective decision-making units was mostly due to accessing markets, geographic conditions (i.e., in the same rice field location), kinship and a large area per household, and seed production. In addition, contract farming was conducted by participants of a seed producer group that was a part of the FC in Vinh Trach and Ta Danh. However, there were conflicts between some members and leaders in the case of Vinh Trach, whilst in Ta Danh the relationship between members of the FC and leaders has become a private relationship between a company and farmers instead of members and leaders in a FC.

The finding shows that, until 2016, the cooperative behaviour of farmers was quite similar to that in 2000 (Miller 2003), and although local government and international organisations have supported a range of development projects to improve cooperation models at the commune level, farmers in the VMD are still concerned with working individually. Similar to a study presented by Bruijn and Van Dijk (2005), members of FCs and general farmers in Vinh Trach and Ta Danh have experienced different conditions over time, and their knowledge, experience and understanding of their environment vary systematically between them, especially farmers' perceptions of social interaction between farmers in their community. Accordingly, they decided on rice-farming activities depending on their perceptions.

In terms of research question four, the consequences of major decision-making influence the output of rice-based farming systems and household livelihoods. Following the literature reviews in Chapter 2, the effect of farmers' decision-making for two or three rice crops, and rice-farming activities on outputs of rice production was presented by yield, production cost, and net income. In Vinh Trach and Ta Danh, members of the FCs had nearly similar rice yields per ha to general farmers. However, members of the FCs in the two communes decided on seed production to gain high income because they were interested in maximising their income, which was slightly similar to the result of the study presented by Herath et al. (1982) when Sri Lankan rice farmers had to choose traditional or high-yield rice varieties for cultivation. The results of the case studies in Vinh Trach and Ta Danh imply that farmers were more interested in increasing profitability than productivity, but this is estimated by farmers rather than estimated by scientists, as shown in the study presented by Dan (2016), when this author compared costs and benefits between two and three rice crops in the VMD. In contrast, general farmers decided on normal rice to cultivate. Income from the rice of members the FC and general farmers in Ta Danh was higher than that in Vinh Trach. Accordingly, farmers have relied on rice yield, cost, net income, and other factors to decide on their crops in coming years. Generally, although farmers have to adapt to a range of threats such as local markets and climate variability (variations in rainfall patterns, temperature, and flooding), they have diverse ways of decision-making for farming activities to achieve high resilience.

Farmers in Vinh Trach and Ta Danh commune had a nearly similar approach to collective and individual decision-making in relation to farming activities. However, they have some differences. Firstly, the land area of farmers in Ta Danh is larger than that in Vinh Trach. Secondly, the number of farmers producing seed in Ta Danh is also larger than that in Vinh Trach because there are many seed companies and other seed stations in Ta Danh. Farmers producing seed for seed companies were not only members of the FC, but also general farmers who were able to have contract farming directly to seed companies, instead of engaging in farmer organisations. Therefore, it was very complicated for the study to clarify which farmers or members of farmer organisations produce seed.

Chapter 6

Farmers' decision-making for rice-based farming systems in the middle zone province of the Vietnamese Mekong Delta: A case study of Can Tho

6.1 Introduction

Can Tho, a central province of the VMD, is considered a favourable province compared to An Giang and Bac Lieu. That is because Can Tho has a slightly higher elevation and is approximately 60 km upstream on the Hau River, and so it is not seriously affected by flooding and the intrusion of saline water (Can et al. 2007). Consequently, Can Tho is a good geographical area for intensive and diversified crop production. Most small-holder farmers in Can Tho practise rice cropping in three sequential rice crops on small plots of land (~1.5 ha). Can Tho contributes nearly 1.5 million tonnes to the total annual rice productivity of the VMD. In order for small-holder rice farmers to maintain or increase rice production in the future, they need to overcome a range of constraints, including climatic constraints (timing, patterns, and intensity of climate events such as rain, storms, floods, and high temperatures) and non-climatic constraints such as access to markets and policies (ICEM 2009; Can 2014). However, it is not always clear how individual farmers or groups of farmers make informed decisions about how to adapt and grow their rice more effectively.

Historically, farmer organisations have been supported in Vietnam, and they allow sharing of decision-making, support networks, and access to resources, and they are supported by Vietnamese Government policies (Ha et al. 2013; Hai 2014). The two main collective organisations supported currently in Can Tho are agricultural cooperatives (ACs), and large-sized farms (LSFs) (Du & Tung 2012; Hai 2014). The AC model is a formal and legal economic organisation with a legal stamp (i.e., legal status, binding contracts, and access to funding) and collective property such as warehouses, farming machines, and collective funding (Hai 2014). LSF is a group of farmers having small land parcels in the same large farm, having several collective farming activities, and receiving support from government including connection to a reliable rice company by the commune authority, as well as supplying a quality rice variety and support for training (Du & Tung 2012). However, there are questions about how the two different models benefit members of the farmer organisations and the broader community in decision-making for implementing the three rice crops and how they decide on adaptation to floods, climate variability, market competition, and other constraints.

Previous studies have demonstrated the benefits for rice production and increased income for members of ACs (Hai 2014). However, farmers can be both part of a collective farmer organisation, and also still identify themselves as individual farmers for decision-making and accessing technical knowledge. Individual farmers can choose or decide on whether to follow government policies as part of a farmer organisation or individually for benefits in terms of their household livelihoods. There are no published studies examining this situation. Furthermore, it is not known what the benefits are of being involved in a group, nor how being involved in a collective farmer organisation helps to deal with climate threats and market constraints. This study will allow an understanding of farmers' perceptions of collective activities on rice production through narratives and measuring social capital.

The purpose of this case study in Can Tho is to enhance the understanding of what decisions rice farmers make, and how they are made when undertaking rice-based farming systems. The specific aims in this study will comprise:

1. Identifying what decisions farmers make about the main rice-based farming systems,
2. Exploring factors influencing farmers' decision-making for rice-based farming systems,
3. Enhancing understanding of farmers' behaviours by examining how members of ACs, LSFs, and individual farmers (i.e., general farmers or non-members of farmer organisations) decide on strategies in relation to a series of farming activities for each of the three rice crops, and
4. Determining the decisions affecting the outputs of the farmers' rice-based farming systems and household livelihoods.

6.2 Research questions

The main research question for this chapter has the same focus that of the previous chapter, namely what are the main questions that farmers have to consider when they make decisions about their rice-based farming systems in Can Tho province?

The specific research questions are:

1. What are the major decisions that farmers have to make about their rice-based farming systems each year?
2. Which factors influence farmers' decision-making for rice-based farming systems, and how will these factors influence them?
3. How do farmers make collective and individual decisions for their rice-based farming systems?
4. What are the consequences of the major decisions about rice-based farming systems and household livelihoods?

6.3 Concepts and methods

6.3.1 Concepts

In this case study in Can Tho, the thesis will follow the same approach as that for An Giang in Chapter 5 for understanding farmers' decision-making about agricultural intensification with three consecutive rice crops each year. A major difference in Can Tho is that farmers make collective and individual decisions about rice farming activities through ACs and LSFs. The process of decision-making depends on factors related to policies and organisation, livelihood capitals, and outside factors including climate variability and access to markets (Scoones 1998; Carswell 1997; Bruijn & Van Dijk 2005).

In 2002, agricultural intensification was gradually implemented in Can Tho more intensively in the rotation of rice crops from two consecutive rice crops to three consecutive rice crops each year, and through improvements to irrigation canals and dykes, and short-term rice varieties (LeCoq & Trebuil 2005). Farmers in Can Tho might also apply an adjustment method to the seasonal calendar. This has been a benefit to the livelihoods of rice farmers in Can Tho, but they might also be confronted with threats relating to conditions of climate variability and access to markets.

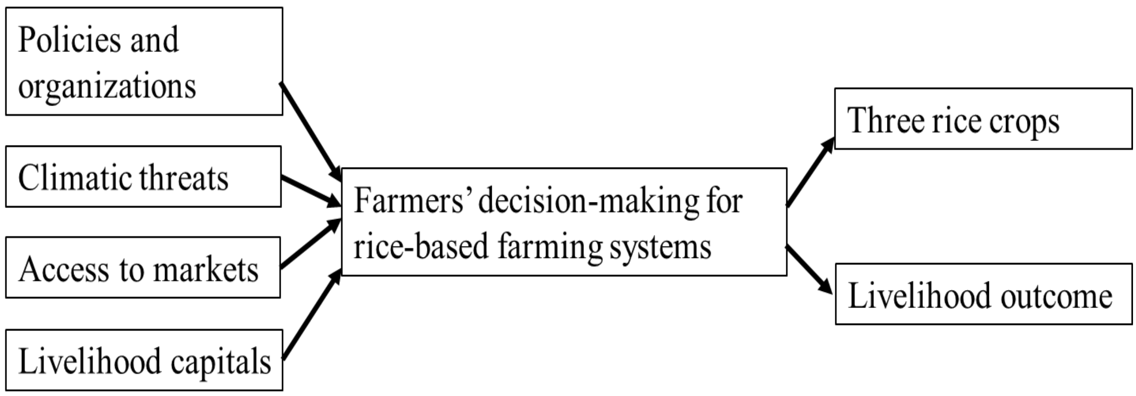

Figure 6.1: Conceptual framework of study showing the linkage between farmers' decision-making, factors (organisations, climatic threats, access market, and livelihood access) and three rice crops and livelihood outcome.
Source: Adapted from Chambers and Covey (1991), Scoones (1998), and Bruijn and Van Dijk (2005)

6.3.2 Research methods

Research sites

Can Tho city and Hau Giang province were separated from Can Tho province in 2000. Although Can Tho is considered a regional city in the VMD, agricultural land accounts for approximately 80% of the land area, and more than 77% of the agricultural land area is devoted to rice production (SOCC, 2015). Therefore, in this study I prefer calling Can Tho city "Can Tho province" (Figure 6.2).

Figure 6.2: The location of Thoi Tan and Truong Xuan A commune in Can Tho province.

This study was conducted in the two communes of Thoi Tan and Truong Xuan A, Can Tho (Figure 6.2). The two communes are located in the moderate flood zones of the VMD (Sanh et al. 1998). Every year, floods and the high tide movement zone impact the rice production of farmers in Can Tho (Huu 2011; CCCO 2015). Furthermore, flood water from upstream An Giang province can cause additional flooding of all farming fields in Can Tho (Huu 2011; CCCO 2015). Farmers and local governments in the two communes also constructed dykes 7 to 8 years ago to protect the third crop from flooding. The total land area is 1,762 ha in Thoi Tan and 1,664 ha in Truong Xuan A, of which 77% and 84% is agricultural land respectively (Table 6.1). The area of three rice crops was 75% in both Thoi Tan and Truong Xuan A (Table 6.1). The number of households was 1,643 in Thoi Tan and 1,524 in Truong Xuan A, which equates to an average land holding of 1.2 ha and 1.1 ha respectively. The majority of households were of Kinh ethnicity (Table 6.1).

Table 6.1: Different land types (ha[1]), ethnicity distribution, and number of households in Thoi Tan and Truong Xuan A commune, Can Tho province in 2014

Indicators	Thoi Tan		Truong Xuan A	
	Number	**%**	**Number**	**%**
Total natural land (ha)	**1,762**	**100**	**1,664**	**100**
Agriculture (ha)	1,346	77	1,391	84
Three rice crops (ha)	1,331	75	1,256	75
Other types[2] of land (ha)	416	23	273	16
Population	**7,575**	**100**	**6,061**	**100**
Kinh ethnicity	6,506	85	6,049	99
Khmer ethnicity	294	4	12	1
Chinese ethnicity	6	1	0	0
Total households	1,643	100	1,524	100
Poor households	95	6	67	4

Source: Collected from People's Committee of Commune
Note: Poverty rate of Vietnamese government officials
1. Ha is hectare
2. Other types of land are land for homestead, markets, schools, and public land

Dykes in the two communes in Can Tho (1.2 m) were about one-third of the height of dykes in An Giang (3.5 m), but were sufficient to allow farmers to cultivate three rice crops a year (field notes in 2015). The dykes in Can Tho are sufficiently large to prevent flood water until the end of the third crop each year. After finishing the third crop, the fields can be flooded for more than one month prior to preparation of the first annual rice crop using gates and drains. In Can Tho, farmers adapt to flooding through the use of dykes, adjusting their seasonal calendars, and pumping water together collectively through farmer organisations or the community.

In general, the two communes have similar environmental conditions and share non-climatic challenges, especially unstable market prices. However, Thoi Tan can be considered a favourable site for rice-based farming systems, whereas Truong Xuan A is unfavourable since it suffers slightly deeper and longer duration flooding than in Thoi Tan. Three rice crops a year were implemented in Thoi Tan (2002) three years earlier than in Truong Xuan A (2005). The AC dominates farmer organisations in Thoi Tan, whereas the LSFs dominate farmer organisations in Truong Xuan A. The AC and the LSFs in the two communes have similar collective activities in rice cultivation such as collectively draining water out of large-sized farms and following the same seasonal calendar, contract farming with companies or research institutes, and improving technical knowledge through collective skills in formal and informal ways. The LSFs in Truong Xuan A did not have collective funding or cooperative property (e.g., driers).

Data collection and analysis methods

There were three main data collection methods used in this case study, comprising household surveys, semi-structured interviews, and focus group discussions (FGDs). A household survey with quantitative and qualitative questions was conducted for Thoi Tan commune with 58 households (34 members of AC and 24 general farmers) and in the Truong Xuan A commune with 62 households (35 members of LSFs model and 27 general farmers). The target for these surveys was the household decision-makers about rice-based farming systems, not necessarily the head of the household; overall, participation by women was relatively low at 6%. Semi-structured interviews were undertaken in the two communes with 15 key informants comprising members of the AC and LSFs, general farmers, brokers (middle people between farmer and trader), owners of combine harvesters and owners of agricultural materials (20% were women participants). These interviews were designed to gain deeper insights about the relationships between members of the AC or LSFs, or general farmers and other actors when farmers decided on their farming activities. FGDs were conducted with the two farmer groups in each of the two communes: (1) households that had participated in the AC, and (2) general farmers who were not involved in the AC. In Thoi Tan, there were 11 participants in the AC and ten participants as general farmers, and in Truong Xuan A there were six members of LSFs and seven participants as general farmers (41% women participation). The findings of this study include quantitative and qualitative data that are presented through descriptive statistics and narratives.

6.4 Background to policies relating to rice development and the results in Can Tho

6.4.1 Background to policies relating to rice production in Can Tho

In Vietnam, there are five levels of authority which were discussed in Chapter 5. A wide range of policies have been developed and implemented over the years in Can Tho (Table 6.2). These policies directly influence rice farming activities, especially the condition for promoting three rice crops and include land use, canal, and dyke development. Another set of policies was related to the market liberalisation which enabled farmers to access a wide range of inputs consisting of seed, fertiliser, pesticide, and agricultural services (e.g., tractors and combine harvesters).

This study focused on the three main farmer organisations (production groups, ACs and LSFs) which affected the rice farming of farmers in the two communes. They were formed, applied and modified in various ways over time because of the small land size of farmers in Can Tho (Table 6.2). According to the head of the Crop Protection Centre of Can Tho and local government (field interviews in February 2016), commune authorities campaigned for farmers to become involved in ACs or LSFs, but farmers preferred to decide more individually rather than collectively. Consequently, I now summarise each of the farmer organisations below.

In Thoi Tan and Truong Xuan A communes, the authorities applied production group models coinciding with land reform policy from 1977 to 1985 (Table 6.2). The mananegement board included one head and two vice heads of each production group, one accountant, and one treasurer. Each production group contained 50–60 households with a total farming area of between 160 and 300 ha. The production groups in Thoi Tan and Truong Xuan A did not apply the work points system as per the old model of ACs in the north of Vietnam (Kerkvilet 2005). All inputs of rice production including seeds, fertilisers and pesticides, and land preparation were supplied by a management board of production group. After harvesting, the farmers' rice had to be collected by a management board of the production group to sell to local government food companies. However, there was no collective cooperative in the two communes from about 1986 until 2002.

6.4.2 Consequences of the process of rice intensification in Thoi Tan and Truong Xuan A

Rice production in the two communes in Can Tho has developed gradually across different periods. From 1976 to 1986 most of the land area in Can Tho was cultivated with one rice crop because canals carrying water from the Mekong River to the paddy field had not been dredged yet. Farming techniques and rice varieties were also limited, and farmers were not able to access materials such as fertilisers, pesticides, credits, and other agricultural services. As a result, paddy yield was only around 3 tonnes/ha/crop (Table 6.2). From 1990 to 1995, rice crops intensified with an increasing rotation from one rice crop to two consecutive rice crops, and a small number of farmers shifted to three consecutive rice crops each year. The yield of paddy in this period improved to approximately 4 tonnes/ha/crop (Table 6.2). From 2002 to the present, the land area of the three rice crops gradually expanded, and the yield increased to approximately 5 tonnes/ha/crop, and has continued to rise gradually to approximately 8 tonnes/ha/crop for the first rice crop, and approximately 6 tonnes/ha/crop for the second rice crop. Elements influencing the increase in yield of paddy through different periods included the improvement of canals and dykes for irrigation and flood protection respectively and better access to materials for farming, to banks, and to other agricultural services. In addition, rice varieties (higher yielding) and farming techniques also improved gradually in this period (FGDs in 2015 and 2016). The study will determine the rice yield in more detail in the output of farmers' decision-making for rice-based farming systems.

Table 6.2: Relevant policies of rice production in Thoi Tan and Truong Xuan A, Can Tho province

Year	Policies	Change in rice farming systems	Farmers response	Rice yield
1976–1980	• Collective/planned economy • Land conversion • Canal development(by hand) • Production group	One rice crop a year	Followed but was not interested in land conversion and this cooperative model then changed to new policies	~ 3 tonnes/ha/crop
1981–1986	• Contract farming with the government, but planning economy • Production group • Improve and open canals (by hand)	One rice crop	Followed but was not interested in land conversion and this cooperative model	~ 3 tonnes/ha/crop
1987–2000	• Market economy • Land conversion • Improve canal (by machine) • Technical knowledge via agricultural extension and farmer associations	2 rice crops a year on rice land	Followed but low productivity of rice because of limited technical knowledge and input supply	~ 4 tonnes/ha/crop
2002	• Cooperative (update) • Technical knowledge • Improve canals • Controlling insect • Seed production • Dike construction • Contract farming	3 rice crops a year on rice land	Followed but some arguments took place when considering costs and benefits (cost of dyke construction and soil quality degradation)	~ 5 tonnes/ha/crop
2007–2013	• Cooperative • Large-size farm model • Technical knowledge • Controlling insect • High seed quality • Improve dyke • Improve canals • Combine harvester (decree 65 of Prime Minister; decree 03 of People's Committee of Can Tho)	3 rice crops a year with high-quality rice variety on the rice land	Farmers were happy with these policies	• 1st crop:~ 8 tonnes/ha/crop • 2nd crop: ~5-6 tonnes/ha/crop • 3rd crop: 6 tonnes/ha/crop

Source: Collected from DARD, FGDs in 2016, and household surveys in 2016

6.5 Results and discussion

6.5.1 Farmers' decision-making for the three rice crops (Research question 1)

Similar to the approach to farmers' decision-making for rice-based farming systems in the An Giang case study (Chapter 5), this section will discuss how farmers make decisions related to three rice crops in Thoi Tan and Truong Xuan A commune in Can Tho because this cropping systems dominates most of the land area in these two communes. The reasons for presenting and discussing what and why farmers decide on three rice crops is because three rice crops dominated the majority of the land area in Thoi Tan and Truong Xuan A (Table 6.1). In addition, the rice is the main source of livelihood income for farmers in both communes. Members of the AC and members of the LSFs, and general farmers in the two communes decide on particular farming activities including choosing production of seed or normal rice (rice for consumption), setting up seasonal calendars for a particular farming system, selecting rice varieties for each crop, etc. Farmers' decision-making about particular farming activities will be discussed in detail in section 6.5.3 because this section presents and discusses what, how, and why farmers make collective and individual decisions about particular farming activities (see Tables 6.10 & 6.11).

Members of the AC, the LSFs and general farmers (non-members) typically made individual decisions with three rice crops for rice-based farming systems in Thoi Tan and Truong Xuan A. Different key factors affected their decision-making including household consumption, access to markets, and collectively draining water out of fallow, large-sized farms after the flood season.

Firstly, members of the AC, LSFs and general farmers in the two communes perceived that they typically preserved enough rice for home consumption, although they also considered economic requirements. According to Mr H. in Thoi Tan, after each rice crop his household regularly sells rice to earn money for expenditure and all consumption in his family, but he has to store rice for household consumption requirements (for humans, chickens, and pigs) until the harvest season of the next crop because this is a common behaviour of his family. The respondents stated that they usually stored much more rice after finishing the third crop for household consumption than other crops because the time to wait for rice from the next first rice crop each year is longer than between other crops.

Secondly, farmers informed me that they could sell rice at suitable prices although they had challenges with low market prices in the first and second rice crops. Farmers in Thoi Tan and Truong Xuan A responded that they access local brokers very easily because brokers are living in their village. According to FGDs held in Thoi Tan in 2016, after finishing each rice crop, the local broker books farmers to sell rice to traders for the next rice crops, but this depends on local market prices. According to Mr C., he is a local rice broker. He had small land size, and his livelihood relied on his broker job. Every rice crop, he contacts farmers in villages, even in communes, to ask them to sell rice to him. He is a representative for traders coming from Dong Thap province (a neighbouring province of Can Tho).

Farmers in the two communes decide on cultivating three rice crops also according to the collective draining of water out of large farms in the first rice crop. Participants in FGDs held in 2016 in Thoi Tan and Truong Xuan A responded that they currently began the first rice crop 3 weeks earlier than they did in 2003 to finish the third rice crop of the year later before floods arrive causing high water levels that damage the rice plants. After harvesting the third rice crop, farmers allow floods to enter their fallow fields in the flood season for up to 6 weeks (20th September to 5th November). Farmers perceived that fallowing in the flood season allows the accumulation of alluvium (i.e., natural fertiliser) from flood water, and helps to flush out pesticides, insects, and diseases. In Thoi Tan, neighbouring farmers drain water together *(làm cùng nhau)*, whereas in Truong Xuan A, the head of LSFs collectively drains water out of large farms for farmers.

Farmers typically used the above important factors to decide whether to cultivate three rice crops. Section 6.5.3 of this chapter will consider in more detail farmers' collective and individual decision-making for important farming activities in each rice crop to enhance insights of farmers' perceptions and behaviours in the process of decision-making for rice-based farming systems.

6.5.2 Factors influencing farmers' decision-making for rice intensification in Can Tho (Research question 2)

Following research question 2 and the literature review of concepts used in this study, factors relating to farmers' decision-making about rice-based farming systems include farmer organisations, climate threat and access to markets, and livelihood assets and access. This section will present and discuss the results of these factors. Regarding the farmer organisations discussed earlier, I selected the agricultural cooperative (AC) in Thoi Tan and the large-sized farms (LSFs) in Truong Xuan A as the key farmer organisations to examine the influence of the AC and the LSFs directly on farmers' formal collective decision-making for farming activities. Using indicators of social capital enables us to understand the resilience of the AC and the LSFs in the two communes, because it might expose collective decision-making about rice farming activities via the relationship between members in the AC and the LSFs through cooperation or working together (Du & Tung 2012; Hai 2014).

Influences of social capital on the resilience of agricultural cooperatives for decision-making for rice faming activities in Thoi Tan and Truong Xuan A

In 2012 an AC was established with the support of the Provincial Government of Can Tho. The AC then received drying machines and cleaning machines to improve the quality of rice varieties after harvesting along with a wide range of training courses on seed production from centres of the Department of Agricultural and Rural Development (DARD) of Can Tho. The management board of the AC in Thoi Tan also attended training courses on management and accounting run by the Cooperative Alliance of Can Tho province (FGDs with AC's members in Thoi Tan in 2016).

The AC of Thoi Tan had 54 members, and at the beginning of formulating the organisation, decision-making was conducted by a management board of the AC, representatives of households who agreed to participate in the AC, and staff of local government (Table 4). Agreements were established at the first conference *(đại hội xã viên)* to determine rules about decision-making, the number of members, objectives, activities, and importantly about funding contributions (i.e., prices of shares). The AC conducted a wide range of training courses to diffuse technical knowledge of rice production such as the "3 reductions" and "3 gains" methods, and seed production for members. In 2014, the main members of the AC concentrated on rice seed contract farming with the Cuu Long Rice Research Institute (CLRRI). However, some members of the AC engaged in seed contract farming according to the demands of CLRRI and the seed centre of Can Tho province. According to the leader of the AC, there are around fourteen members involved in seed production; they regularly produce seed in the first rice crop, while the majority of members of the AC produce normal rice (i.e., rice for consumption) in the other two rice crops each year.

Social capital influencing the resilience of the agricultural cooperative and collective decision-making

The social capital indices were used in Chapter 5 to measure social capital between members in the farmer clubs. In this chapter, the indices of social cohesion, social trust, and social commitment were constructed via collective farming activities to measure social capital between members in the AC and the LSFs.

This case study points out a few high scores and a few low scores and relates this to the different forms of social capital. The indices (i.e., statements) of social cohesion, social trust and social commitment achieved a moderate score of agreement among participants (Table 6.3). For example, the statement, "Members will share new knowledge with their members" in social cohesion received a relatively high mean score of 3.4 of agreement of participants. Support for the statement "I am confident that organisation assists members to get harvest machines in time of crop seasons" in social trust obtained a low score of 2. This means that most farmers were not all that confident about other members for this activity. In contrast, the statement "Organisation's members inform other members and the community about the pests and diseases their crops get" of social commitment attained a score of 3.2. The results of the study imply that many farmers involved in the AC were not satisfied with their AC for several collective activities, which negatively influenced the resilience of the AC and collective decision-making for rice production. This dissatisfaction needs to be recognised and addressed if the AC wishes to develop this model further in the future.

Table 6.3: Members' perceptions about statements of social capital (mean ± sd) of members in the agricultural cooperative (AC) in Thoi Tan, Can Tho province

Statements of social capital	Members of AC[1] (n=34 HHs[2])
1. Social cohesion	
1.1 Members will share new knowledge with other members	3.4 (±0.9)
1.2 People are friendly in the organisation	3.6 (±0.8)
1.3 Members usually agree to begin crop at the same time	3.9 (±0.8)
1.4 Members are willing to work together to protect crops	2.8 (±1.1)
1.5 I regularly participate in working groups	2.9 (±1.1)
2. Social trust	
2.1 I am confident that the organisation assists members to get harvest machines in time of crop seasons	2.0 (±1.7)
2.2 I am confident that the organisation supplies seeding in time in internal rule of farmer organisation	2.8 (±1.5)
3. Social commitment	
3.1 Organisation's members inform other members and the community about pests and diseases their crops get	3.2 (±1.1)
3.2 Farmer organisations are active and inform all members every time they have training (with outside agencies)	3.3 (±1.2)
3.3 Farmer organisation is willing to protect members in transactions with output companies	3.1 (±1.4)
3.4 Members have good duty to their contract with companies	2.6 (±1.3)
3.5 Members of the organisation respect the rules of organisation (follow seasonal calendar of organisation)	3.6 (±0.7)

Source: Household surveys in 2015

Note: 5= completely agree; 4= agree; 3=Neutral; 2=disagree; 1= completely disagree

1. AC is agricultural cooperative
2. HHs is number of households

Results from FGDs held in 2016 and the high standard deviation for some values due to a range of value provided by respondents (Table 6.3), farmers' perceptions of the AC were divided into two groups, positive perceptions of the AC and negative perceptions of the AC. Members of the AC who were relatives of the leader of the AC, or were neighbours of the leader of the AC, had positive perceptions of the AC. The leader of the AC in Thoi Tan commented as follows,

> During the period of operation from establishment in 2012 to the present (2016), members of AC attended several training courses in seed cultivation from CLRRI and other divisions of DARD. We also encouraged farmers in the community to join collective pumping of water for the beginning of the first rice crop when the annual flood recedes from the field. However, it is very difficult to develop AC because we could not find new contract farming for seed production as well as normal rice. According to the laws of AC in Vietnam, our AC had a legal stamp, thus companies did not want to sign contract with our AC because they would have to pay compensation if they did not comply with it. Our AC could not get loan from banks, while almost all members

> in the AC have a small farm of around one ha, and have a limited financial capital. This led to a lack of financial capacity to contribute to collective funding of AC.
>
> (Field interview Mr M. in February 2016)

The narrative from this informant indicates that there are numerous constraints within the AC in Thoi Tan in collective action decision-making, even though they had a range of support from various divisions of the DARD of Can Tho province. Nevertheless, although the AC had limited collective finance, and sought customers for outputs of seed production, many members who have a close relationship with the head of the AC greatly appreciated the role of the AC in seed production. For example, Mrs Kh., a member of the AC, had a close relationship with the head of the AC. She commented that,

> The AC was a good model because it supplied members and other farmers in the community with opportunities to access good certified rice varieties to produce good quality rice. Members of the AC attend training sessions by scientists of the government, and can also exchange farming experiences through monthly meeting.
>
> (Field interview Mrs Kh. in June 2015)

Mrs Kh's comments show that the AC in Thoi Tan has some constraints, but has still provided benefits for members via enhancing technical knowledge. Additionally, members had a good opportunity to produce seed to improve their livelihoods. Unlike Mrs Kh., other members of the AC, who did not have a close relationship with the management board of the AC, had contrasting perceptions of the AC. For example, Mr Tr., one member, said that,

> The head of the management board of the AC should be a good example to take care of members of the AC by giving priority to members of the AC producing seeds of rice, while he, his son and his kin did it.
>
> (Field interview Mr Tr. in June 2015)

According to the perceptions of Mr Tr., the AC in Thoi Tan had a diversity of disagreements among different members. On the one hand, members who had a close relationship with the head of the AC via kinship or as a neighbour supported maintaining the AC. On the other hand, other members did not give support to the AC because they did not gain benefit from it. Trust and commitment should be constructed before becoming involved with the AC. According to the head of the AC, although a large number participated in the AC, he could not trust most members in the AC. As a result, he only invited members whom he trusted in relation to seed production. In short, members of the AC must be trusted before they go into an organisation.

Following the FGDs held in 2016, general farmers claimed that they could not participate because their farming area was small (area < 1 ha). In addition, they did not have money to contribute to the collective funding of the AC. The most important issue is that they do not want to cooperate. For example, Ms Th, 50-year-old farmer, and her household, had 0.7 ha of rice land and participated in the FGDs and household surveys. She told me that,

> It was difficult for us when we participated in the AC. I attended only the first meeting, and I saw many men and only a few women in the AC. I felt lonely and shy when I talked. In addition, I had a small farm size *(đất ít)* and did not have money to share with the AC. Therefore, I did not want to join anymore.
>
> (Field interview Ms Th in June 2015)

In this case, Ms Th. indicated that gender issues and small land size were barriers for collective decision-making in cultivating farming activities. Although every member was equal in the AC in Thoi Tan, some women members felt lonely and shy when very few women were involved in this AC. Additionally, small land size is a constraint in achieving cooperation of members in the AC.

Large-sized farms in Truong Xuan A

Truong Xuan A adopted LSFs in 2012, and they have functioned well since 2014 with 78 households engaging in approximately 70 ha (i.e., the total area of LSFs). The original participants regularly agreed to engage in this model and included local officials, members of farmer unions and advanced farmers who had good technical knowledge (FGDs, 2016). In addition, the LSFs can function with an agreement of interdependency between local officials, farmers, and a rice company. Besides the contract farming with the rice company, the LSFs in Truong Xuan A had to organise several collective rice farming activities including the collective draining of water out of large-sized farms at the same time, planting the same rice varieties, using the same seasonal calendars for beginning and finishing at the same time with all farmers in the same LSF. The members of the LSFs in Truong Xuan A made these collective decisions so that they could all grow the next rice crops during the same period.

Social capital influencing the resilience of LSFs and collective decision-making in Truong Xuan A

Similar to the approach for measuring social capital in the case of the AC in Thoi Tan commune, the statement “Members usually agree to begin a crop at the same time” received a mean score of 4.3 of agreement from the participants of the LSFs in Truong Xuan A (Table 6.4). Similarly, farmers supported the statement “I believe that the farmer organisation supplies good services for irrigation and draining of water out of farms” of social trust with a score of 4. Social commitment regarding the statement “Farmer organisations are active and inform to all members every time they have training (with outside agencies)” also had strong agreement (i.e., a score of 3.5). In general, farmers who participated in the LSFs highly valued the model of LSFs in Truong Xuan A in the first crop between 2014 and 2015 because the leader[12] of the LSFs had good coordination for the tasks of harvesting and collecting rice from farms to warehouses of the rice company. Consequently, the LSF model was expanded to other farms in Truong Xuan A for the first rice crop in 2015–2016. Nonetheless, a problem emerged in the first rice crop in 2015–2016, which will be discussed in the climate section because climate variability influenced the social capital between members, and between members and rice companies. This problem has had negative impacts on collective decision-making for rice farming activities in following years.

[12] The leader of the LSFs was a head of a village, and he coordinated collective activities of the LSFs.

Table 6.4: Members' perceptions about statements of social capital (mean ± sd) of members in the large-sized farms (LSFs) in Truong Xuan A, Can Tho province

Statements of social capital	Members of LSFs[1] (n=35 HHs[2])
1. Social cohesion	
1.1 Members will share new knowledge with their members	3.7 (±1.2)
1.2 People are friendly in the organisation	3.8 (±1.0)
1.3 Members usually agree to begin crop at the same time	4.3 (±0.5)
1.4 Members are willing to work together to protect crops	2.7 (±1.2)
1.5 I regularly participate working groups	3.0 (±1.1)
2. Social trust	
2.1 I believe that the farmer organisation supplies good services of irrigation and draining of water out of farms	4.0 (±0.7)
2.2 I am confident that the organisation assists members to get harvest machines in time of crop seasons	3.2 (±1.3)
2.3 I am confident that the organisation supplies seeding in time in internal rule of farmer organisation	3.8 (±1.0)
3. Social commitment	
3.1 Organisation's members inform other members and the community about pest and diseases their crops get	3.2 (±0.9)
3.2 Farmer organisations are active and inform to all members every time they have training (with outside agencies)	3.5 (±1.0)
3.3 Farmer organisation is willing to protect members in transactions with output companies	3.7 (±1.1)
3.4 Members have good duty to their contract with companies	3.8 (±0.9)
3.5 Members of organisation respect the rules of organisation (follow seasonal calendar of organisation)	4.0 (±0.8)

Source: Household surveys in 2015

Note: 5= completely agree; 4= agree; 3=Neutral; 2=disagree; 1= completely disagree

1. LSFs is large-sized farms
2. HHs is number of households

Generally, social capital plays an important role in connecting different farmers through rice farming activities or tasks relating to farming activities in both the AC and the LSFs models. The AC is an economic organisation, while LSFs are working together *(làm cùng nhau)* at the same time and in the same rice field. However, they have also had negative impacts directly or indirectly from climate variability and negative aspects of social capital. Accordingly, a decline in social capital has progressively affected farmers' collective decisions for rice farming activities because it is able to reduce the process of reaching agreement between members in farmer organisations for collective decision-making, which will be presented and discussed in more detail in section 6.5.3.

Climate variability influencing farmers' collective and individual decisions for the three rice crops

Climate variability in Can Tho province

Mean monthly maximum temperature (1996–2016) in Can Tho province follows a pattern with the lowest maximum temperature in January (32 °C) and the highest maximum temperature in April (35 °C; Figure 6.3). The recorded monthly values for maximum temperature were typically higher than the mean from 2014 to 2016. The highest observed maximum temperature was 36 °C in April 2014, and there was a run of 17 consecutive months with higher than mean temperatures (from May 2015 to September 2016).

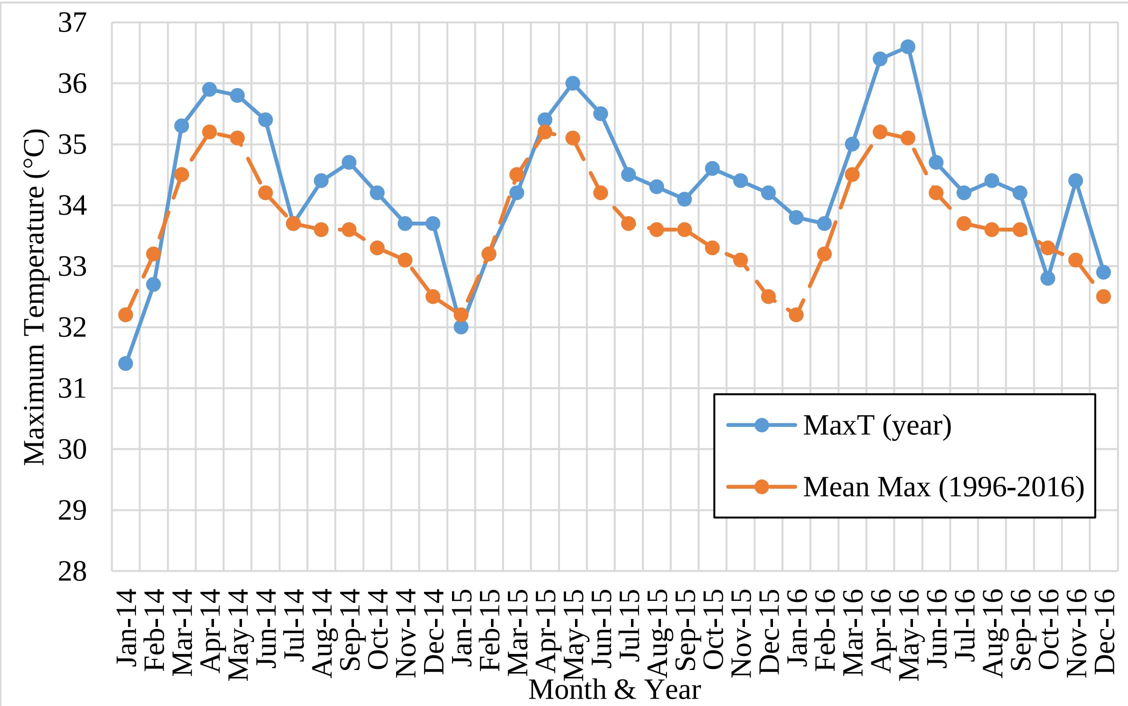

Figure 6.3: Comparison of monthly maximum temperature (°C) in 2014, 2015 and 2016 with mean monthly maximum temperature from 1996 to 2016 from Can Tho province.
Source: National Hydro-Meteorological Service of Vietnam

The pattern of the monthly minimum temperature follows with the lowest minimum temperature in January (20 °C) and the highest minimum temperature in April (23 °C; Figure 6.4). The observed monthly values for minimum temperature were roughly similar to the mean minimum temperature in 2014, 2015, and 2016. The lowest recorded minimum temperature was 17.5 °C in January 2014, and the highest observed monthly minimum temperature was 25 °C in May 2015.

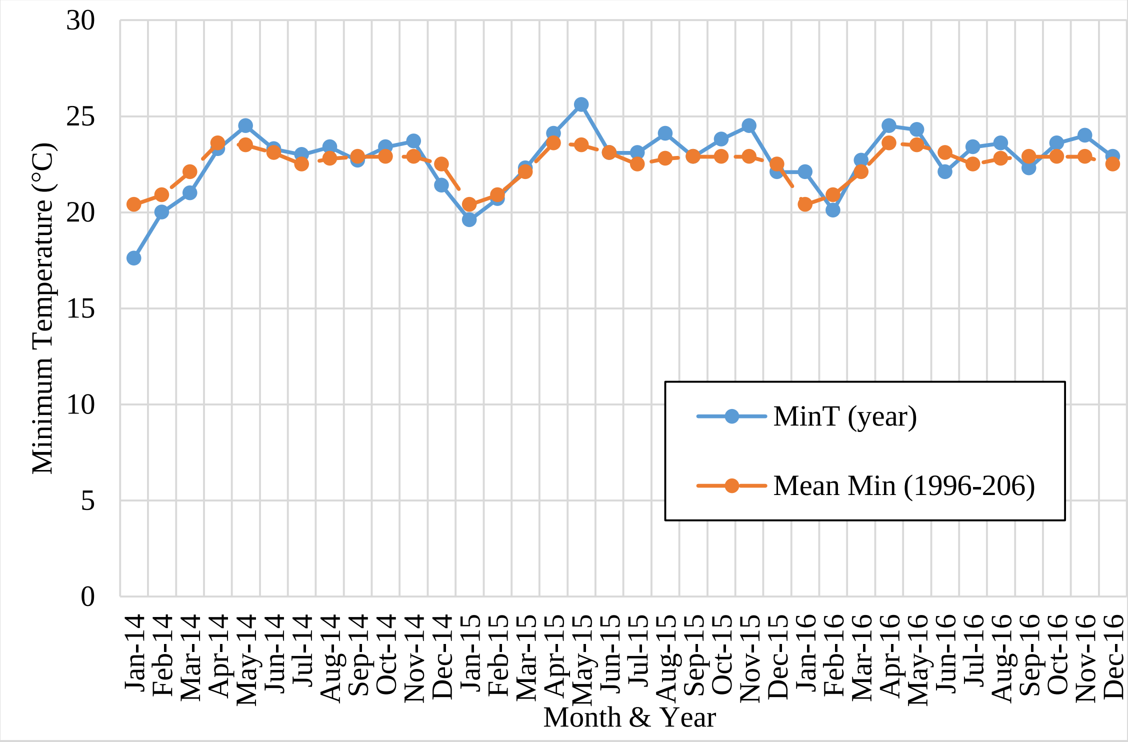

Figure 6.4: Comparison of monthly minimum temperature (°C) in 2014, 2015 and 2016 with mean monthly minimum temperature from 1996 to 2016 from Can Tho province.
Source: National Hydro-Meteorological Service of Vietnam

The annual rainfall in Can Tho is 1,597 mm. Located in the middle of the VMD, the wet season in Can Tho starts in March and goes through to December with a peak in rainfall normally in October (~270 mm; Figure 6.5). The annual rainfall was higher than the mean rainfall in 2014 (1,711 mm) and lower than mean rainfall in 2015 (1,498 mm). In 2016, the annual rainfall (1,659 mm), and recorded monthly rainfall was much lower than the mean with 70 mm in September, but there was a sharp increase and it reached a peak value of 440 mm in October (Figure 6.5).

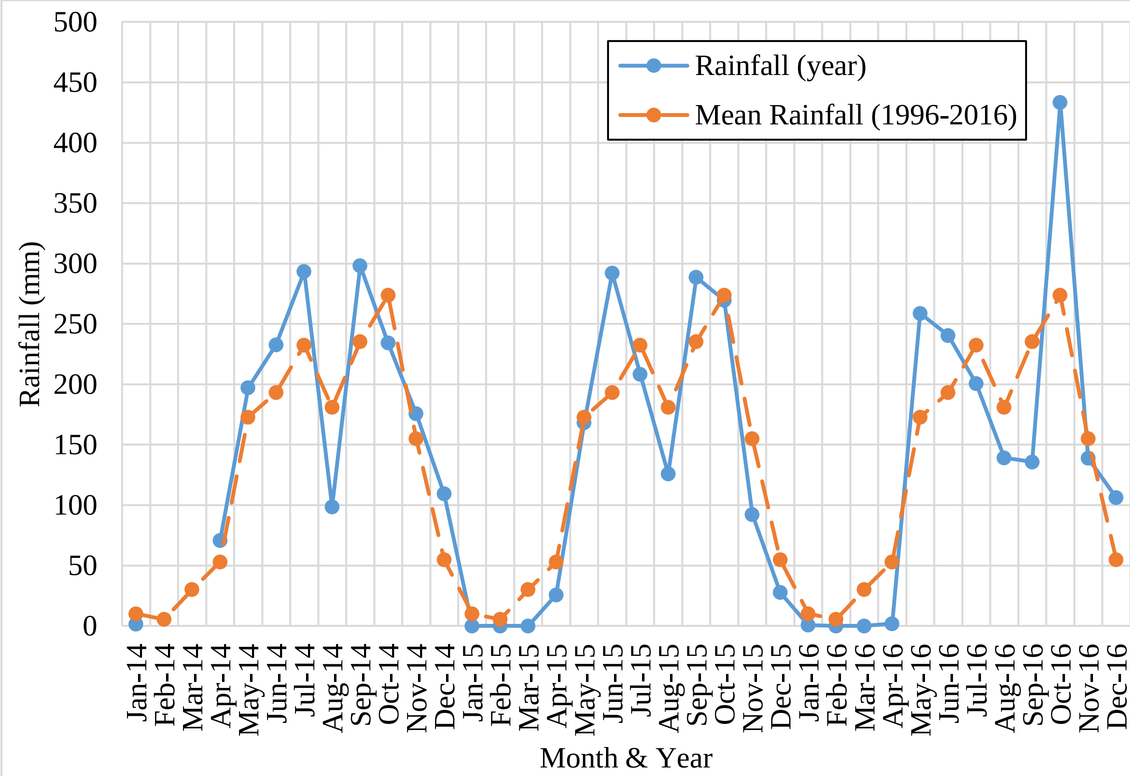

Figure 6.5: Comparison of monthly rainfall in 2014, 2015 and 2016 with mean monthly rainfall from 1996 to 2016 from Can Tho province.
Source: National Hydro-Meteorological Service of Vietnam

Monthly flooding levels typically follow a pattern with the highest level in October (~190 cm) and the lowest in May (~120 cm) in the period between 1996 and 2016 (Figure 6.6). The pattern of the monthly flooding level was roughly similar to the mean in 2014, 2015, and 2016 because Can Tho is located in the middle of the VMD. Although the flood in Can Tho is much lower than in An Giang, the monthly flood level in Can Tho is affected by tides from the East Sea of the VMD (CCCO 2015). Therefore, upstream provinces such as An Giang had small floods in 2015 and 2016, while flooding levels in Can Tho did not differ between the mean and 2014, 2015, and 2016.

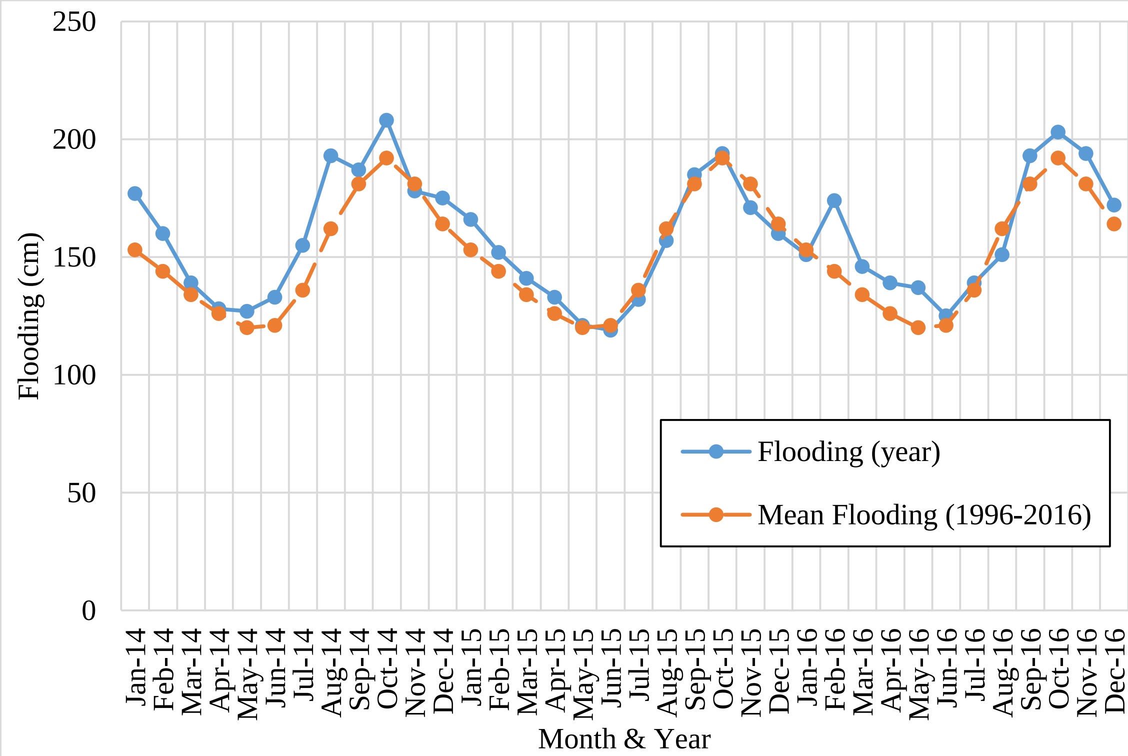

Figure 6.6: Comparison of monthly flooding level in 2014, 2015 and 2016 with mean monthly flooding level from 1996 to 2016 from Can Tho province.
Source: National Hydro-Meteorological Service of Vietnam

Farmers' perceptions of climate variability in the first rice crop (November–February)

Flooding meant members of the AC and the LSFs, and general farmers in Thoi Tan and in Truong Xuan commune were unable to prepare land and sow seed for the first rice crop early (see seasonal calendar in Figure 6.7), but they could adapt to floods by collectively draining large-sized farms for the beginning of the first crop as per the previous discussion (FGDs in 2016). This will be discussed in the section on how farmers make collective and individual decisions for farming activities. Farmers noted that the cooler weather is advantageous for cultivating rice in the first crop, and this provides a good opportunity for farmers and the rice company to make collective decisions for conducting contract farming in this rice crop.

Crops and weather	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Three rice crops	First			Second crop			Third crop				First crop	
Dry season (hot)	*	**	***	***	**							
Abnormal rains						***	***	**	***	***	**	
Flood season							*	**	**	***	**	*

Figure 6.7: Seasonal calendar of rice farming and relevant factors of weather to rice farming in Thoi Tan and Truong Xuan A
Source: FGDs with members in Thoi Tan and Truong Xuan A
Note: *: less frequent; ** frequent; *** very frequent

As discussed in the section on the social capital and resilience of the LSFs in Truong Xuan A commune, members of the LSFs trusted the good coordination of the leaders of the LSFs and staff of rice companies in contract farming for normal rice production in the first rice crop between 2014 and 2015. Then, the LSFs model was expanded to other large-sized farms in Truong Xuan A commune; thus the rice area in 2015–2016 was more than one and half times the area in 2014. The members were unhappy with the contract with the rice company for the first rice crop in 2015–2016 due to a series of negative factors. In particular, the weather in Can Tho province was regularly cool in the first rice crop from December to February (Figure 6.3). However, similar to Thoi Tan, at the beginning of 2016, the weather cooled suddenly at the same time as the rice crops were ripening, which led to the sudden maturation of paddy. Then, there was a decline in productivity with yields reduced to 0.7 tonnes/ha/crop compared to 1 tonne/ha/crop in previous years. Quicker maturing rice also influenced the time of harvest owing to the large area of maturing rice at the same time. Besides, high water levels due to tidal movement at the same time as the harvest caused combine harvesters to work slowly. This constraint affected the time of harvest for wide areas of paddy of farmers, and also led to delaying the beginning of the second rice crop compared to normal (FGD in 2016). In this case, respondents claimed that the head of the LSFs (who was also the head of a village) in the commune prioritised harvesting rice for households of local officials and their relatives before them, while their rice ripened before the rice of local officials. Mr Ph., a member of the LSFs, has joined LSFs since this model began in this commune. He stated that,

> I was disappointed with the coordination between company and the leader of the LSFs this year because my paddy ripened on the field, but I had to wait for harvesting and collecting my grain. With the problem like this, I thought it was difficult for locals to have a higher level of cooperation as a cooperative.
>
> (Field interview Mr Ph. in February 2016)

The impressions of Mr Ph. provide more understanding of the constraints to collective decision-making in contract farming in the coming years in Truong Xuan A commune. The fieldwork was conducted with FGDs in the period of harvesting and transporting grain from the fields of farmers to the warehouse of the company. Participants in FGDs in 2016 argued that the cooperative behaviour was not fair and transparent for every member of the LSFs. It seems that farmers play multiple roles (i.e., farmer and authority) in a rice community. Consequently, more than 50% of the members of the LSFs decided to change their contract farming to another company for the first rice crop of 2016–2017.

Although many members of the LSFs had negative perceptions of the LSFs in the commune, other members who had good relationships with the head of village (i.e., head of LSFs), or who were advanced farmers, perceived that the LSFs model provided them with a range of benefits such as collecting new technical knowledge, and contracting with the rice company at stable market prices for their rice after harvesting. Mr X. is a good example of an advanced farmer and local authority in the context of Truong Xuan A commune. He was a 54 year-old, advanced farmer, and also head of the farmer union in a village of Truong Xuan A. He said that,

> I liked to join the LSFs in the Truong Xuan A commune because I have participated in training courses every year since I joined this programme. Before LSFs was existed in my commune, I had also participated in other training courses that were organised by the station of Plant Protection Centre. This year (2016), our LSFs undertook a training course of IPM (Integrated Pest Management) with Jasmine rice by applying new technical knowledge for adapting to climate variability in my commune. If I want to develop my rice production I need to learn more new knowledge.
>
> (Field interview Mr X. in February 2016)

The story of Mr X. indicates that there were advanced farmers as well as local authorities in the commune pioneering implementation of a variety of pilot projects for rice production models or applying innovations in technical knowledge in rice production before the majority of farmers in the community. Consequently, they were often prioritised in rice production ahead of other farmers in the community. In contrast, a huge number of farmers waited for other farmers to go first. If they saw this model running successfully, then they would learn and apply it. So, they might have lost their opportunities to gain benefits from this model.

Farmers' perceptions of climate variability in the second rice crop (February–May)

According to participants in FGDs conducted in 2016, very hot weather was an unexpected weather condition for all respondents to cultivate the second rice crop (Figure 6.3; Figure 6.7). Can Tho is located in the middle of the VMD, which enables farmers to have adequate water to irrigate their rice fields whenever required. However, it was difficult to irrigate when canals were shallow or where water could not be guaranteed for both day and night time irrigation, therefore, farmers had to wait for water from tidal movements that pushed water from the ocean up to the Mekong River (Figure 6.7). Generally, farmers were happy to wait for water to rise from water tidal movements and pay for petrol costs.

Figure 6.8: Shallow canals in low tide in Thoi Tan commune in June 2015
Source: author (2015)

Farmers' perceptions of climate variability in the third rice crop (June–September)

In 2014 and 2015, abnormally heavy rains occurred during the third rice crop in Thoi Tan and Truong Xuan A (Figure 6.5; Figure 6.7), and farmers did not have to spend money on irrigation costs. On the other hand, when abnormally heavy rains occurred frequently, it created advantageous conditions for insects and diseases to damage paddy. In addition, if abnormal heavy rains occurred near the harvest season, they affected paddy by making the stems of rice plants fall on the ground of the rice field (lodging). Costs for harvesting lodged rice increased because paddy could not be harvested by combine harvesters. Farmers had to hire labour to harvest by hand (VND 500,000/ha); nearly double the cost of harvesting by machine (VND 270,000/ha). The quality of rice would be reduced, and then the prices of rice were sequentially lower than in normal conditions (FGDs in 2016). In order to enhance understanding of how farmers in Thoi Tan and Truong Xuan A decide on farming activities to cope with abnormal heavy rains, the study will discuss this in detail in section 6.5.3.

In short, sudden cool temperatures affected rice farming in the first rice crop. In contrast, abnormally heavy rains damaged rice in the third rice crop. Therefore, climate variability threats both directly and indirectly influenced collective decision-making on rice farming in the two communes in Can Tho province.

Access to local rice markets

Declines in the price of rice regularly occur in the first and second rice crops. However, this problem affects general farmers in Thoi Tan and Truong Xuan A, and members of the AC who have not had seed contract farming in the first rice crop (FGDs in 2016). In contrast, members of the AC who had contracts with CLRRI for seed production had regularly access good prices because of seed contract farming. Also, members of the LSF in Truong Xuan A did not have challenges with market downturns in the first rice crop owing to normal rice contract farming with the rice companies. However, members of the LSFs in Truong Xuan A still had challenges with lower prices for rice in the second rice crop because they did not sign contract with the company in this season.

Members of the AC and the LSF, and general farmers in Thoi Tan and Truong Xuan A reported that market prices for the third rice crop were regularly higher than for the first and second rice crops. If their rice field were not damaged by abnormal rains, they could obtain high incomes from rice production. According to the participants of FGDs conducted in 2016, the weather during the first and second crop was better than that for the third crop, so Can Tho had too much rice in the first and second rice crops.

Finally, the role of a broker[13], a middle person in a transaction between a trader[14] and a farmer, is important to understand. Brokers helped traders pay the bond to general farmers, but traders still disrupt contracts if market prices drop sharply. According to Mr Ch. (field interview in February 2016), a broker in Thoi Tan commune, when rice prices fall sharply, traders sometimes accept losing their bond money to avoid having to buy rice at contractual prices from general farmers. Generally, general farmers in Thoi Tan and Truong Xuan A have to deal with unpredictable drops in the price of rice and how they make decisions to deal with this uncertainty will be discussed in section 6.5.3.

Generally, there are lots of opportunities for farmers to make a range of decisions that are influenced by interaction between different actors including farmers, brokers, and traders. These will be explored in more detail, when farmers sell rice to the market, in section 6.5.3.

Livelihood capitals

As discussed in Chapter 2, livelihood capital includes human, social, physical, natural, and financial capital (Scoones 1998, DFID 1999). Formal social capital is used to measure the relationship between members of ACs and LSFs, thus the study only selected categories that might be considered advantageous and disadvantageous for farmers' decision-making in the following results and discussion.

Human capital in rice production

The mean age of heads of households ranged from 50 to 57 years for Thoi Tan as well as Truong Xuan A commune (Table 6.5). The majority of household heads were male, over 90% of households in Thoi Tan, and 94% and 89% of households with members of the LSFs and general farmers in Truong Xuan A respectively (Table 6.5). Owing to shortages of rural labour and the movement of their children to cities, most farmers in

[13] A broker is a middle person who help traders outside the commune to connect with farmers. They ask farmers to sell rice to traders who they work for. Brokers normally charge fees from traders of around VND 20.000/tonne (~ USD 1/tonne) for each transaction.
[14] A trader is a business person who asks brokers to contact farmers to sell rice for them.

the two communes had to conduct most rice farming activities by themselves. Nevertheless, a few younger small landholders have remained, and these often work as off-farm labour for their relatives or neighbours. For example, Mr H., a 34-year-old farmer in Thoi Tan, said in FGDs held in 2016 that,

> I have a small land parcel for rice farming. Besides working on my farm, I also work as a labourer for my relatives and my neighbour such as sowing seed and fertiliser, and spraying pesticide. When rice harvesting season comes, I work as a porter for a broker who is a middle man between traders and farmers.
>
> (Field interview Mr H. in February in 2016)

Mr H. was able to find agricultural jobs in Thoi Tan at various times to support his family livelihood. The story also implies that human and social capital existed not only at the household scale but also in a small community, which created an adequate supply of labour for rice production through bonding social capital between labour and owners in a range of rice farming activities, as well as through kinship in the local community.

Table 6.5: Age, gender and education of head of households, and labourers of households of members of agricultural cooperative (AC), members of large-sized farms (LSFs), and general farmers in Thoi Tan and Truong Xuan A, Can Tho province

Indicator	**Thoi Tan**		**Truong Xuan A**	
	Members of AC[1] (n=34 HHs[3])	**General farmers (n=24 HHs)**	**Members of LSFs[2] (n=35 HHs)**	**General farmers (n=27 HHs)**
Age of head of household (mean ± sd)	53 (±11)	52 (±9)	57 (±12)	50 (±13)
Gender (%)	100	100	100	100
Male	94	96	94	89
Female	6	4	6	11
Education (%)	100	100	100	100
Illiterate		4	3	4
Primary school	44	46	57	59
Secondary school	35	50	40	37
High school	21			
Total members/hh (mean ± sd)	4 (±1)	4 (±1)	4 (±1)	4 (±1)
Total labour (mea ± sd)	3 (±1)	3 (±1)	3 (±1)	3 (±1)

Source: Household surveys in 2015

Notes: 1. AC is agricultural cooperative, and

2. LSFs is large-sized farms

3. HHs is number of households

Heads of households in the two communes had low education levels. Less than half (44% of AC members and 46% of general farmers) of household heads in Thoi Tan had a primary school education level, while over 50% of household heads had had a primary school education in Truong Xuan A (Table 6.5). Although farmers in Can Tho regularly relied on local technical knowledge for their rice farming, high education levels contributed significantly to the acquisition of new technical knowledge from a variety of pathways including televisions programmes and attending training courses. In addition, their experience and local knowledge might affect their decision-making for selecting rice varieties.

Land and water as significant natural capital of households in Thoi Tan and Truong Xuan A

Land and water were the two most important natural resources for rice cultivation because they affect farmers' decisions for selecting rice variety. In Thoi Tan commune, the mean total land area of households of members of the AC (1.79 ha) was larger than those of general farmers (1.49 ha) (Table 6.6). Similarly, in Truong Xuan A, total land of households of members of the LSFs (1.99 ha) was nearly double the land area of general farmers (1.05 ha) (Table 6.6). Rice cultivation occupies approximately 90% of agricultural land for households in both Thoi Tan and Truong Xuan A (Table 6.7). In contrast, the land areas of other crops were regularly smaller than 0.1ha.

Table 6.6: Summary of different types of land area (mean ± sd) for each household of members of agricultural cooperative (AC), members of large-sized farms (LSFs), and general farmers in Thoi Tan and Truong Xuan A, Can Tho province

Land type	**Thoi Tan**				**Truong Xuan A**			
	Members of AC[1] (n=34 HHs[3])		**General farmers (n=24 HHs)**		**Members of LSFs[2] (n=35 HHs)**		**General farmers (n=27 HHs)**	
	ha[4]	**%**	**ha**	**%**	**ha**	**%**	**ha**	**%**
1. Homestead	0.01 (±0.01)	1	0.02 (±0.01)	1	0.02	1	0.01	1
2. Agriculture	1.70 (±1.19)	93	1.36 (±0.07)	90	1.89 (±1.28)	94	1.01 (±0.84)	96
3. Leased	0.03 (±0.14)	2	0	0	0	0	0.01 (±0.08)	1
4. No work	0.06 (±0.09)	4	0.12 (±0.24)	9	0.09 (±0.16)	5	0.02 (±0.04)	2
Total land	1.79 (±1.19)	100	1.49 (±0.86)	100	1.99 (±1.25)	100	1.05 (±0.83)	100

Source: Household surveys in 2015

Note: 1. AC is agricultural cooperative
2. LSFs is large-sized farms
3. HHs is number of households
4. Ha is hectare

Table 6.7: Summary of different types of agricultural land area (mean ± sd) for each household of members of agricultural cooperative (AC), members of large-sized farms (LSFs), and general farmers in Thoi Tan and Truong Xuan A, Can Tho province

Types of agricultural land area	**Thoi Tan**				**Truong Xuan A**			
	Members of AC[1] (n=34 HHs[3])		**General farmers (n=24 HHs)**		**Members of LSFs[2] (n=35 HHs)**		**General farmers (n=27 HHs)**	
	ha[4]	**%**	**ha**	**%**	**ha**	**%**	**ha**	**%**
1. Rice	1.47 (±0.97)	87	1.22 (±0.78)	90	1.75 (±1.30)	92	0.96 (±0.77)	95
2. Orchard	0.16 (±0.37)	9	0.04 (±0.06)	3	0.09 (±0.17)	5	0.03 (±0.08)	3
3. Pond	0.01 (±0.04)	1	0	0	0.03 (±0.13)	2	0.01 (±0.02)	1
4. Dyke	0.02 (±0.07)	2	0.09 (±0.24)	7	0.02 (±0.04)	1	0.01 (±0.04)	1
5. Other	0.02	1	0	0	0	0	0	0
Total	1.70 (±1.19)	100	1.36 (±0.07)	100	1.89 (±1.28)	100	1.02 (±0.84)	100

Source: Household surveys in 2015
Data from Table 6.6

Note: 1. AC is agricultural cooperative
2. LSFs is large-sized farms
3. HH is number of households
4. Ha is hectare

Water Access: The central and provincial governments, as well as farmers, invested money to improve different scales of canals for extracting water from the Hau River (a branch of the Mekong River) to deliver to rice fields (FGDs with local officials held in 2015). On account of this, farmers in Thoi Tan and Truong Xuan A were always guaranteed water for irrigation in the dry season (January–July) and during high flood levels. However, in the dry season, farmers in Thoi Tan and Truong Xuan A were faced with a lack of water in a short time and had to wait for water to elevate up in tidal movements from the ocean (Figure 6.7). Farmers in the two communes still needed to consider the flood situation annually in order to make suitable decisions (FGDs in 2016). For example, there was no flooding in 2015, and then members of the AC, the LSFs, and general farmers in the two communes decided not to drain water from large farms.

Physical capital of households in Thoi Tan and Truong Xuan A

Tractors, hand tractors, combine harvesters, sprayers, pumping machines and other mechanical devices are important physical assets. A small number (3%) of households in Thoi Tan as well as Truong Xuan A possessed a tractor, and also a few households in the two communes had hand tractors with a small capacity for land preparation (Table 6.8). Similarly, combine harvesters were only owned by one household in each commune. Therefore, the majority of households in Thoi Tan and Truong Xuan A had to rent tractors for land preparation for each rice crop, but these were easy to access because owners of these machines could be found inside and outside of the commune.

A large majority of households in Thoi Tan (members of the AC 97% and general farmers 96%) and Truong Xuan A (members of the LSFs 100% and general farmers 89%) had pumping machines and sprayers because such physical capital has been cheap and these activities take place in each rice crop (Table 6.8). Similarly, 89% of members of the AC and 96% of general farmers in Thoi Tan owned sprayers.

Table 6.8: Farming machines, fishing, transport machines, and communication devices of the households of members of agricultural cooperative (AC), members of large-sized farms (LSFs), and general farmers in Thoi Tan and Truong Xuan A, Can Tho province

Machine or tool	**Thoi Tan**				**Truong Xuan A**			
	Members of AC[1] (n=34 HHs)		**General farmers (n=24)**		**Members of LSFs[2] (n=35)**		**General farmers (n=27)**	
	HHs[3]	**%**	**HHs**	**%**	**HHs**	**%**	**HHs**	**%**
1.Farming machine								
1.1.Tractor	1	3	0	0	1	3	0	0
1.2.Hand tractor	3	9	2	8	4	12	0	0
1.3.Rice combine harvester	1	3	0	0	1	3	0	0
1.4.Pumping machine	34	97	23	96	34	100	24	89
1.5.Sprayer for pesticide and herbicide	31	89	23	96	34	100	25	93
2.Transport machine								
2.1 Paddle boat	16	46	11	46	12	35	13	48
2.2 Big boat/motorboat	26	74	16	67	27	79	17	63
2.3 Bicycle	21	60	14	58	17	50	11	41
2.4 Motorbike	30	86	18	75	32	94	20	74
2.5 Other	0	0	1	4	1	3	0	0
3. Communication device								
3.1.Television	34	97	24	100	34	100	26	96
3.2.Radio	8	23	4	17	3	9	2	7
3.3.Mobile phone	33	94	23	96	34	100	27	100

Source: Household surveys in 2015

Notes: 1. AC is agricultural cooperative

2. LSFs is large-sized farms

3. HHs is number of households

Financial capital of households in Thoi Tan and Truong Xuan A

Farmers in Thoi Tan and Truong Xuan A commune were able to access a variety of financial sources. In particular, 56% of the households of members of the AC in Thoi Tan saved some of their earning in 2014, while for general farmers it was 50%. This is because most of the farmers involved in the AC in Thoi Tan had a larger land size than general farmers, so income from rice was higher than that of general farmers (will be discussed in section 6.5.4). In addition, they produced seed that they could sell for much higher prices than normal rice. Similarly, the percentage of members of the LSFs (53%) in Truong Xuan A who saved money was higher than that of general farmers (41%), again because many of the households having large land size participated in the LSFs model (Table 6.9). Credit from banks was also a major credit source for farmers in the two communes. Farmers in the two communes accessed credit simply if they had a certificate of land use. A consequence of this is that 38% of members of the AC and 29% of general farmers in Thoi Tan received loans from different banks (Table 6.9).

Table 6.9: Saving and debt of households of members of agricultural cooperative (AC), members of large-sized farms (LSFs), and general farmers in Thoi Tan and Truong Xuan A, Can Tho province

Financial source	**Thoi Tan**				**Truong Xuan A**			
	Members of AC[1] (n=34)		**General farmers (n=24)**		**Members of LSFs[2] (n=35)**		**General farmers (n=27)**	
	HHs[3]	**%**	**HHs**	**%**	**HHs**	**%**	**HHs**	**%**
1. Saving	19	56	12	50	18	53	11	41
2.Credit	13	38	7	29	17	50	15	56
2.1.Local agriculture bank	5	15	2	8	13	38	7	26
2.2.Policy bank	7	21	3	13	2	6	4	15
2.3.Women's union	0	0	2	8	1	3	3	11
2.4.Commercial banks	1	3	1	4	0	0	1	4

Source: Household surveys in 2015
Notes: 1. AC is agricultural cooperative
2. LSFs is large-sized farms
3. HHs is number of households

Compared to Truong Xuan A, Thoi Tan is a more favourable commune regarding bio-physical factors such as flood levels and acid-sulphate soil (CLUES project). Besides, the findings of this thesis have identified that the majority of farmers (members of the AC and general farmers) in Thoi Tan accessed and used new technical knowledge for rice production, especially produce seed and high-quality rice (Jasmine 85), before farmers in Truong Xuan A. Therefore, they might select different rice varieties for each rice crop in the three rice crops system, which will be explored in section 6.5.3 of this chapter. Regarding livelihood capital, members of the AC and the LSFs, and general farmers in the two communes, typically had a range of basic resources for rice-based farming systems. They did not face challenges in accessing agricultural input supplies and agricultural services in relation to decision-making about rice farming activities. However, farmers' perception and behaviour might influence decision-making for rice farming activities. Thus, farmers' decision-making for collective and individual decision-making for farming activities will be considered in the next section.

6.5.3 Decision-making of members of the AC and the LSFs and general farmers for farming activities of three rice crops in Thoi Tan and Truong Xuan A (Research question 3)

This section will illustrate findings and provide a discussion of collective and individual decision-making for different rice-cropping rotations. Tables 6.10 and 6.11 summarise farmers' collective and individual decision-making for farming activities around the three rice crops in Thoi Tan and Truong Xuan A.

Table 6.10: Decision-making of members of the agricultural cooperative (AC) and general farmers for each rice crop in Thoi Tan

Farming activities	**Members of agricultural cooperative**		**General farmers**	
	Crop 1	**Crop 2 and 3**	**Crop 1**	**Crop 2 and 3**
Collective decision-making for farming activities				
Pumping water out of the fields after the flood season for beginning first rice crop	Members, general farmers, local government, and management board of AC[1]	NA[3]	Members, general farmers, local government, and management board of AC	NA
Setting up seasonal calendar of rice farming	Members, general farmers, local government, and management board of AC	NA	Members, general farmers, local government, and management board of AC	NA
Contract farming to sell seed	Members (producing seed), management board of cooperative, CLRRI[2]	NA	NA	NA
Selecting rice varieties	Members (producing seed), management board of cooperative, CLRRI ***(OM 5451 or Jasmine 85)***	NA	NA	NA
Access combine harvesters	Members and management board of AC	NA	NA	NA
Training farming techniques	Members and management board of AC	NA	NA	NA
Selling seed to institute	Members (producing seed), management board of cooperative, CLRRI	NA	General farmers and broker (via traders)	General farmers and broker (via traders)
Individual decision-making for farming activities				
Selecting sources of rice varieties	Members without producing seed	All members	General farmers	General farmers
Selecting rice varieties	Members without producing seed	All members	General farmers ***(Jasmine 85)***	*General farmers* ***(OM 5451 or OM 4218)***

Preparing land	All members	All members	General farmers	General farmer
Method of sowing seed	Members ***(transplanting)***	All members ***(row-sowing)***	General farmers ***(row-sowing)***	*General farmers* ***(row-sowing)***
Irrigation activity	All members	All members	General farmers	General farmers
Accessing financial capital (access credit, saving, buy materials paid at the end of crop) for investing in rice production	All members	All members	General farmers	General farmers
Accessing farming materials (fertiliser, pesticide, petrol, etc.)	All members	All members	General farmers	General farmers
Applying fertiliser and pesticide	All members	All members	General farmers	General farmers
Accessing farming labour for sowing seed and sprayer pesticide	All members	All members	General farmers	General farmers
Selling rice to traders	Members without producing seed	All members and broker (via traders)	General farmers and broker (via traders)	General farmer and broker (via traders)
Accessing combine harvesters	Broker	Broker	Broker	Broker
Accessing farming labour for harvesting and porter	Broker	Broker	Broker	Broker

Source: Focus group discussion in 2016

Note: 1. AC is agricultural cooperative

2. CLRRI is Cuu Long Rice Research Institute

3. NA is not available

Table 6.11: Decision-making of members of large-sized farms (LSFs) and general farmers for each rice crop in Truong Xuan A

Farming activities	**Members of large-sized farms**		**General farmers**	
	Crop 1	**Crop 2 and 3**	**Crop 1**	**Crop 2 and 3**
Collective decision-making for farming activities				
Setting up a seasonal calendar for rice farming	Members, general farmers, local government, and head of LSFs[1]	NA[2]	Members, general farmer, local government, and head of LSFs	NA
Pumping water out of fields after the flood season for beginning first crop	Members, general farmers, local government, and head of LSFs	NA	Members, general farmer, local government, and head of LSFs	NA
Contract farming to sell normal rice (i.e., rice for consumption)	Members, head of LSFs, local government, and rice company	NA	NA	NA
Selecting rice varieties	Members, head of LSFs, local government, and company ***(Jasmine 85)***	NA	NA	NA
Accessing rice varieties	Members, head of LSFs, local government, and rice company	NA	NA	NA
Accessing combine harvesters	Members and head of LSFs	NA	NA	NA
Training farming techniques	Head of LSFs and members	NA	NA	NA
Selling rice to rice company	Members, head of LSFs, local government, rice company	NA	NA	NA
Individual decision-making for farming activities				
Preparing land	Members	Members	General farmers	General farmers
Accessing rice varieties	NA	Members	General farmers	General farmers
Selecting rice varieties	NA	Members ***(IR50404)***	General farmers ***(IR50404)***	General farmers ***(IR50404)***
Method of sowing seed	Member ***(using hand)***	Member ***(using hand)***	General farmers ***(using hand)***	General farmers ***(using hand)***
Irrigation activity	Members	Members	General farmers	General farmers
Accessing financial capital (access	Members	Members	General farmers	General farmers

credit, saving, buy materials paid at the end of crop) for investing in rice production				
Accessing farming materials (fertiliser, pesticide, petrol, etc)	Members	Members	General farmers	General farmers
Applying fertiliser and pesticide	Members	Members	General farmers	General farmers
Accessing farming labour for sowing seed and sprayer pesticide	Members	Members	General farmers	General farmers
Accessing farming labour for harvesting and porter	Members	Members	General farmers	General farmers
Selling rice to traders	NA	Members and broker ***(via traders)***	General farmers and broker ***(via traders)***	General farmers and broker ***(via traders)***
Accessing combine harvesters	Broker	Broker	Broker	Broker
Accessing farming labour for harvesting and porter	Broker	Broker	Broker	Broker

Source: Focus group discussion in 2016

Note: 1. LSFs is large-sized farms

2. NA is not available

Collective decision-making of members of the agricultural cooperative and the large-sized farms and general farmers for farming activities of the first rice crop in Thoi Tan and Truong Xuan A

Setting up the seasonal calendar (Tables 6.10 and 6.11). The beginning of the first rice crop is dependent on the timing of the seasonal calendar of the second and third crops in Thoi Tan commune (Figure 6.7). This activity was decided by the members of the AC, general farmers, and local officials in the commune at the office of the committee, office of the village, or the house of the vice-head of the village (Table 6.10). Members of the LSF, general farmers, and local authorities and the head of the LSFs in the commune had a meeting to decide on seasonal calendars for rice production, which were set up according to the guidelines of the Plant Protection Centre of the provincial DARD (FGDs with local officials held in 2015 and FGDs with farmers held in 2016).

Pumping water out of fields after the annual flood season. In Thoi Tan, this activity was decided by members of the AC, general farmers, and local authorities in the commune (Table 6.10). They made decisions about the time for pumping water out of large fields after the flood receded to low levels in the large fields, but the water level inside the fields was still higher than the borders of land parcels of different farmers who had land parcels in the same field (Figure 6.9). All farmers having land parcels in the same fields used their own machines to pump water at the same time before water levels receded below the borders of land parcels. In Truong Xuan A before pumping members of the LSF, general farmers, local authorities, and the leader of the LSFs had a meeting to make collective decisions, not only the timing of the pumping, but also the pumping fee because this activity was collectively operated by the leader of the LSFs (Table 6.11).

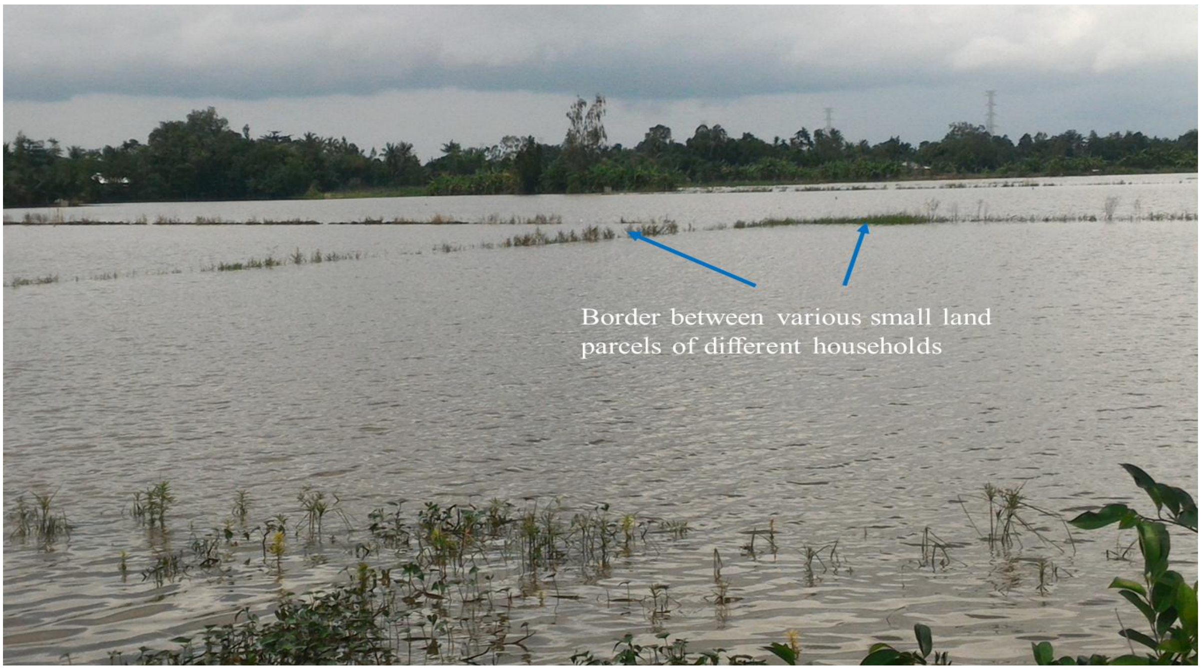

Figure 6.9: A small flood on the fallow parcels in a large farm in Can Tho province in 2016 showing borders between fields.
Source: Author (2016)

Contract farming and selecting rice varieties for seed production of members of the AC of Thoi Tan (Table 6.10). The selection of rice varieties was a collective decision by the management board of the AC, members of the AC, and staff of the CLRRI at the home of the head of the AC. Rice varieties for seed production were supplied by staff of the CLRRI. The most common rice varieties were Jasmine 85 (65%) and OM 5451 (29%) for the first rice crop (Table 6.12). According to participants of FGDs held in 2016, the CLRRI decided how much seed of each variety would be produced. However, Jasmine 85 was only suitable for weather conditions in the first rice crop in Thoi Tan commune.

Table 6.12: Rice varieties used for the first rice crop of members of agricultural cooperative (AC) in Thoi Tan and members of large-sized farms (LSFs) in Truong Xuan A, Can Tho province

Rice variety	**Members of AC[1] in Thoi Tan**		**Members of LSFs[2] in Truong Xuan A**	
	HHs[3]	**%**	**HHs**	**%**
1. Jasmine 85	22	65	35	100
2. OM 5451	10	29	0	0
3. OM 4218	2	6	0	0
Total	**34**	**100**	**35**	**100**

Source: household surveys in 2015
Notes: 1. AC is agricultural cooperative
2. LSFs is large-sized farms
3. HHs is number of households

Contract farming for normal rice production, selecting rice varieties, and selling rice to rice company of the LSFs in Truong Xuan A (Table 6.11). These activities were made as collective decisions by the members, the head of the LSFs, the local authority, and the rice company (Table 6.11). The meeting for decision-making was undertaken at the committee office of the village. The agreement on contract farming required participants (i.e., farmers) to use the same rice variety (Jasmine 85; 100% of respondents) from the seed centre of the DARD of Can Tho or a reliable seed company (Table 6.11). Respondents informed me that they decided to sign a contract with a particular company in 2014 because it is a reliable company. Farmers trusted them through the recommendation of the People's Committee of Truong Xuan A commune.

Selecting combine harvesters and hire labour for harvesting (Tables 6.10 and 6.11). In Thoi Tan, this activity was collectively decided by members and the management board of the AC. In 2016, one member of the AC had a combine harvester. His combine harvester worked for most of the members of the AC with a lower price than those from outside the commune, VND 0.26 million/ha (USD 120) compared to VND 0.28 million/ha (USD 130) (field notes in 2015). In Truong Xuan A, this activity was made as individual decisions by the head of the LSFs, but members of the LSFs made collective decisions regarding this activity and asked him to coordinate similar to the coordinator for the collective draining of water after the flooding season. The majority of owners of combine harvesters working for LSFs were in Truong Xuan A commune.

Individual decision-making of the members in agricultural cooperative in Thoi Tan and LSFs in Truong Xuan A and general farmers for farming activities of the first rice crop

The members of the AC, the LSFs and general farmers in Thoi Tan and Truong Xuan A had similar approaches to making individual decisions for farming activities including preparing land, irrigation, accessing financial capital, applying fertiliser and pesticide, and accessing farming labour for sowing seed and spraying pesticide. The majority of these rice farming activities were decided similarly to the rice farming activities of the case study in An Giang province (Chapter 5) because under economic liberalisation, farmers are able to access agricultural materials at agricultural shops at commune markets. Also, it is still possible to access labour in rural areas for farming activities such as transplanting, sowing seed or spreading fertiliser, and spaying pesticide. General farmers in Thoi Tan and Truong Xuan A decided on some rice farming activities relying on the context of Thoi Tan and Truong Xuan A commune (Table 6.10; Table 6.11).

Accessing rice variety for the first rice crop. The majority (66%) of general farmers in Thoi Tan decided to access rice varieties from agricultural material shops (i.e., varieties from seed companies), and 17% from CLRRI (Table 6.13). Besides, some members of the AC also sold rice varieties to general farmers in the community if they produced much more seed than required under the contract with the CLRRI. Compared to Thoi Tan, general farmers in Truong Xuan A regularly use rice varieties from neighbours (33%), family (33%), and the CLRRI (26%). Farmers in Truong Xuan A used to buy original varieties from CLRRI to produce certified seed for the next rice crop season, including 26% of general farmer respondents (Table 6.13), After that, they used the same seed two or three times for several consecutive rice-cropping seasons. Then, they bought new original seed to produce new certified seed again. Farmers in Truong Xuan A perceived that owing to their small land size, this method helped them minimise costs, and the quality of rice did not vary widely from the certified varieties sold in the free markets.

Table 6.13: Source of seed collected for the first rice crop of general farmers in Thoi Tan and Truong Xuan A, Can Tho province

Source of rice varieties	**General farmers in Thoi Tan**		**General farmers in Truong Xuan A**	
	HHs	**%**	**HHs**	**%**
1. Agricultural material shop	16	66	1	4
2. Seed production centres	1	4	0	0
3. Neighbour	2	8	9	33
4. Family	0	0	9	33
5. Research institute	4	17	7	26
6. Member of farmer organisation	1	4	1	4
Total	**24**	**100**	**27**	**100**

Source: Household surveys in 2015
Notes: HHs is number of households

Selecting a rice variety for the first rice crop in Thoi Tan. Most farmers chose to use Jasmine 85 in Thoi Tan (Table 6.14). Several of the general farmers had contracts with a rice company, but they signed contracts by themselves and without the guarantee of a local commune authority. If they had any disagreement with the rice company at the end of the seasonal crop regarding market prices or quality of rice, they had to deal with it individually. On the other hand, the majority of farmers without contracts with rice companies will sell their grains to traders via local brokers.

Table 6.14: Rice varieties used for the first rice crop of general farmers in Thoi Tan and Truong Xuan A, Can Tho province

Rice variety	General farmers in Thoi Tan		General farmers in Truong Xuan A	
	HHs	%	HHs	%
1. Jasmine 85	21	88	2	7
2. IR 50404	0	0	25	93
3. OM 5451	2	8	0	0
4. OM 4218	1	4	0	0
Total	**24**	**100**	**27**	**100**

Source: household surveys in 2015
Notes: HHs is number of households

Selecting rice varieties for the first rice crop in Truong Xuan A. The majority of general farmers (93%) decided to use IR 50404 for the first rice crop (Table 6.14). General farmers believed that IR 50405 suited the soil of their land, the weather, and was less prone to insect attack and diseases than other rice varieties, especially high-quality rice (Jasmine 85). Additionally, the market prices were similar for each rice variety in 2014, with VND 4.4 million/tonne (~ USD 200) for IR 50404 compared to VND 4.5 million/tonne (~ USD 230) for OM 5451 and VND 4.7 million/tonne (USD 230) for Jasmine 85 (household survey data for 2015). General farmers also responded by saying that applying the same rice variety between different farmers in the same rice field or village enables them to sell rice easier than if there are many rice varieties in the same field or village because a general farmer regularly has a small land size (1 ha) (Table 6.7).

Accessing traders for selling rice and other activities of harvesting paddy. General farmers in Thoi Tan or Truong Xuan A make decisions together about harvesting activities (Tables 6.10 and 6.11). A broker has been considered to be a representative of traders in the local area because traders buying the rice of general farmers in the two communes frequently came from neighbouring provinces such as An Giang and Dong Thap province. Also, a broker decided on the activities of hiring labour and combine harvesters for harvesting the rice of general farmers (field notes in 2016).

Individual decision-making of the members of the AC and the LSFs, and general farmers in Thoi Tan and Truong Xuan A for farming activities of the second and third rice crop

In the second and third rice crops, members of the AC in Thoi Tan and the LSFs in Truong Xuan A did not make formal collective decisions in relation to contract farming with the CLRRI for seed production, or with the rice company for Jasmine rice production. This is because the output of seed production or normal rice production in the second and third rice crops was not of high quality due to harvesting activity in the rainy season. This quality issue is a constraint to gaining agreement on the quality of rice between members of the AC and the CLRRI, or between members of the LSFs and the rice company. Therefore, most of the members of the AC in Thoi Tan, and members of the LSFs, and general farmers in the two communes make individual decisions in relation to the majority of farming activities for the second and third rice crops.

Selecting rice varieties in Thoi Tan. Two main rice varieties were used in the second and third rice crops by members of the AC and general farmers. In particular, 50% of members of the AC used OM 4218 and 44% used OM 5451 for cultivating the second rice crop, whereas 74% used OM 4218 and 18% used OM 5451 for the third rice crop (Table 6.15). OM 4218 was selected by 54% of general farmers for cultivating the second rice crop, and by 83% of general farmers for the third rice crop. The participants in FGDs reported that these rice varieties have a strong body, and can adapt to increasing climate variability, insects, diseases, and pests, and have suitable market prices in the situation of their commune.

Table 6.15: Rice varieties used for the second and third rice crops of members of agricultural cooperative (AC) and general farmers in Thoi Tan, Can Tho province

Rice variety	Members of AC[1]				General farmers			
	Second crop		Third crop		Second crop		Third crop	
	HHs[2]	%	HHs	%	HHs	%	HHs	%
1.OM 4218	17	50	25	74	13	54	20	83
2.OM 5451	15	44	6	18	6	25	4	17
3.IR 50404	2	6	1	3	3	13	0	0
4.Jasmine 85	0	0	0	0	2	8	0	0
Total	**34**	**100**	**32**	**100**	**24**	**100**	**24**	**100**

Source: household surveys in 2015
Notes: 1. AC is agricultural cooperative
2. HHs is number of households

Selecting rice variety in Truong Xuan A. IR 50404 was decided by 94% of members of the LSFs and 96% of general farmers for cultivating the second rice crop (Table 6.16). These general farmers and members of the LSF reported that IR 50404 was suitable for the soil of their land and for the climatic conditions (sometimes very hot), and it suffered less from diseases, insects, and pests in Truong Xuan A. Also, these farmers felt they could sell IR 50404 with suitable market prices in the local market. For the third rice crop, 69% of respondents of the LSFs made decisions to use OM 4218, while 74% of general farmers still decided to use IR 50404. Members of the LSFs tended to use high-quality rice more than did general farmers and OM 4218 was considered to cope with abnormal rains better than IR 50404. Generally, farmers decided on rice varieties for each rice crop depending on a range of factors related to access to markets, climatic conditions, and the characteristics of particular rice varieties.

Table 6.16: Rice varieties used for the second and third rice crops of members of large-sized farms (LSFs) and general farmers in Truong Xuan A, Can Tho province

Rice variety	Members of LSFs[1]				General farmers			
	Second crop		Third crop		Second crop		Third crop	
	HHs[2]	%	HHs	%	HHs	%	HHs	%
1.IR 50404	33	94	11	31	26	96	20	74
2.OM 4218	2	6	24	69	1	4	7	26
Total	**35**	**100**	**35**	**100**	**27**	**100**	**27**	**100**

Source: household surveys 2015
Notes: 1. LSFs is large-sized farms
2. HHs is number of households

Accessing rice variety with members of the AC and general farmers in Thoi Tan. Members of the AC who had not had contract farming with the CLRRI selected rice varieties from other members of the AC (18% of households for the second crop and 21% of households for the third rice crop) (Table 6.17). Twenty one percent of general farmers bought rice varieties from their neighbour for the second rice crop, and 25% of households for third rice crop. Additionally, 25% and 21% of general farmers bought rice varieties from research institutes for the second rice crop and for the third rice crop respectively.

Table 6.17: Source of rice variety collected for the second and third rice crops of members of agricultural cooperative (AC) and general farmers in Thoi Tan, Can Tho province

Source of rice varieties	Members of AC[1]				General farmers			
	Second crop		Third crop		Second crop		Third crop	
	HHs[2]	%	HHs	%	HHs	%	HHs	%
1. Research institute	9	26	9	26	5	21	6	25
2. Agricultural material shops	7	21	5	15	5	21	4	17
3. Family	3	9	2	6	5	21	6	25
4. Neighbour	3	9	3	9	5	21	4	17
5. Members of AC in Thoi Tan	6	18	7	21	3	13	3	13
6. Seed production centre	1	3	1	3	1	4	1	4
7. Farmer organisation	4	12	5	15	0	0	0	0
8. Seeding station	1	3	2	6	0	0	0	0
Total	**34**	**100**	**34**	**100**	**24**	**100**	**24**	**100**

Source: household surveys in 2015
Notes: 1. AC is agricultural cooperative
2. HHs is number of households

Access to rice variety of members of LSFs and general farmers in Truong Xuan A. Members of the LSFs and general farmers accessed rice varieties from three fundamental sources including neighbours, family, and the rice research institute (Table 6.18). For example, 46% of members of the LSFs sourced rice varieties from neighbours for the second rice crop and 43% of members from neighbours for the third rice crop. In contrast, 19% and 22% of general farmers bought rice varieties from such sources for the second and third rice crops respectively (Table 6.18).

Table 6.18: Sources of rice variety collected for the second and third crops of members of large-sized farms (LSFs) and general farmers in Truong Xuan A, Can Tho province

Source of rice varieties	**Members of LSFs[1]**				**General farmers**			
	Second crop		**Third crop**		**Second crop**		**Third crop**	
	HHs[2]	**%**	**HHs**	**%**	**HHs**	**%**	**HHs**	**%**
1. Family	11	31	11	31	22	81	19	70
2. Neighbour	16	46	15	43	5	19	6	22
3. Research institute	8	23	9	26	0	0	1	4
4. Agricultural material shops	0	0	0	0	0	0	1	4
Total	**35**	**100**	**35**	**100**	**27**	**100**	**27**	**100**

Source: household surveys in 2015
Notes: 1. LSFs is large-sized farms
2. HHs is number of households

According to respondents to the household surveys in 2015 and FGDs held in 2016, members of the AC and general farmers in Thoi Tan, and members of LSFs and general farmers in Truong Xuan A had interactions in relation to using rice varieties in their commune. However, many advanced farmers in Truong Xuan A, who were involved in the LSFs and had good technical knowledge, produced seed for their neighbours and for general use from original seed bought from the CLRRI. In contrast, general farmers in Truong Xuan A relied on their local knowledge to reserve rice varieties from normal rice. In particular, 2–3 weeks prior to harvesting, farmers could select a small area within their field to practise some activities including selecting good paddy, eliminating bad paddy, and weeding to reserve grains to be able to use as a rice variety in the next rice crops.

To sum up, throughout farmers' decision-making for the rice farming section above, the study identifies that weather conditions, access to markets, and characteristics of different activities are important factors influencing farmers' decision-making. In other words, farmers' experience of these farming activities influenced their new reflections for decision-making.

6.5.4 Effects of farmers' decision-making on the output of the three rice crops (Research question 4)

As in An Giang (Chapter 5), farmers' decisions on rice farming in Can Tho affected the outputs of different rice farming activities as well as the final output of rice production, and the contribution of this income sequentially to household income for enhancing household resilience (Ha 2012). Therefore, rice yield, cost and income of rice production, and other livelihood income sources are significant outputs of rice production.

The first rice crop regularly returned higher net income than the second and third crops on account of its higher mean yield (9 tonnes/ha compared to 6.6 tonnes/ha for the second crop and 5.8 tonnes/ha for the third rice crop) in the case of the members of the AC in Thoi Tan (Table 6.19). The mean net income for households in Thoi Tan for the first crop was VND 50 million for members of the AC and VND 41.7 million for general farmers, whereas for the second rice crop it was VND 20.6 million for members of the AC and VND 17.1 million for general farmers. The high standard deviation for some values is because some members had a larger farm size than other members in the AC. In terms of net income from rice by ha, although the net income of rice production in the three rice crops of members of the AC was always higher than that of general farmers, there were not broad differences between members of the AC and general famers in Thoi Tan.

In Truong Xuan A, on account of the contract with the rice company for the first rice crop, members of the LSFs sold grains to the rice company at VND 5 million/tonne (for Jasmine 85), while general farmers had to sell their grains to local brokers at lower prices than Jasmine 85. Consequently, members of the LSFs attained much higher net income than general farmers for the first crop, namely VND 31.1 million/ha compared to VND 24.4 million/ha (Table 6.19). The net income of the second and third rice crops of members of the LSFs did not differ from that of general farmers as a result of farming the same rice variety for the second rice crop.

Table 6.19: Mean (± sd) rice yield, gross income, cost, and net income (VND million = ~ USD 45.5) for each of the three rice crops by household and by hectare (ha) of members of agricultural cooperative (AC) and members of large-sized farms (LSFs) and general farmers in Thoi Tan and Truong Xuan A, Can Tho province

Indicator	Thoi Tan				Truong Xuan A			
	Members of AC[1] (n=34)		General farmers (n=24)		Members of LSFs[2] (n=35)		General farmers (n=27)	
	HH[3]	Ha[4]	HH	Ha	HH	Ha	HH	Ha
First rice crop								
Yield 1 (tonne)		9.0 (±1.6)		8.7 (±1.4)		9.5 (±0.7)		9.1 (±1.5)
Gross income 1	76.6 (±52.9)	50.7 (±12.3)	63.2 (±43.9)	47.8 (±6.9)	72.7 (±43.1)	47.7 (±3.9)	41.1 (±36.1)	38.6 (±6.2)
Cost 1	26.6 (±19.8)	16.9 (±3.5)	21.5 (±15.4)	16.1 (±3.1)	25.4 (±15.1)	16.5 (±2.7)	15.1 (±12.9)	14.4 (±2.9)
Net income 1	50.0 (±35.8)	33.7 (±11.8)	41.7 (±29.7)	31.7 (±7.1)	47.3 (±29.1)	31.1 (±4.5)	26.0 (±23.6)	24.2 (±6.0)
Second rice crop								
Yield 2 (tonne)		6.6 (±1.0)		6.2 (±0.7)		6.5 (±0.7)		6.7 (±0.8)
Gross income 2	47.0 (±28.1)	31.0 (±6.2)	38.0 (±25.2)	29.4 (±4.0)	46.0 (±31.1)	26.9 (±3.4)	29.0 (±23.1)	27.5 (±3.4)
Cost 2	26.4 (±17.6)	16.9 (±2.9)	20.9 (±14)	15.9 (±2.8)	26.4 (±19.3)	15.1 (±3.3)	15.3 (±13.3)	15.0 (±3.5)
Net income 2	20.6 (±13.8)	14.1 (±5.9)	17.1 (±12.6)	13.4 (±3.7)	19.5 (±14)	11.8 (±4.8)	13.7 (±10.7)	12.5 (±5.0)
Third rice crop								
Yield 3 (tonne)		5.8 (±1.1)		5.4 (±0.8)		5.8 (±1.0)		6.1 (±0.9)
Gross income 3	45.4 (±32.6)	29.1 (±7.4)	33.5 (±21.7)	25.7 (±3.7)	43.0 (±30.8)	25.1 (±5.0)	25.8 (±20.2)	25.0 (±4.3)
Cost 3	24.5 (±16.4)	16.2 (±2.7)	21.4 (±15.7)	15.9 (±2.8)	26.1 (±20.0)	14.9 (±3.5)	15.8 (±15.2)	14.7 (±3.2)
Net income 3	20.8 (±18.1)	12.9 (±7.4)	12.0 (±8.2)	9.7 (±4.6)	16.8 (±15.0)	10.1 (±6.7)	10.0 (±7.0)	10.2 (±4.8)

Source: Household surveys in 2015

Notes: 1. AC is agricultural cooperative
2. LSFs is large-sized farms
3. HH is household
4. Ha is hectare

Mean on-farm income accounted for 83% (VND 110 million) of the total income of members of the AC, and 81% (VND 82.3 million) of the total income of general farmers in Thoi Tan. In Truong Xuan A, on-farm income constituted 79% (VND 99.5 million) of household income for members of the LSFs, and 82% (VND

57.8 million) for general farmers. Non-farm income comprises livelihood activities outside agricultural production (Ellis, 2000). Non-farm income of households in this study including official salaries, local businesses, and other services also made a significant contribution to the total income of households (Table 6.20). For instance, in Thoi Tan, mean non-farm income constituted 13% (VND 16.2 million), and 14% (VND 13.8 million) of household income of members of the AC and general farmers, respectively. Similarly, non-farm activities were responsible for 10% (VND 12.5 million) of the household income of members of the LSFs, and for 12% (VND 8.4 million) in the case of general farmers.

Table 6.20: On-farm, off-farm and non-farm income (mean ± sd) (VND million = ~ USD 45.5) of members of agricultural cooperative (AC), members of large-sized farms (LSFs), and general farmers in Thoi Tan and Truong Xuan A, Can Tho province

Income source	Thoi Tan				Truong Xuan A			
	Members of AC[1] (n=34 HHs[3])		General farmers (n=24 HHs)		Members of LSFs[2] (n=35 HHs)		General farmers (n=27 HHs)	
	Mean	%	Mean	%	Mean	%	Mean	%
1. On-farm	110 (±7)	83	82.3 (±53)	81	99.5 (±69)	79	57.8 (±45)	82
2. Off-farm	5.8 (±23)	4	5 (±18)	5	14.2 (±68)	11	3.9 (±9)	6
3. Non-farm	16.2 (±27)	13	13.8 (±34)	14	12.5 (±30)	10	8.4 (±20)	12
Total	**132 (±75)**	**100**	**101.1 (±67)**	**100**	**126.2 (±105.6)**	**100**	**70.1 (±47)**	**100**

Source: Household surveys in 2015
Notes: 1. AC is agricultural cooperative
2. LSFs is large-sized farms
3. HHs is number of households

6.6 Conclusion

In conclusion, the case study reviewed main findings to respond to the overall research question about what farmers in Can Tho have to consider when they make decisions about growing three rice crops.

In terms of research question one, the majority of farmers in Thoi Tan and Truong Xuan A decided on three rice crops for rice-based farming systems. They relied on several key factors to decide on this farming system, including household consumption, market price, and collective draining of water *(làm cùng nhau)* at the same time and in the same rice field after the flooding season (if there was a high flood level on their farm).

Regarding research question two, a wide range of factors influenced farmers' collective and individual decision-making for rice farming activities. Firstly, social capital between members of the AC and the LSFs is a significant factor for the resilience of the AC and the LSFs in the process of collective decision-making, especially in the case of seed contract farming by members of the AC, and normal rice contract farming in the LSFs. However, informal social capital (through kinship) of members embedded inside the AC and the LSFs had a negative effect on members of the AC and the LSFs.

Weather conditions in the first rice crop are an advantage for cultivating rice crops, while farmers have encountered high temperatures in the second rice crop, and abnormally heavy rain during the third rice crop. However, in Truong Xuan A, sudden period of cool weather in the first cropping season influenced rice yield and benefited certain members in the LSFs, leading to distrust between other members and the leader of the LSFs. In principle, in the case of contract farming between farmers and the rice company, LSFs are expected to be a good solution to overcome not only an unstable market, but also to be able to respond to threats in relation to climate variability and hazards to achieve good outputs (i.e., rice productivity). However, in practice, social capital amongst members in the LSFs can easily be demaged by unexpected events such as by sudden bad weather. In the second rice crop, members of the AC, the LSFs and general farmers in the two communes had enough water to irrigate rice in the dry season because their farms were located in the middle of the VMD. However, abnormally high rainfall often influenced farmers' decision-making for rice varieties.

Access to local markets is an important factor for farmers making collective and individual decisions about seed and normal rice contract farming, or who are selling rice in free markets. Unstable market prices in a local area were one of the factors promoting farmers' decision-making to engage in the LSFs in Truong Xuan A. However, as the contract price of high-quality rice is not much higher than low-quality rice (short grain rice; IR 50404), general farmers in Truong Xuan A have not been interested in cultivating this rice variety (Jasmine 85).

In terms of research question three, farmers made collective and individual decisions for their rice-based farming systems. Farmers' decision-making for a series of farming activities for each rice crop in Can Tho province was found to be conducted by individuals with members of the AC and the LSFs, and general farmers. In contrast, collective decision-making was only undertaken when farmers could not undertake farming activities by themselves, and they needed to collaborate with other relevant households in their community such as for draining water out of fields at the same time and in the same rice field. In addition, contract farming was conducted between participants of the AC in Thoi Tan and the CLRRI, and between participants of the LSFs in Truong Xuan A and the rice company. However, there were perceptions of conflicts between members and leaders in either the AC or the LSFs regarding transparency and unfairness leading to low trust among them. Therefore, similar to Miller (2003) and the case study in An Giang, the study in Can Tho found that farmers preferred working together *(làm cùng nhau)* rather than cooperatively *(hợp tác)* because working together here means working at the same time and in the same rice field, while cooperation involves sharing economic benefits.

In terms of research question four, the consequences of the major decisions made influence the output of rice-based farming systems and household livelihoods. Rice yield and net income from rice production provides measures of the effect of farmers' decision-making on farming activities. In Thoi Tan, members of the AC gained a higher income than general farmers from three rice crops. In Truong Xuan A, members of the LSFs received a net income much higher than that of general farmers from the first rice crop because members of the LSFs made collective decisions for normal rice contract farming with the rice company, while general farmers decided to cultivate the rice variety IR 50404. General farmers in Truong Xuan A recognised that Jasmine 85 had a higher price than IR 50404, but they had good experience with cultivating IR 50404 regarding climatic conditions, fewer insects, and low production costs. In most cases, general farmers adopted a safety first principle when deciding between the uses of IR 50404 or Jasmine 85.

Having observed the process of farmers' decision-making about rice-based farming systems in this study, I think that farmers are conservative and slow to change in decision-making. In this case study, different groups of members of the AC and the LSFs, and general farmers, relied on their perception and experience to decide to continue or change rice-based farming systems or farming activities.

Chapter 7

Farmers' decision-making for rice farming systems in the coastal zone province of the Vietnamese Mekong Delta: A case study of Bac Lieu

7.1 Introduction

Bac Lieu is a coastal province in the VMD with rice and shrimp farming being the two main agricultural livelihood pathways of the majority of farmers. Bac Lieu contains areas of saline water and fresh water, providing lots of significant livelihood options for farmers. Rice productivity in Bac Lieu increased gradually from approximately 0.6 million tonnes in 1996 to approximately 1 million tonnes in 2014 (GSO 2000; 2014). Similarly, shrimp also increased gradually from approximately 0.08 million tonnes to 0.11 million tonnes between 2010 and 2014. The three main household livelihoods in Bac Lieu include intensive rice cultivation in the fresh-water zone, integrated systems of shrimp-rice in the brackish water zone, and shrimp specialisation in the saline water zone (Tuong et al. 2003; Hoanh et al. 2003). Although rice and shrimp productivity increased in the last decade, a wide range of threats and constraints has occurred, especially for shrimp in the shrimp-rice system. According to Ha (2012), the two main factors which might influence the risks to shrimp include inferior seed[15] and poor water conditions, which are key factors contributing to diseases. Rice production might be less risky than raising shrimp, but the impacts of climate change and sea level rise are predicted to become more seriously in the future (ICEM 2009). Drought might also constrain farmers' rice farming activities in the fresh-water zone in Bac Lieu where three rice crops dominate land farming areas. To address these problems, it will be necessary for central government, provincial government, commune authorities and farmers to improve infrastructure by building and reinforcing dykes and constructing sluice gates to control saline water intrusion, and improving canals to facilitate fresh-water distribution. Part of the solution to these problems might also lie in promoting collective action in farmer organisations. Farmers' solutions, strategies, and capacity need to be examined to enhance the understanding of how farmers make decisions about rice-based farming systems in this province when threats occur.

A range of field research has been undertaken in Bac Lieu province, and past studies have focused on the impacts of a series of sluice gates controlling saline water

[15] Shrimp seed is baby shrimp which is delivered from eggs.

on farmers' livelihoods in changing zones of farming systems (Tuong et al. 2003; Ut 2004; Can et al. 2010). In recent years, a few studies have highlighted livelihood resilience of farmers in brackish water zones in relation to reducing risks and improving multiple shrimp systems (Ha 2012). Key findings from these studies in relation to livelihood constraints include reducing natural fish, low education, low technical knowledge in rice-shrimp production, and changing livelihoods from fishing to migration, especially with poor people. However, Can et al. (2010) found efforts by provincial governments to control salt water intrusion have also had benefits for rice farmers. The sluice gates, together with canals supplying fresh water from the Mekong River has allowed rice farmers to cultivate two and three rice crops in some parts of Bac Lieu province. The transition from one, to two, to three rice crops per year has increased the income of farmers dramatically (Can et al. 2010). Regarding shrimp farming, a study conducted by Ha (2012) also determined that shrimp households did not sell shrimp during the periods of market downturns; they stored shrimp in shrimp fields to wait for improvements in market prices. They also protected mangroves, and did not use chemicals on their field in order to maintain good environmental conditions for shrimp. In addition, the area of rice or shrimp cultivation has undergone various changes as a result of various food security policies and by different responses of farmers. Farmer organisations including farmer clubs (FCs) and agricultural cooperatives (ACs) are examples of organisations that contribute to improving collective decision-making in relation to rice-based farming systems in Bac Lieu province. Very few studies have been undertaken across multiple zones in Bac Lieu province in the last few years to gain more understanding of how local farmers decide on rice-based farming systems. In addition, the Bac Lieu case study is considered to be unfavourable compared to the case studies in An Giang and Can Tho because rice intensification and rice-shrimp system of farmers in Bac Lieu might be more sensitive to saline water intrusion and drought in the dry season in the VMD. Therefore, Bac Lieu is an important case study to examine in this thesis.

The chapter identifies farmers' decision-making for rice-based farming systems in Bac Lieu province. There are four specific aims in this study. The specific objectives in this chapter are to:

1. Determine the major decisions that farmers have to make about their rice-based farming systems each year,

2. Figure out factors influencing farmers' decision-making for rice-based farming systems,
3. Understand how farmers make collective and individual decisions for their rice-based farming systems, and
4. Identify the impact of these decisions' on the output of the farmers' rice-based farming systems and household livelihoods.

7.2 Research questions

The main research question in this thesis is:

"What are the main questions that farmers have to consider when they make decisions about their rice-based farming systems in Bac Lieu province?". This is broken down into four specific questions:

1. What are the major decisions that farmers have to make about their rice-based farming systems each year?
2. Which factors influence farmers' decision-making for rice-based farming systems, and how will these factors influence them?
3. How do farmers make collective and individual decisions for their rice-based farming systems?
4. What are the consequences of the major decision about rice-based farming systems and household livelihoods?

7.3 Concepts and methods

7.3.1 Concepts

Agricultural intensification (the three consecutive rice crops) and integrated farming systems (i.e., rice-shrimp) are the two main rice-based farming systems in Bac Lieu in the VMD. Farmers' decision-making for rice farming systems can be expected to be based on factors relating to household resources, livelihood capitals, policies and farmer organisations, climate change, and access to markets (Bruijn & Van Dijk, 2005; Bosma et al. 2012; Ha 2012). The process by which farmers make livelihood decisions was discussed in more detail in Chapter 2. The main factors affecting farmers' decision-making for rice-based farming systems in Bac Lieu are sluice gate control for securing the first rice crop in fresh-water zones from saline water, and controlling saline water for raising shrimp and rice production in brackish water zones. Formal farmer organisations comprising FCs and ACs were considered to be aid organisations in the two research sites (i.e., two communes). Furthermore, climate threats and access to markets affected farmers' decision-making for rice-based farming systems and farming activities. Finally, livelihood capitals including human capital, social capital, physical, natural capital and financial capital might affect farmers' decision-making for rice farming activities (Figure 7.1).

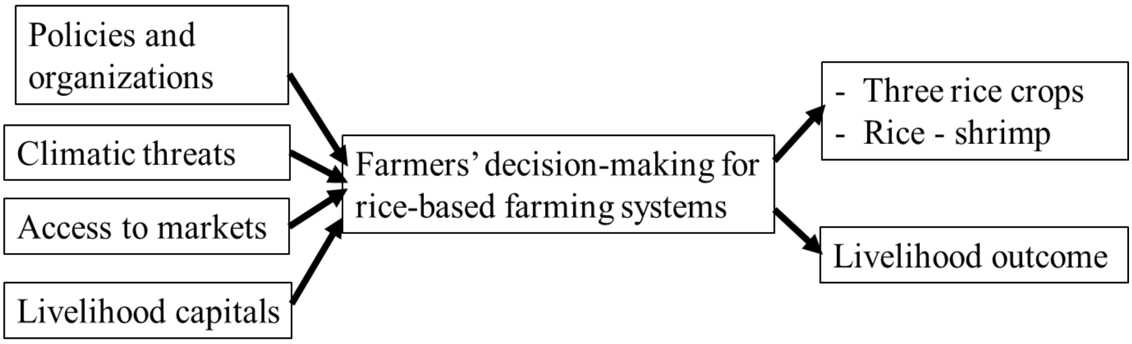

Figure 7.1 Conceptual framework showing the linkage between farmers' decision-making for rice-based farming systems, farmer organisations, climate threats, access to markets, livelihood capital, three consecutive crops or rice-shrimp, and livelihood outcome adapted for Bac Lieu. Source: Adapted from Chambers and Covey (1991), Scoones (1998), and Bruijn and Van Dijk (2005)

7.3.2 Research methods

Research sites

Two communes are used in this study (Figure 7.2). National Road No. 1 divides Hoa Binh commune into two ecosystem zones with the two farming patterns. The National Road No. 1 is also a barrier to control saline water and flooding. Rice production in fresh water is located to the north of National Road No 1, while intensive shrimp production in saline water is to the south of National Road No. 1. Hoa Binh is located in a favourable area[16] with complete control of saline water in Hoa Binh district. Phuoc Long commune of Phuoc Long district is located in an unfavourable area in the brackish water zone of Bac Lieu.

[16] Favorable area is in relation to fresh-water area where three rice crops are protected from saline water intrusion by sluice gate control.

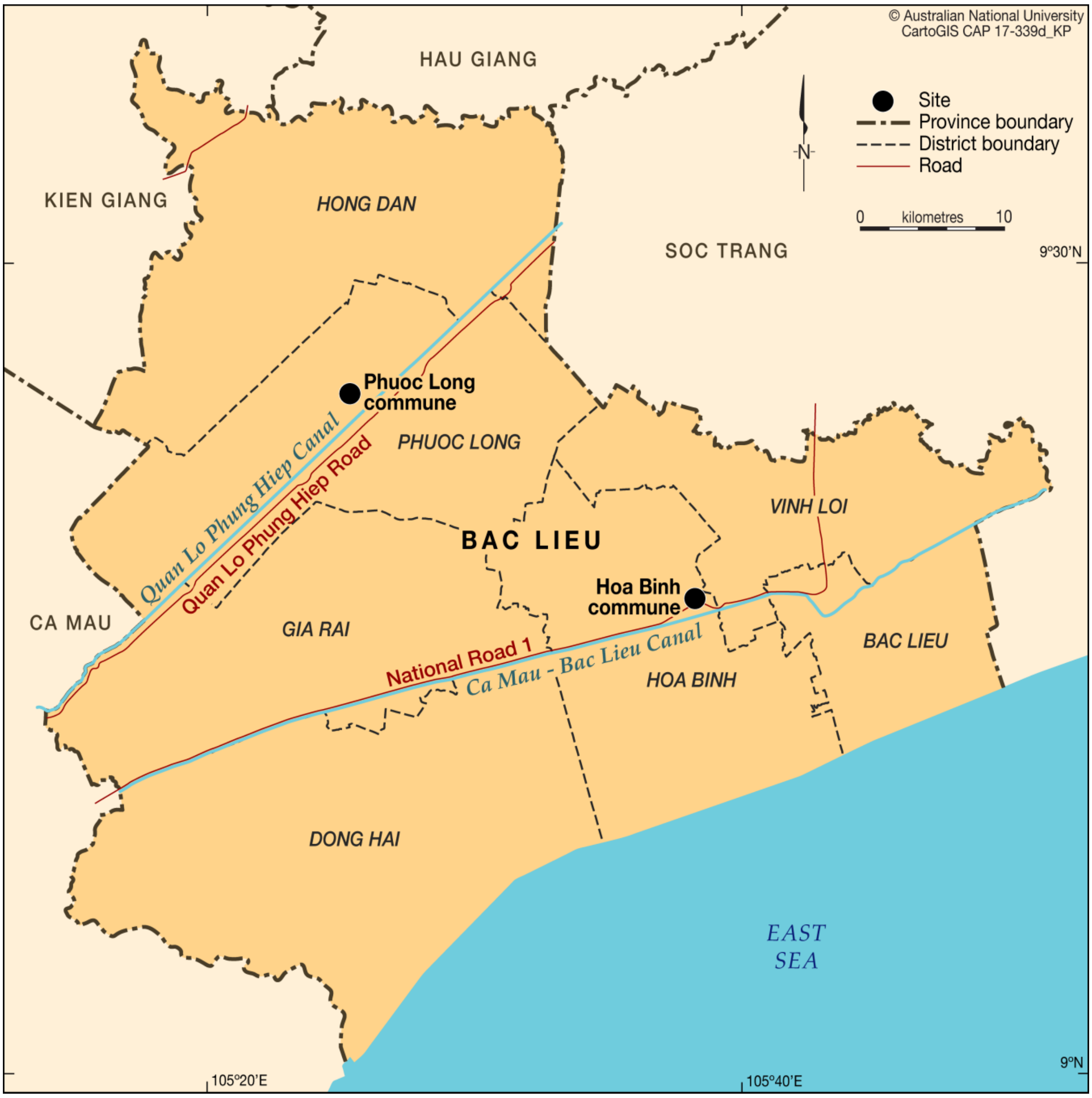

Figure 7.2: The location of Hoa Binh and Phuoc Long communes of Bac Lieu province.

The total land area in Hoa Binh commune is 2,686 ha, with 32% of land devoted to three rice crops and 41% devoted to mono shrimp (Table 7.1). It has a high population with 20,341 people, 76% of whom were Kinh (Table 7.1). Other ethnicities include Khmer (23%) and Chinese (1%). The land area of Phuoc Long is three times larger than Hoa Binh with 7,640 ha. Integrated shrimp-rice systems dominated 85% of the total land area in Phuoc Long. The population is 16,714 and 93% of the people are Kinh. Other ethnicities include Khmer (6%) and Chinese (1%).

Table 7.1: Different land types (ha[1]), ethnicity distribution, and number of households in Hoa Binh and Phuoc Long commune, Bac Lieu province

Indicators	Hoa Binh		Phuoc Long	
	Number	%	Number	%
Total land area (ha)	2,686	100	7,640	100
Agriculture (ha)	861	32	7,170	94
Three crops of rice (ha)	861	32	0	0
Shrimp-rice (ha)	0	0	6,457	85
Shrimp (mono)	1,121	42	0	0
Other types[2] of land (ha)	704	26	470	6
Population	**21,189**	**100**	**16,714**	**100**
Kinh ethnicity	16,053	76	16,714	93
Khmer ethnicity	5,968	23	963	6
Chinese ethnicity	168	1	73	1
Total households	4,635	100	3,887	100

Source: Collected from People's Committee of Commune
Note: Poverty rate of Vietnamese government officials
1. Ha is hectare
2. Other types of land are land for homestead, markets, schools, forest, and public land

Data collection and analysis methods

Household surveys, semi-structured interviews, and focus group discussions (FGDs) were the three main data collection methods used in this study. The household surveys with quantitative and qualitative data were conducted in 48 households (21 members of the FC and 27 general farmers) in Hoa Binh commune and 43 households (11 members of the FC and 32 general farmers) in Phuoc Long commune. Very few female respondents (3 respondents) participated in the survey (see Table 3.3 in Chapter 3). The semi-structured interviews were undertaken in the two communes with 15 key informants comprising members of the FC, general farmers, brokers (middle people between farmers and traders), owners of combine harvesters and owners of agricultural materials. These interviews enabled more insights into the relationships between members of the FC, the AC, general farmers and other actors when farmers decided on their rice-based farming systems as well as other farming activities. FGDs were undertaken with two groups in each of the two communes: (1) households that have, and (2) general farmers who have not been involved in the FC. The number of participants involved in the FC and general farmers were six members of the FC and eight general farmers in Hoa Binh, and six members of the AC and six general farmers in Phuoc Long. The findings of the study include quantitative and qualitative data, which are presented by descriptive statistics and narratives (see more detail in Chapter 3).

7.4 Background to policies relating to rice development and the results in Bac Lieu

7.4.1 Background to policies relating to rice and rice-shrimp farming

Bac Lieu is a province with diverse land uses; thus the provincial government has applied a wide range of policies relating to the development of agriculture and aquaculture. This study focuses on the main policies that might directly affect rice production in the fresh-water zone with a completely controlled saline water intrusion zone, and rice-shrimp system in the brackish water zone. These policies included land use, production groups *(tập đoàn sản xuất)*, agricultural cooperatives (ACs), canal and sluice gate construction, and seed improvement. The two research sites in Bac Lieu were different in applying policies at the commune level; thus this chapter sometimes discusses a particular location separately.

Production group in Bac Lieu (1977–1985)

A production group *(Tập đoàn sản xuất)* was introduced into Hoa Binh commune between 1978 and 1986. A production group had from 5 to 6 sub-groups. Their functioning was quite similar to other production groups in the case studies in An Giang and Can Tho. Compared to Hoa Binh commune, the production group was applied in Phuoc Long commune in 1979, and dissolved after 1984. Phuoc Long was considered to be a pilot of production groups in Bac Lieu province by applying the work points system, which was similar to the old model of ACs in the north of Vietnam (Kerkvliet 2005; De 2006). In this period, the majority of households had a small land area (<1ha); thus the commune authorities forced farmers to group their land together to establish a production group. Farmers worked according to the work points system. For example, each farmer who worked eight hours a day received ten points, and they would receive rice after collective harvesting of rice according to their total points.

Although local government encouraged farmers to engage in this model of the production group, many farmers did not support it because their land was taken into the collection of the production group. According to Mr T., the head of a village in Phuoc Long, although the majority of farmers did not actively resist commune authority, they attempted to resist the production group model by a variety of strategies. For instance, they informed me that they got sick so that they did not have to work, while they spent time on their private garden land because in the period between 1976 and 1986 farmers still owned small areas of garden land. Additionally, if they received fertiliser from the management board of production groups to use on collective rice farms, then they saved fertiliser to spread on their private garden, instead of using it fully for the collective rice farms.

After around five years, the commune authority and high level authorities recognised that the model of this production group was not effective. They decided to abandon this model in Phuoc Long commune. After 1986, farmers in Phuoc Long were able to access an input supply of rice at the local free markets for their rice production under the policy of the market economy (field interview with Mr H., an old head of a village in Phuoc Long).

Sluice gate construction for controlling saline to implement the three rice crops and shrimp-rice systems in Bac Lieu (1990 to 2016)

Between 1990 and 2000, a series of sluice gates was constructed along National Road No. 1 and Quan Lo Phung Hiep road to control saline water in the fresh-water zone and brackish water zone for cultivating the two and three consecutive rice crops and raising shrimp respectively (Figure 7.3). In 2016, there were approximately 44 sluice gates; the sluice gates of the main canals such as Lang Tram and Gia Rai-Ho Phong located along National Road No. 1 were opened and closed for three days each month to extract saline water from the ocean via the Ca Mau-Bac Lieu canal to deliver to the brackish water zone so that farmers could raise shrimp from February to August.

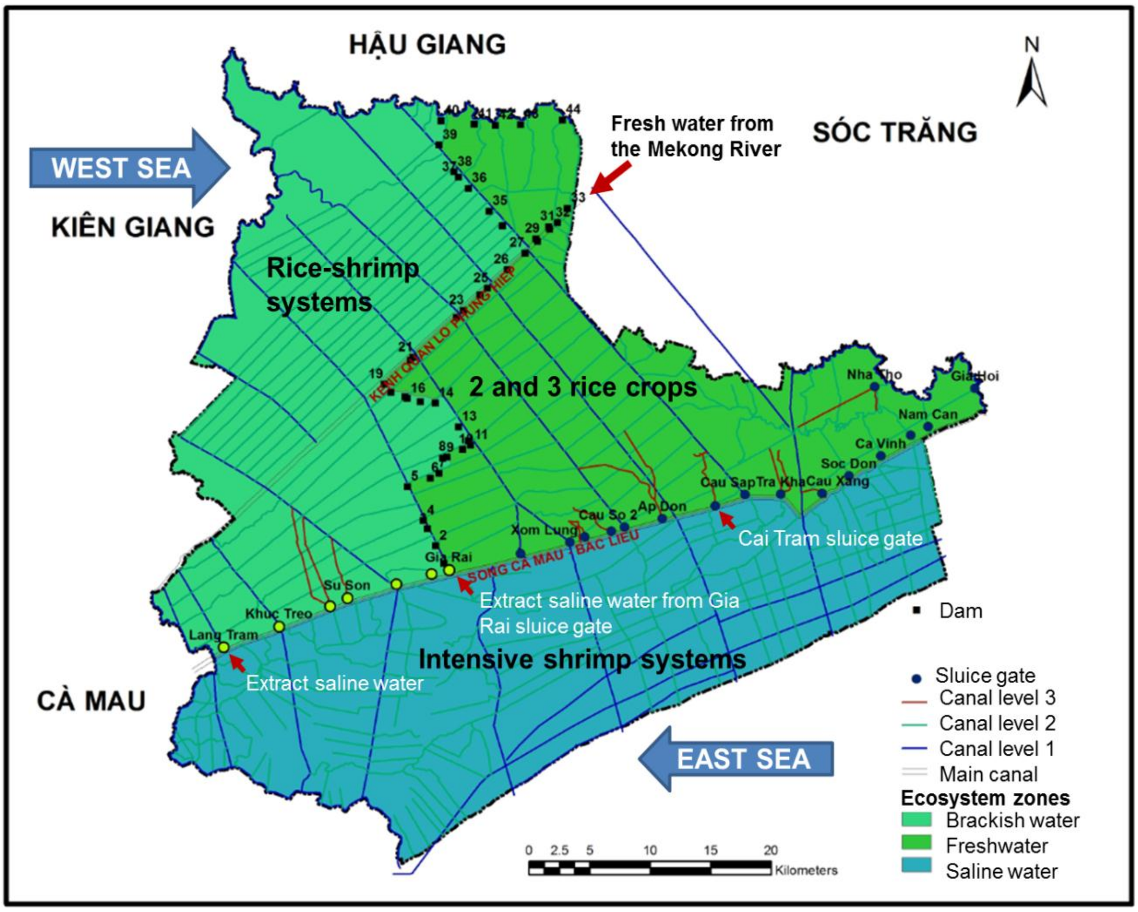

Figure 7.3: Sluice gate system in Bac Lieu province showing fresh water, brackish and saline water zones
Source: Modified from CLUES project

Compared to functions of a series of sluice gates in brackish water zones, a series of sluice gates along National Road No. 1 located in the fresh-water zone (from Xom Lung back up to the Nam Can sluice gate) was constructed to lock saline water intrusion for cultivating rice during the year. However, these sluice gates are able to be opened when heavy rains occur over many days, and this elevate the water level in the fresh-water zone to be higher than water levels on Ca Mau-Hoa Binh canal. Accordingly, a series of sluice gates controlling water in the fresh-water zone were able to open to drain water out of this zone through Ca Mau-Bac Lieu canal to release water to the East Sea of the Delta (field interview with irrigation official of the Department of Agricultural and Rural Development of Bac Lieu in 2016).

Similar to the series of sluice gates along National Road No. 1 in the fresh-water zone, a series of sluice gates along Quan Lo Phung Hiep were also constructed to protect the three rice crops zone (Figure 3.7). Such sluice gates protected rice cultivation in the fresh-water zone not only against saline water from the brackish water zone but also from saline water intrusion from Kien Giang province and Ca Mau province. Annually, such sluice gates usually open permanently from September to January to extract fresh water from the Mekong River to irrigate rice in the fresh-water zone.

Hoa Binh

The Cai Tram canal was one of the canals connecting the Ca Mau-Bac Lieu canal and the Quan Lo Phung Hiep canal (Figure 7.3). This is one of the canals of Bac Lieu across rice farms in Hoa Binh commune. The Cai Tram sluice gate along National Road No. 1 was constructed before 2000 to block saline water intrusion from the Ca Mau-Bac Lieu canal into the fresh-water zone. On account of the Cai Tram sluice gate and extracting water from the Mekong River via Quan Lo Phung Hiep canal, farmers with land in the fresh-water zone of Hoa Binh were able to increase rice farming from one to three consecutive rice crops each year.

Phuoc Long

The brackish water zone in Phuoc Long commune was dependent on the two canals, namely Pho Sinh-Gia Rai and Phuoc Long where saline water was extracted from the Ca Mau-Bac Lieu canal. The Gia Rai sluice gate located on National Road No. 1 played a fundamental role in controlling saline water during the dry season to allow farmers in Phuoc Long commune to raise shrimp from February to August. In addition, farmers in Phuoc Long commune using saline water in the dry season were not only from the Ca Mau-Bac Lieu canal but also from the West Sea via the Cai Lon River across adjacent Kien Giang province, a coastal province (Figure 7.3).

7.4.2 The consequences of the process of rice intensification in Hoa Binh and rice-shrimp systems in Phuoc Long

The consequences of the process of rice intensification in Hoa Binh

There were three major periods in the process of rice development in Hoa Binh commune. In the beginning of this process, farmers in the commune cultivated one long-term rice crop (6 months: May to October) a year from 1976 to 1990 (Table 7.2). The rice yield was only about 5 tonnes/ha/crop because although canals were dredged in this area, rice varieties as well as technical knowledge had not been improved. In 2000 there was a big change from one rice crop to two consecutive rice crops each year owing to adequate fresh water being extracted from the Mekong River and shorter duration varieties. The output of the second (May to August) and third rice crops (September to December) in this period were approximately 5 tonnes and approximately 7 tonnes/ha/crop. The three consecutive rice crops system was widely practised in 2009 after some advanced farmers had pilots in Hoa Binh.

Table 7.2: Relevant policies of rice production and outputs in Hoa Binh

Year	Policies	Change in rice farming system	Requests for conducting different rice patterns	Rice yield
1976–1995	• Control/planned economy • Land conversion • Canal development(by hand) • Production group	One long-term rice crop (6 months)	• Lack of fresh water • Lack of technical knowledge	~ 5 tonnes/ha/crop
2000	• Market economy • Seed improvement • Operating sluice gates • Improve and open canals (by hand)	Two rice crops with more short-term duration (~ 100 days)	Enough water from upstream, but sluice gate was not safe	• 1st rice crop: ~ 6 tonnes/ha/crop • 2nd rice crop: ~ 7 tonnes/ha/crop
2009–2015	• Market economy • Seed improvement • Operating sluice gates • Improve and open canals (by hand) • Enough fresh water	Three rice crops	Enough water from upstream, but sluice gate was not safe	• 1st rice crop: ~ 7.8 tonnes/ha/crop • 2nd rice crop: ~ 6.7 tonnes/ha/crop • 3rd rice crop: ~ 6.9 tonnes/ha/crop

Source: Collected from DARD and FGDs in 2016 in Hoa Binh, and household surveys in 2015

The consequences of the process of rice-based farming systems in Phuoc Long

Farmers in Phuoc Long commune have experienced different models of farming systems both in rice production and aquaculture. Between 1976 and 1985, the output of the rice crop only reached approximately 3 tonnes/ha due to a lack of technical knowledge and agricultural materials such as fertiliser and low quality of rice varieties. A short-term rice variety was substituted for a long-term variety during the period 1986 to 1990, and the yield increased to approximately 4 tonnes/ha/crop (Table 7.3). After 1990, farmers in Phuoc Long commune alternated between one rice crop and two rice crops each year. The rainy season, along with fresh water from upstream of the VMD, enabled farmers to cultivate two rice crops. The two rice crops in Phuoc Long commune resulted in an increase from 4 to 5 tonnes/ha/crop.

The emergence of the shrimp-rice system was a significant change in Phuoc Long commune in 2000. At that time, the provincial government closed a series of sluice gates along National Road No. 1 to make it compulsory for all farmers on the north side of National Road No. 1 in Bac Lieu to cultivate two rice crops (Hoanh et. al, 2003). However, not all rice farms in the fresh-water zone were guaranteed adequate water to irrigate rice in the dry season (January to July), especially for land located at the end of the fresh-water zone, Phuoc Long being a good example. In addition, shrimp has a higher value than rice. Afterwards, farmers in sub-zones with uncertain water access negotiated with the provincial government to open sluice gates located near their zone so that they were able to raise shrimp in the dry season (February to August) and cultivate rice crops (September to January). In 2014, rice in the model of shrimp-rice (one rice crop each year and one shrimp crop each year) could achieve approximately 6 tonnes/ha (Table 7.3).

Table 7.3: Relevant policies of rice, and shrimp-rice pattern and outcome in Phuoc Long

Year	**Policies**	**Change in rice farming systems**	**Farmers response**	**Rice yield**
1976–1985	• Planned economy • Land redistribution (twice) • Production group • Dredged canals	One rice crop	Did not support production groups	~ 3 tonnes/ha/crop
1986–1990	• Market economy • Disintegrating production group			~ 4 tonnes/ha/crop
1991–1999	• Market economy • Improving seed • Improving canals	Two rice crops	Did not support the two rice crops	~ 5 tonnes/ha/crop
2000–2015	Operation of sluice gate	Shrimp-rice	Support	~6 tonnes/ha/crop

Source: Collected from DARD and FGDs in 2016 and household surveys in 2015
Note: Participants could not remember output (productivity) of shrimp

7.5 Results and discussion

7.5.1 Farmers' decision-making about the three rice crops and rice-shrimp systems (Research question 1)

Similar to the approach of farmers' decision-making in relation to rice-based farming systems in the An Giang case study (Chapter 5), this section will discuss what farmers decide to do (and how and why) with three rice crops in Hoa Binh and what they decide to do (and how and why) in the rice-shrimp model in Phuoc Long. Three rice crops dominated the majority of the land area for rice-based farming systems in Hoa Binh, while rice-shrimp occupies a majority of the land area in Phuoc Long commune (Table 7.1). In addition, members of the FC in Hoa Binh, members of the AC in Phuoc Long and general farmers in the two communes decide on a range of farming activities such as selecting rice varieties or shrimp seeds, accessing rice varieties and shrimp seeds, etc. (Tables 7.11 & 7.14). This section will discuss, in detail, farmers' decision-making about three rice crops in Hoa Binh and rice-shrimp systems in Phuoc Long. Later in section 7 .5.3, I will discuss the role of the FC and the AC in decision-making in more detail.

Farmers' decision-making for the three rice crops in Hoa Binh

In Hoa Binh, the majority of members of the FC and general farmers decided on three consecutive rice cops for rice-based farming systems. According to the participants in the FGDs held in 2016, a range of factors affecting their decision-making for selecting three rice crops each year. These factors include the safety first principle (i.e., rice for household consumption), access to markets, conditions of saline intrusion, and drought. These factors influence households' income from rice production.

Members of the FC and general farmers responded that they considered household consumption and net income of rice production for each rice crop. They regularly store enough rice for household consumption until they have the output of new rice crops, and also need money for expenditure and reinvestment for new crops. According to Mr L., a 78-year-old male farmer, his family does not sell his total rice harvest to traders because if he does that, then he has to buy rice at a higher price for household consumption. Generally, farmers have still maintained the behaviour of storing rice for consumption although they have to sell rice for expenditure.

Access to markets is the most important factor for members of the FC and general farmers deciding on cultivating rice, instead of other crops. According to Mr L., a member of the FC, crops other than rice are difficult to sell in the local market. He said that, more recently, several agricultural extension projects from Can Tho University have recommended other upland crops such as corn and soy beans and offered relevant technical advice. However, farmers in his community were not interested in growing these crops because of constraints to selling the products. In contrast, although rice has unstable market prices, farmers were able to sell rice to traders through local brokers in local markets.

According to farmers in Hoa Binh, they were worried about the first rice crop more than other crops because of saline intrusion. For example, Mr S., a 57-year-old farmer who was a member of the FC in Hoa Binh, had two land parcels in different locations. The first was located near the Cai Tram sluice gate, and the second was further away from the sluice gate. He lost the rice of the first rice field in the first crop in 2014 and 2015 due to saline water intrusion from an unsafe sluice gate. In 2016 he decided to stop cultivating the first rice crop at the land parcel near this sluice gate, while the second land parcel was cultivated in 2016.

Drought was one of the most important factors influencing farmers' decision-making about two or three rice crops. Irrigation for rice cultivation in the first crop of farmers in Hoa Binh regularly relies on fresh water delivered by the Mekong River. However, more recently a dry season with high temperature caused a lack of fresh water in the Mekong River. Unlike farmers in the upstream zone of the VMD, farmers in Bac Lieu were concerned about the combination of drought and saline water intrusion, instead of floods, because they had not experienced floods for many years.

Farmers' decision-making for rice-shrimp system in Phuoc Long

In Phuoc Long, all members of the AC and general farmers decided on cultivating the rice-shrimp system each year because of two crucial elements, the salinity conditions of saline water and the seasonal distribution of rain water. Compared to farmers in Hoa Binh, members of the AC and general farmers in Phuoc Long responded that they only depend on the salinity of saline water for raising shrimp (February–August) and rain water for growing rice (i.e., one rice crop from September to January). They contended that the main income of this farming system is from raising shrimp, while they cultivate rice for household consumption. However, if total rice productivity is much more than required for household consumption, then they sell to markets. According to Mr D., a 58-year-old farmer, he does not sell rice immediately after harvesting because he also obtains shrimp for selling after finishing rice crop. Recently, farmers in Phuoc Long have cultivated rice coinciding with shrimp and other aquatic species in the rice crop in the same field, but the productivity of shrimp is lower than raising shrimp as a single crop (note: farmers could not remember the productivity of shrimp to compare). Besides having rice to consume and sell for gaining income, farmers in Phuoc Long perceived that the roots of paddy from rice cultivation also generate good water environmental conditions for raising shrimp because farmers do not feed their shrimp in the mixed rice-shrimp system, unlike in intensive shrimp system which require additional feeding (Ha 2012). In 2015, while the community was able to cultivate rice with less rain than over many previous years, they decided on continuing with raising only shrimp in this season (September–February) (FGDs in 2016).

Generally, farmers in Hoa Binh based decisions on a safety first principle, access to markets and saline water intrusion to decide on three rice crops, while farmers in Phuoc Long decided on cultivating rice-shrimp systems due to salinity conditions of saline water and the seasonal distribution of rain water. The next section will discuss in more detail the factors influencing collective and individual decision-making for farming activities on the three rice crops and rice-shrimp system.

7.5.2 Factors influencing farmers' decision-making for rice-based farming systems (Research question 2)

Influences of social capitals on the resilience of farmers' club and agricultural cooperative

Current farmer club in Hoa Binh

The farmer club (FC) in Hoa Binh was established in 2002. The aim of this FC was to build capacity in technical knowledge for cultivating rice seed, normal rice (i.e., rice for consumption) for members, and producing rice seed for the seed centre of the Department of Agricultural and Rural Development (DARD) of Bac Lieu province. The networks of the FC included the seed centre, the agricultural extension centre, and Can Tho University. The number of members of the FC increased from 28 in 2002 to 46 in

2004, and then declined to 25 members in 2015. The main reason for the reduction of members and activities of the FC was the decrease in projects from Can Tho University and the seed centre of Bac Lieu (FGDs in 2016).

Social capital influencing resilience of the farmer club

Social capital plays a significant role in FC resilience in Hoa Binh. Although the FC in Hoa Binh did not have formal collective activities in relation to rice farming activities, these activities including training courses and setting up seasonal calendars broadly contributed to building human capacity of the FC's members and rice community in Hoa Binh commune. I selected several collective activities of the FC in Hoa Binh to measure the degree of social capital (from completely disagree = 1 to completely agree = 5) via indices (i.e., statements) of social cohesion and social commitment.

The mean score of social cohesion with members of the FC in Hoa Binh varies from 2.6 to 4.1 (Table 7.4). The two top scores were, "People are friendly in the organisation" to a high degree (score = 4.1) and, "Members will share new knowledge with their members" (score = 3.9). The standard deviation is very high for some values because of the wide range of values provided by respondents, but also because members of the FC were not sure about assessment of statements related to activities that required a large number of participants regularly involved in an organisation.

Table 7.4: Members' perceptions about statements of social capital (mean ± sd) of members in the farmer club in Hoa Binh, Bac Lieu province

Statements of social capital	Members of FC[1] (n = 21 HHs[2])
1. Social cohesion	
1.1. Members will share new knowledge with their members	3.9 (±0.6)
1.2. People are friendly in the organisation	4.1 (±0.4)
1.3. Members usually agree to begin crop at the same time	2.9 (±1.1)
1.4. Members are willing to work together to protect crops	2.7 (±1.0)
1.5. I regularly participate working groups	3.1 (±1.1)
2. Social commitment	
2.1. Organisation's members inform other members and the community about pest and diseases their crop get	3.3 (±0.8)
2.2. Farmer organisations are active and inform all members every time they have training (with outside agencies)	3.6 (±0.8)
2.3. Members of organisation respect the rules of organisation (follow seasonal calendar of organisation)	3.3 (±0.9)

Source: Household surveys in 2015

Note: 5= completely agree; 4= agree; 3=neutral; 2=disagree; 1= completely disagree

1. FC is farmer club; 2. HHs is number of households

Generally, the score of cohesion statements was higher than commitment statements because commitment statements related to beneficial activities such as training, then leaders of the FC used to give priority to their relatives (kin) and neighbours before other members were considered. Accordingly, some members without leader's relatives did not have strong support for the FC. Until 2016, although support from the seed centre of Bac Lieu and Can Tho University had declined since 2015, the FC in Hoa Binh attempted to maintain activities consisting of sharing technical knowledge and setting up seasonal calendars, and selecting rice varieties with an informal approach.

Current agricultural cooperative in Phuoc Long

The AC in Phuoc Long was established in 2012 with 11 members (FGDs in 2016). The aim of this AC was to contribute to reducing costs for cultivating rice-shrimp systems via selling cheap inputs for their members. Additionally, the AC created opportunities to enhance capacity for members via supporting attendance at training courses, which were organised at the commune level. Members also regularly had meetings to share technical knowledge and information in relation to rice-shrimp systems for cultivating more effectively.

Social capital influencing the resilience of agricultural cooperative in Phuoc Long

In Phuoc Long, the two statements with the highest scores were, "Members will share new knowledge with their members" (score = 3.8) and, "People are friendly in the organisation" (score = 3.8) (Table 7.5). Scores for the other statements varied between 2.3 and 3.6 (Table 7.5).

Table 7.5: Members' perceptions about statements of social capital (mean ± sd) of members in the agricultural cooperative in Phuoc Long, Bac Lieu province

Statement of social capital	Members of AC[1] (n=11 HHs[2])
1. Social cohesion	
1.1. Members will share new knowledge with their members	3.8 (±0.4)
1.2. People are friendly in the organisation	3.8 (±0.8)
1.3. Members usually agree to begin crop at the same time	2.5 (±0.8)
1.4. Members are willing to work together to protect crops	2.3 (±0.6)
1.5. I regularly participate working groups	3.4 (±0.9)
2. Social commitment	
2.1. Members in organisation inform other members and the community about pest and diseases their crop get	3.6 (±0.6)
2.2. Members will inform other members and community of the time they discharge waste water outside to the community	3.1 (±1.0)
2.3. Farmer organisations are active and inform to all members every time they have training (with outside agencies)	2.9 (±0.8)
2.4. Members of organisation respect the rules of organisation (follow the seasonal calendars of organisation)	2.9 (±1.6)

Source: Household surveys in 2015

Note: 5= completely agree; 4= agree; 3=Neutral; 2=disagree; 1= completely disagree

1. AC is agricultural cooperative; 2. HHs is number of households

It was obvious that the collective activities of members in the AC of Phuoc Long commune concentrated on collective skills, namely sharing and attending training. They were unable to decide on, and work together on farming activities at the same time as rice farming patterns in the fresh-water zone, namely Hoa Binh commune, because they relied on natural factors (i.e., saline water, drought, and less rain), the characteristics of farming systems, and less cooperative behaviour of farmers in Phuoc Long. Therefore, they frequently made individual decisions in relation to their rice-based farming systems and farming activities.

Influence of climate variability on farmers' collective and individual decisions for the three rice crops and rice-shrimp system

Climate variability in Bac Lieu province

Monthly maximum temperature follows a pattern with the highest maximum temperature in May (34.8 °C) and the lowest maximum temperature in December (31.4 °C; Figure 7.4). The recorded monthly values for maximum temperature were typically higher than the mean maximum temperature in 2014, 2015, and 2016. The highest observed values for maximum temperatures were 35.8 °C in May 2014, 35.6 °C in May 2015, and 36 °C in May 2016. There was a run of 11 consecutive months with higher-than-average maximum temperatures (from May 2015 to March 2016). These high temperatures might cause the death of shrimp due to increasing salinity[17]. Accordingly, this threat might lead farmers in Phuoc Long to change their decision-making from rice-shrimp to mono-shrimp each year, which was discussed in section 7.4.1.

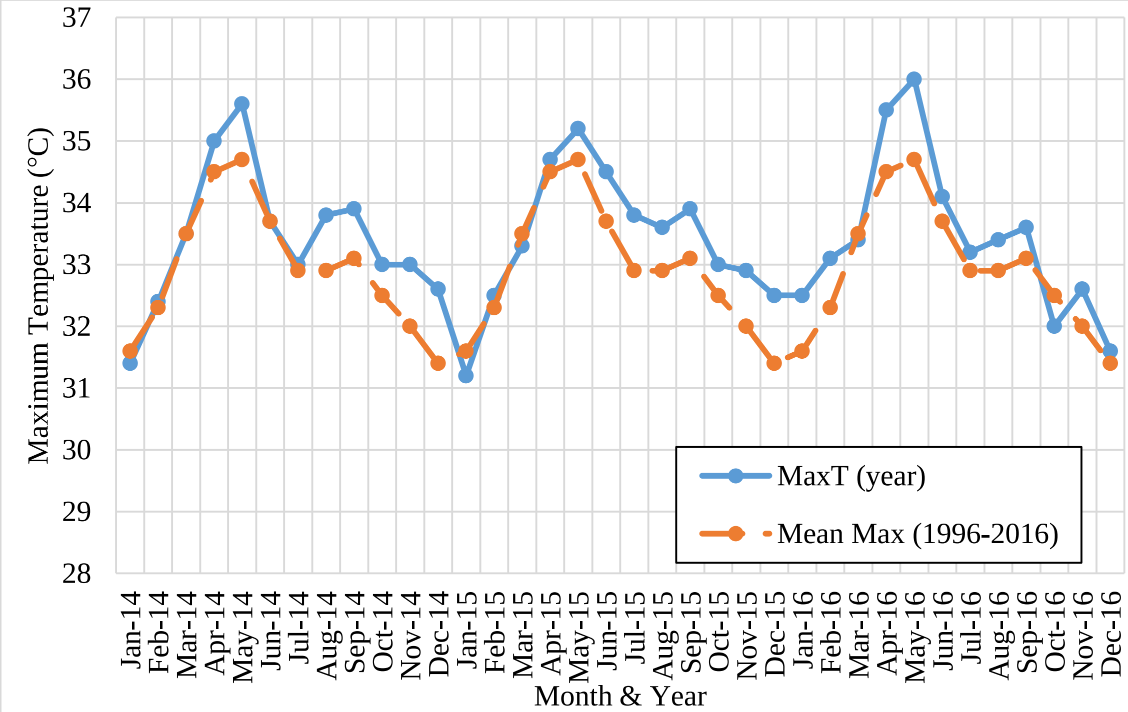

Figure 7.4: Comparison of monthly maximum temperature (ºC) in 2014, 2015 and 2016 with the mean monthly maximum temperature (ºC) from 1996 to 2016 from Bac Lieu province. Source: National Hydro-Meteorological Service of Vietnam

The annual rainfall in Bac Lieu is 2,049 mm. The monthly rainfall in 2014 (1,835 mm) and 2015 (1,746 mm) was mostly lower than the mean rainfall (1996–2016). In particular, monthly rainfall had a high increase and decrease between May and December in 2014 compared to the mean (1996–2016), nearly similar to the mean in 2015. Monthly rainfall in 2014 increased in July (250 mm), and reached a peak of 420 mm in August, but it rose again and reached a new peak at 330 mm in November, and dropped in December. The peak of monthly rainfall in Jun 2015 (350 mm) was higher than the mean (290 mm), but there was less rain than the mean from October to December in 2015. Generally, the low rainfall in 2015 led to a change in farmers' decision-making for farming systems with rice-shrimp farmers in the brackish water zone in Bac Lieu. In contrast, very high rainfall occurred in August 2016 (2,083 mm)

[17] The high temperatures caused increased evaporation of the water thus increasing the concentration of salts.

causing localised inundation and impacting harvest activities of the second rice crop of rice farmers in the fresh-water zone in Bac Lieu. Lower than mean rainfall in 2015 caused a change in farmers' decision-making for rice-shrimp systems, which is presented in the section 7.5.1.

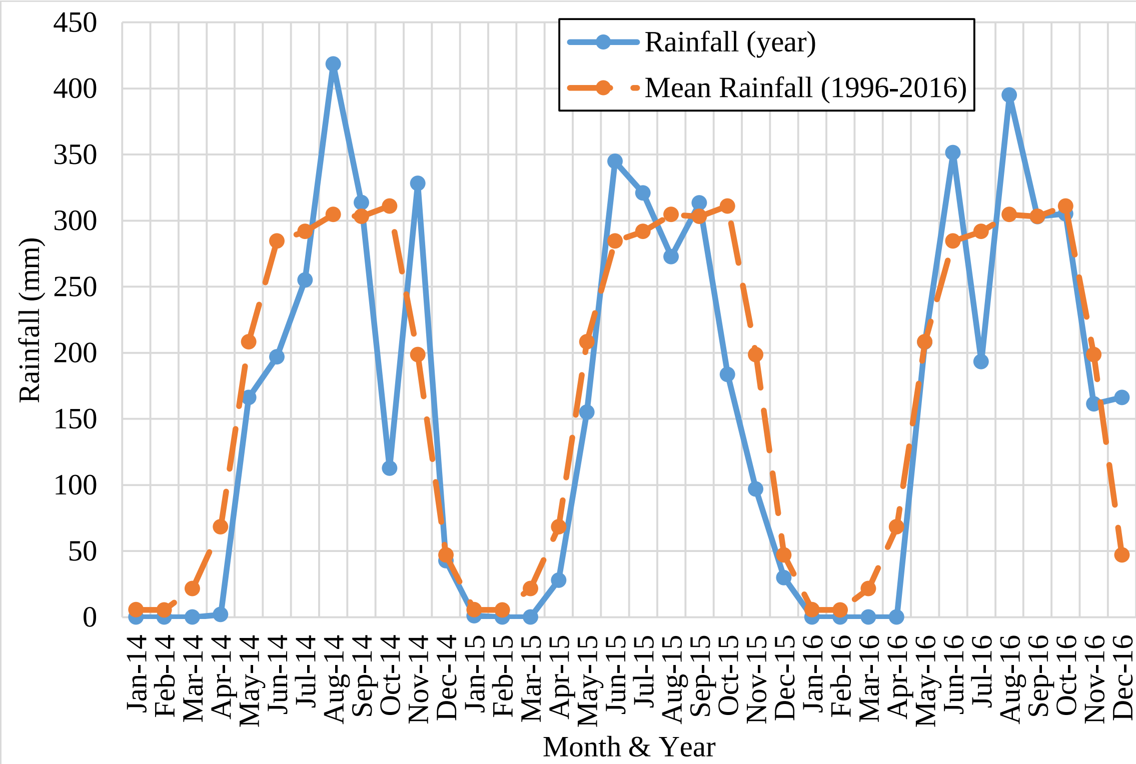

Figure 7.5: Comparison of monthly rainfall in 2014, 2015 and 2016 with the mean monthly rainfall from 1996 to 2016 from Bac Lieu province.
Source: National Hydro-Meteorological Service of Vietnam

Monthly maximum salinity generally follows a pattern of increasing salinity levels in January through to a peak in April and May (25 grams/litre), then a decline in June (10 grams/litre; Figure 7.5). Salinity is not recorded in the other months. Salinity levels were close to the mean in 2014, but were much higher in 2015, with a peak value of 33 grams/litre (Figure 7.6). Salinity levels in the water increased when it was pumped from a canal to a shrimp field because the large water surface area is exposed to sunshine with high temperatures in the same period, which evaporates the water thus increasing the concentration of salts. This threat caused farmers to lose shrimp in 2015.

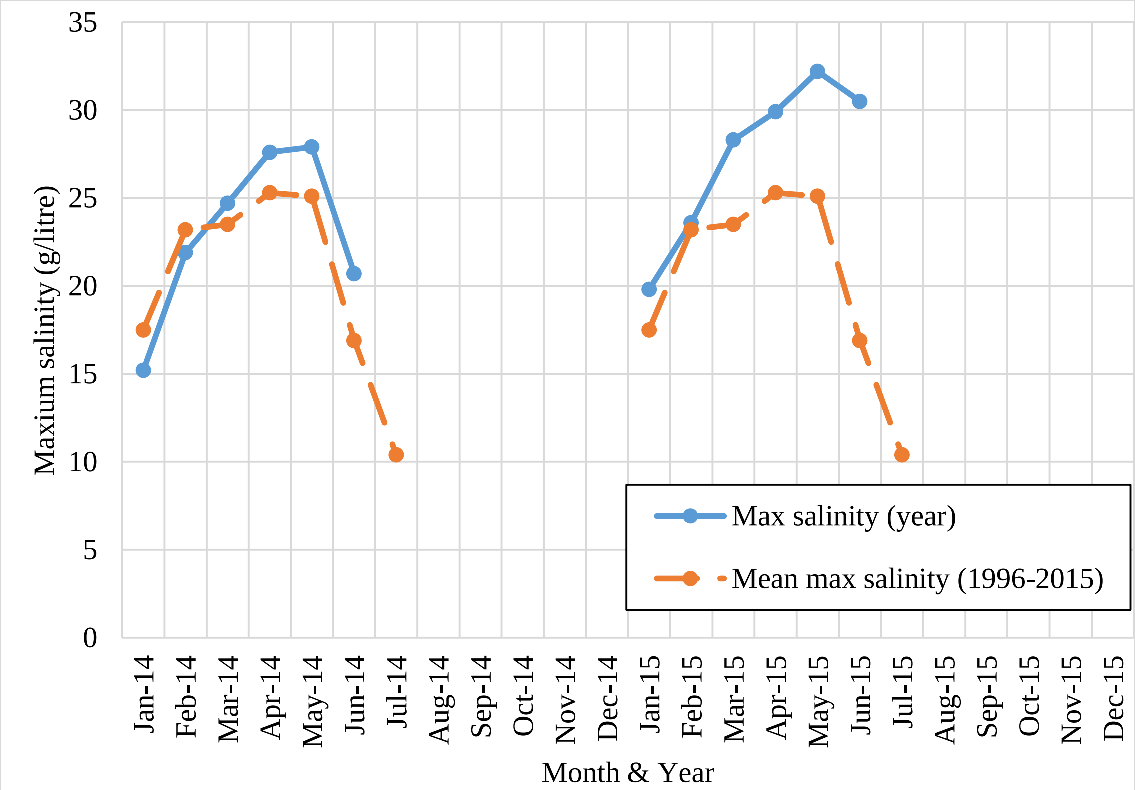

Figure 7.6: Comparison of monthly salinity in 2014 and 2015 with the mean monthly rainfall from 1996 to 2015 from Bac Lieu province.
Source: National Hydro-Meteorological Service of Vietnam

Farmers' perceptions of climate variability in the three rice crops in Hoa Binh

Climatic threats were barriers to agricultural development in Vietnam and the VMD (McElwee 2010). Climatic conditions include extreme weather events, and drought or excess rain, whereas economic, environment, technology, and government policies accounted for non-climatic factors. These factors might influence farmer behaviour, agricultural decision-making, and adaptive decision-making (Smit et al. 1996; Bryant 1994; Bryant et al. 2000).

The first rice crop in Hoa Binh commune (January–April). Saline water intrusion, drought, and land location have been three serious threats influencing farmers' decision-making for farming activities. Members of the FC and general farmers had to adapt to such threats because sluice gates along National Road No. 1 in the Hoa Binh area were old, and saline water was able to intrude into canals near sluice gates in the dry season more seriously between March and April. Additionally, the dry season also caused a lack of fresh water delivered by the Mekong River (see the seasonal calendars in Figure 7.7). The following sections will discuss saline intrusion, drought and disadvantageous land locations for rice cultivation in more detail.

Crops and weather	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Three rice crops	First crop				Second crop				Third crop			
Dry season (hot)	*	**	***	***	***	*						
Abnormal rains						**	***	***	***	***	**	

Figure 7.7: Seasonal calendar of crops and relevant factors of weather to rice farming in Hoa Binh
Source: FGDs in 2016
Note: * less frequent, ** frequent, *** very frequent

Firstly, for saline intrusion, the land located near sluice gates was very sensitive to saline water intrusion from the Ca Mau-Bac Lieu canal where saline water is permanently located. The Cai Tram sluice gate in the Hoa Binh has deteriorated in recent years and is no able to guarantee to block the intrusion of saline water. As a result, saline water has reached rice land around two kilometres inland from the sluice gate in recent years. If farmers did not test[18] the salinity of water in the canals in the fresh-water zone carefully before irrigating rice field, then the saline water killed paddy on the field. Therefore, farmers with land located near sluice gates decided to release the land for fallow in the first crop in the coming years (FGDs in 2016).

[18] Only two farmers in household surveys in Hoa Binh commune have testing equipment for water salinity. Each piece of equipment costs VND 100,000 (~ USD 5). Farmers did not buy this equipment and irregularly test salinity because saline water intrusion only occurred in 2014, 2015 and 2016 due to an unsafe sluice gate.

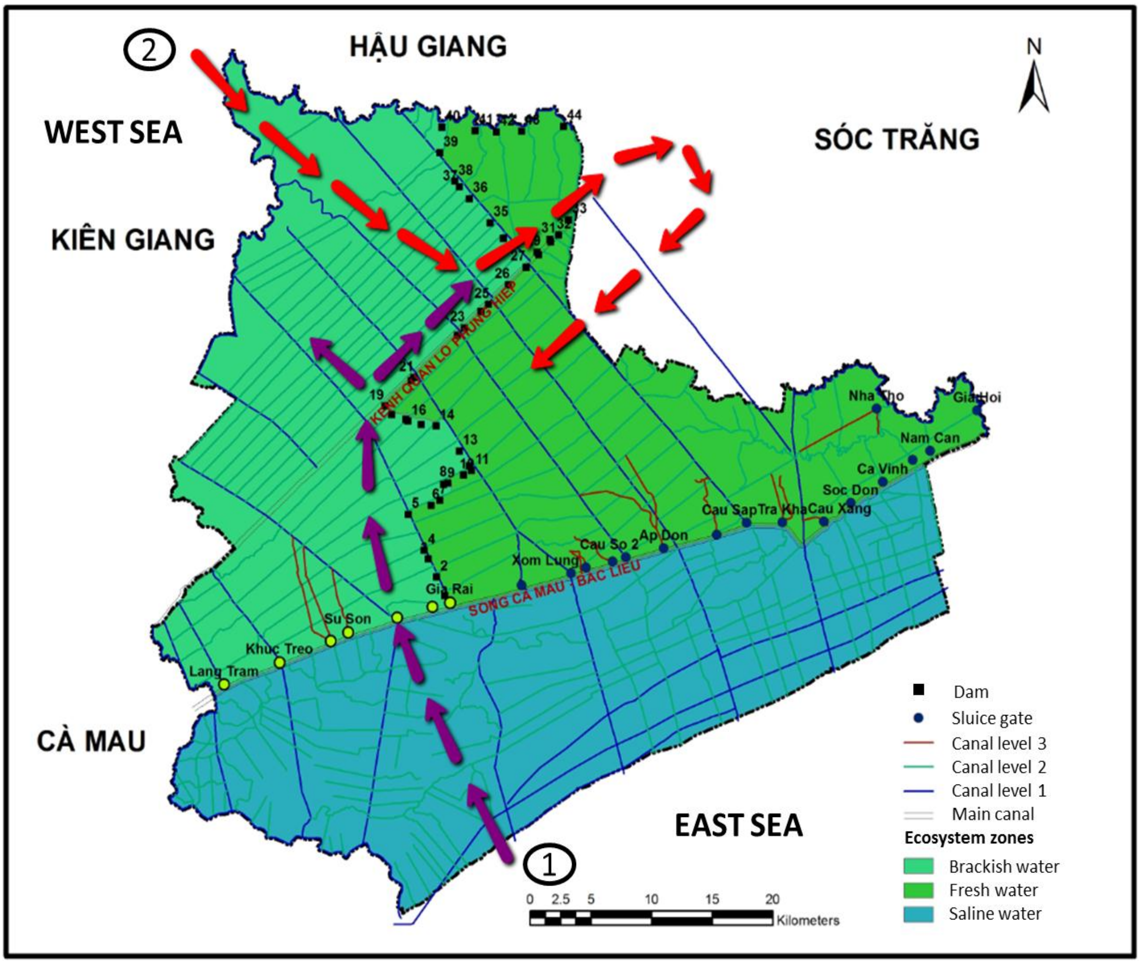

Figure 7.8: Showing two tracks of extracting saline water for raising shrimp in Bac Lieu: (1) extracting saline water from the East Sea (purple arrows) through the Ca Mau-Bac Lieu Canal, and (2) saline water intruding from West Sea (red arrows) through Kien Giang province.
Source: Adapted from CLUES project between 2011–2015

Secondly, saline water intrusion along with drought in the fresh-water zone appeared in 2016 because saline water reaching Soc Trang province from the West Sea of the VMD turned back into the fresh-water zone of Bac Lieu province (Figure 7.8), salinising the canals in the fresh-water zone of Bac Lieu. Many rice fields in Hoa Binh, which is far from Cai Tram sluice gate and from Soc Trang, had not been affected by saline water, but the commune and village authority encouraged farmers to store fresh water to cope with drought (FGDs in 2016). They constructed temporary dams to lock the heads of collective small canals to reserve fresh water, and then conducted collective pumping of water from large canals into these small canals for irrigating rice when farmers needed it. However, it was difficult to convince farmers to participate in this solution to overcome drought because many farmers argued that they had not seen saline water intrusion in their location yet. For example, one participant in the FGDs contended that,

> I did not see saline water in my location although television informed of saline water intrusion and drought in Bac Lieu. I also saw an amount of fresh water in canals around our area, so why did we have to construct temporary dams to store fresh water. At that time, I saw local authorities and other farmers pumping a lot of fresh water into collective canals to preserve it, and then I extracted this water for irrigating without pumping by machine because the water level in collective canals was higher than water level on my rice field.
>
> (A participant responding in FGDs with general farmers in 2016)

The argument from this participant in FGDs implied that farmers' perceptions of drought and saline water intrusion was of a very small area and in the short term. This is a challenge for collective decisions for irrigating collectively in terms of farmers' perceptions of climate variability. Moreover, it seems that their perception and behaviour is more focused on their own individual situation than on collective action from the authority and community because the water was pumped into collective canals to be preserved. If rice fields of farmers did not need water, then they did not irrigate. Water storage was only consumed when it was necessary for the rice field. Moreover, the commune authority advised farmers of the need to save water to deal with drought. Consequently, the head of Lang Giai village argued with these farmers that,

> Last dry season, following the commune authority, our village encouraged farmers to have a meeting at my village office. At that time, not many people participated and I had to invite them many times. Commune authority provided pumping machine and supplied petrol to pump water from large canals into small collective canals. The commune authority also provided money to buy materials, namely timbers for constructing temporary dams to store fresh water. We intended to preserve water in case it was necessary for the rice field. However, it was difficult to convince farmers to participate.
>
> (Field interview Mr L. in September 2016)

Via the story of Mr L., the community, including the commune authority and farmers, played a significant role in collective decision-making for adaptation to drought and saline water intrusion in rice farming in Hoa Binh. Nonetheless, some farmers in this area did not see the need or have the desire to work together. Therefore, collective action for coping with climate variability and climate change is likely to continue to be a challenge in the future.

The second rice crop in Hoa Binh (May-August). The start of the rainy season influenced the beginning of the second rice crop. The second rice crop in Hoa Binh was not constrained by drought if farmers waited until the beginning of the rainy season to begin the crop (see the seasonal calendars in Figure 7.7). It might influence the timing of the third rice crop, and the time of the first rice crop of the year later, and then farmers might be unable to finish the first rice crop before the driest months (March and April). Additionally, the three rice crops area in Hoa Binh was located in the fresh zone of Bac Lieu and as a result rice production depended on sluice gate control from the irrigation company of the DARD in Bac Lieu. If rains were very heavy, but the sluice gate was opened late, then the water level on the canal was elevated higher than the rice field. Next, inundation conditions on the rice field caused combine harvesters to work slowly on the rice field, and then the grain got wet, which reduced prices for the rice due to soil grain (i.e., dirty grain). Mr S. a member of the FC of Hoa Binh, contended that,

> I had more than three hectares of rice field. Too much rains in this year (2016) influenced the quality of my grains including soil and wet, and then the trader asked me to reduce one tonne of grain by 30% instead of reducing price of rice, but I did not agree because I saw that only about 5% of my grain was wet and dirty, and then I decided to carry this grain to my home to dry in the yard of my house and sell it later.
>
> (Responding during the FGDs with members of the FC held in 2016)

The account of Mr S. shows that abnormally heavy rains at the wrong time of the season indirectly reduced market prices for farmers. In the section on farmers' decision-making, we will determine how farmers decide on strategies for rice farming activities to cope with heavy rains.

The third rice crop in Hoa Binh (September–December). According to the participants of FGDs conducted in 2016, farmers continued to be constrained at the beginning of the third rice crop because of the rainy season (Figure 7.7). In particular, three or four weeks after sowing rice varieties, if the nursery of rice plants was not growing well in all areas of the field, farmers had to patch some areas with new plants. Additionally, farmers regularly reserve nursery plants for patching areas where plants have died. After this time, generally farmers did not have any extreme constraints on their rice cultivation because the third rice crop was harvested at the end of December when it was cooler.

Raising shrimp in Phuoc Long (February–August). High salinity is one of the threats that farmers in Phuoc Long considered when they decided on raising shrimp (see the seasonal calendars Figure 7.9). The combination of high salinity and other constraints, including shrimp seed, inadequate saline water, and poor water conditions, damaged shrimp.

Crops and weather	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rice-shrimp		Shrimp							Rice/shrimp/fresh water prawn			
Dry season (hot)	*	**	***	***	***	**						
High salinity		***	***	***	**							
Abnormal rains						**	***	***	***	***	**	

Figure 7.9: Seasonal calendar of shrimp-rice and relevant elements of weather to rice-shrimp farming in Phuoc Long
Source: FGDs in 2016
Note: * less frequent, ** frequent, *** very frequent

Inadequate saline water and an increase in salinity in 2015 and 2016 challenged farmers in Phuoc Long. For example, several villages in Phuoc Long commune are located far from Quang Lo Phung Hiep canal and smaller canals. Additionally, the sharp increase in salinity in 2015 and 2016 damaged shrimp, with salinity increasing from 25 grams/litre to approximately 33 grams/litre if saline water was pumped on the shrimp field from canals due to large water areas of shrimp fields being affected by sunshine.

Poor water conditions on canals were also a serious constraint for farmers. Farmers (members of the AC and general farmers) were able to receive waste water from canals into their shrimp fields because other farmers drained waste water from their shrimp ponds out into communal canals without informing the community. Farmers raising shrimp had to adapt to this challenge by increasing the density of shrimps per unit (ha) to gain higher productivity than raising a small density of shrimp. However, farmers did not know that each time they lost damaged shrimps, and then drained waste water out of canals, other farmers might inadvertently pump this waste water into their shrimp fields. Until 2016 the commune authority did not have any rules to manage water conditions in the shrimp community.

Rice crop in Phuoc Long (September–January). Drought and high salinity in 2015 and 2016 caused damage not only to shrimp but also to rice crops in Phuoc Long (see the seasonal calendar in Figure 7.9). To maintain their livelihoods, farmers decided to continue raising saline shrimp at similar quantities to the main saline shrimp season (February to August) during the rice season from August to January. However, they lost shrimp in 2015 because shrimp was very slow in growing, or even did not grow. Although they there were raising shrimp at the same time as cultivating rice, farmers did not find the precise cause of this problem; there was a wide range of possible causes including seed sources, poor water conditions, and diseases.

In short, climate variability, including changes in patterns and times of temperature, drought, salinity, and abnormal rains increased environmental risks in the two farming systems in the two communes. Farmers in the two communes considered on factors in relation to climate variability to respond to these threats. This study will identify farmers' decision-making for farming activities to cope with these threats in section 7.5.3.

Access to local markets

In Hoa Binh, members of the FC and general farmers regularly confront market downturns for selling rice in the first rice crop due to higher supply than demand. The majority of traders who bought rice in Hoa Binh came from outside Bac Lieu (FGDs in 2016). They preferred to buy rice in the short term to save trade costs and save time. Accordingly, they bought rice via brokers from farmers who did not have contracts for farming with companies, as in the case of general farmers in An Giang and Can Tho.

In the second rice crop of 2016, as discussed earlier, farmers had to cope with reduced prices for rice because rains reduced the quality of the rice. In this case, brokers and traders asked farmers to reduce the quantity of rice instead of reducing the price of rice. Generally, farmers in Hoa Binh had to deal with heavy rains and low market prices due to low quality.

In Phuoc Long, farmers were constrained in accessing reliable seed for shrimp, which relates to input supply rather than output. Actually, shrimp seeds were sold widely at the commune and district markets. However, farmers found it difficult to select reliable shrimp seed stations to buy good quality shrimp seed. Most farmers raising shrimp do not regularly test shrimp seed due to high testing costs, so they usually purchase shrimp seed from seed stations or companies that they feel they can trust, rather than directly checking for themselves the quality of seed. Owing to this factor, farmers were exposed to high risks when raising shrimp in this model (FGDs in 2016).

Livelihood capitals

Livelihood capitals include human, social, physical, natural, and financial capital (Scoones 1998). Formal social capital is used to measure relationships between members of the FC and the AC above; thus the study only selected categories that might be considered advantageous and disadvantageous for farmers’ decision-making in the following discussion.

Human capital

Human capital in this study includes age, gender and education level of respondents, and household size (Table 7.6). The mean age (59 years) of members of the FC in Hoa Binh was slightly higher than that of general farmers (57 years). Some heads of household were more than 70 years old. Secondly, the majority of respondents in Hoa Binh were men (members of the FC 100% and general farmers 96%); they provided key labour and decided most of the farming activities in their family. Thirdly, members of the FC had a low formal education level (primary school 38%, and high school 9%). General farmers had a high education level, particularly secondary school (to year 9) (48%) and high school (to year 12) (22%). Finally, the mean household size of a household in Hoa Binh was five persons, three of whom were the main labour force of a family.

The mean age (51 years) of respondents who were members of the AC in Phuoc Long was lower than that of general farmers (58 years; Table 7.6). Additionally, 100% of the AC members and 91% of general farmers who responded were male. Moreover, the education level of the respondents in Phuoc Long was also low, with 50% of general farmers completing primary school, 37% completing secondary school and 9% reaching high school. Finally, an average family for members of the AC in Phuoc Long had three main labourers, while an average general farmer family had four main labourers.

Table 7.6: Age, gender and education of head of household and labourers of households of members of members of farmer club (FC), agricultural cooperative (AC) and general farmers in Hoa Binh and Phuoc Long, Bac Lieu province

Indicator	Hoa Binh		Phuoc Long	
	Members of FC[1] (n=21 HHs[3])	General farmers (n=27 HHs)	Members of AC[2] (n=11 HHs)	General farmers (n=32 HHs)
Age of head of household (mean ± sd)	59 (±11)	57 (±15)	51 (±16)	58 (±12)
Gender (%)	100	100	100	100
Male	100	96	100	91
Female	0	4	0	9
Education (%)	100	100	100	100
Primary school	38	26	18	50
Secondary school	48	48	55	38
High school	9	22	27	9
College	0	0	0	3
University	5	4	0	0
Total members/hh (mean ± sd)	5.0 (±2)	5.0 (±2)	5.0 (±1)	5.0 (±2)
Total labour (mean ± sd)	3.0 (±2)	3.0 (±2)	3.0 (±1)	4.0 (±2)

Source: Household surveys in 2015
Notes: 1. FC is farmer club
2. AC is agricultural cooperative
3. HHs is number of households

Generally, farmers in Hoa Binh and Phuoc Long had an education level between primary school and secondary school. They typically depended on experience, local knowledge, and technical knowledge from training for their decision-making about selecting farming activities. However, this is also one of the constraints for farmers' informal collective decision-making because they do not have experience in relation to the work of setting up institutions for collective decision-making and cooperation.

Natural capital

Land properties of farmers. The mean total land area (2.26 ha) of a household of the FC in Hoa Binh was larger than that of general farmers (1.52 ha) (Table 7.7). The standard deviation is high for some values because of large land areas of some farmers compared to other farmers in Hoa Binh. Agricultural land area dominated the majority of household land area, with 96% (2.2 ha) for members of the FC, and 97% (1.48 ha) for general farmers. Agricultural and aquacultural land of a household in Phuoc Long dominated the majority 84% (2.24 ha) and 84% (2.38 ha) of household land area for members of the AC and general farmers respectively. Each household in Phuoc Long had a small percentage of non-working land, 15% (0.39 ha) for members of the AC and 10% (0.28 ha) for general farmers.

Table 7.7: Summary of different types of land area (mean ± sd) for each household of members of farmer clubs (FCs), members of agricultural cooperative (AC), and general farmers in Hoa Binh and Phuoc Long, Bac Lieu province

Land type	**Hoa Binh**				**Phuoc Long**			
	Members of FC[1] (n=21 HHs[3])		**General farmers (n=27 HHs)**		**Members of AC[2] (n=11 HHs)**		**General farmers (n=32 HHs)**	
	ha[4]	**%**	**ha**	**%**	**ha**	**%**	**ha**	**%**
1.Homestead	0.02 (±0.01)	1	0.02 (±0.01)	1	0.02 (±0.04)	1	0.02 (±0.02)	1
2.Agriculture	2.20 (±1.19)	96	1.48 (±1.46)	97	2.24 (±1.31)	84	2.38 (±1.22)	84
3.Leased	0	0	0	0	0	0	0.16 (±0.92)	5
4.No work	0.06 (±0.08)	3	0.04 (±0.05)	2	0.39 (±0.42)	15	0.28 (±0.23)	10
Total	**2.26 (±1.20)**	**100**	**1.52 (±1.48)**	**100**	**2.63 (±1.65)**	**100**	**2.83 (±1.68)**	**100**

Source: Household surveys in 2015

Note: 1. FC is farmer club

2. AC is agricultural cooperative

3. HHs is number of households

4. ha is hectare

In Hoa Binh, the mean rice farming area of households of members of the FC (1.96 ha) was larger than for general farmers (1.43 ha) (Table 7.8). Rice farming areas accounted for 89% of agricultural land for members and 97% of that for general farmers. In Phuoc Long, where rice and shrmp are cultured in the same area, the ratio of dyke area to pond (and rice field) area was highly variable; for members of the AC the average was 15% (0.34 ha) for ponds and 16% (0.35 ha) for dykes.

Table 7.8: Summary of different types of agricultural land area (mean ± sd) for each household of members of farmer club (FC), members of agricultural cooperative (AC), and general farmers in Hoa Binh and Phuoc Long, Bac Lieu province

Types of agricultural land	Hoa Binh				Phuoc Long			
	Members of FC[1] (n=21 HHs[3])		General farmers (n=27 HHs)		Members of AC[2] (n=11 HHs)		General farmers (n=32 HHs)	
	ha[4]	%	ha	%	ha	%	ha	%
1. Rice or shrimp-rice	1.96 (±1.33)	89	1.43 (±1.40)	97	1.54 (±1.33)	68	1.59 (±0.91)	68
2. Orchard	0.11 (±0.22)	5	0.05 (±0.11)	3	0.02 (±0.05)	1	0.08 (±0.13)	3
3. Pond	0	0	0	0	0.34 (±0.38)	15	0.43 (±0.44)	18
4. Dyke	0	0	0	0	0.35 (±0.39)	16	0.27 (±0.22)	11
5. Other	0.13	6	0	0	0	0	0	0
Total	**2.20 (±1.19)**	**100**	**1.48 (±1.46)**	**100**	**2.24 (±1.31)**	**100**	**2.38 (±1.22)**	**100**

Source: Household surveys in 2015
Data from Table 7.9
Note: 1. FC is farmer club
2. AC is agricultural cooperative
3. HHs is number of households
4. Ha is hectare

Water sources in Hoa Binh and Phuoc Long. As discussed earlier in the climate variability section, water was the most significant factor for rice cultivation by farmers in Hoa Binh and Phuoc Long communes. Section 7.5.3 (i.e., farmers' decision-making for farming activities of three rice crops and rice-shrimp system) will discuss in more detail how farmers access water for irrigating three rice crops in Hoa Binh, and for use in rice-shrimp systems.

Physical capital

In Hoa Binh, most of the farmers in the FC and general farmers had pumping machines and sprayers, with 90% of members of the FC and 70% of general farmers having pumping machines (Table 7.9). The number of households owning hand tractors and rice combined harvesters was much lower, with 24% of members of the FC and 26% of general farmers having hand tractors. The main reason for this low rate of ownership is the relatively high cost of this kind of equipment.

Farmers in Phuoc Long had tools for cultivating rice and tools for raising shrimp. For example, 56% of general farmers had nets for catching shrimp. Paddle boats were significant means of transportation to assist farmers to move around the rice-shrimp fields, with 53% of general farmers owning paddle boats (Table 7.9). Finally, televisions and telephones were communication pathways used not only for accessing weather information, especially salinity, but also for updating technical knowledge as well as market information. Accordingly, 82% of members of the AC and 97% of general farmers had televisions.

Table 7.9: Farming machines, fishing, and transport machines of members of farmer club (FC), members of agricultural cooperative and general farmers Hoa Binh and Phuoc Long, Bac Lieu province

Machine and tool	Hoa Binh				Phuoc Long			
	Members of FC[1] (n=21)		General farmers (n=27)		Members of AC[2] (n=11)		General farmers (n=32)	
	HHs[3]	%	HHs	%	HHs	%	HHs	%
1. Farming machine								
1.1 Tractor	0	0	1	4	0	0	0	0
1.2 Hand tractor	5	24	7	26	0	0	1	3
1.3 Rice combined harvester	1	5	0	0	0	0	0	0
1.4 Pump machine	19	90	19	70	11	100	32	100
1.5 Sprayer for pesticide and herbicide	17	81	23	85	9	82	25	78
2. Fishing								
2.1 Nets	1	5	5	19	5	45	18	56
2.2 Hook line	1	5	1	4	0	0	0	0
2.3 Other	0	0	0	0	2	18	6	19
3. Transport machine								
3.1 Paddle boat	0	0	9	33	5	45	17	53
3.2 Big boat/motorboat	7	33	7	26	7	64	12	38
3.3 Bicycle	10	48	14	52	6	55	13	41
3.4 Motorbike	21	100	25	93	10	91	32	100
3.5 Other	1	5	2	7	0	0	0	0
4. Communication machine								
4.1 Television	20	95	27	100	9	82	31	97
4.2 Radio	6	29	6	22	2	18	9	28
4.3 Mobile phone	18	86	25	93	9	82	32	100
5. Water store								
5.1 Tank	7	33	7	26	5	45	11	34
5.2 Tape water	13	62	10	37	0	0	4	13

Source: Household surveys in 2015

Note: 1. FC is farmer club

2. AC is agricultural cooperative

3. HHs is number of households

Financial capital

Financial capital of farmers in Hoa Binh as well as Phuoc Long included two main sources, namely savings (i.e., income derived by selling their crops) and credit. In Hoa Binh, 33% of members of the FC and 56% of general farmers had savings (Table 7.10). In terms of credit arrangement, 22% of members of the FC and 44 % of general farmers accessed credit from several local banks, including the agricultural bank, the policy bank and commercial banks. In Phuoc Long, 36% of members of the AC and 37% of general farmers in Phuoc Long used a savings for their financial capital. General farmers in Phuoc Long also obtained loans from banks, but in only 28% of households.

Table 7.10: Saving and debt of the households of members of farmer club (FC), members of agricultural cooperative (AC), and general farmers in Hoa Binh and Phuoc Long, Bac Lieu province

Financial source	**Hoa Binh**				**Phuoc Long**			
	Members of FC[1] (n=21)		**General farmers (n=27)**		**Members of AC[2] (n=11)**		**General farmers (n=32)**	
	HHs[3]	**%**	**HHs**	**%**	**HHs**	**%**	**HHs**	**%**
1. Saving	9	33	15	56	4	36	12	37
2. Credits	6	22	12	44	3	27	9	28
2.1 Local agriculture bank	3	11	3	11	3	27	8	25
2.2 Policy bank	3	11	5	19	0	0	1	3
2.3 Commercial banks	0	0	4	15	0	0	0	0

Source: Household surveys in 2015

Note: 1. FC is farmer club

2. AC is agricultural cooperative

3. HHs is number of households

Compared to Phuoc Long where farmers cultivated rice-shrimp systems, Hoa Binh was considered a more favourable commune because three rice crops per year could be cultivated, owing to the use of sluice gates to control saline water intrusion. Although the two communes are located in different ecosystem zones, in fresh water and in a brackish water zone, farmers in both communes were impacted by threats from climate variability. For example, rice farmers in Hoa Binh coped with drought and saline water intrusion, whereas farmers in Phuoc Long had to cope with high salinity when raising shrimp, and less rain when cultivating rice.

Commonly, members of the FC in Hoa Binh and the AC in Phuoc Long, and general farmers in the two communes, had a wide range of basic resources in livelihood capital, except for access to water resources. They had few challenges in accessing agricultural input supplies or agricultural services. However, farmers' perception of different factors in relation to increasing climate variability, access to markets, and accessibility to resources of livelihood capital might influence decision-making for rice farming activities. Therefore, the next section of the study continues with determining and discussing how farmers decide on implementing farming activities.

7.5.3 Farmers' decision-making for farming activities of three rice crops and rice-shrimp systems (Research question 3)

Previous studies relating to farmers' decision-making considered different processes of decision-making. Ha (2013) examined the process of livelihood decision-making during market downturns and periods of environmental risk, while others have examined elements influencing farmers' decision-making when adopting a farming system (Bosma et al. 2012) or deciding on land use (Trung et al. 2017). In contrast to these studies, this section will focus on farmers' decision-making in relation to farming operations and activities. Decision-making was divided into two major forms, collective and individual (Table 7.11). Collective decision-making in rice farming activities of farmers was a common informal approach. Farmers who had land in the same field asked each other to undertake management activities at similar times. Collective decision-making, as discussed in this chapter consisted of setting up seasonal calendars, selecting rice varieties, and selling rice (Table 7.11). In contrast, individual decision-making comprises most other rice-farming activities such as preparing land, irrigating, sowing seed, applying fertilisers, spraying pesticides, and accessing finances (Table 7.11).

Table 7.11: Summary of decision-making of members of the farmer club and general farmers for each rice crop in Hoa Binh

Farming activities	**Members[1] of Farmer Club**		**General farmers[2]**	
	Crop 1	**Crop 2 and 3**	**Crop 1**	**Crop 2 and 3**
Collective decision-making for farming activities (informal forms of decisions)				
Setting a seasonal calendar for rice farming	Members and general farmers	Members and general farmers	Members and general farmers	Members and general farmers
Selecting rice varieties	Members and general farmers (Described data in Table 7.12)	Members and general farmers (Described data in Table 7.12)	Members and general farmers (Described data in Table 7.12)	Members and general farmers (Described data in Table 7.12)
Accessing combine harvesters	Members and general farmers, and brokers	Members and general farmers, and brokers	Members and general farmers, and brokers	Members and general farmers, and brokers
Training farming techniques	Members	Members	NA[3]	NA
Accessing farming labour for harvesting and porter	Brokers	Brokers	Brokers	Brokers
Selling rice to traders	Members, general farmers and brokers (via traders)	Members, general farmers and brokers (via traders)	Members, general farmers and brokers (via traders)	Members, general farmers and brokers (via traders)
Individual decision-making for farming activities				
Preparing land	Members	Members	General farmers	General farmers
Accessing rice varieties	Members	Members	General farmers	General farmers
Access source of rice varieties	Members (Described data in	Member (Described data in	General farmers	General farmers

	Table 7.13)	Table 7.13)	(Described data in Table 7.13)	(Described data in Table 7.13)
Method of sowing seed	Members *(hand)*	Members *(hand)*	General farmers *(hand)*	General farmers *(hand)*
Irrigation activity	Members	Members	General farmers	General farmers
Accessing financial capital (access credit, saving, buying materials paid for at the end of crop) for investing in rice production	Members	Members	General farmers	General farmers
Accessing farming materials (fertiliser, pesticide, petrol, etc.)	Members	Members	General farmers	General farmers
Applying fertiliser and pesticide	Members	Members	General farmers	General farmers
Accessing farming labour for sowing seed and spraying pesticide	Members	Members	General farmers	General farmers

Source: Focus group discussion in 2016
Note: 1. Member is members of farmer club
2. General farmers is non-members of farmer club
3. NA is not available

Collective decision-making of members of the farmer club and general farmers for farming activities of each rice crop of members in Hoa Binh

Setting a seasonal calendar and selecting rice varieties in Hoa Binh (Table 7.11). Members of the FC and general farmers had informal collective decision-making for setting up a seasonal calendar and selecting rice varieties including timing the beginning and finishing of rice crops, or rice varieties for the same rice field for various reasons (Table 7.11). Firstly, the same seasonal calendar and rice variety facilitate the control of pests and diseases, especially rats. Secondly, the majority of traders buying farmers' rice in this commune were from outside Bac Lieu. They relied on several local brokers in Hoa Binh. Participants of FGDs contended that traders wanted to buy variety OM 4900 rice. Consequently, OM 4900 rice was used by 86% of members of the FC and 81% of general farmers for the first rice crop, and 67% of members of the FC and 59% of general farmers for the second rice crop (Table 7.12).

Table 7.12: Rice varieties used for each of three rice crops of members of farmer club (FC) and general farmers in Hoa Binh, Bac Lieu province

Rice variety	Members of FC[1]						General farmers					
	Crop 1st		Crop 2nd		Crop 3rd		Crop 1st		Crop 2nd		Crop 3rd	
	HHs[2]	%	HHs	%	HHs	%	HHs	%	HHs	%	HHs	%
1. OM 4900	18	86	14	67	17	81	22	81	16	59	1	4
2. OM 2517	2	10	1	5	0	0	1	4	1	4	1	4
3. Nang Hoa 9	0	0	0	0	0	0	0	0	1	4	18	67
4. OM 5451	1	5	6	29	4	19	3	11	8	30	1	4
5. OM 5472	0	0	0	0	0	0	0	0	1	4	6	22
6. RVT (National Seed)	0	0	0	0	0	0	0	0	0	0	0	0
Total	**21**	**100**	**21**	**100**	**21**	**100**	**27**	**100**	**27**	**100**	**27**	**100**

Source: household surveys in 2015

Note: 1. FC is farmer club

2. HHs is number of households

Selecting time for harvesting, combine harvesters for rice production, and accessing local brokers for selling rice in Hoa Binh (Table 7.11). Selecting the time for harvesting rice, accessing combine harvesters and local brokers (who were representatives for traders outside of the province) were decided informally through collective action by farmers (i.e., both members of the FC and general farmers) who had a land parcel in the same field, by brokers, and by owners of combine harvesters because traders coming from outside Bac Lieu were interested in trading in a large rice area in a short time to minimise time and transportation cost (Table 7.11). Local brokers were considered to be the most powerful actors in the decision-making owing to the small number of traders from outside Bac Lieu province.

Individual decision-making of members of the farmer club and general farmers for each rice crop in Hoa Binh

Similar to the case study in An Giang province, farmers individually decided on most rice farming activities in each rice crop, such as accessing land preparation services, irrigating, accessing funding, accessing and using fertiliser, pesticide and petrol, labour for sowing, patching nursery, and spraying pesticide (Table 7.11). The study only discusses decision-making for several important farming activities consisting of selecting rice variety, accessing irrigation, and using fertiliser because these farming activities directly relate to the outputs of rice cultivation.

Accessing rice varieties. After 2005, owing to a policy of rice variety development in An Giang and other provinces of the VMD, farmers were able to access certified rice varieties from a wide range of sources. Local agricultural material shops and seed production centres were two main sources in Hoa Binh where members of the FC and general farmers bought rice varieties for cultivating rice in first, second, and third rice crops (Table 7.13). For example, the percentage of members of the FC that bought rice varieties from local agricultural material shops for the first crop was 53% of respondents, for the second crop 52%, and for the third crop 43%. Generally, the majority of members in the FC in Hoa Binh and numerous general farmers had good technical knowledge of rice production; thus they decided on using high quality rice varieties from reliable sources.

Table 7.13: Sources of seed collected for each of three rice crops of members of farmer club (FC) and general farmers in Hoa Binh, Bac Lieu province

Source of rice varieties	**Members of FC[1]**						**General farmers**					
	Crop 1st		**Crop 2nd**		**Crop 3rd**		**Crop 1st**		**Crop 2nd**		**Crop 3rd**	
	HHs[2]	**%**	**HHs**	**%**	**HHs**	**%**	**HHs**	**%**	**HHs**	**%**	**HHs**	**%**
1. Agricultural material shops	11	53	11	52	9	43	21	78	19	70	20	74
2. Seed production centre	7	33	7	33	9	43	1	4	1	4	1	4
3. Neighbour	0	0	0	0	0	0	1	4	2	7	1	4
4. Family	3	14	3	14	3	14	4	15	3	11	3	11
5. Seeding station	0	0	0	0	0	0	0	0	2	7	2	7
Total	**21**	**100**	**21**	**100**	**21**	**100**	**27**	**100**	**27**	**100**	**27**	**100**

Source: Household surveys in 2015

Note: 1. FC is farmer club

2. HHs is number of households

Irrigation activity. Farmers of the FC and general farmers in Hoa Binh also decided on irrigation activities individually because they had pumping machines (Table 7.9). However, some farmers also had to pump water via a long plastic tube across other farmers' parcels of land (illustrated in Figure 7.10, irrigating land parcel 7 across land parcel 2 from the canal). Commonly, farmers did not have to pay any fee to cross other farmers' fields if they used a small plastic tube. The context of farmers who have to pump water via their neighbour to irrigate their rice field was similar to a case study in Tra Vinh (Miller 2003). However, in 2000, farmers in Tra Vinh had to cooperate with their neighbour to conduct consecutive pumping or via ditch *(mương)* along the land of their neighbour. This is an informal cooperative case between farmers having land parcels in the same rice field.

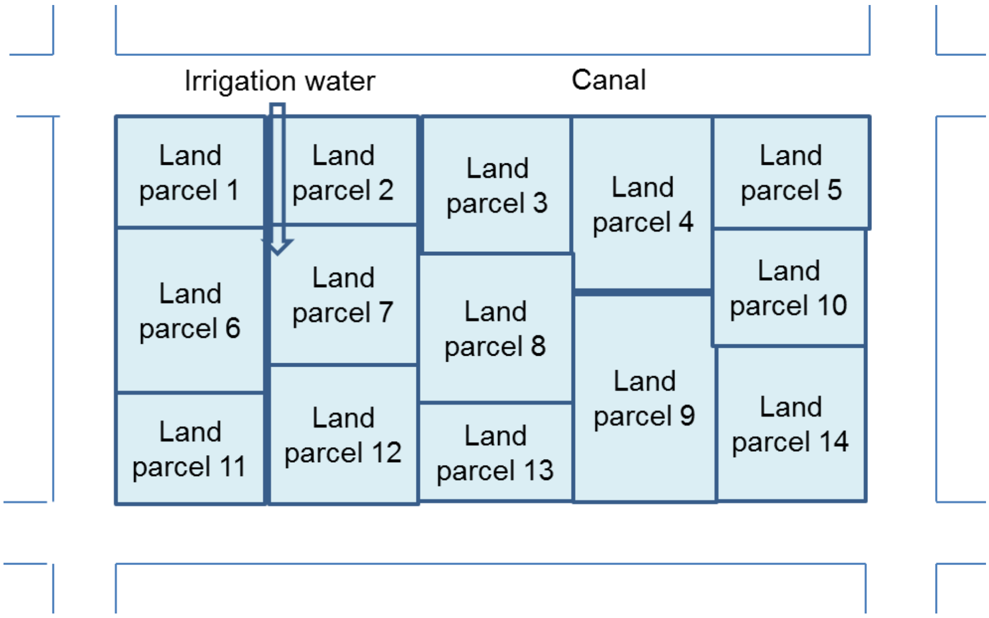

Figure 7.10: Description of water irrigation of households far from canals in Hoa Binh commune

Applying fertiliser for each rice crop. Members of the FC and general farmers made individual decisions about applying fertiliser for each rice crop. However, general farmers used a large amount of fertiliser in the first rice crop (~ 800 kg/ha) compared to the second or third rice crops (~ 500 kg/ha) (FGDs in 2016). Generally, farmers perceived that they were able to gain a high rice yield in the first rice crop despite coping with drought at the end of the crop. They contended that the temperature at the beginning of the first crop was a positive factor for paddy (see Figure 7.4), and they were only concerned about drought at the end of the crop in April.

Collective decision-making of members of the agricultural cooperative and general farmers for farming activities of raising shrimp in Phuoc Long

The AC in Phuoc Long was established in 2012, and they have had several collective tasks of raising shrimp including supplying inputs, supplying or introducing training courses to members, and sharing technical knowledge and information. The majority of activities were conducted informally at the house of the head of the AC. Besides, they set up a seasonal calendar by collective decision-making, but this is an informal approach because their farms have different conditions from one farmer to another (Table 7.14). Moreover, the timing of when seed of shrimp was bought was different from one member to another of the AC. Generally, they had not collectively decided on particular farming activities in raising shrimp on the farm such as irrigating, and starting and finishing at the same time which looked similar to rice cultivation in the fresh-water zone.

According to the head of the AC, farming shrimp was not easy because it was associated with farming techniques linking rice and shrimp activities. For instance, after finishing rice cultivation, farmers needed to prepare the field for raising shrimp more carefully to mitigate diseases damaging shrimp. Consequently, it was difficult to reach agreement among farmers regarding accurate timing for the beginning of raising shrimp. Table 7.14 describes farmers' individual decision-making about rice farming activities of rice-shrimp systems much more than farmers' collective decision-making. Findings of individual decision-making will be provided to give more insights into shrimp cultivation in the next section.

Table 7.14: Summary of decision-making of members and general farmers for each rice crop in Phuoc Long

Farming activities	**Members[1] of Agricultural Cooperative**		**General farmers[2]**	
	Shrimp	**Rice, saline shrimp, and fresh-water prawn**	**Shrimp**	**Rice, saline shrimp, and fresh-water prawn**
Collective decision-making for farming activities				
Training farming techniques	Members	Members	NA[3]	NA
Input supply	Members	Members	NA	NA
Individual decision-making for farming activities				
Preparing Land	Members	Members	General farmers	General farmers
Accessing rice varieties and shrimp seed	Members	Members	General farmers	General farmers
Selecting rice varieties	Members	Members (Described data in Table 7.15)	General farmers	General farmers (Described data in Table 7.15)
Method of sowing seed (rice varieties)	Members	Members (using hand)	General farmers	General farmers (using hand)
Irrigation and drain of water out of rice-shrimp fields	Members	Members	General farmers	General farmers
Accessing financial capital (access credit, saving, buy materials paid at the end of crop) for investing rice production	Members	Members	General farmers	General farmers
Accessing farming materials (fertiliser, pesticide, petrol, etc)	Members	Members	General farmers	General farmers
Applying fertiliser and pesticide	Members	Members	General farmers	General farmers
Accessing farming labour for sowing seed and sprayer pesticide	Members	Members	General farmers	General farmers
Accessing farming labour for harvesting and porter	Members	Members	General farmers	General farmers
Selling shrimp to local traders	Members		General farmers	
Accessing farming labour for harvesting and porter		Members		General farmers
Selling rice to traders		Members		General farmers
Accessing thresher machines		Members		General farmers

Source: Focus group discussion in 2016

Note: 1. Member is members of agricultural cooperative

2. General farmers is non-members of agricultural cooperative

3. NA is not available

Individual decision-making of members of the agricultural cooperative and general farmers for raising shrimp in Phuoc Long commune

Members of the AC in Phuoc Long decided individually on most farming activities of their shrimp farming, similarly to general farmers. Therefore, the study will discuss generally farming activities for both members of the AC and general farmers. Table 7.14 illustrates a wide range of shrimp farming activities.

Preparing field for raising shrimp (trenches and rice platform). Farmers cut down the rest of paddy body after harvesting rice, and then they use chemicals to quickly dissolve the paddy roots (Figure 7.11). Farmers also improved the trenches around the rice fields every three years.

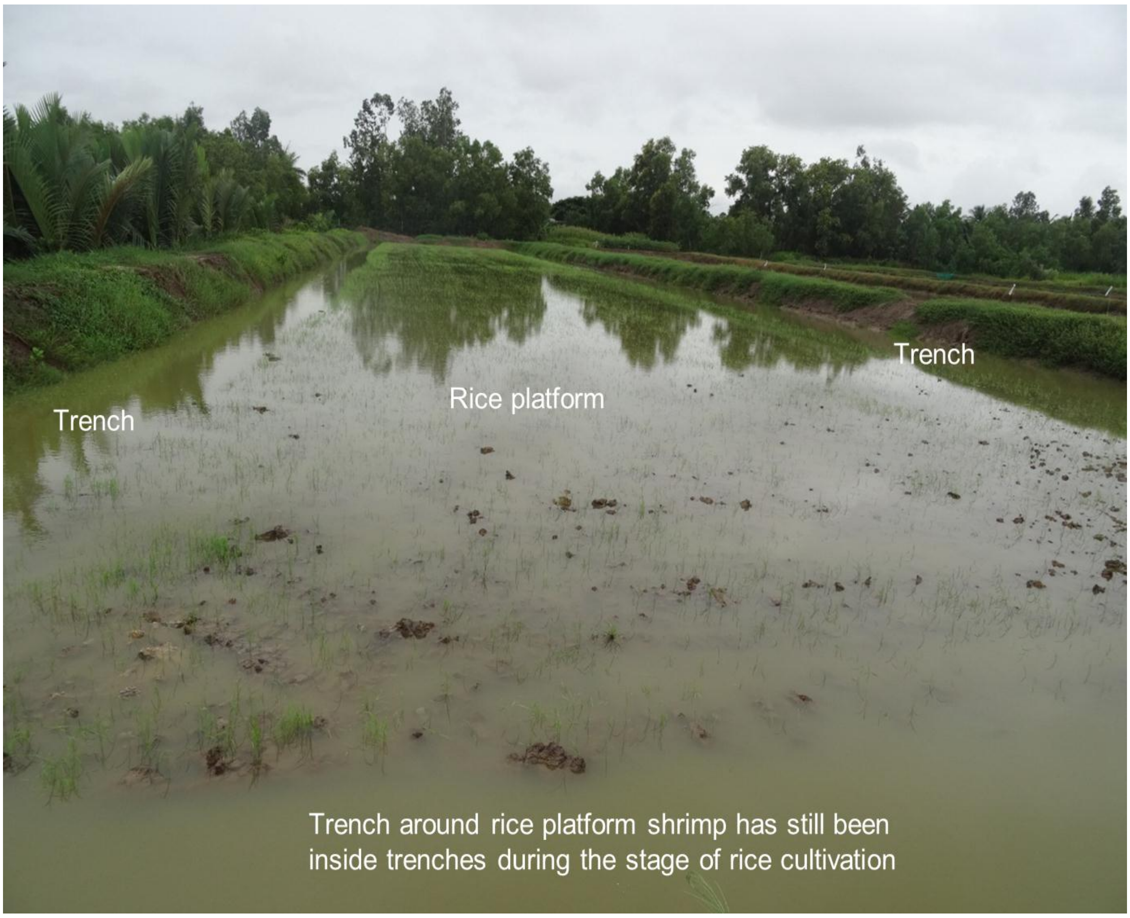

Figure 7.11: A rice and shrimp field in Phuoc Long commune
Source: Author (2016)
Note: Ponds (i.e., trench) are located around the edge of the rice field (i.e., rice platform) and are about 1 m deep.

Accessing and applying fertiliser and chemicals to make suitable water environment for shrimp (Table 7.14). Farmers did not naturally feed shrimp in the rice-shrimp model because the shrimp lived on disintegrated paddy roots, but they had to apply some fertilisers and chemicals to make the water environment suitable and to kill diseases in trenches and rice platforms so that shrimp could grow.

Accessing finance and shrimp seed (Table 7.14). Members of the AC and general farmers in Phuoc Long individually decided on accessing finance and shrimp seed, but members of AC were prioritised in buying input materials from the AC on credit payment before general farmers. However, both members of AC and general farmers had to buy shrimp seed in cash from shrimp seed stations, although there was a wide range of shrimp seed stations in the commune, because raising shrimp was riskier than rice.

Frequent harvesting of mature shrimp and frequent dropping shrimp seeds (Table 7.14). Raising shrimp in integrated shrimp-rice model, farmers applied the approach of, "frequent harvesting of mature shrimp and frequent dropping shrimp seeds" *(thả bù tỉa thưa)*. For example, at the beginning of raising shrimp (February), shrimp seeds were dropped into pond of shrimp, and then in April farmers drop new shrimp seed a second time. Finally, they drop new shrimp seed one more time in June. Farmers begin harvesting mature shrimp in May, then harvest twice a month, until the end of the shrimp farming season (FGDs 2016).

Selling shrimp to local traders (Table 7.14). The majority of members of the AC and general farmers regularly sell shrimps directly to local traders, and this was simply due to available local traders at the commune. Then, local traders sell to agencies of the sea food company in Bac Lieu city. However, farmers could not sell shrimp directly to the company because they applied the approach of "Frequent harvesting of mature shrimp and frequent dropping shrimp seeds", and then they harvested only a few kilograms each time.

Individual decision-making of members of the agricultural cooperative and general farmers for rice production in Phuoc Long

Rice was cultivated from September to January in Phuoc Long. Farmers raised a small number of shrimps and Giant fresh-water shrimp (i.e., fresh-water prawn) coinciding with paddy on rice fields to supplement their incomes. Figure 7.8 demonstrates the shrimp-rice pattern where rice, saline shrimp and Giant fresh-water shrimp were cultivated and raised at the same time. However, saline shrimp in the rainy season grows more slowly than in the dry season (i.e., the main season of saline shrimp) because salinity in the rice field is lower than 4 grams/litre. With such a pattern, members of the AC and general farmers individually decided on their farming activities.

Preparing land for rice farming (Table 7.14). After finishing the main shrimp farming, farmers drained the saline water out of canals so that all shrimps on the field moved down the ponds (trenches) around the rice fields. At that time, mature shrimps were harvested, while young shrimp that were small remained in the rice field until the end of the rice crop. Land preparation was implemented across several dates. For instance, the combination of different activities for land preparation included using rain water or fresh water from a canal (if there was fresh water in canals), drying and ploughing. After that, farmers continued to clean out saline water from the soil on the field until they thought the soil was completely cleaned of the saline water, or only a very small degree of salinity (2 grams/litre) remained in the soil. Farmers could then sow their rice. Until 2016, farmers in Phuoc Long depended on rain water for individual decisions for land preparation.

Selecting rice variety for rice cultivation in rice-shrimp farming in Phuoc Long. Members of the AC and general farmers in Phuoc Long had to decide upon using saline-resistant varieties (~ 4 grams/litre). In particular, 91% of general farmers and 55% of members of the AC selected rice variety Mot Bui Do for rice cultivation, while only 36% of members of the AC utilised rice variety FLAI (Table 7.15). Although the two rice varieties could resist salinity of 4 grams/litre, the majority of farmers in Phuoc Long decided on using Mot Bui Do (VND 10,000/kg = ~ USD 0.5/kg) because it was much cheaper than FLAI (VND 100,000/kg = ~ USD 4.5/kg).

Table 7.15: Rice varieties used for rice cultivation of rice-shrimp system of members of agricultural cooperative (AC) and general farmers in Phuoc Long, Bac Lieu province

Rice variety	Members of AC[1]		General farmers	
	HHs[2]	%	HHs	%
1. Mot Bui Do	6	55	29	91
2. FLAI	4	36	0	0
3. ST5	0	0	1	3
Total	**10**	**91**	**30**	**94**

Source: Household surveys in 2015
Notes: 1. AC is agricultural cooperative
2. HHs is number of households

Accessing rice variety. Members of the AC in Phuoc Long bought rice varieties from seeding station (27% of households) and the agricultural office of the district (27%), while 37% of general farmers bought rice varieties from seed companies, and 13% from seeding agencies (Table 7.16). According to the FGDs (2016), owing to policies encouraging the private sector to produce seed and trade, farmers had numerous choices to access to good rice varieties from sources in Phuoc Long commune.

Table 7.16: Sources of rice varieties collected for rice cultivation of rice-shrimp system of members of agricultural cooperative (AC) and general farmers in Phuoc Long, Bac Lieu province

Source of rice varieties	Member of the AC[1]		General farmers	
	HHs[2]	%	HHs	%
1. Agricultural material shops	1	9	12	37
2. Seed production centre	1	9	3	9
3. Neighbour	1	9	3	9
4. Family	2	18	5	16
5. Seeding station (produce)	3	27	1	3
6. Seeding agency (traders)	0	0	4	13
7. Agricultural office of district	3	27	2	6
Total	**11**	**100**	**30**	**93**

Source: Household surveys in 2015
Note: 1. AC is agricultural cooperative
2. HH is number of households

Accessing and applying fertilisers. Members of the AC had more advantages than general farmers in accessing fertilisers and pesticide. The AC regularly supplied fertiliser and pesticide to their members on credit until the end of rice farming, and at lower prices than other shops.

Irrigation and draining activity. In the brackish water zone farmers had to wait for fresh water from the Mekong River as well as rain water to use for rice farming. Fresh water from the Mekong River has become scarce since 2012, and farmers typically depended on rain water because saline water still existed in the canals around Phuoc Long commune in the first period of the rainy season (FGDs in 2016). Consequently, farmers only spent petrol on individually pumping water out of rice fields to rescue nursery when rains were too much, and water levels in the rice field, along with saline water outside internal canal were also too high at the same time (Figure 7.12).

Figure 7.12: Pumping water from rice-shrimp field out to public canals in the rainy season
Source: Author (2016)

Applying pesticide. Unlike the three consecutive rice crop model, rice-shrimp farmers in Phuoc Long had to minimise the use of pesticides on rice field due to raising shrimp at the same time as rice (FGDs in 2016). Moreover, rice was cultivated only one season a year, so diseases and insects could not persist and transfer to the next annual crop.

Accessing harvesting. Unlike cultivating two and three rice crops, most paddy field in rice-shrimp zone had to be harvested by hand (through manual labour) and threshed by thresher machines because the rice land of the rice-shrimp pattern is very soft due to raising shrimp at the same field, so combine harvesters could not move on the field. Before the arrival of the harvest season, local labourers contacted farmers to book a date for harvesting. The local labour had networks with labourers from other rural areas in the province (FGDs in 2016). Harvest activities were conducted mostly during advantageous times (i.e., the drying season).

Selling rice to traders. After harvesting grains, farmers stored grains in the yard of their house. It was unnecessary to sell to traders immediately as farmers in Hoa Binh commune did, because they also collected saline shrimp and fresh-water prawn at the same time. They could sell shrimp to pay the cost of rice production, which was a relatively small amount of money. They frequently sold rice to traders outside the province (FGDs in 2016).

In summary, farmers in the two communes depend on their perception and behaviour of farming activities, and factors relating to climate variability, access to local markets, and water conditions to make decisions. The study will continue presenting and discussing the output of farming systems as the effects of farmers' decision-making.

7.5.4 Effects of farmers' decision-making on output of three rice and rice-shrimp systems (Research question 4)

Yields and income generated from different activities in the three rice crops and the rice-shrimp system were used as a measure of how farmers' decision-making impact rice-based farming systems and farming activities. Intensification of rice production and diversification into shrimp production are both important pathways to improved household livelihoods and poverty reduction, but both may also generate more vulnerability to risk factors (Scoones 1998; DFID 1999).

Members of the FC and general farmers in Hoa Binh had to adapt to a range of threats including salinity, drought, abnormally heavy rains, and market price downturns in 2015 and 2016, but they were able to attain high yields and high income from each rice crop in 2014. For example, in 2014 the rice yield of the first crop of members of the FC obtained 7.7 tonnes/ha, the second crop was 6.8 tonnes/ha, and the third rice crop was 6.9 tonnes/ha (Table 7.17). Rice yields for each crop were similar for general farmers (Table 7.17). Although there was a small difference between the rice yield of members of the FC and general farmers, net income per hectare of rice in each crop of members of the FC was only slightly higher than general farmers. In particular, the first rice crop of members of the FC returned an average of VND 14.2 million/ha compared to VND 13.1 million/ha for general farmers because the cost of the first rice crop of members of the FC (VND 21.8 million/ha) was lower than that of general farmers (VND 24.2 million/ha). According to Mr L., a head of the FC, members of the FC usually apply technical knowledge associated with the "three reductions and three grains" method, reducing fertilisers and pesticides to minimise the cost of each rice crop. In contrast, general farmers use a large amount of fertiliser (800 kg/ha in the first rice crop), which increases in the cost of rice crop farming (FGDs with general farmers).

Table 7.17: Mean (± sd) rice yield, gross income, cost, and net income (VND million = ~ USD 45) for each of three rice crops by household and by hectare (ha) of members of farmer club (FC) and general farmers in Hoa Binh, Bac Lieu province

Indicator	**Members of FC[1] (n=21)**		**General farmers (n=27)**	
	HH[2]	**Ha[3]**	**HH**	**Ha**
First rice crop				
Yield 1 (tonnes)		7.7 (±0.9)		7.8 (±1.0)
Gross income 1	86.9 (±50.5)	36.1 (±4.7)	76.7 (±53.3)	37.3 (±4.7)
Cost 1	57.0 (±42.6)	21.8 (±4.0)	48.9 (±33.8)	24.2 (±4.5)
Net income 1	29.8 (±18.6)	14.2 (±6.7)	27.7 (±27.3)	13.1 (±7.6)
Second rice crop				
Yield 2 (tonnes)		6.8 (±0.6)		6.5 (±1.1)
Gross income 2	79.9 (±45.7)	33.8 (±4.2)	66.9 (±54.5)	30.9 (±6.6)
Cost 2	48.3 (±35.4)	18.8 (±2.9)	39.7 (±27.6)	20.5 (±5.7)
Net income 2	31.5 (±15.2)	14.9 (±5.7)	27.2 (±33.2)	10.3 (±10.2)
Third rice crop				
Yield (tonnes)		6.9 (±0.9)		6.7 (±0.8)
Gross income 3	80.0 (±47.3)	34.0 (±4.1)	67.2 (±49.3)	32.4 (±4.8)
Cost 3	49.1 (±36.8)	19.2 (±2.9)	41.2 (±29.7)	20.5 (±4.0)
Net income 3	30.8 (±14.1)	14.7 (±5.3)	25.9 (±23.6)	11.9 (±6.2)

Source: Household surveys in 2015

Note: 1. FC is farmer club

2. HH is household

3. Ha is hectare

For shrimp farming, members of the AC had slightly higher net income (VND 27.3 million/ha) than general farmers (VND 23.2 million/ha). The net income of some farmers was very high, meaning the standard deviation was high in some cases. It was hard to determine the reason for the difference between income of members and general farmers because there was a wide range of risks and uncertainties from raising shrimp such as water environment, increasing salinity, and low quality of shrimp seed (FGDs in 2016). However, it seems that members of the AC applied technical knowledge in the rice-shrimp pattern much more than general farmers because they gained technical knowledge from training courses organised by the commune authority. Their technical knowledge helped them reduce the risks in cultivating rice-shrimp systems.

Table 7.18: Mean (± sd) gross income, cost, and net income (VND million = ~ USD 45) for raising shrimp and for rice cultivation in rice-shrimp system by household and by hectare (ha) of members of agricultural cooperative (AC) and general farmers in Phuoc Long commune, Bac Lieu province

Indicators	Members of AC[1] (n=11)		General farmers (n=32)	
	HH[2]	Ha[3]	HH	Ha
Shrimp (Jan to Jul)				
Gross income	84.5 (±85.5)	40.5 (±19.7)	77.1 (±52.4)	35.7 (±18.1)
Cost	24.6 (±14.2)	13.2 (±6.4)	26.8 (±22.3)	12.5 (±6.8)
Net income	59.9 (±76.0)	27.3 (±17.1)	50.3 (±48.6)	23.2 (±20.8)
Rice crop (Aug to Dec)				
Yield (tonnes)		4.0 (±2.1)		3.0 (±1.4)
Gross income	31.0 (±54.7)	16.6 (±11.3)	19.4 (±27.6)	10.1 (±10.4)
Cost	14.9 (±15.1)	11.7 (±3.0)	14.5 (±11.8)	9.0 (±2.9)
Net income	16.1 (±40)	4.9 (±10.3)	4.8 (±19.9)	1.1 (±9.4)

Source: Household surveys in 2015
Note: 1. AC is agricultural cooperative
2. HH is household
3. Ha is hectare

Similar to shrimp, members of the AC also received a much higher net income from rice cultivation (VND 4.9 million/ha) compared to general farmers (VND 1.1 million/ha). According to the participants of FGDs with members of the AC, in recent years there was uncertainty with the timing of the rainy season that caused the death of rice because saline water remained inside the soil, but a wide number of farmers in the commune did not identify this threat. Moreover, rains were less in quantity and less regular than before, and then insufficient water led to the death of rice seedlings in the nursery. Finally, the location of land for most members of the AC was nearer to Quang Lo Phung Hiep canal than that of general farmers. Thus, members of the AC had an advantageous location to use fresh water from the Mekong River.

On-farm income provided 92% (VND 100.4 million) of household income for members of the FC and 78% (VND 84.6 million) for general farmers in Hoa Binh (Table 7.19). Non-farm income came from a diverse range of livelihood activities such as acting as local traders, doing construction work, salaries from local official positions, and miscellaneous remittances. The non-farm income for FC members contributed 7%

(VND 8.2 million) and for general farmers contributed 12% (VND 12.9 million) to household incomes.

Similarly, on-farm income dominated 84% (VND 82.2 million) of household income of members of the AC, and 78% (VND 65.7 million) of general farmers in Phuoc Long. Non-farm income was relatively high: for example it was 13% (VND 12.5 million) for members of the AC, and 19% (VND 16.1 million) for general farmers (Table 7.19).

Table 7.19: On-farm, off-farm, and non-farm income (mean ± sd) (VND million = ~ USD 45) of members of farmer club (FC), members of agricultural cooperative (AC), and general farmers in Hoa Binh and Phuoc Long, Bac Lieu province

Income source	Hoa Binh				Phuoc Long			
	Members of FC[1] (n=21 HHs[3])		General farmers (n=27 HHs)		Members of AC[2] (n=11 HHs)		General farmers (n=32 HHs)	
	Mean	%	Mean	%	Mean	%	Mean	%
1.On-farm	100.4 (±45.8)	92	84.6 (±84.0)	78	82.2 (±93.2)	84	65.7 (±59.7)	78
2.Off-farm	0.4 (±1.7)	1	11.1 (±44.7)	10	3.5 (±8.0)	4	2.4 (±9.4)	3
3.Non-farm	8.2 (±16.9)	7	12.9 (±28.4)	12	12.5 (±15.8)	13	16.1 (±32.3)	19
Total	**109.0 (±45.2)**	**100**	**108.6 (±91.7)**	**100**	**98.2 (±97.7)**	**100**	**84.2 (±74.0)**	**100**

Source: Household surveys in 2015
Notes: 1. FC is farmer club
2. AC is agricultural cooperative
3. HHs is number of households

7.6 Conclusion

In conclusion, the case study reviewed main findings to respond to the overall research question about what farmers in Bac Lieu have to consider when they make decisions about rice-based farming systems in Bac Lieu.

In terms of research question one, there are several major decisions that farmers have to make about their rice-based farming systems each year. In Hoa Binh, farmers decided on cultivating three consecutive rice crops each year, while farmers in Phuoc Long decided on a rice-shrimp system. In Hoa Binh, based on the safety first principle, access to markets, saline water control by government, and drought were the three main factors influencing farmers' decision-making about rice-based farming systems. In contrast, in Phuoc Long farmers considered saline water control and annual distribution of rains to decide on a particular rice-shrimp system.

Regarding research question two, various factors influenced farmers' decision-making for rice-based farming systems. There were a range of factors influencing farmers' decision-making for farming activities of each rice crop in Hoa Binh. Members of the FC and general farmers relied on social capital of the FC, saline water control, and access to local markets for making collective and individual decisions. Particularly, the study identified that access to local markets was a constraint both for members of the FC and general farmers in the three rice crops because they relied on powerful local brokers. In Phuoc Long, factors relating to farmers' decision-making about raising shrimp include salinity, reliable seed sources, and poor water condition, whereas annual distribution of rains is the most important factor in deciding whether to cultivate rice or shrimp, and other crops. Of all these factors, saline water control by the provincial government is still the most important factor for farmers' decision-marking about farming activities when raising shrimp.

In terms of research question three, farmers made collective and individual decisions for their rice-based farming systems. Farmers in Hoa Binh and Phuoc Long made individual decisions for most rice farming activities of the three rice crops or shrimp-rice patterns, except for selecting rice varieties, setting up seasonal calendars, and accessing combine harvesters for harvesting activities in Hoa Binh commune. Similar to the case studies in An Giang and Can Tho, it seems that farmers in Bac Lieu also preferred to make individual decisions rather than collective decisions.

The finding that when shifting from two to three rice crops per year, general farmers in Hoa Binh used a large amount of fertiliser in the first crop to offset soil degradation, is similar to a prediction of McElwee (2017). But farmers also have the view that with favourable climatic conditions, the yield from the first crop can be maximised by large applications of fertiliser, even though cultivating three consecutive crops per year is a major factor leading to soil degradation.

In a general comparison between Hoa Binh and Phuoc Long, Hoa Binh is a favourable commune with completely controlled saline water so that farmers can cultivate three rice crops each year. In contrast, farmers in Phuoc Long relied on saline water for raising shrimp and fresh water from rains and from the Mekong River for cultivating rice. Farmers in Hoa Binh were more secure than those in Phuoc Long. That is because although they had constraints with drought in the first rice crop and abnormal rains, they still gained rice from the second and third rice crops. In contrast, farmers in Phuoc Long had to cope with uncertainties and threats in raising shrimp.

In terms of research question four, the consequences of the major decision-making influence the output of rice-based farming systems and household livelihoods. Although farmers in Hoa Binh and Phuoc Long coped with constraints, they have also individually adapted to maintain the output from the three rice crops and rice-shrimp system respectively. The output of rice farming of members of the FC in Hoa Binh was higher than for general farmers. Similarly, members of the AC of Phuoc Long had more effective outputs of the rice-shrimp system than general farmers.

Chapter 8

General discussion of the three case studies

8.1 Introduction

In all three case studies, in An Giang, Can Tho and Bac Lieu, intensification from two to three consecutive rice crops each year has increased rice productivity and farm income significantly. There have been few studies identifying the factors influencing the change from two to three rice crops. It seems that rice farmers in the main rice producing areas of the VMD have encounted a range of threats associated with changing and unpredictable weather patterns and other events linked to climate change (ICEM 2009). In addition, farmers have had problems accessing local markets in recent years (Nhan et al. 2013). Both these issues are supported by observations from the farmers during the present study. Similarly, in the coastal area of the VMD, farmers had to confront environmental risks and market downturns with shrimp (Ha 2012). There have been a few studies investigating the influence of climate change (or climate variability) and markets on rice-based farming systems, and livelihood resilience of farmers in the VMD (Ha 2012; Nhan et al. 2013; Hoa 2014; Tuan 2015; Binh 2015). However, there have been very few studies exploring decisions that farmers make in relation to rice-based farming systems across a range of provinces in the VMD, and how they make those decisions.

According to Bruijn and Van Dijk (2005, p. 5), “decision-making units may range from an individual to much larger units such as villages, regions, states and even international organisations”. There are a few studies that discuss farmers’ individual decision-making for different farming systems or land use (Bosma et al. 2012; Ha 2012; Trung et al. 2017). For example, Bosma et al. (2012), and Trung et al. (2017) determined factors influencing multiple farming systems in the VMD, and in other regions of Vietnam and Thailand. Similarly, a framework for analysing decision-making was applied by Alexander and Larson (2016) to identify which factors influence smallholders’ decisions about rice and other crops to support their livelihoods in the southern Lao PDR. However, very few studies encompassed farmers’ collective decision-making about rice-based farming systems in the VMD. Therefore, this thesis discusses farmers’ collective and individual decisions for rice-based farming systems in the VMD across multiple case studies of An Giang, Can Tho and Bac Lieu.

The decisions that farmers have to make about their farming systems include: (1) what farmers decide about the main rice-based farming systems, (2) which factors influence farming activities, and how they influence them, (3) how farmers make collective and individual decisions for farming activities in a particular farming system within a crop season, and (4) the consequences of decision-making on the outputs of farming systems. Across the three provincial case studies, it is possible to identify similarities and differences between farmers' decision-making about rice-based farming systems and farming activities across multiple case studies at commune levels in the three provinces.

This chapter will discuss the similarities and differences in farmers' decision-making about the main rice-based farming systems across multiple case studies in the three provinces. Secondly, the chapter identifies and discusses how different factors influence farmers' decision-making for farming activities for each farming system. Thirdly, the study determined similarities and differences in how farmers in multiple case studies make collective and individual decisions for farming activities. Finally, the chapter provides a range of comparisons in relation to outputs of farming systems in different study sites as the consequences of decision-making about rice-based farming systems.

8.2 Agricultural policies and farmer organisations

8.2.1 Evolution of farmer groups

Production group

Under the collective economy of Vietnam from 1976 to 1986, there were two models of production groups *(tập đoàn sản xuất)* in the multiple case studies in An Giang, Can Tho and Bac Lieu. The first model operated quite similarly to the institutional arrangement of the old model of agricultural cooperatives *(Hợp tác xã: ACs)* in the north of Vietnam (Kerkvilet 2005). In Vinh Trach commune of An Giang province and Phuoc Long commune of Bac Lieu province, farmers compulsorily gave away their land to form large collective farms. Farmers in the same large farm had to work collectively, and they received work points. After harvesting, they received rice according to the number of work points they received from their collective work in the same field with other farmers. In contrast to the first model, the institutional arrangement of the second model group allowed farmers to own their land. Except for inputs and outputs which were controlled by a management board of production groups, farmers (i.e., members of farmer groups) worked individually on their own land that was distributed under the land policy from 1976 to 1986. For example, farmers received rice varieties, fertilisers and pesticide from the management board of production groups, and they decided individually on how to use them on their own land. After harvesting they owned the output after paying taxes to the management boards of the production groups. The finding of this thesis shows that the first model of production was not common in the VMD because the local authorities only conducted such models as a pilot project before expanding to a large scale. The first model of production group had been unsuccessful in Vinh Trach commune, An Giang (Chapter 5) and Phuoc Long commune in Bac Lieu (Chapter 7). The second model of production group was implemented in the majority of communes in the study region between 1976 and 1986, and was currently operational in all communes involved in the case studies described in this thesis.

This history of the production group model has negatively influenced current farmer organisations at local levels such as agricultural cooperatives (ACs), farmer clubs (FCs), and large-sized farms (LSFs) because farmers had negative perceptions of collective land policies and working collectively according to working point systems during the period 1976–1986 (FGDs in multiple farmer groups in 2016). Additionally, as observed by Cox and Viet (2014), the institutional arrangements of the production groups also affected farmers' distrust. Accordingly, although the production groups finished three decades ago, as at 2016, participants involved in this thesis were not interested in being involved in different forms of farmer organisations currently being promoted.

8.2.2 Clarifying the degree of individual autonomy of farmers' decision-making about rice-based farming systems

There is a wide spread of international research interest in relation to the degree of agency that people in Vietnam have in the conduct of their daily activities. Do people follow detailed government instructions or do they have a significant degree of freedom to decide for themselves what they will do? This thesis provides a detailed case study of the degree of agency exercised by farmers in the VMD.

In relation to the degree of individual autonomy for, farmers' decision-making, I clarify two periods in relation to economy policy for easy understanding of the historical context in Vietnam (1976–1986 and post 1986). From 1976 to 1986, as presented in the case studies in Chapters 5, 6 and 7 with the policy of production groups, it was compulsory for farmers in the VMD to be in a production group model. In this period, there was no private sector such as agricultural material shops (i.e., input supply) or rice traders (i.e., output supply) in local communes. Every type of input was supplied by production groups. All members in a production group had to sell their product to local governmental food companies via acceptance by production groups that they belonged to. Generally, production groups controlled the input and output of farmers (described in three case studies).

Since 1986, under the economic liberalisation policy, farmers have had rights to own their resources such as land and equipment, and they could access input supplies from local markets (Lecoq & Trebuil 2005). They were able to make individual decisions for farming activities as previously discussed in Chapters 5, 6, and 7. However, it is difficult to clarify the degree of individual autonomy that a farmer has, because farmers regularly have to follow the law of the Vietnamese government. For example, farmers have five rights in relation to land use rights including the rights to sell, to buy, to exchange, to mortgage, and to inherit (Tuyen 2010). In addition, local governments could not make them compulsorily engage in cooperative work, or participate in projects they were not interested in, for example, in order to construct dykes to secure rice in the third rice crop in the flooding area, as shown for An Giang province. In 2009, the local government in Ta Danh commune had a meeting with all farmers who had land parcels in the same field. If they were not interested, then they could decline to be involved in constructing dykes to cultivate three rice crops. Local government had to campaign to convince some farmers, who did not agree, to agree to conducting three consecutive rice crops. The local government supported the money for dyke construction (mentioned in Chapter 5). Therefore, in 2011, all farmers in this large farm (300 ha) agreed to conduct dyke construction for cultivating three rice crops.

Farmers have had rights to make individual decisions since 1986; thus, every time local governments implemented new policies, programmes, or projects, they could not force farmers to adopt the new policies, programmes, and projects immediately in a large or all the area of a village or commune. They have to start at a small scale, and consider whether farmers agree to participate or not. This is quite similar to the diffusion of innovations in a pilot location in a community before extending it to a larger scale (Minh et al. 2010; Tin et al. 2011). For example, in Ta Danh, in 2011, there was a large field (300 ha) for three rice crops, then in 2016 they added 400 ha to make a total of 700 ha. For the first farm (300 ha), local government had to encourage farmers through a subsidy for dyke construction. However, after 2011, other farmers agreed to pay the full costs of construction by themselves because they perceived that they could gain benefits from a third crop in Ta Danh. According to these farmers, market prices in the third crop are usually higher than for other crops. Market prices are one of the factors encouraging farmers to agree to cultivate a third rice crop. Generally, if we discuss the individual autonomy of farmers, we have to specify situations on a case-by-case basis and in different places and times.

8.3 Farmers' decision-making for the main rice-based farming systems

8.3.1 The rice intensification and rice-shrimp patterns (Research question 1)

Farmers in the three provinces decided on cultivating three consecutive rice crops more than five years ago. The study found that there was a wide range of factors influencing the way farmers make decisions for the three rice crops. Firstly, members of farmer organisations and general farmers in all case studies maintained the behaviour of storing rice for household consumption requirements after finishing each rice crop, although they produced rice in relation to economic considerations. Secondly, similar to Bosma et al. (2012), market prices are one of the most important factors affecting farmers' decision-making about cultivating rice or other crops such as upland crops. Except for farmers in Phuoc Long commune, the majority of members of farmer organisations and general farmers in the three provinces contended that rice is easier to sell than other crops in their communes (Chapters 5, 6, and 7).

There were two different factors influencing farmers' decision-making for three rice crops in An Giang and Can Tho. In An Giang, dyke construction is the key factor impacting farmers' decisions about cultivating two or three rice crops, because of high flood levels. In contrast, farmers' collective decision-making is the crucial factor affecting farmers' choice for cultivating three rice crops in Can Tho because flooding in Can Tho is smaller than in An Giang. However, floods in Can Tho often damaged rice in the third rice crop. In addition, farmers in Can Tho would allow floods to enter fallow fields to accumulate alluvium (natural fertiliser from flood water) (see Chapters 5 and 6). Generally, depending on the geographical conditions of each province, farmers under varying degrees of influence of local authorities made different choices about their rice-based farming systems.

In Bac Lieu, members of the FC and general farmers in Hoa Binh mainly depended on sluice gate controlling saline water and delivered fresh water from the Mekong River to make decisions about three rice crops, especially the first rice crop. In the first rice crop, farmers who had land located near the old sluice gate were able to cope with saline water intrusion from this sluice gate (Chapter 7). In addition, drought may damage rice at the end of the first rice crop when there is a shortage of water supplied from the Mekong River. Members of the FC and general farmers in Hoa Binh typically decided on three rice crops or two rice crops depending on their ability to control saline and cope with drought, instead of to cope with flooding. In another study presented by McElwee (2017) it was reported that more than 70% of respondents thought that they will not do certain things if floods occur in Bac Lieu in the future. Since there were no floods in their areas, they did not believe there would be floods in the future. In addition, the study in the coastal zone of the VMD presented by Smajgl et al. (2015) found that 65% of households would not change their present livelihood activities and would not migrate out of their present village even if their production was hypothetically reduced by 50% or more for five years or perhaps longer. However, rice farmers in Hoa Binh have released land for fallow instead of planting the first rice crop when their rice fields were impacted by saline water intrusion in the last few years. In contrast, rice-shrimp farmers continued with raising shrimp as a main crop in the rice season (September – January) under a rice-shrimp system because there was less rain in 2015 (Chapter 7).

In Phuoc Long, Bac Lieu, members of the AC and general farmers used water conditions to decide on rice-shrimp patterns for rice-based farming systems. In particular, they decided on raising shrimp from February to August due to saline water. In contrast, the rainy season between September and January prompted farmers to make decisions on cultivating rice crops (Chapter 7). Participants responded that they did not have any problems with market prices of shrimp because they were able to access reasonable prices in 2014. Farmers in Phuoc Long, however, decided to cultivate each rice crop each year because of household consumption considerations and making a good water environment for raising shrimp in the dry season (Chapter 7). However, in Phuoc Long, due to less rains and being unable to access fresh water in internal canals in 2015, farmers who had land located far from Phung Hiep canal (the main canal that delivers fresh water from the Mekong River), decided on raising shrimp in the rice season (from September to January).

Members of farmer organisations and general farmers (non-members) in the three provinces in the VMD had particular perceptions and behaviour when dealing with threats such as flooding, access to local markets, draining water, and saline water control. They perceived and used resources based on their context to implement their farming systems. Similarly, the study presented by Ha (2012) found that shrimp farmers in Bac Lieu and Ca Mau province, the two coastal provinces in the VMD, decided on how long and what day they should open or close the sluice gates to change water based on their experiences with seeing the difference between the water colour in their ponds and in the canals. Generally, the findings of perceptions of fishers and shrimp farmers about decisions in the study presented by Ha (2012) and rice and shrimp farmers' perceptions and behaviour in the case studies of this thesis are similar to the studies presented by Bruijn and Van Dijk (2005). Bruijn and Van Dijk (2005) found local people adapted to threats in relation to climate variability in central and south Mali by understanding and using the physical and social environment.

8.3.2 Factors influencing farmers' decision-making for farming activities (Research question 2)

A range of factors influence farmers' decision-making about livelihoods, land uses, and particular farming systems in Vietnam and other countries including Laos, Indonesia, and Thailand (Ha 2012; Bosma 2012; Alexander & Larson 2016; Grünbühel & Williams 2016; Trung et al. 2017). These studies were mentioned and reviewed in chapters one and two.

For example, according to Alexander and Larson (2006), in southern Lao PDR, a range of factors affected farmers' decision-making when they considered rice, crops and livestock including lack of funds, disease, lack of water for irrigation, knowledge, lack of labour, weather conditions, flooding, droughts, low prices, market access, and seed varieties. In addition, they have regularly alternated rice with other crops, namely rattan shoots, cassava, maize and sweet corn, among others. Many farmers could sell products to companies at the farm gates. They also received support from companies such as machines to slice cassava for drying. However, a lack of experience in planting crops caused indebtedness, and then farmers returned to rice cultivation (Alexander & Larson 2016).

There were a few studies on farmers' decision-making or factors influencing farmers' decisions in relation to livelihoods, land use, and farming systems, and a few studies on collective decision-making outside Vietnam and in Vietnam. However, these studies focused on individual decisions rather than collective decisions. Social capital is considered a significant factor to assist members in farmer organisations to reach agreement in collective decision-making and to build a strong organisational resilience, which will be explored for the VMD.

Social capital influencing farmer organisations and farmers' collective decision-making

The discussion in this section will focus on similarities and differences in social capital between members in farmer organisations. Social capital plays an important role in resilience of the three forms of farmer organisation including ACs, FCs, and LSFs. These organisations play important roles on farmers' collective decisions for collective farming activities in rice-based farming systems. Before discussing the influence of social capital on these farmer organisations, this chapter discusses the institutions and main activities of the farmer organisations in the three provinces.

Agricultural cooperatives in Thoi Tan in Can Tho, and Phuoc Long in Bac Lieu

Through reviewing ACs in Vietnam, laws related to cooperatives were issued in 1993 and updated in 2003 (SOCENCOOP 2012). Under these laws, ACs worked as a share company, but with the important provision that all members of an AC have the same right to elect, and be elected as members of the management board of the AC. However, in practice, members of the management board of the AC in Thoi Tan, Can Tho have always worked in communes or for village authorities because the ACs in the research sites of this study were closely tied to local authorities, and they received support from the centres of DARD including the Agricultural Extension Centre (AEC), Crop Protection Centre (CPC), and Rural Development Centre (RDC) (Chapter 6). As a result, they relied on support from government much more than if working independently (Chapter 6). According to Borda-Rodriguez and Vicari (2014), ACs need to be independent of the support of external organisations to withstand a wide range of constraints, namely funding to support activities of collective skills and internal credit. However, the ACs in the case studies of Borda-Rodrigues and Vicari (2014) were able to be large scale because one of the ACs could sell their product to global markets, while the AC in Can Tho operated on a small scale, and still relied on support from the DARD not only for collective skills but also for equipment for producing seed.

Farmer Clubs in Vinh Trach and Ta Danh, An Giang, and Hoa Binh, Bac Lieu

There were very few references to farmer clubs (FCs) in the VMD, so this discussion highlights the findings from the case studies. FCs were in Vinh Trach and Ta Danh commune of An Giang province and Hoa Binh commune of Bac Lieu (Chapters 5 and 7). The functions of FCs include conducting pilots of innovation, and disseminating and sharing technical knowledge on cultivating rice for members. In other words, the operation typically focuses on activities in relation to collective skills. The study implied that FCs were aid organisations under the control of a local authority to promote farmers participating in activities of local authorities. The study identified that the majority of members were also core advanced farmers assisting agricultural organisations including AEC, CPC, or Science Institutions to examine and expand innovations collectively and individually to other farmers in rice communities. As in many other farmer organisations, the majority of members of FCs formed a seed producer group so that they could receive support from the AEC of the DARD, namely dryer machines and international projects via Can Tho University.

Large-sized farm model in Truong Xuan A, Can Tho Province

The LSFs examined in this study all involved collaboration between different actors including farmers, local authorities, scientists and rice companies. Local authorities played an important role in connecting farmers participating in LSFs with rice companies to sustain market prices. Additionally, members of the LSFs benefitted in collective skills from the support of the DARD via training in applying the "three reductions and three grains" method to cope with climate variability in rice production.

Generally, ACs, FCs, and LSFs were supported and promoted by local authorities following policies of the provincial governments. The provincial government provided broad support through funding and technical knowledge transfer via different centres of the DARD and international aid organisations. However, local areas had a range of approaches that supported working together informally. For example in Vinh Trach commune and Hoa Binh commune, based on their trust in each other they had several collective activities to deal with constraints including rats, disadvantaged locations of fields and output market prices (Chapters 5 and 7).

There were a number of important findings relating to social capital in all three provinces. Social cohesion was considered stronger by respondents than social trust and social commitment. This is because statements for measuring social cohesion were constructed from collective skills that were regular collective activities of FCs, ACs, and LSFs. In addition, farmers worked together in seed production or on normal rice crops (i.e., rice for consumption) because they had a common aim (i.e., planting the same crops), as in the case study of Mali (Borda-Rodriguez & Vicari 2014). Strong social capital helped farmers in the Delta reach rapid agreement, or build consensus in collective decision-making in a farmer organisation (Tuan 2014). Chan et al. (2006) clarified that social cohesion is a status of works that is an interaction among members of society. The degree of social cohesion depends on the repeated interactions among people in a group. Moorman et al. (1993) noted that trust is viewed as a belief, a confidence, and an expectation about exchange trustworthiness of partners in a social group. Morgan and Hunt (1994) explained that social commitment is where someone makes the maximum effort for maintaining relationships by committing their partners or members to an organisation. However, the collective action that required high trust and commitment was a constraint if outside negative factors influenced decision-making about the collective activities of members in an organisation. Accordingly, social capital between members was non-functional or low in degree in terms of social commitment and trust.

A good example for how trust and commitment varied between members and heads of farmer organisations was the case study of the LSFs in Truong Xuan A in Can Tho province (Chapter 6). Some members of the LSFs were disadvantaged in the first rice crop due to harvesting a large farm area at the same time and with uncertain water elevation (Chapter 6). Consequently, many members of the LSFs asserted that they were not interested in being involved in the LSFs. This illustrated low social commitment and trust between members and the head of the LSFs leads to unfairness and lack of transparency when the head of the LSFs coordinated the harvesting farming activity to harvest and collect rice for the members of LSFs. This is also a case where the action of one individual negatively affected other people around him, and when actions cause positive or negative side-effects for other people (Coleman 1990). Accordingly, members of the LSFs disrupted the farmers' collective decision-making for contract farming in the first rice crop of the subsequent year. For example, more than 50% of farmers in the LSFs made collective decisions for signing contract farming with other rice companies in the first rice crop 2016–2017 (fieldwork in June 2017). Songsak and Aree (2008) also argued that trust-building between different actors in relation to the success of contract farming is very important for farmers' decision-making with new contract farming. The result of case study in Can Tho also confirmed the prediction from the study by Howie (2011). When the pumping club was upgraded to LSFs and ACs, there were disputes between members instead of a cohesive approach to help members to access good markets to sell agricultural products.

ACs, FCs, and LSFs in the research sites of An Giang, Can Tho, and Bac Lieu were dependent on the support of policies and external organisations in terms of finance and collective skills. Moreover, members participating in these organisations did so because they had not had many opportunities to access technical knowledge in the last ten years. However, in recent years, they have had more chances to access technical knowledge from different pathways (Chapters 5, 6, and 7). ACs and LSFs were the two significant organisations so they could sell their product collectively for higher prices than they would have received by selling individually to traders. Farmers were involved in the two forms of farmer organisations for selling their products with higher prices than selling that from individuals to traders.

The seed producer group in Vinh Trach, An Giang is a good example of maintaining social capital between members in a farmer organisation. This group made collective decisions about contracts for seed production with seed companies and other consumers. The majority of members in this group were neighbours and relatives, which is a form of informal social capital (Thuy et al. 2011; Tuan et al. 2014). This informal social capital allowed them to reach agreement quickly for collective decision-making. That is because they had trust in and commitment to collective action (Tuan, 2014). Although the leader of the farmer organisation withdrew from his position in the FC, he had been a leader of a seed production group, but this was a smaller scale than the FC. Similar to Trung et al. (2017), social membership plays a significant role with rice farmers when making decisions for producing and selling seed to rice companies via a leader of seed producer group. Therefore, it seems that there is a range of small farmer groups with strong social capital inside FCs, and they can still influence farmers' decision-making for various farming activities.

Climate variability and other hazards

Studies on climate change, climate variability and hazards relevant to climate have been undertaken in different countries such as in the Nile Basin of Ethiopia (Deressa et al. 2011), and in Southwest Nigeria (Apata 2011), as well as in Vietnam (Adger 1999; McElwee 2010, Binh 2014; Hoa 2013; 2014). Approximately one half (51%) of farmers perceived that temperature in the Nile Basin of Ethiopia had increased, and slightly more than 53% of farmers felt that rainfall had decreased compared to the past 20 years (Deressa et al. 2011). In Vietnam, people experienced a range of threats in relation to climate variability and other hazards including storms, typhoons, flooding, and drought across multiple regions from the north to the south (McElwee 2010). In the VMD, the change of flood regime has been affected by climate, intervention from infrastructure projects (i.e., hydroelectric power dams) upstream in the Mekong River, and by embankments inside of the VMD (Tuan 2014).

This thesis has contributed more detailed findings as to how climate variability threats and other hazards influence farmers' decision-making. In particular, cool weather is typically a positive factor influencing the first rice crop in Can Tho, An Giang and Bac Lieu provinces. However, farmers in each province had different constraints from factors relating to flood or drought in first rice crop. For example, in Can Tho, flooding is a key factor encouraging farmers' collective decision-making for cooperatively adjusting seasonal calendars to cultivate three consecutive rice crops. Adjusting the seasonal planting calendar was also one of the adaptive strategies to climate variability or other hazards such as rising salinity in the coastal area of the VMD (Hoa et al. 2014; Binh 2015). However, these studies did not determine whether seasonal calendars were adjusted collectively or individually. The Can Tho case study here showed that members of the LSFs and general farmers made collective decisions for beginning sooner than previous years, and for the collective draining of water out of fallowed, large-sized farms. They made collective decisions for these activities so that they were able to finish the third rice crop of the year later before high flood levels arrived (Chapter 6). In addition, in Truong Xuan A, Can Tho, the uncertainty of water elevation in the canals and river, along with cool weather for the first rice crop in 2015–2016, caused a large area of rice field to mature in a short period, which led to conflict for harvesting rice between members and the leader of LSFs (Chapter 6). This problem indirectly influenced members' decision-making for the next round of contract farming. In Hoa Binh, Bac Lieu, members of the FC and general farmers had a threat of drought because the seasonal calendar for the first rice crop in Hoa Binh was the end of April, the driest month in Bac Lieu as well as the VMD. Also, farmers with land located near an unsafe sluice gate have been sensitive to saline water intrusion. Typically, the climate issue, flooding, drought, and saline water intrusion influenced farmers' decision-making for cultivating the first rice crop.

In the case of Hoa Binh, Bac Lieu province, although there was a range of previous studies from independent scientists, governmental organisations and international organisations on predictions of serious climate hazards such as flooding, sea level rise, high salinity, and rainfall variation (McElwee 2010; MONRE 2009; ADB 2013), the perceptions of some farmers of climate threats in relation to saline water intrusion in Hoa Binh were simple. They were not very concerned about climate threats in relation to sea level rise, saline intrusion, and flood (Chapter 7). Smajgl et al. (2015) also found that 65% of households in the coastal zone of the VMD would not change their present livelihood activities and would not migrate out of their present village even if their production was hypothetically reduced by 50% or more for five years or more. However, Rickards and Howden (2012) showed that a spatial relocation might help adaptors to reduce their exposure to impacts by identifying a new area where they are able to continue their original activities or occupation. In contrast, farmers' decisions in the case of Hoa Binh might be based on worldviews because they were asked about issues that would happen in the future, instead of current situation. It seems that some farmers were more concerned for themselves than collectively for their neighbours and community when they dealt with saline water intrusion (Chapter 7). Therefore, there is still a gap in perceptions between some local farmers and scientists, the Vietnamese government, and international organisations. Farmers' perceptions of climate change and factors influencing adaption choices depended on a wide range of factors including their age, wealth, knowledge of climate change, and education (Deressa et al. 2010). Out of these factors, education plays a significant role in farmers' perception and adaptation choices (Deressa et al. 2010; Apata 2011). Of interest was that the education of farmers in Hoa Binh, Bac Lieu was mostly to primary school and high school level (Chapter 7), and the average age was 57 for both members of the FC and general farmers.

In An Giang, the second rice crop in which year was constrained by drought for the first two months and then abnormal heavy rains at the end of the rice cropping season. In contrast, farmers in Bac Lieu were threatened by the abnormal heavy rains in 2014 and 2015 because according to the seasonal calendar such rice crops were cultivated in Bac Lieu in the rainy season. Annually, the quality of rice in the second season in Hoa Binh, Bac Lieu, and the two communes in An Giang was not as good as the first and third rice crops. Then, rice prices were generally low because of poor quality (e.g., wet and dirty) (Chapters 5 and 7). Therefore, members of the FCs and general farmers in An Giang and Bac Lieu had to decide on different farming strategies such as applying water saving methods to cope with drought, and using kali (i.e., Kali Clorua, potassium, choride fertiliser) to make the stems of rice plants strong to cope with abnormal rains (Chapters 5 and 7). In addition, members of the FC in Vinh Trach and Ta Danh collectively decided to drain water out of rice fields. This activity was conducted by the AC in Vinh Trach and by the head of the FC in Ta Danh.

The third rice crop in Can Tho was constrained by abnormal heavy rains in 2014 and 2015 (Chapter 6). Similar to An Giang and Bac Lieu, the quality of rice in this season was lower than the first and second rice crops. However, if farmers obtained rice with good quality, then they would sell at high prices. In 2014 and 2015, the market prices of rice in the third rice crop were higher than for the first two crops because less rice was produced from the third crop and so supply was limited. Many local areas in the VMD, such as Ta Danh commune, An Giang, did not cultivate a third rice crop in 2014 and 2015. The low market prices for the third rice crop were a consequence of abnormal heavy rains which reduced the quality of rice because it was wet and dirty. Farmers in Can Tho decided on using different rice varieties to mitigate this constraint from abnormal rains (Chapter 6).

The rice-shrimp system in Phuoc Long, a commune of Bac Lieu, was more challenging for farmers than the farming systems in other case studies examined in this thesis. There was an increase in salinity in 2015 and 2016 (>25 grams/litre) because of extreme heat affecting the shrimp (Chapter 7). Additionally, poor quality of shrimp seed and poor water condition in the public internal canals were two negative factors damaging shrimp production of farmers in Phuoc Long commune. Some farmers in Phuoc Long, with land located far from Quan Lo Phung Hiep canal, were constrained because waste saline water was always present in internal canals. Water levels in these canals were lower than in the main canal (i.e., Quan Lo Phung Hiep) so had not exchanged with the main canal because it was far from the main canal. Additionally, saline water in these canals has been impacted by saline water from Kien Giang province (a neighbouring coastal province) bordering the West Sea of the VMD. If saline water in these canals recedes and flows down back to the ocean via Quan Lo Phung Hiep canal, then saline water from the Kien Giang side is able to move into this area. Accordingly, farmers in Phuoc Long were also concerned by the quality of this saline water source because farmers in Kien Giang province also cultivated shrimp-rice. Saline water in Kien Giang might contain diseases for shrimp in Phuoc Long.

In Phuoc Long, extreme heat and drought are two other factors affecting rice cultivation. Although farmers regularly grew rice in the rainy season, less rain in 2015 meant the rice nursery died after two or three weeks on account of existing saline water in the soil (Chapter 7). Therefore, farmers with land located far from the main canal were constrained not only for shrimp culture but also for rice cultivation. They had to decide on raising shrimp in the rice season (August–January) in 2015. However, the findings of this thesis are similar to the study presented by Can et al. (2010); after the provincial government constructed sluice gates for controlling saline water, farmers in the brackish water zone in Bac Lieu regularly faced problems accessing suitable saline water for raising shrimp and fresh water for cultivating rice.

Besides adverse climatic conditions such as changing temperature, drought, and heavy rains, the study also found that rats, insects and diseases were other factors influencing farmers' decision-making (FGDs in 2016). For example, rats are very common in each rice crop due to cultivating three consecutive rice crops. Rats can live from one cropping season to another, as found in An Giang (Brown & Phung 2011). However, farmers usually decide to use pesticide to cope with diseases, insects and other pests rather than alternative methods such as IPM (integrated pest management) or "the 3 reductions and the 3 gains" method (i.e., reducing seed, reducing fertiliser, and reducing pesticide and gaining an increase in yield, in quality, and in profit), even though they have gained technical knowledge government training programmes, and from agricultural extension programmes on television (Huan et al. 2008). According to

Huan et al. (2008), farmers used less seed, fertiliser and pesticides for rice cultivation after a 3 reduction and 3 gains campaign than before the campaign, partly through altered decision-making. However, farmers in the three provinces argued that they had already used some technical knowledge in relation to the three reductions and three gains method such as reducing seed, but dealing with diseases, insects and other pests had become more complicated because of changing weather conditions forcing farmers to decide to use pesticides.

Generally, climate variability, drought, saline intrusion, abnormal rains, and flooding influenced each rice cropping season and rice-shrimp farming systems in different research sites of the three provinces including Vinh Trach and Ta Danh in An Giang, Thoi Tan and Truong Xuan A in Can Tho, and Hoa Binh and Phuoc Long in Bac Lieu. Farmers in research sites also made different decisions to adapt to and cope with these threats.

Access to local markets

According to Loc and Son (2011), more than 90% of rice produced in the VMD was sold to traders (through brokers) at the farm gate. Normally, only members of farmer organisations (ACs, LSFs, and FCs) or informal farmer groups sold directly to rice companies via contract farming. Therefore, general farmers (i.e., non-members of farmer organisations) easily fell into trouble when market downturns occurred and they were beholden to brokers. According to Loc and Son (2011), farmers regularly coped with risk from access to market prices in the VMD.

In the first rice crop, general farmers producing normal rice without conducting contract farming with rice companies faced challenges with lower market prices because supply exceeded demand. This was a common constraint for general farmers in most case studies (Chapters 5, 6, and 7). Members of the FC and general farmers in Hoa Binh, Bac Lieu also had fewer choices to sell their rice than those in An Giang because the majority of traders came from outside Bac Lieu. Consequently, farmers in Bac Lieu frequently received lower prices than those in An Giang. As a result, local access to market prices influenced farmers' decision-making when selecting which rice varieties to grow for the first rice crop.

The price for rice from the second rice crop was usually lower than that for the first and third crops in all three provinces. Low prices for the second crop were due to the low quality of rice produced, and higher supply than demand (Chapters 5, 6, and 7). The low quality of rice from the second crop was because, according to the seasonal calendar for An Giang and Bac Lieu, it was grown in the rainy season, and so rice tended to get wet and dirty, because the stems of the rice plants fell to the ground. Accordingly, traders asked farmers to accept lower prices than contract prices (i.e., a contract between traders and farmers two weeks before harvesting rice). Farmers in Bac Lieu were more constrained than those in An Giang, because low rice quality is a good opportunity for traders from outside Bac Lieu to force farmers to reduce prices (Chapter 7). Actually, farmers in Bac Lieu had very few alternative choices for selling their rice because there was no access to a dryer service in Hoa Binh and so they were unable to store grain and wait for higher prices. In addition, rice farmers with small scale farms (i.e., small land area) could not access other rice markets (e.g., sell rice directly to traders outside Bac Lieu and companies). Finally, farmers needed to sell rice as soon as they could after harvesting because they needed money to pay agricultural materials shops where they bought fertilisers and pesticides on credit.

In the third rice crop, members of the ACs and the LSFs, and general farmers in the two communes in Can Tho typically enjoy better prices than for the first and second crops. However, abnormally heavy rain often affects rice quality, because it is not possible to harvest with a combine harvester after heavy rain. As a result, paddy has to be cut by hand (requiring labour), increasing the harvest cost, and the quality of rice is also reduced (Chapter 6). Therefore, access to markets and weather conditions in the third rice crop influenced farmers' decision-making about selecting rice varieties in Can Tho (Chapter 6). The findings of this thesis are also similar to findings of Bosma et al. (2012) and Alexander and Larson (2016). Bosma et al. (2012) found that access to suitable prices for the outputs of a farming system affected farmers' decision-making about integrated farming systems in the VMD, while Alexander and Larson (2016) found that low prices and market access were important factors influencing small-holder farmers' decision-making when they considered rice, crops, and livestock in southern Lao PDR.

Livelihood capital

Livelihood capital includes human, social, natural, physical, and financial capital (Scoones 1998; DFID 1999). The study found that rice farmers were dependent on their experiences and collective skills from a range of sources such as ACs, FCs, and other local organisations, because the majority of rice farmers had a low education level (Chapters 5, 6, and 7). The number of family labourers working in rice production was not different between communes in the three provincial case studies. Rural labourer working in rice production has decreased because of migrating out of rural areas and working in industrial provinces and cities (Chapters 5, 6, and 7). However, there are some cases of small households who worked as agricultural labour for other farmers (Chapter 6).

Farmers in Ta Danh commune, An Giang province, had a larger land size for rice than other communes in the three case studies (Chapters 5, 6 and 7) because this commune was developed later than others. Being located upstream in the VMD where there was serious flooding, most agricultural land was used for two rice crops, whereas most of the land area in other communes of the three provinces was used for three rice crops (Chapters 5,6, and 7).

The majority of farmers in the three provincial case studies had basic tools and equipment for rice production including sprayers for pesticides and pumping machines. In recent years, households in Ta Da commune have applied sprayers for seed and fertiliser which save time and are more effective than applying by hand. Based on household surveys, combine harvesters were common in communes in An Giang province, but were in short supply in other provinces. Many farmers in Can Tho and Bac Lieu had to rent combine harvesters from owners coming from An Giang via brokers with higher prices of around 2.7 million VND/ha in Can Tho and 3 million VND/ha in Bac Lieu compared to 2.2 million VND (100 USD)/ha in An Giang.

There were similarities between farmer organisations in the three case studies in access to finance including saving money from livelihood activities (on-farm, non-farm, and off-farm), credit from banks (government banks and private banks), and through credit on agricultural materials from agricultural shops (Chapters 5,6, and 7), meaning farmers had to pay agricultural shops after finishing the rice crop.

In a previous study, applying the method of quantitative data analysis, Trung et al. (2017) found a range of livelihood capitals positively and negatively influencing farmers' decision-making about land use. These included household physical capital, financial capital, and social capital. In contrast, a lack of funds, of water for irrigation, of knowledge, and of labour influenced farmers' decision-making in Laos when they considered rice, crops, and livestock (Alexander & Larson 2016). Similarly, in Indonesia, land size and lack of labour directly impacted farmers' decision-making when they considered adopting new cattle management practices Grünbühel and Williams (2016). However, this thesis found that except for access to water in the case of Bac Lieu, livelihood capitals typically did not directly affect farmers' decision-making because members of farmer organisations and general farmers (non-members) were not greatly limited by lack of categories of human, social, financial, natural, or physical capital. Additionally, these farmers were able to access locally agricultural services such as land preparation, labourers, and combine harvesters.

8.3.3 Farmers' collective and individual decision-making for farming activities (Research question 3)

Rice cultivation involved a range of activities including preparing land, irrigating, selecting rice varieties and its sources, accessing materials (fertilisers and pesticides), accessing labour, accessing traders for selling rice, and accessing combine harvesters. Members of farmer organisations (ACs, FCs, and LSFs) and general farmers made collective and individual decisions on rice farming activities.

Collective decision-making for farming activities

Collective decision-making was often used for selecting rice varieties and their sources, and for setting up seasonal calendars because setting up a seasonal calendar and selecting rice varieties influenced the time of harvesting and reduced hazards from rats and golden apple snails. This form of decision-making took place in most case studies for different reasons. For example, in An Giang, the seed producer group applied collective decision-making because members of the FCs had the same aim to sign a contract with seed companies to produce seed. Secondly, farmers with land located far from canals relied on farmers with land located next to canals so they made collective decisions to use the same rice varieties, and the same seasonal calendars for planting and harvesting. In Can Tho, members of the LSFs and general farmers in Truong Xuan

A made collective decisions to adjust seasonal calendars to grow three consecutive rice crops. In addition, members of the LSFs collectively decided on contracts with the rice company in the first rice crop. Members of the AC in Thoi Tan, Can Tho made collective decisions to sign contracts with CLRRI to produce rice seed. Generally, collective decision-making about producing seed or normal rice (i.e., rice for consumption) with high quality varieties has usually been done by members of the FCs in An Giang, and the AC and the LSFs in Can Tho because they were advanced farmers, and they perceived that they obtained benefits from collective activities such as training and sharing knowledge (Chapters 5 and 6), which was also found in the study presented by De (2006). In addition, they had strong informal social capital including kin and neighbours (Chapters 5 and 6). Therefore, these collective activities of farmer organisations contributed to the development of seed clubs or agricultural cooperatives in the VMD (Tin et al. 2011).

The forms of collective decision-making and working farming activities in recent years were similar to those in the case studies in Tra Vinh and Dong Thap in 2000 (Miller 2003). Although advanced farmers and normal farmers are involved in farmer organisations, their collective farming activities are still limited mainly to working together at the same time and place, instead of in cooperatives. For example, members of the FCs and seed producer group in An Giang signed contracts for seed production via the leaders of these organisations, while members of the LSFs in Can Tho signed contracts for farming via an agreement between the People's Committee of the commune, farmers, and the company. However, members of the LSFs did not share any benefits as did ACs. Therefore, although farmers have been involved in some collective decision-making for farming activities, their participation in farmer organisations seems to be symbolic rather than proactive, which is similar to participation rungs from a case study in India (Aref 2011). Members engaging in farmer organisations were not empowered to decide on collective harvesting activities when they engaged in contract farming to produce normal rice for a rice company. LSFs in Can Tho are a good example. The leader of LSFs decided and coordinated this activity, and they had a problem in the first rice crop in 2015 and again in 2016. Then, these members of this cooperative model changed their contract farming to another rice company.

In Hoa Binh of Bac Lieu, members of the FC and general farmers had an informal approach to collective decisions about using the same rice varieties, and setting times for planting and harvesting because farmers with land far from canals were dependent on farmers with land located next to canals (Chapter 7). Besides, most of the traders who bought rice in Hoa Binh commune were from outside Bac Lieu province. A lack of diversity of traders was also a constraint for farmers. As a result, they had to sell rice at the same time as other farmers with land parcels in the same field as theirs. However, selling rice at the same time helps farmers negotiate to achieve a good price for their rice.

Generally, when farmers have the same aims (e.g., seed producer groups in An Giang: Chapter 5, the AC and the LSFs in Can Tho: Chapter 6), or the same challenge (e.g., Hoa Binh commune in Bac Lieu: Chapter 7), they are more likely to make collective decisions related to their common livelihoods. Nevertheless, similar to Songsak and Aree (2008), external factors such as unexpected adverse weather conditions can indirectly influence farmers' views on the benefits of collective decisions, as in the case study of the LSFs in Truong Xuan A, Can Tho.

Farmers' individual decision-making for farming activities

Members of FCs, ACs, LSFs, and general farmers made individual decisions for the majority of rice farming activities including preparing land, irrigating, accessing financial sources, accessing and using rice varieties, fertiliser, pesticide, hiring labour for spraying pesticide, selling rice, and accessing labourers for harvesting (i.e., chapters 5, 6 and 7). In all three provinces, decisions on the choice of rice varieties was considered to be one of the most significant factors in the production of each rice crop because it is associated with a wide range of factors including managing pests and diseases, coping with climate variability, the duration of cultivation, rice quality, and especially market price.

Similar to findings presented by Dan (2016), IR 50404 and OM 6976 are the current preferred rice varieties for the first rice crop in An Giang province, especially IR 50404 in Vinh Trach commune, while farmers in Ta Danh decided on a wider range of rice varieties (Chapter 5). Actually, the choice was initially based on market demand in Vinh Trach and Ta Danh, and then a final decision made based on farmer perceptions of estimated costs and benefits. For example, IR 50404 had lower market prices than varieties with higher quality, but the cost for cultivating IR 50404 was also lower than the higher quality rice (Chapter 5)

In Can Tho, farmers in Thoi Tan decided on a high quality rice variety for their cultivation in the first rice crop, namely Jasmine 85. In contrast, the majority of general farmers in Truong Xuan A still used IR 50404 for the three rice crops because they were familiar with using it; they preferred to save production costs by minimising input into rice production. Moreover, market prices for Jasmine 85 have often been less than VND 0.5 million higher than for IR 50404, typically VND 4.4 million/tonne for IR 50404 compared to VND 4.6 million/tonne for Jasmine 85 in 2016. IR 50404 was sold commonly to traders coming from An Giang and Dong Thap.

The vast number of farmers in Bac Lieu, however, concentrated on a high quality rice variety, namely OM 4900. As discussed in Chapter 7, members of the FC and general farmers decided on OM 4900 because the majority of traders coming from outside Bac Lieu bought the rice of farmers via local brokers. These networks had been operating for more than five years. Additionally, OM 4900 suited climatic conditions of the commune of Hoa Binh, Bac Lieu. Furthermore, since Bac Lieu was considered to be a coastal province, high quality rice was needed in order to attract traders from outside the province.

In the context of the brackish water zone of Bac Lieu province, saline water existed inside farming land and internal canals, and members of the AC and general farmers had to decide on rice varieties that coped with salinity as a suitable strategy for cultivating rice crops in the rainy season. Mot Bui Do and FLAI were two common rice varieties in Phuoc Long commune. However, Mot Bui Do was chosen by the majority of farmers in Phuoc Long because it was cheaper than FLAI (Chapter 7).

The approach of farmers' decision-making in relation to rice-based farming systems in the Delta

In all six communes of the three provinces, the study found that farmers had similar approaches to decision-making in relation to rice-based farming systems from the upstream province (An Giang) to the coastal zone (Bac Lieu). This is because their decisions were based on similar factors.

Firstly, they cultivated rice, and they had to depend on ecosystems such as water and soil conditions to decide on access to irrigation and input supply and services for improving their rice productivity. Secondly, the climatic conditions in the VMD were mostly similar in each province, though flooding was a problem in An Giang and Can Tho, and drought and saline water intrusion was a problem in Bac Lieu (Chapters 5, 6, and 7). However, farmers made collective and individual decisions to adapt to and cope with these threats, as discussed earlier. Thirdly, farmers were able to access input supply systems and agricultural services in the local community very easily because of the development of the private sector in the market economy (Chapters 5, 6, and 7). For example, there were seven shops selling agricultural materials (fertiliser and pesticide) in Truong Xuan A commune in Can Tho. Fourthly, private sector market for rice is very dynamic in the Delta, and farmers regularly sell their rice to traders through local brokers (Chapters 5, 6, and 7). This is similar to the findings of Loc and Son (2011) where more than 93% of productivity of rice was sold to traders (throughout local brokers) at the farm gate. Last but not least, policies in relation to agricultural production, particularly rice production in the VMD, were similar from one province to another. Credit for farmers to buy combine harvesters, improvements in rice varieties, and infrastructure including high dykes for securing rice in the flooding zone, and sluice gates for securing rice in the coastal zone are common throughout the Delta.

Although farmers in An Giang, Can Tho, and Bac Lieu used some similar approaches to decide their rice-based farming systems, they also made different collective and individual decisions for different farming activities. In terms of collective decisions, members of the FCs in research sites of An Giang have had more collective activities (training and sharing technical knowledge, and draining water out of rice fields) than those in Can Tho and Bac Lieu. That is because the majority of members of the FCs in An Giang were advanced farmers. They were a good example from which other general farmers (non-members) could learn farming techniques. Advanced farmers also encouraged general farmers to participate in collective activities (Chapter 5). In contrast to An Giang, the number of members of the FC and the AC in Bac Lieu was small (Chapter 7). Therefore, they have very few collective activities for decision-making.

In terms of individual decision-making, farmers in An Giang, Can Tho, and Bac Lieu also make different decisions about farming activities. For example, general farmers in Vinh Trach of An Giang and Truong Xuan A of Can Tho prefer to use lower quality rice varieties (IR 50404), while general farmers in Ta Danh of An Giang, Thoi Tan of Can Tho, and Hoa Binh of Bac Lieu prefer to use higher quality varieties such as Jasmine 85, OM 4900, and OM 5451. In addition, although members of farmer organisations and general farmers (non-members) in all three provinces were able to access rice varieties, members of farmer organisations and general farmers in An Giang were able to obtain certified rice varieties easier and cheaper than those in Can Tho and Bac Lieu. That is because many farmers in Can Tho and Bac Lieu frequently bought rice varieties that were produced and delivered from An Giang. Besides, many farmers in Truong Xuan A of Can Tho usually use rice varieties from their family and buy from their neighbours (Chapter 6)

Generally, although there are many common elements in the approach of all farmers in making decisions about rice-based farming systems, members of farmer organisations and general farmers in the three provinces also made different decisions about particular farming activities. That is because of a range of different factors that were discussed in section 8.3.2.

8.3.4 Consequences of farmers' decision-making on the output of farming systems (Research question 4)

Output of rice-based farming systems is one of the outcomes of livelihood activities (Scoones 1998; Ellis 2000). Also, this is the output of farmers' decision-making. Therefore, members of ACs, FCs, LSFs and general farmers relied on the output of farming systems to make decisions about new farming systems and farming activities. According to Bruijn and Van Dijk (2005), farmers decide on their livelihood pathways or strategies based on cumulative experience over time including their knowledge and understanding of the environment. However, very few studies have discussed the consequences of decision-making on the outputs of farming systems, and the output of farming systems as being good experience so that farmers decide on crops in the coming years. In the following section, the study makes some comparisons of yield and income from rice production as a consequence of farmer decision-making in the three case studies.

Rice yield varied across the three case study provinces. In the first rice crop, farmers in Can Tho typically obtained a higher rice yield than farmers of other provinces, while Bac Lieu had the lowest rice yield in this crop for several reasons (Chapters 5, 6, and 7). Farmers in Can Tho enabled flood water to enter their fallow fields for around two months to collect alluvium and clean insects and diseases after one year of cultivation. In contrast, the area of the three rice crops in An Giang and Bac Lieu did not collect alluvium from flood water due to securing rice in the third rice crop. Farmers in Bac Lieu had more challenges than those in An Giang because farmers in Bac Lieu were constrained by drought and saline intrusion, especially farmers with land near unsafe sluice gates.

Similar to rice yield, the cost of rice production of farmers in Can Tho was lower than in An Giang and Bac Lieu owing to obtaining alluvium from flooding, along with enough water for irrigation without pumping (Chapters 5, 6, and 7). These factors enabled farmers in Can Tho to reduce fertiliser, pesticide, and irrigation costs. In Bac Lieu, due to drought in the first rice crop, farmers had to spend a lot of money on irrigation. Additionally, favourable weather conditions for the first rice crop encouraged farmers to use a large amount of fertiliser to offset poor soil quality and to gain a higher yield than other rice crops. Accordingly, the cost for fertiliser was higher than in other provinces.

In 2014, farmers in Bac Lieu obtained a lower net income from the first rice crop than the two other provinces because of the lower rice yield and high cost (Chapters 5, 6, and 7). In contrast, farmers in Can Tho had a lower net income in the second rice crop than other rice crops or the same crop in other provinces because wet (rainy) conditions reduced yield. Although farmers had to adapt to a range of threats from climate and markets, members of farmer organisations, and general farmers attained benefits from farming systems. Therefore, they still decided to cultivate three rice crops or two rice crops on their farming land.

Although members of the FC and general farmers in Bac Lieu earned a lower net income from the first rice crop than the two other provinces, net income from the three rice cropping seasons each year (total income from rice) of these farmers was higher than that of members of the AC and the LSFs, and general farmers in Can Tho. That was because farmers in Bac Lieu had a larger area for growing rice than farmers in Can Tho (Chapters 6 and 7). However, except for general farmers in Truong Xuan A, the majority of farmers in Can Tho had a higher total on-farm income than that of Hoa Binh in Bac Lieu because farmers in Can Tho earned additional on-farm income from other crops and livestock, including growing bananas, mangoes, chillis, and cucumbers, and raising fish, pigs and chickens.

Comparing total household income between provinces, members of the FCs and general farmers in An Giang had higher incomes than members of the AC, the LSFs, and the FC, and general farmers in Can Tho and Bac Lieu, because farmers in An Giang had larger land areas than those in the other two provinces. In addition, many members of the FCs in An Giang produced seed rather than normal rice for consumption. General farmers in Truong Xuan A, Can Tho had a lower household income compared to farmers elsewhere because of their small land area and little non-farm and off-farm income.

In comparing between members of farmer organisations and general farmers in each commune about output of rice-based farming systems, members of farmer organisations regularly obtained higher rice yields, net income from the two or three rice crops, or total household income than general farmers in each research site of the three provinces (Chapters 5, 6, and 7). That is because the majority of members of the FCs, the ACs, and the LSFs were advanced farmers or relatives of advanced farmers in their community. They are considered a farmer group "getting ahead" (DaCosta & Turner 2007) compared to other farmers in their community because they usually have good technical knowledge in rice and seed production, and have larger land area than general farmers. Advanced farmers are pioneers in engaging with farmer organisations such as seed production groups or agricultural cooperatives, and implementing and adopting innovation of technical knowledge of rice cultivation (De 2006; Tin 2009), whereas general farmers (non-members) can be considered a farmer group "getting by" (DaCosta & Turner 2007). They usually adopted new technical knowledge after advanced farmers, and also had smaller land areas and other livelihood capital, and especially low educational levels compared to members of farmer organisations; an example in this thesis is general farmers in Truong Xuan A, Can Tho. Therefore, they might face more difficulties and be more vulnerable to risk factors in rice production compared to members of farmer organisations. For example, Thong and James (2017) noted that a decrease in fish and other aquatic product in the flooding zone of the VMD (e.g., due to high dykes for securing third rice cropping season in the flood season) is more challenging for the poor than for others.

In terms of comparison between this thesis and other studies of outputs of rice-based farming systems as the consequence of farmers' decision-making, there have been no similar studies. However, there have been a range of studies relating to decision-making, which focused on factors influencing on farmers' decision-making, or what farmers decide, rather than evaluating the output of farmers' decision-making. These studies were discussed in other sections of this chapter.

8.4 Conclusion

In conclusion, the three case studies demonstrated that farmers in An Giang, Can Tho, and Bac Lieu have to consider a range of issues when making decisions about rice-based farming systems in the three provinces.

Research question one considered the major decisions that farmers have to make about their rice-based farming systems each year. Farmers, including members of farmer organisations and general farmers, across multiple cases study of An Giang and Can Tho, and Hoa Binh commune of Bac Lieu decided on three consecutive rice crops as their main rice-based farming systems, while farmers in Phuoc Long decided on a rice-shrimp system. In An Giang, Can Tho, and Bac Lieu, farmers' decision-making about the three rice crops is typically related to their dependence on access to suitable market prices, household consumption, high dykes, sluice gates controlling saline water, and the collective draining of water out of farms after the flooding season. Farmers in Phuoc Long, Bac Lieu mostly relied on saline water conditions for raising shrimp, and rainy conditions to cultivate rice.

Research question two considered factors influencing farmers' decision-making for rice-based farming systems. Firstly, social capital typically plays an important role in farmer organisations. However, in most of the case studies, there were only low to moderate levels of social trust and commitment between members, and between members and leaders of farmer organisations (Chapters 5, 6, and 7) because informal social capital between members in organisations such as kinship and neighbours, caused a decline in formal social capital. In other words, similar to Songsak and Aree (2008), working together did not satisfy all members involved in contract farming with companies and other organisations. Also, the findings of case studies in the VMD presented by Miller (2003) have typically remained true in recent years, as this present study found that farmers in the VMD still preferred working together *(làm cùng nhau)* rather than cooperatively *(hợp tác)* to achieve a collective goal. In addition, participation in farmer organisations in the VMD is more symbolic than genuine participation (the highest participation level) (Aref 2011). Accordingly, the role of farmer organisations in farmers' collective decision-making for farming activities has declined in recent years, and is likely to deteriorate further without external support from government or international aid programmes.

Secondly, climate change and changes in climate variability, for example, changes in patterns of temperature and rainfall influenced different rice crops. The climatic conditions in the first rice crop were generally good for rice cultivation, although in some years unusually cool weather adversely affected rice yield. Heavy rain often damaged paddy in the second rice crop in An Giang and Bac Lieu, leading to a fall in yield and rice quality. Therefore, climate variability is also factor influencing a farmer's decision-making for selecting rice varieties.

Thirdly, local access to markets is considered to be most important for farmers' decision-making about farming activities. General farmers typically encountered lower market prices for the first rice crop because supply exceeded demand, and they also had problems with low market prices when they sold rain-affected rice to traders via local brokers. Farmers in Bac Lieu had fewer options for accessing markets and selling rice than those in An Giang and Can Tho.

In terms of research question three, farmers made collective and individual decisions for their rice-based farming systems. Generally, the process of decision-making for farming activities was similar in all case studies in the three provinces. Members of farmer organisations and general farmers made individual decisions on most farming activities, except for collective decisions involving setting up seasonal calendars, selecting rice varieties, draining water out of rice fields, and selling rice.

Research question four looked at how major decision-making influenced the output of rice-based farming systems and household livelihoods. The output of rice-based farming systems, including two or three rice crops and rice-shrimp, were the main livelihood outcomes of farmers, as demonstrated across the case studies in all three provinces. Farmers in Bac Lieu typically gained lower rice yields and net income per hectare than farmers in Can Tho and An Giang. In addition, the decision by farmers to increase the amount of fertiliser led to higher rice yields in the first rice crop than other crops in Bac Lieu province, but it also increased the production cost for the first rice crop. General farmers in Truong Xuan A had the lowest income from rice-based farming systems compared to other farmers in Can Tho, and in An Giang and Bac Lieu, mainly because they had smaller land areas than other farmers. These farmers also had the lowest total household income because, in addition to their small land area, they had little non-farm or off-farm income.

Generally, across the multiple case studies of the three provinces, the study found that farmers decided on rice-based farming systems with two and three consecutive rice crops, or rice-shrimp systems because they depended on their knowledge, experience and understanding of their environment, which varied systematically between farmers; an important factor here was their perceptions of social interaction between farmers in their community. In other words, similar to the findings of Bruijn and Van Dijk (2005), the process of farmers' decision-making about rice-based farming systems and farming activities depended on perceiving and using the social and physical environment.

Chapter 9

Conclusion

9.1 Introduction

This chapter provides a summary of the main findings, policy implications, limitations, and areas for future research. This study set out to identify farmers' decision-making about rice-based farming systems across multiple case studies in three provinces (An Giang, Can Tho, and Bac Lieu) in the VMD. Policy implications are drawn via recommendations based on positive and negative factors influencing farmer's collective and individual decision-making about farming activities under conditions of climate variability and hazards in relation to a range of factors. These include floods, abnormal rains, drought, increasing salinity of saline water, saline water intrusion, access to local markets, and advantages or constraints from farmers' livelihood capitals for farmers' decision-making about rice-based farming systems. The limitations of this research will be explored, and recommended will be made on areas for future research on farmer organisations and collective adaptation to climatic and non-climatic challenges in the coming years.

9.2 Findings and policy implications

9.2.1 Findings

The thesis responded to the overall research question about what farmers have to consider when they make decisions about rice-based farming systems in each of three provinces in the VMD (An Giang, Can Tho, and Bac Lieu).

Research question one asked about the major decisions that farmers have to make about their rice-based farming systems each year. Farmers in An Giang, Can Tho, and Hoa Binh commune in Bac Lieu made decisions specifically relating to rice-based farming systems with either two or three consecutive rice crops, whereas in Phuoc Long, Bac Lieu their decisions were related to a rice-shrimp farming system. Farmers decided on the type of farming system and the annual calendar of farming activities based on their knowledge and experience of local conditions. Firstly, in An Giang, members of the farmer clubs (FCs) and general farmers in Vinh Trach decided on three rice crops, while members of the FCs and general farmers in Ta Danh decided on a mix of two or three rice crops for rice-based farming systems. The two main factors influencing decisions for selecting the rice-based farming systems were access to local markets and dyke infrastructure for protecting rice from high flood levels. Secondly, in Thoi Tan and Truong Xuan A communes of Can Tho, members of the agricultural cooperatives (ACs), large-sized farms (LSFs), and general farmers made decisions based on collective drainage of water out of farms after the annual flood season. That is because the collective drainage of water out of fallow fields after the flood season now allowed farmers to begin the first rice crop three weeks earlier than they did in 2003, enabling them to harvest the third rice crop of the year before floods arrive and damage the crop. Members of the AC and general farmers in Thoi Tan drained water out of fallow fields after the flood season together with farmers who had land parcels in the same farm. In contrast, members of the LSFs and general farmers in Truong Xuan A collectively drained water according to the decision of the leader of the LSFs. Thirdly, in Bac Lieu, members of the FC and general farmers in Hoa Binh depended on control of saline water by the provincial government and drought for decision-making about whether to grow three rice crops a year. The main water source for irrigation in the first rice crop is delivered from the Mekong River. However, farmers with land fields next to unsafe sluice gates controlling saline water managed to cope with saline water intrusion due to old sluice gates. In the other two rice cropping seasons, farmers utilised rain water during the rainy season. In contrast to Hoa Binh, members of the AC and general farmers in Phuoc Long decided on rice-shrimp due to saline water conditions (February to August) for raising shrimp, and fresh water from rain (September to January) for cultivating one rice crop because cultivating rice helped farmers to improve the soil environment after raising shrimp, thereby providing a good environment for raising shrimp the following year.

Research question two was about factors influencing farmers' decision-making for rice-based farming systems. The results of this investigation show that there were a range of factors influencing farmers' collective and individual decisions about farming activities. Firstly, social capital in the ACs, the FCs, and the LSFs in the six communes of three provinces scored high for social cohesion. However, statements of social cohesion in this thesis were related more to collective activities associated with training and sharing knowledge than to activities involving the sharing of economic benefits; thus social cohesion between members of the farmer organisations did not influence collective decisions on important farming activities in relation to economic benefits. In contrast, social trust and social commitment between members of these farmer organisations typically had a moderate score implying that these farmer organisations were not very resilient. The moderate level of social capital contributed to weak formal collective decision-making. However, formal and informal social capital is embedded into the ACs, the FCs, and the LSFs. Informal social capital such as kinship, neighbours or other institutions influenced formal social capital between members of an organisation. For example, good relationships between formal authorities and the leader of LSFs encouraged the leader of LSFs to give preferential treatment to those who were both authorities and farmers in contract farming between LSFs and a rice company. Kinship also enabled leaders to prioritise their relatives to engage in collective activities of ACs or FCs, such as contract farming between ACs or FCs and seed companies for seed production. After engaging in FCs, the heads of FCs utilised formal social capital between them and members to promote members to engage with seed contract farming with their company.

A key finding to emerge from this study is that high flood levels in the canals coinciding with heavy rains encouraged farmers and local authorities to make collective decisions about draining water out of large farms in the flood season in An Giang and Can Tho. However, farmers in Hoa Binh, Bac Lieu mostly ignored collective water control when dealing with saline water intrusion and drought in 2016. This implies that formal social capital[19] was not strong. Therefore, working collaboratively together is likely to continue to be a problem in relation to managing climate variability issues in the coming years, particularly for Hoa Binh.

The study identified that access to market prices not only influenced farmers' decision-making about the main rice-based farming systems, but also farming activities such as deciding which rice varieties to grow. However, access to local markets was a constraint for farmers in Hoa Binh, Bac Lieu, because rice traders came from outside this province to buy rice, and therefore transaction costs were very high. Accordingly, rice farmers were dependent on local brokers who were representatives of rice traders to buy farmers' rice, at lower value, and were ultimately price takers. In addition, local brokers and traders were more powerful in forcing farmers to reduce the quantity of rice sold if rice became wet and dirty during the rainy season.

[19] Social capital was not measured by quantitative methods for this activity because the FC in Hoa Binh did not have this activity when drought and saline water intrusion occurred seriously in 2016.

In terms of research question three, farmers made collective and individual decisions for their rice-based farming systems. The study found that farmers made decisions about which type of rice-based farming system to adopt, and about specific farming activities of particular farming systems including intensification of rice (i.e., two or three consecutive rice crops) and rice-shrimp farming system each year. Members of FCs, ACs, and LSFs and general farmers mostly decided on farming activities as individuals, except for some key collective decisions including setting seasonal calendars, the draining of water out of rice fields, selecting rice varieties, and selling rice to traders via brokers or a rice company.

The findings revealed that different forms of farmers' collective decision-making occurred across different communes of the three provincial case studies. These included a range of farming activities according to different conditions (markets, location of land, flooding, and saline water control) cultivated over two or three rice crops or in rice-shrimp systems for Bac Lieu. Formal and informal farmer organisations in An Giang were more diverse than in the other two provinces because of the mix of rice seed production and normal rice cultivation. Additionally, rice markets in An Giang were more active than in Bac Lieu and Can Tho.

Farmers' collective decision-making around rice-based farming systems depended on a range of different factors. In particular, the location of land parcels in the same large farm was a typical factor to encourage farmers to make collective decisions about rice farming activities such as seasonal calendars and rice varieties. Secondly, topographical conditions and small dykes were two major factors affecting farmers' collective decision-making about seasonal calendars for each rice crop. Thirdly, central and provincial authorities supported farmers in contract farming and improving rice quality for export, by providing technical knowledge for farmer, and encouraging them to work together by participating in different forms of farmer organisations in the local community. Finally, kinship was an important factor influencing collective decision-making in normal rice production because members having kin in their farmer organisations trusted each other. Kinship allowed leaders of informal groups to encourage their siblings to participate in contract farming, ACs, LSFs, and FCs. However, preferential treatment or unfair practices in ACs, FCs, and LSFs have resulted in mistrust of these organisations, and this study found that farmers continue to prefer working together (working at the same time and in the same farm) rather than cooperatively (cooperating and sharing economic benefits).

Research question four explored how the consequences of major decision-making influenced the output of rice-based farming systems and household livelihoods. The study identified that output of rice cultivation was the consequence of farmers' decision-making about rice-based farming systems. Output of two or three rice crops, and rice-shrimp farming were also a main livelihood outcome of farmers in An Giang, Can Tho, and Bac Lieu. The rice yield and net income per hectare of farmers in Hoa Binh, Bac Lieu was less than that of farmers in An Giang and Can Tho because they were constrained by unfavourable water conditions, saline water intrusion, drought, and abnormally heavy rains. In addition, their community in Hoa Binh, Bac Lieu did not have strong social capital in working together to overcome these constraints. However, household income of some farmers in Can Tho was lower than farmers of other provinces. Generally, farmers' decision-making was based on their knowedge of local conditions and their experience, and most farmers are slow to change the way they make decisions, especially in relation to collective decisions.

9.2.2 Policy implications

The results of this study determined that insufficient transparency existed between heads and members of farmer organisations which caused distrust of the heads of farmer organisations. Accordingly, in Can Tho, members did not have a good relationship with heads of the farmer organisations, so they withdrew from farmer organisations and they decided to work together[20], instead of cooperating[21]. One potential solution for improving trust and encouraging greater participation in farmer organisations is for local authorities to consider arranging the seasonal calendar through a participatory process with most of the households participating in the farmer organisations. In addition, LSFs and local authorities in Can Tho need to formulate regulations for clear, effective and transparent governance of farmer organisation in the future.

For Bac Lieu, it would be possible for local authorities to encourage farmers to be more involved with farmer organisations through training in practical farming activities, along with appropriate principles of transparency and commitment. These

[20] Working together is working at the same time and in the same place.
[21] Cooperation is sharing economic benefits.

institutional and governance principles might build trust for farmers to be involved in projects (Borda-Rodriguez & Vicari 2014) and achieves the objective of collective adaptation to climate variability or other hazards. Local authorities need to be more proactive in encouraging farmers to participate in farmer organisations and engage in collaborative decision-making by providing effective training and good organisational governance. If not, then it might be very difficult to build sufficient trust and social commitment to deal effectively with the challenges posed by climatic variability, sea level rise, and other consequences of climate change in the future.

The findings of the study imply that the new policy of ACs (2017) for continuing promotion of the AC model in the VMD needs to be evaluated and examined by practical social scientists (i.e., the combination of good monitoring and evaluation, a learning cycle, more participatory involvement across all stakeholders and sectors) instead of relying only on evaluation and reports from communes. Practical social science methods might help central government and provincial governments to fully understand the practical situations in the local communes. Then, it could help determine which communes or districts should have these policies applied in the future.

One of the most important suggestions from the findings of this study is that evaluating or conducting research on farmer organisations in the VMD should not be completely dependent on general evaluation, reports, or individual quantitative data. Both quantitative and qualitative approaches are needed to determine the practical factors influencing farmer organisations; this thesis was able to achieve greater insights in this way, rather than relying on one single method. This is because farmer organisations were quite different from other issues in social science research in the VMD, and each organisation was at a different stage of maturity and embedded in different institutional arrangements.

In recent years, the DARD (2016) of the three provinces has continued support for rice-based farming systems in the same landscapes, and to continue to upgrade current infrastructures, but have not continue to have financial supports for farmers building new dykes (Chapter 5). Policies relating to financial support for strong encouraging farmers to build dyke were practiced during 2001-2010. In this period, dyke construction was considered an important policy in An Giang province because dyke construction helped to increase quantity of rice by cultivating three rice crops (Howie 2011). Since 2011, local authorities and farmers have given thought to how to access good market prices after completing dyke construction. LSFs and ACs were suitable cooperation models to help farmers gain access to good market prices.

The provincial authority in An Giang has had a program of agricultural reconstruction to continue to develop agriculture in different local ecosystem zones. At Vinh Trach and Ta Danh commune, where this thesis conducted the research, local authorities continue to set policies associated with the cultivation of two or three rice crops. According to Mr T, a local official of Vinh Trach commune, agricultural reconstruction has planned to continue to improve agricultural production for each commune, district, and province, but he has not seen any changes because agricultural reconstruction policy was issued in 2015. According to a formal document from DARD in An Giang (2016), a plan for developing rice-based farming system at commune and district level is to continue to develop high quality rice on a large scale using the organisation structure of LSFs together with ACs. That is because the objectives of the provincial authority are to increase the quantity of high quality rice in the province, and to increase the resilience of farmers and farmer organisations.

In An Giang, ACs plays an important role to coordinate LSFs. According to DARD (2016), they continue to enhance the rice-producing capacity of both advanced farmers and LSFs. In particular, centres of DARD also continue to train the leaders of ACs in AC management methods and skills. The provincial authority continues to encourage food companies to have contract farming with the members of LSFs and ACs in order to help farmers to obtain stable market prices. In An Giang, the provincial authority combined their plan and support from outside organisations such as the World Bank for building farmers' capacity in areas such as IPM and correct seeding rates. LSFs and ACs were places where provincial authorities supported interaction with international organisations to expand technical knowledge to other areas in communes and districts. Therefore, improving capacity of LSFs and ACs is one of the good policies for agricultural development in An Giang in the future.

In Can Tho, the provincial authorities did not have special policies for developing agricultural production, but they had plans from 2016-2020 (DARD 2016). They continue to support and maintain rice-based farming zones with three rice crops and encourage establishing LSFs and ACs. This enables farmers to set up good contracts with rice companies. Farmers who engage in LSFs have the opportunity to enhance their resilience to deal with climate variability and other constraints. For example, members of LSFs in Truong Xuan A were supported in training on IPM through World Bank funding. Generally, LSFs and AC are models for connecting between farmers, companies and local authorities (Can 2014).

In Bac Lieu, farmers in Phuoc Long continue with rice-shrimp, and they cannot change to other farming systems such as intensive shrimp model for several reasons. According to local authorities and farmers, intensive shrimp requires high investment of money, which is beyond the limited capacity of most farmers. In addition, most farmers who are implementing the rice-shrimp farming system already had bank loans, and the local banks could not continue to lend them more money. In Phuoc Long commune, the ecosystem zone for rice-shrimp does not suit intensive shrimp. For example, in 2016 the weather was very hot and suffered drought conditions, with less rain than other years, some farmers changed from rice-shrimp farming to intensive shrimp. However, shrimp could not grow adequately, and 2017, they returned to rice-shrimp system when there was enough rain water for cultivating rice in the rainy season. According to the result of FGDs in 2017, farmers continue with rice-shrimp because rice and shrimp are complementary (Chapter 7). In particular, rice plants contribute to improve the environmental conditions for shrimp, and shrimp also generate good organic fertiliser for rice. Farmers do not need to use much fertiliser for rice. Generally, in Bac Lieu, it is important that local authorities and the community work together to improve water quality, as discussed above, and in chapter 7 and chapter 8.

The relationship between my thesis and other studies outside Vietnamese Mekong Delta, and outside Vietnam about factors influencing farmers' decision-making

In chapter 8, I discussed factors influencing farmers' decision-making about rice-based farming systems, other crops, or animal production. Climate variability (e.g., abnormal rain, drought, hot weather) and access to local markets were the two key factors affecting collective and individual farmers' decisions when cultivating rice or raising shrimp (Chapters 5, 6, and 7). For example, abnormally heavy rains reduced rice quality of farmers in Bac Lieu (Chapter 7). Farmers had different choices to respond to this problem. For example, farmers selected rice varieties for second and third rice crops, which were most suitable for periods of abnormally heavy rains (Chapter 7). They also sold rice to traders at the same time as their neighbours so that they could gain suitable prices. Similarly, access to local markets also influenced farmers' decisions when they selected suitable rice varieties for cultivating first, second, or third rice crops (Chapters

5, 6, and 7). In addition, the social capital of members in LSFs, ACs, and FCs affected their collective and individual decision-making. For example, members of the LSFs and the AC in Can Tho (Chapter 6), who were relatives of leaders or local officials, received economic benefits from contracts with companies for producing normal rice (i.e., rice for consumption) or rice seed. During the period of harvesting rice, these members were also favoured to harvest and sell rice before other members.

In the two case studies in Ha Tinh of Vietnam and Ubon Ratchathani of Thailand, Trung et al. (2017) examined factors influencing farmers' decision-making for land use selection. Trung et al. (2017) found that a range of livelihood capital influenced farmers' decision-making about land use. They included the area of irrigated land shared, distance from the homestead to crop field, number of agricultural labourers, age and gender of household heads, numbers of tractors and water pumps, house area, financial transfers, frequency of weather shocks and risks. In contrast to Trung et al. (2016), my study shows that members of LSFs, ACs, and FCs and non-members had few constraints in relation to human, physical, and financial capital when they made decisions about farming activities. However, climate variability was a major factor influencing decision-making. For example, in Bac Lieu, drought affected farmers' decision-making about rice production in the first rice crop in Hoa Binh, while rain water influenced farmers' decision-making about rice production in the rainy season in Phuoc Long.

In a case study in Northern Thailand, Duangiai et al (2015) found that farmers changed individual decision-making from rice to commercial crops because of the increase in population size, conservation policies, and markets. For example, conservation policy prevented farmers who practised shifting cultivation were no longer able to move from this area to another in the forest zone. Although farmers changed to commercial crops, they also kept rice cultivation in a small area of land for their food security. However, Duangiai et al (2015) did not mention collective decision-making. My study showed the process of collective and individual farmers' decision-making (Chapters 5, 6, and 7).

In southern Lao PDR, Alexander and Larson (2006) found that a range of factors affected farmers' decision-making about rice, crops and livestock for their livelihood activity. These factors included lack of funds, diseases, lack of water for irrigation, knowledge, lack of labour, weather conditions, flooding, droughts, low prices, market access, and seed varieties. In addition, farmers regularly alternated rice with other crops, namely rattan shoots, cassava, maize and sweet corn, among others. Many farmers could sell products to companies at the farm gates. They also received supports from companies, for example machines to slice cassava for drying. However, a lack of experience in planting crops caused indebtedness, and then farmers returned to rice cultivation.

In a case study in Indonesia, land size and lack of labour directly impacted farmers' decision-making when they considered adopting new cattle management practices (Grünbühel and Williams 2016). However, Grünbühel and Williams (2016) did not discuss details about the process of farmers' decision-making.

In Kyrgyzstan, Zhumanova et al (2016) reported that farmers' decision-making about the increase in livestock number depended on climatic conditions and environmental carrying capacity of pasture. However, Zhumanova et al. (2016) did not examine collective decision-making for this case.

The relationship between my thesis and other studies outside Vietnam about farmers' decision-making

In my study, there was little evidence for collective decision-making for irrigated water in the three provinces (An Giang and Can Tho, and Bac Lieu), especially in Hoa Binh and Phuoc Long, Bac Lieu. In Hoa Binh, Bac Lieu, in 2016 local authority and farmers stored water in collective canals. Someone used this water for irrigating their rice field when it was not really needed. They wanted to store water in their rice field as much as possible (this case was presented in detail in Chapters 7 and 8).

Most relevant case studies outside Vietnam have focused on factors that influenced farmers' decision-making rather than the process of making the decision, apart from one case study in Indonesia which reported collective decision-making for irrigation (Matthews 2007). In that case, a shortage of water forced farmers to work together to decide an irrigation timetable with schedules for different rice fields. That helped avoid conflict between owners of different rice fields and it also helped farmers to cope with pests. In contrast, in this thesis, the finding in Phuoc Long found that, when rice-shrimp farmers did not have enough rain water for cultivating rice, they changed from rice-shrimp to intensive shrimp rather than storing water collectively to cope with fresh-water scarcity. Similarly, local authorities had not thought enough about collective irrigation to save water for rice cultivation. As mentioned earlier, the World Bank supported funding for Phuoc Long and built one model of collective irrigation for rice-shrimp system in one village. However, in 2017 they were under construction and they have not had meetings to discuss how to involve everyone to cooperate. Therefore, the outcomes from this model of collective irrigation management should be examined in the future.

Recommendation for developing rice-based farming systems in the future

The VMD has a range of different ecosystem zones; An Giang is representative of flooded provinces in the upper delta, Can Tho is representative of areas with acid-sulphate soils in the middle zone, and Bac Lieu is representative of areas experiencing saline water intrusion in the coastal zone. Based on the result of the study, I have further recommendations for each province in the process of developing rice-based farming systems under constraints that was found from the result of the study.

<u>In An Giang,</u> if the provincial government, local government and farmers continue to increase high quality of large rice area, then they should consider following main recommendations.

- The provincial government should support funding for local government and farmers to upgrade infrastructure, in particular maintaining high dykes.
- To increase productivity of rice with high quality, provincial government should fund the building of sluice gates to connect current LSFs and to enlarge rice fields. This would allow local authorities and farmers to control water in the flood season more effectively, in particular when there are the combination of floods and rains.
- The provincial government should encourage local authorities and farmers to open sluice gates of rice fields within high dyke areas after cultivating rice every three years. This would enable rice fields to receive alluvium from flooding to improving soil quality and to flush out insects and other pests.
- The decision to open sluice gates should be made collectively by local authorities and farmers who have land parcels inside high dykes. Agreement is needed about the time for opening and closeing gates. Opening gates at the wrong time could risk breaking the dykes due to high floods. Thus, the groups

need to be careful about the timing of this activity and have a good solution to overcome this challenge. This decision could be compromised when market price of rice increased, if farmers do not agree to open gate because they want to continue to cultivate rice in the flood season rather than stopping for opening gate to improve soil, and they think only about current economic benefit instead of future environmental and other sustainable benefits.

- The provincial government needs to provide further training on technical knowledge of rice cultivation for farmers. Crop protection should be maintained due to climate variability and the demand for high quality rice on national and international markets.
- To improve the collective sector such as ACs, LSFs, and FCs, the provincial government needs to support funding to establish good models of AC. That is because local people prefer to work individually rather than collectively. The AC need to show their importance so that non-members are interested to participate. For example, ACs can help farmers address constraints such as finding good markets for their output, providing good agricultural services, and supplying suitable pesticides and training.
- In the local area, the local authority and farmers should make collective decisions for different collective activities such as pumping water outside from rice fields within high dyke areas. The role of the local authority is to observe and help farmers address constraints when they make collective decisions. However, local authorities should work with transparency, equality, and commitment for all farmers who have land in the high dyke area. In another words, the relation between local authority and farmers should be cooperation, instead of contestation (Howie 2011).

<u>In Can Tho</u>: The provincial government, local authorities, and farmers should continue to cultivate high quality rice in the future (similar to An Giang). Environmental conditions in Can Tho are more favourable than in An Giang and Bac Lieu because farmers can access fresh water easily and are impacted by small floods only. However, they have other constraints that should be overcome to achieve their objectives. Based on the result of study, the study has some following recommendations.

- Most of the rice areas in Can Tho have lower flood than in An Giang; therefore, they do not need to build high dykes similar to those in An Giang. The provincial government should provide an electricity system and build collective irrigation systems for local area to allow farmers to reduce pumping cost when they drain water out of fallow field after the flood season before beginning the first rice crop.

- The provincial government should support technical knowledge and equipment of seed production for ACs so that the activity of seed production can be extended in Can Tho province. Farmers can then access good seed at a suitable price. According to the study result, farmers in Can Tho are disadvantaged by having to buy rice varieties at high prices in the free market.
- Similar to An Giang, the provincial government in Can Tho should also establish or select good ACs and LSFs to be good examples for adoption in other areas. That is because ACs and LSFs help farmers access suitable market prices for their output. These ACs and LSFs should work in collective decision-making and have transparency, equality, cohesion, trust, and commitment among members, and between members and leaders. That is because the two case studies in Can Tho found negative social capital when relatives of the leader of the AC gained benefits from seed production, whereas other members could not be involved in contracts for seed production. Similarly, the leader of the LSFs favoured members who were both local officials and farmers.

In Bac Lieu: if provincial government, local authority and farmers should continue to cultivate rice and shrimp on the area of rice-based farming systems. They should consider following crucial recommendations to overcome the current constraints and future challenges.

- To deal with saline water intrusion and drought in Bac Lieu, the provincial government should invest in information technology systems to monitor water salinity. Accorrding to officials of irrigation management centre of Bac Lieu, staff of this centre had to test salinity of saline water using manual equipment. They need funds from government to build an information system for monitoring the salinity of the water. This programme would provide data to inform decisions. Farmers would then be confident to make decisions about their farming activities where they receive a reliable data on salinity from government.

- To deal with saline water intrustion and drought in the areas where two or three rice crops are grown in the dry season, the provincial government should upgrade current sluice gates and improve maintenance. Many sluice gates are old and have not worked well in recent years resulting in saline water accidentally leaking into fields and damaging rice crops.
- The provincial government should support funding and encourage local authorities and farmers to building collective irrigation systems. This would enable farmers to protect their rice from drought in the dry season, and allow more rain water to be stored in the rainy season to irrigate rice in the dry season.
- In order to build and operate an irrigation model in the fresh-water area, local authorities and farmers need to have collective decision-making activities for irrigation. A management board needs to be created involving the participation of farmers in collective decision-making for collective activities, including the time and cost for collective irrigation. They need to work with transparency, equality, trust and commitment among participants.
- Provincial and local government need to develop good models of cooperative irrigation to encourage cooperative behaviour of farmers. That is because farmers currently prefer working individually rather than collectively.
- Farmers in the fresh-water zone had challenges with selling rice, most farmers in the Hoa Binh selling their rice via local brokers at low prices. The provincial government and local authorities should facilitate negotiations between rice companies and farmers so that they are able to reach agreement for developing contracts.
- In saline water areas, the provincial government should upgrade canals every three years, instead of every five years similar to rice zone. Canals in the rice-shrimp area fill up with sediment from shrimp farming faster than in monocrop rice areas. Additionally, the area of raising shrimp is far from Phung Hiep canal (i.e., main canal extracting fresh water from the Mekong River to deliver to rice field) and saline water sources from sluice gates. This policy would contribute to overcoming the constraints of low quality and quantity of saline water for raising shrimp in the saline zone in the dry season.
- The provincial and local government should support the development and building of models of water control for saline and fresh water for rice-shrimp farmers. Saline water is required for raising shrimp whereas fresh water is

required for cultivating rice. The model of water control could contribute to improving the quality of saline water and minimise disease for shrimp. This model would provide fresh water for rice cultivation by extraction from the Mekong River and from rain water.

- Similar to fresh-water area for cultivating three rice crops, provincial and local authorities should provide funding and establish a management board for the water control model. The management board should be elected by farmers who have land parcels in the same large rice field, and be supported by local authorities. The management board should work with transparency, trust and commitment to ecourage farmers agree to participate in this model, farmers who use water for their field would be charged a fee. Thus, they need to work in transparently and treat all members who participate equally and fairly.
- The government should monitor and certify the quality of shrimp seed because shrimp seed was sold free on the market without being tested regularly by government officials.
- The provincial government should provide funding for a seed centre to run trials of rice varieties that can cope with saline soil (e.g., salinity >4 grams/litre). Furthermore, the rice centre should supply a greater amount of seed for local farmers than in recent years. Farmers have not had enough good seed to produce, and they have to pay at high prices for seed.

9.3 Limitations and future research

9.3.1 Limitations

The research methods of this thesis allowed me to collect the majority of data and information for this thesis. However, there were limitations and constraints in relation to selecting research sites, selecting farmer organisations, and applying a mixed-method data collection approach during the fieldwork in the VMD.

Firstly, selecting a suitable research site was a challenge in this study, although the research sites in this thesis built on research sites of the CLUES project. I needed research sites suited to the research objectives and research questions with conditions including two or three rice crops and rice-shrimp. Another requirement was that the research sites needed to have formal farmer organisations with collective farming activities so that research tools could be constructed with indices (i.e., statements) for measuring social capital factors. This enabled me to enhance the understanding of the diversity of different communes across the three provinces. This is because I could talk with different interviewees including farmers, local officials, local brokers (i.e., a middle person connecting farmers and rice traders), owners of combine harvesters, and owners of local agricultural materials shops.

Secondly, the study could not apply comparative case studies for different ACs or different LSFs across different provinces in the VMD because this thesis aimed to understand farmers' decision-making about rice-based farming systems and collective decisions for farming activities in those systems. As a result, the study had to identify the diversity of forms of farmer organisations to understand the collective actions of not only formal rural organisations, but also informal farmer groups, and the interactions between members of farmer organisations and general farmers (non-members).

Thirdly, conducting the research with a mixed-method approach of data collection (focus group discussions, semi-structured interviews, and household surveys) and multiple case studies across the three provinces allowed me have more insight into a range of issues in relation to diverse farmer organisations (FCs, ACs, and LSFs). The mixed-method approach offered complementary data collection between different methods in order to achieve enough data including qualitative and quantitative data (Chapter 3). In addition, the thesis enabled me to determine the relationship between local policies, geographical conditions, weather conditions, farmers' cooperative behaviours, and local rice markets. However, the range of communes in this study was a challenge for structuring the logical contents of the study because the topic and research methods of this thesis were new to local communities. In particular, some farmers did not understand the meaning of the terms in the Vietnamese language, namely decision-making; accordingly my research assistants and I had to spend time on explanation. Using a Likert scale method to ask farmers to estimate the score of social capital from 1 (completely disagree) to 5 (completely agree) was also challenging for us when we conducted household surveys because farmers were not familiar with this method, and so we had to spend time to explain this method.

Fourthly, there were two other constraints when I conducted focus group discussions. The first is that I sometimes discussed things with participants that proved to be unsuitable for focus group discussions despite working with local officials to help identify participants and interviewees in their commune. This made me spend more time on focus group discussions. This constraint did not influence the results of the data collection because there was only one unsuitable participant out of 6 or 8 participants in a focus group discussion. The second constraint is that I had to change the times for conducting focus group discussion with farmers in An Giang and Bac Lieu, although local officials helped me send formal invitation to invite farmers. This is because farmers were busy with harvesting rice, and preparing fields at the beginning of the new rice cropping season.

Fifthly, I also had constraints when I conducted semi-structured interviews with provincial officials in the VMD. In particular, it was difficult to meet to interview heads of the agricultural extension centre and other offices which belonged to the Department of Agriculture and Rural Development of provinces. These interviewees usually informed me that they were busy, and I had to work with their staff. However, their staff provided very little information in relation to data and information of this thesis at provincial scale (see Chapter 3). Then, I had to spend time on collecting data from different sources such as statistical offices of provinces and references. Generally, I collected the majority of data and information for this thesis by applying a mixed-method approach, but I had different constraints during fieldwork. The experience from conducting this thesis is very important for me and other scientists who would like to conduct future studies similar to my study in the VMD.

9.3.2 Future research

ACs should continue to be a significant topic of research in the future, but with comparative case studies or multiple case studies across different ecosystem zones in the VMD and over time. The case study approach and cognitive forms of social capital (cohesion, trust and commitment) or principles of governance (accountability and transparency) should be applied to explore the practical context of successful ACs and unsuccessful ACs, instead of only relying on the costs and benefits of organisations and members. Forms of social capital and factors of governance enable the researchers to identify practical factors influencing the process of cooperation and disagreement of participants engaging in ACs. Additionally, the case study approach allows us to understand, not only a certain context, but also factors relating to interactions between members within farmer organisations in communities. This type of study might require high funding resources and expertise in social sciences.

Future studies on collective adaptive capacity and strategies of farmers should be conducted across different zones of the VMD, especially coastal zones. Coastal zones were determined to be the most vulnerable zones in this research with poor weather conditions in relation to the pattern and time of rains, saline water, and markets. In 2016 and 2017, several communes in Bac Lieu planned to construct models of irrigation projects to deal with drought by controlling water in the rainy season for cultivating rice in the dry season in the fresh-water zone. The model of irrigation controls for good water conditions for rice and shrimp farming in the dry season and rainy season in the future. Methods that focus on aspects of social capital, institutions, and governance are recommended to be applied to understand factors in relation to transparency, accountability and commitment, and trust among members, and among members and leaders of irrigation organisations. These factors are significant indicators to evaluate whether cooperative models can be successful and sustainable in the long term.

Appendices

Appendix 1: Focus group discussion

The Australian National University
College of Asian Pacific, Crawford School of Public Policy

Focus Group Discussion Guidelines
For farmer groups
(*To be translated into Vietnamese*)

Roles of Farmer Groups in Adapting to Climate Change and Development Pressures in the Vietnamese Mekong Delta

Type of research:	PhD research
Principal investigator:	Hieu Hong Hua
Research sites:	An Giang Province
	Can Tho City
	Bac Lieu Province

Introduction and objectives of the focus group discussions

I am very grateful to your willingness to participate in the focus group discussion. Without your help, I cannot do this study.

My name is Hieu Hua, a PhD candidate at the Crawford School of Public Policy, the Australian National University, Australia. I am conducting this research for my PhD at the ANU. Before studying ANU I was a researcher of Mekong Delta Development Research Institute, Can Tho University. My PhD research explores the roles of farmer groups in adaptation to change of farming system and climate. The focus groups are implemented in the selected communes of An Giang Province, Can Tho City, and Bac Lieu Province.

For those of you who have never experienced getting involved in a focus group discussion, I would like to provide a brief introduction to what it is. Focus group is a useful way to gather information through a discussion. Accordingly, I will raise a number of questions or issues. Your participation in the discussion is strongly appreciated.

There are no right or wrong answers. Any kind of response, whether it is positive or negative, is welcome. I am very interested in hearing your views, comments and any experiences you may have. Also, I would like this to be a group discussion, so do not wait for your turn to provide a response. However, you are reminded that when someone is speaking, you are requested to wait until they finish their talk. Then you can have your say.

The objective of this study is to gather information on how to strengthen community capacity in adaptation to climate change as well as agricultural and aquaculture development, the way and policies your community improve capacity building throughout working together and individual to adapt to changes of climate and agricultural production. Those who are the key sources of information will be collected for the study.

The result of this study contributes to enhance the understanding requirement for strengthening community capacity in adaptation to changes of climate and agricultural and aquacultural production. It provides empirical evidence of how working together relates to resilience of farmer group and individuals in dealing with difficulties and constraint from changes of climate and agricultural and aquacultural production.

I would appreciate it greatly if all of you can be honest and participate fully in the discussion. The confidentiality of your identity will be kept safe and we can have this discussion in a relaxed and informal manner. Again, thank you very much for your participation in the group discussion. Do you have any questions before we get started?

Firstly, I would like to have your personal information.

Let us begin our group discussion.

1. What is general background of farmer group?

    Example:

    Number of members; farming system of members, capitals of members (land, water, main equipment), cooperative activities of farmer group, the social relationship between members

2. What is the network between farmer group and partners? (using Venn diagram)
3. How did community and individual make decisions on their farming?
4. How were the seasonal calendar of production and climate in the community?

Example

Activities and events	Monthly											
	1	2	3	4	5	6	7	8	9	10	11	12
Rice production												
Shrimp production												
Other crops												
Flooding												
Saline water												
Raining												
Temperature (hot, cool, cold)												
Salinity frequency												

Note: times in year; occurred sort or long time, low or high, frequency

5. Were there any special changes or events of climate, agricultural and aquaculture farming, and farmer groups in recent years?

Example

Time	climate	Farming system	Farmer group	Dike/sluice gate	Cooperative	Mass organisation

Note: times in year; sort or long time, low or high, frequency

6. How did climate influence farming system?

Example

Events of climate change	Impacts
Abnormal hot temperature and lack of water in dry season	• Increased cost for pumping water into field • Lack of water in dry season • Increase salinity
Abnormal raining or changing seasonal calendar of raining	• Increased cost of pumping water out and falling paddy • More insects and rodents (An Giang only); Reduced productivity of rice • Change time, cost of sowing seed, harvest, fertiliser, pesticide, weed, post-harvest
Other factors	Lack of labor in harvest, sowing, transplanting

7. What are activities of farmer groups or working together in adaptation to change of climate and farming systems?

Activities	Score from constraint to high strength				
Training	1	2	3	4	5
Cooperation with agency					
Output market					
Support harvest machine					

8. What are advantages and disadvantages of adaptation to change of farming system?

   Example

Factors	Score from constraint to high strength				
Soil degradation	1	2	3	4	5
Irrigation management					
Output market					
Raining in harvest seasons					

   1 = high constraints, 2 = constraint, 3 = neutral, 4 = strength, 5 = high strength

9. How did community and individual make decisions on their farming? Including rice-based farming systems and farming activities.
10. How have farmers applied materials into production and yields in recent years?

    Example

    Fertiliser application much more than before *(group with changing farming system)*

Indicator	2013	2010
Yield (tonnes)		
Fertiliser (kg)		
Pest and diseases management		
Irrigation		
Seed		

11. What are strategies in adaptation to change of farming system? (group with changing *farming system)*

12. How have these strategies or experiences have applied? (good/bad), and why?

13. Could you define the *success (good) and un-success (bad)* of farmer groups?

    Examples:

    - High number of members
    - Good cooperation with outside agencies
    - High active response to high flood
    - Government support

14. What are factors that influence on *success (good) and un-success (bad)* of farmer groups or mass organisations in adaptation to changes of farming system and climate? (weight ranking)

Example

Factors	Small land size (1)	Member attitude (2)	High input price (3)	Total
Small land size (1)	0	1	1	5
Member attitude (2)	1	0	1	0
High input price (3)	1	3	0	1

15. What is strength and weakness of resilience factors of farmer group?

factors		Score from constraint to high strength				
Member	Education	1	2	3	4	5
	Experience					
	Cohesion					
	Trust					
	Gender (women)					
Collective skills	Learning					
	Sharing					
Network	Outsider agency					
	Company					
Innovation	New technique					
	New canal					
	New seeding					
Government support	Finance					
	No tax					
	Training					

16. What are the constraints of working together?
17. What are the main factors influencing on the increase or the decrease in working together in this period?
18. What need to be done to improve working together in the future? (using weight ranking)

Example

Ways	Government campaign	Enhancing leader capacity			
Government campaign					
Enhancing leader capacity					

19. Are you happy to share your experience of working farmer group with other local communities? If yes, how can you share to them; if not, please give us reasons.

Appendix 2: Guideline for semi-structured interviews

The Australian National University
College of Asian Pacific, Crawford School of Public Policy

Semi-structured Interview Guidelines
For Key government officials, group leaders, and experienced farmers
(*To be translated into Vietnamese*)

Roles of farmer groups in adapting to climate change and development pressures system in the Vietnamese Mekong Delta

Type of research:	PhD research
Principal investigator:	Hieu Hong Hua
Research sites:	An Giang province
	Can Tho city
	Bac Lieu province

Introduction and objectives of the Semi-structured interview

Thank you for your agreement to get involved in this interview. Your personal viewpoint is highly appreciated and important to my study.

My name is Hieu Hua, a PhD candidate at the Crawford School of Public Policy, the Australian National University, Australia. I am conducting this research for my PhD at the ANU. Before studying ANU I was a researcher of Mekong Delta Development Research Institute, Can Tho University. My PhD research explores the roles of farmer groups in adaptation to change of farming system and climate. The focus groups are implemented in the selected communes of An Giang Province, Can Tho City, and Bac Lieu Province.

This interview is to identify how to strengthen community capacity in adaptation to climate change as well as agricultural and aquaculture development, the way and policies your community improve resilience throughout working together and individual to adapt to changes of climate and agricultural production.

The result of this study contributes to enhance the understanding requirement for strengthening community capacity in adaptation to changes of climate and agricultural and aquaculture production. It provides empirical evidence of how social capital relates to resilience of farmer group in dealing with difficulties and constraints from change of climate and agricultural and aquaculture production.

During the interview process, please let me know if you are not willing to respond to any questions and we will skip them. It is also eligible for you to refuse or withdraw from the interviews any time of your discomfort to the questions.

Finally, I would hereby like to express my appreciation for your participation in the interview.

Name of interviewer:..

Place of interview:……………………………..Date:……..……………………………

Name of respondent:………………………………..Date:………………..……………

Respondent's occupation: ………………………Contact number: ……………………

Farmer perception of cooperatives and farmer groups

1.1 Before cooperative policies (before 1975)

1. Have there been any forms of working together in agricultural and aquaculture production in your commune?
2. How did they organise farmer groups?
3. How did farmer groups or community make decisions on their goals/works/farming?
4. Were there group/team leaders?
5. What were the activities like?
6. Why did they work together?
7. What did they contribute to groups and community?

   Ex: time, money, variety, knowledge and other resources
8. What did farmers think of farmer groups in the commune? And why did they think so?
9. What did you think of farm groups in the commune? And why?

1.2 Period of cooperative policies in collective economy: 1975-1986

Formal cooperative or farmer group

1. When was the process of cooperative applied into the commune?
2. How many activities were there in cooperatives or farmer groups?
3. How did other main policies relate to cooperatives and farmer groups?
4. How did farmers get involved into cooperatives?

5. How did farmer groups or community make decisions on their goals/works/farming?
6. What and how much did farmer have to contribute to?
7. What and how much did farmer get?
8. Who gained and lost more benefits than other in cooperative? Why?
9. Did they support cooperative forms and institutions? Why?
10. How many percentages of household in this commune supported the cooperatives?
11. If farmers did not support, what did they do at that time?
12. How did local government apply new policies to improve cooperatives and farmer groups?

Informal cooperative or farmer group

1. Have there been any forms of working together in agricultural and aquaculture production in your commune in this period?
2. How did they organise farmer groups?
3. How did farmer groups or community make decisions on their goals/works/farming?
4. Were there group/team leaders?
5. What were the activities like?
6. Why did they work together informal form, but not formal form?
7. What did they contribute to groups and community?

    Ex: time, money, variety, knowledge and other resources

8. What did farmers think of farmer groups in the commune? And why did they think so?
9. What did you think of farm groups in the commune? And why?
10. What are the main factors influencing on the increase or the decrease in working together in this period?

1.3 Period of farmer groups and cooperative policies in market-oriented economy

Formal cooperative and farmer groups

Division of period is based on the issue time of policies:

Ex: Cooperative: 1996; 2003

Farmer cluster: 2005

More policies will be found in the field work

Informal cooperative or farmer group

1. Have there been any forms of working together in agricultural and aquaculture production in your commune in this period?
2. How did they organise farmer groups?
3. How did farmer groups or community make decisions on their goals/works/farming?
4. Were there group/team leaders?
5. What were the activities like?
6. Why did they work together informal form, but not formal form?
7. What did they contribute to groups and community?
   Ex: time, money, variety, knowledge and other resources
8. What did farmers think of farmer groups in the commune? And why did they think so?
9. What did you think of farm groups in the commune? And why?
10. What are the main factors influencing on the increase or the decrease in working together in this period?

Climate changes and agricultural production and aquaculture farming

1. What kinds of climate change might influence agricultural and aquaculture production?
   Ex: Abnormal raining; flooding; salinity intrusion, hot temperature
2. How is raining season in the commune?
3. More/less raining at the beginning or at the end of season; or common?
4. How did abnormal raining impact on production?
5. How has flooding level changed in the commune?
   Ex: Higher/lower; occur sooner/later; short/long time
6. How did flood or saline water intrusion affect production?
7. How did local people resist/prevent/adapt to the constraints?
8. Why did farmers choose this measure to deal with constraints?
9. How much does it cost to deal with constraints?
10. Has it worked well/not, and reasons for that?

Working together; farmer groups to deal with climate change

1. Have farmers ever worked together to deal with climate change for agricultural and aquaculture production?
2. How have they worked?

Ex: Contribute their time, labour, sharing experiences/information.

3. How did farmer groups or community make decisions on their goals/works/farming?
4. How do they share benefits in working together/groups?
5. What kinds of challenge did working together have, and how did the group solve that problems?
6. Has local government supported working together/farmer groups? Why?
7. What has government supported or assisted working/farmer groups together?
8. Is working together important? And why?
9. **B.5. If you were to change to a new rice variety, what are the most important features?** ***(this question will be asked in semi-structured interview)***

10. 1 = not at all important

11. 2 = of little importance

12. 3 = neither unimportant or important

13. 4 = important

14. 5 = very important

Characteristic	1	2	3	4	5
1. Height					
2. Salt tolerant (SalTol)					
3. Flood tolerant (Sub1)					
4. High temperature tolerant					
5. Higher yield					
6. Growth duration					
7. Stem strength					
8. Pest and disease resistance					
9. Grain quality					
10. Good output price					

Working together in increasing adaptive capacity of climate change in the future

1. Have farmers in the commune supported working together in the future? Why?
2. If they support, how do they need to do to work together?
3. What kinds of activities are they interested in working together?
4. How will farmer groups or community make decisions on their goals/works/farming?

   Regarding micro-credit: capital, interest, duration, sources of borrowing (the relationship between borrowers and lenders), and purpose of expenditures.

Regarding training: number of trainings (and reasons for selecting this training), number of participated people, location and duration, who in involvement, frequency.

Regarding controlling saline water intrusion or flood: who involvement, ways of control, cost, working together or individual, participation.

Other innovation: seedling (experiment), apply new technique.

5. Has this kind of work/model been ever done /applied in the commune before or other place?
6. If your commune has successful farmer groups/model, are you willing to share to other places? Why and why not?
7. What are the main factors influencing the success of farmer groups?
   Ex: kinship, strong institution, government support, good land quality and irrigation system, good topography, etc.
8. What are the main factors influence on learning and sharing information?
   Ex: education, knowledge, social capital

Learning from change of farming system *(for experience farmer with change of farming system)*

1. What are the main constraints and advantages of new farming system?
   Ex: poor irrigation system, weak dike, big raining in harvest season, difficult to find good variety, difficult to control insect, high yield,
2. How did households deal with constraints?

Ex: upgrade dikes, book harvest machines early, found rice varieties early, learning new techniques to control insects

3. Is that successful to deal with constraint?
4. If there are any unsuccessful, please give us the reasons for this.

Appendix 3: Questionnaire for Household surveys

The Australian National University

College of Asian Pacific, Crawford School of Public Policy

Questionnaire for Household Survey

Members of farmer group

(*To be translated into Vietnamese*)

Roles of farmer groups in adapting to climate change and development pressures in the Vietnamese Mekong Delta

This research identify how to improve your resilience and community in adaptation to climate change as well as agricultural and aquacultural development, the way you improve resilience throughout working together and individual to adapt to changes of climate and agricultural production in your community.

I would appreciate it greatly if you can honestly provide your responses to this survey. Your information disclosed in the survey is confidential. The researcher really appreciates your taking the time to do this.

Investigator

Hieu Hua, PhD Candidate

Crawford School of Public Policy

The Australian National University, Canberra, ACT 0200

Email: hieu.hua@anu.edu.au

Phone: +61. 0424024900

Local Contact

Hieu Hua, Researcher

Mekong Delta Development Research Institute

Can Tho University

3/2 street, Ninh Kieu district, Can Tho city

Phone: 0948460977

ACTIVITY CODES

0 = no income activities (invalid, student, unemployed,…)

Production activities / crops:	Paid activities / jobs:
1 = Growing rice 2 = Growing vegetables 3 = Growing fruit trees 5 = Aquaculture 6 = Livestock (any kind of livestock, cows, pigs, poultry…) 7 = Fishing 8 = Collecting other aquatic species 9 = Collecting forest products (collecting wood, honey…) 10= Making handicrafts (baskets, sawing, weaving…) 11 = Growing mushroom 12= Growing cereal (including sesame?) 15 = Sugar cane 16 = Cassava, jam, 17 = Other (specify) ____________________ 18 = Other (specify) ____________________	51 = Farm labour; 53 = Food processing or sale of agricultural goods (not produced by you); 54 = Manufacturing Industry; 55 = Construction related activities; 57 =Tourism (accommodation, restaurants, food stalls, tours etc) and services other; 58 = Government employee; 59 = Food processing or sale of fish and other aquatic animals and plants (not grown or caught by you); 62= Family business other 63= Remittance from another activity 63xx = remittance + code for activity if declared (i.e. 6354) 64= other services 65= pension 66= income from land or other property lease 68 = Other (specify) ____________________ 69 = Other (specify) ____________________

A.06 Date of Survey and Start time		
		A.00 Survey number: **A.07 Initials of Interviewer:**

A.1 Household identification and location

A.01 Country code	***4***
A.02 Province	
A. 03 District/ county	
A. 04 Commune/ village committee	
A. 05. Village name/ natural village / Hamlet	
A.1.1 Has HH head/ family moved into this village?	*Yes = 1* *No =0*
IF YES, ANSWER A1.2 – A1.4:	
A.1.2.If yes, what year did that person move?	Year
A.1.3. Did that person move voluntarily?	Yes = 1 No =0
A.1.4. Where did that person move from? (name of province)	41= (province within study area; please provide names)

	42= Other province in Delta (or South Vietnam?) *43*= Other province in other part of Vietnam *44*= Other country

No	Relation to the HH head *(code)*	Lives permanently in HH *(y=1; n=0)*	Age *(numb)*	Gender *1=male 2=female*	Education *(code)*	Main Activity *(code)*		HH ethnicity *(code)*	Active membership *(code)*	

Person being interviewed (number from table above) __________

1 (head), 2 (spouse), 3 (child), 4 (child in-laws), 5 (grand child), 6 (parents), 7 (sibling), 8 (relatives), 9 (other…)	*0 (illiterate), 1 (primary), 2 (basic secondary), 3 (secondary/ high school), 4 college 5= university and higher*	*on your laminated sheet (page 1)*	*41 (kinh), 42 (Hoa), 43 (Khmer), 44 (Cham), 45 (others - write.)*	*41 (farmer association), 42 (woman union), 43 (youth union), 44 (veteran union), 45 (agricultural extension club), 46 Cooperative groups 47 Cooperative 48 Farmer club 49 Seedling group 50 Large model field 0 (no organisations)*

A.3 Household assets

Please indicate which of the following is OWNED (not borrowed or rented) by the household.

Asset	Code
A.30 Homestead *(codes: if no = 0; if yes = size in m2)*	m2 1= concrete- tiled 2= prefab-steel 3= concrete-steel 4= wood-cottage 5= wood-steel
A.31 Total farm size *(codes: if no = 0; if yes = size in m2)*	
If yes: : A.32 How much is under your own production? m2	
A.33 How much is leased to others to produce m2	
A.34 How much is not worked on? m2	
Does your land include: A.35 Orchards *if no = 0; if yes = size in m2)*	m2 0= no 1 = Irrigated 2 = Rainfed 5 = Abandoned 6 = groundwater
A.36 Ponds or trenches	m2 0= no 1 = Irrigated 2 = Rainfed 5 = Abandoned 6 = groundwater
A.37 Rice fields	m2 0= no 1 = Irrigated 2 = Rainfed 5 = Abandoned 6 = groundwater
A.38 Dikes	m2 0= no 1 = Irrigated 2 = Rainfed 5 = Abandoned 6 = groundwater
A. 39 Livestock	………………………………number
A. 310 Upland crops (vegetables) /flowers	m2 0= no 1 = Irrigated 2 = Rainfed 5 = Abandoned 6 = groundwater
A. 3111 others	m2 0= no 1 = Irrigated 2 = Rainfed 5 = Abandoned 6 = groundwater
A.312 Does your HH own any of the following	1 = tractor

farm machinery	2 = hand tractor 3 = rice harvester 4 = pump 5 = milling equipment 6 = livestock/fish feed equipment 7 = sprayer for pesticide and herbicide 8 = others…………………….. 0=no

A.314 Does your HH own any of the following fishing gear	1 = nets (cast, gill, pulling, lift, bottom) 2 = hook line 3 = traps 4 = damming/fencing 5 = fishing boat 6 = others……………………………... 0=no
A.315 Does your HH own any of the following mode of transport	1 = paddle boat 2 = big boat/motorboat 3 = bicycle 4 = motorbike 5 = van 6 = mini-truck 7= car 8= others……………………... 0=no
A.316 Does your HH own any of the following HH items	1 = TV 2 = radio 3 = mobile phone 4 = tank 5 = tape water 0=no
A. 317 Does your household have any long-standing debts? *codes: if no = 0; if yes = 1*	…………………………………….
A.318 Did your household save any money last year? *codes: if no = 0; if yes = 1*	…………………………………….

A317.1 If you have long-standing debts please provide more following information

Sources of borrow (*)	interest	Period of borrow	Returning time
A317.11			
A317.12			
A317.13			

Note: (*) 1= local agricultural bank, 2 = policy bank, 3 = cooperative, 4 = farmer cluster, 5 = farmer club, 6 = farmer union, 7 = women union, 8 = neighbour, 9 = relative, 10 = others

A318.1 If you save money for other people loan please provide more following information

Who borrow	interest	Period of loan	Returning time
A318.11			

Note: (*) 1= local agricultural bank, 2 = policy bank, 3 = cooperative, 4 = farmer cluster, 5 = farmer club, 6 = farmer union, 7 = women union, 8 = neighbour, 9 = relative, 10 = others

A.4 For the land you use for agricultural production please indicate

	Area (ha)	Ownership(*)	Land-used pattern(**)	Land location (***)
A.41 + Orchard *(including trench)*				
A.42 + Fish ponds				
A.43 + Field, plot 1				
A.44 + Field, plot 2				
A.45 + Field, plot 3[22]				
A.48 + Other________				

(*): 1 = self ownership (1a: husband; 1b: wife; 1c: others); 2 = rented in; 3 = rented out

(**): 1= rice-rice; 2=rice-rice-rice; 3=rice-upland crop; 4=rice-upland crop-rice; 5=upland crops; 6= vegetable; 7=rice-fish; 8=rice-shrimp; 9=shrimp; 10=fish; 11= fallow; 12=other (_________)

(***): 0= not participate in any forms of farmer group, 1 = the same land location of other member in cooperative, 2 = the same land location of other member in large model field, 3 = the same location of other member in farmer club, 4 = other

A.5 What is the soil and salinity conditions of your field plots?

	Soil type(*)	Salinity affected(**)	Irrigation status in dry season(#)	Irrigation status in wet season(#)	Drainage status(##)
A.51 Field, plot 1					
A.52 Field, plot 2					
A.53 Field, plot 3					
A.54 Field, plot 4					

(*): 1= alluvial; 2=acid sulphate; 3=saline

(**): 1=yes; 2=no

(#): 1=tidal & good; 2=tidal & moderate; 3=tidal & bad; 4=pumping; 5=rainfall; 6=groundwater

(##): 1=tidal & good; 2=tidal & moderate; 3=tidal & bad; 4=pumping

[22] Including dike, trench in rice-fish/shrimp system. In this case please estimate the proportion of dike (%), trench (%) and field surface (%) that sum up 100%.

Part B: Household activities

B.1. LOCATION OF LIVELIHOOD ACTIVITIES

B.1.1.Where does your most important livelihood activity take place? (code)

1= within the commune; 2= outside the commune and comuting daily; 3= outside the commune and comuting occasionally

B.2. What are your sources of information about weather conditions?

1 = do not use at all

2 = use occasionally

3 = use monthly

4 = use weekly

5 = use daily

Source	**Frequency of use**				
	1	2	3	4	5
1.Radio					
2. Newspaper					
3. Television					
4. Neighbour					
5. Family member					
6. Internet					
7 Traditional knowledge					
8. Local extension staff					
9. Scientists					
10.Field Station					
11. Members from farmer group					
12. Group member					
13. other (specific)					

B.3. What are your sources of information about rice varieties

	1	2	3	4	5
1.radio					
2. Newspaper					
3. Television					
4. Neighbour					
5. Family member					
6. internet					
7 Traditional knowledge					
8. Local staff					
9. Scientists					
10.Field station					
11. Members from farmer group					
12. Farmer group					
others (specify)					

B4. Where would you get the new variety?

1= Company

2= Seed production centre

3= Neighbour

4 = Family

5 = Seed production Club

6 = Research Institute

7 = University

8 = member of farmer group

9 = Farmer group

How often do you change your rice variety? (years)

Part B: Household activities (livelihood strategies)

In the previous year/ cropping year (Jan 2014 – December 2015)

Part B.6: Outputs and costs of production activities (focus on main crops of each research site)

1. B6.01 Crop/harvest 1…………………..B8.011 Grown area…………………….m²

Outputs/inputs	*Amount (ton, kg, day, amount)*	*Unit price (đồng)*	*Amount (đồng)*
B6.01.1 Outputs			
B6.01.11 Total output		*N/A*	*N/A*
B6.01.12. Sold			
B6.01.13. Home consumption			
B6.01.14. Animal feed			
B6.01.15. Others………………………………			
B6.01.16. By-products: Sold Farm reused			
B6.01.2 Costs			
B6.01.21 Land preparation/pen/pond construction			
B6.01.22. Seed			
B6.01.23. Fertilisers/feed: 23.1. 23.2. 23.3. 23.4.			
B6.01.24. Pesticides/medicine			
B6.01.25. Energy (fuel, electricity):……			
B6.01.26. Other materials………………………			
B6.01.27. Irrigation……………………			
B6.01.28. Harvesting: .280 Machine ☐ Manual ☐			
B6.01.29. Total hired labour			
B8.01.3 Total costs	*NA*	*NA*	

2. B6.02 Crop/harvest 2…………………..B8.021 Grown area…………………….m^2

Outputs/inputs	*Amount (ton, kg, day, amount)*	*Unit price (đồng)*	*Amount (đồng)*
B6.02.1 Outputs			
B6.02.11 Total output		*N/A*	*N/A*
B6.02.12. Sold			
B6.02.13. Home consumption			
B6.02.14. Animal feed			
B6.02.15. Others………………………			
B6.02.16. By-products: Sold Farm reused			
B8.02.2 Costs			
B6.02.21 Land preparation/pen/pond construction			
B6.02.22. Seed			
B6.02.23. Fertilisers/feed: 23.1. 23.2. 23.3. 23.4.			
B6.02.24. Pesticides/medicine			
B6.02.25. Energy (fuel, electricity):……			
B6.02.26. Other materials………………………			
B6.02.27. Irrigation……………………			
B6.02.28. Harvesting: .280 Machine ☐ Manual ☐			
B6.02.29. Total hired labour			
B8.02.3 Total costs	*NA*	*NA*	

B6.03.1 cost and output of other crops

	Other crops	Cost	Total output	Price	Amount
	B6.03.11				
	B6.03.12				
	B6.03.13				

Note: 1= water melon; 2=corn; 3 = other upland crops (specific……..)

B6.04.1 Cost and output of livestock and poultry

	Livestock and poultry	Cost	Total output	Price	Amount
	B6.04.11 Pig				
	B6.04.12 Chicken				
	B6.04.13 Dug				
	B6.04.14 others				

Part B.7: Household (non-farming/paid) activities that generated direct cash income (including pension and subsidy from the government)
(for HH members only)

Activities	Tháng											
	6/10	7	8	9	10	11	12	1/11	2	3	4	5
7.01 Code:												
7.11 Persons												
7.21 Days/month												
7.31 Hrs/day												
7.41 Location (code)												
7.02 Code:												
7.12 Persons												
7.22 Days/month												
7.32 Hrs/day												
7.42 Location (code)												

Location: 1= within commune; 3= outside commune and commuting daily; 4= outside commune and commuting sometimes

C. NATURAL AND HUMAN INDUCED HAZARDS, VULNERABILITY, RISK, COPING CAPACITY & ADAPTATION STRATEGY

C.1. Has your family experienced the following within the last 10 years

1 = not at all important

2 = of little importance

3 = neither unimportant or important

4 = important

5 = very important

Event	0=No 1= Yes	Year of event	If yes how important was this to your livelihood				
1. Higher than normal temperatures			1	2	3	4	5
2. Lower than normal temperatures							
3. Small/big floods							
4.High Tides							
5.Heavy rains							
6.Droughts							
7.Salinity intrusion							
8.Acidification							
9.Storms							
10.Cyclone							
11.Lightning							
12 late onset monsoon rain							
13.Soil erosion							
14.Insects outbreak							
15.Diseases outbreak							
16. Pests (could be rats, golden snail etc…)							
17. Irrigation supply problems							

C.2. Please tell us how these experiences have affected your agricultural production?

No Change =0 **negative = 1** **positive = 2**

Event	Rice	Vegetable	Upland crop	Shrimp	Fish
1. High temperature Change Change (kg)	________ ______	________ ________	_______ _______	_______ _______	_____ _____
2. Low temperature Change Change (kg)	________ ______	________ ________	_______ _______	_______ _______	_____ _____
3.Abnormal floods Change Change (kg)	________ ______	________ ________	_______ _______	_______ _______	_____ _____
4.High tides Change Change (kg)	________ ______	________ ________	_______ _______	_______ _______	_____ _____
5. Heavy rains + Change Change (kg)	________ ______	________ ________	_______ _______	_______ _______	_____ _____
6. Droughts Change Change (kg)	________ ______	________ ________	_______ _______	_______ _______	_____ _____
7. Salinity intrusion + Change Change (kg)	________ ______	________ ________	_______ _______	_______ _______	_____ _____
8. Acidification Change Change (kg)	________ ______	________ ________	_______ _______	_______ _______	_____ _____
9. Storms Change Change (kg)	________ ______	________ ________	_______ _______	_______ _______	_____ _____

10. Cyclones Change Change (kg)	________ ______	________ ________	_______ _______	_______ _______	______ ______
11. Lightning Change Change (kg)	________ ______	________ ________	_______ _______	_______ _______	______ ______
12. Soil erosion Change Change (kg)	________ ______	________ ________	_______ _______	_______ _______	______ ______
13. Insect outbreak Change Change (kg)	________ ______	________ ________	_______ _______	_______ _______	______ ______
14. Diseases outbreak Change Change (kg)	________ ______	________ ________	_______ _______	_______ _______	______ ______
15. Pests (snails, rats,...) Change Change (kg)	________ ______	________ ________	_______ _______	_______ _______	______ ______
16. Irrigation supply problems Change Change (kg)	________ ______	________ ________	_______ _______	_______ _______	______ ______

C.3. How has this affected your

Agricultural production and infrastructure	Type of natural hazards*	Your response**	Who made that decision
Rice production	________ ________ ________	________ ________ ________ ________ ________ ________	________ ______ __ ________ ________ ________ ________
Vegetable production	________ ________	________ ________ ________ ________	________ ______ __ ________ ________
Fruit trees	________ ________	________ ________ ________ _______	________ ______ __ ________ ________
Fish production	________ ________	________ ________ ________ ________	________ ______ __ ________ ________
Shrimp production	________ ________	________ ________ ________ ________	________ ______ __ ________ ________
Other production (specify)			
Off-farm			
Non-farm			

Type of natural hazards:
1) High temperature, 2) Low temperature, 3) Floods, 4) Tidal movements,
5) Unusual rains, 6) Drought, 7) Salinity intrusion, 8) Acidification, 9) Storms,
10) Cyclone, 11) lightning, 12) Soil erosion, 13) Insect outbreak, 14) Disease outbreak
15) Others (specify________________________________)

*****How have you responded***
1) Adjust seasonal calendar
2) Apply new technology
3) Use physical stress-tolerant crop varieties
4) Use crop varieties resistant to pests and diseases
5) Apply new rice-based farming systems
6) Change water-management methods (alternated wetting and drying method, constructing dams,

7) Narrow/stop farm and hire out land
8) Shift to services, trading activities
9) Migration
10) Borrow loans, decided by husband [ ]; wife [ ]
11) Working together with members of farmer group and community to respond (specific: activity)
12) No change
13) Others (specify)

Decision
1 myself
2 spouse
3 myself and spouse
4 family
5 together with neighbours
6 together with farmer group and community

C.4. How do these factors affect your production?

Factors	Not sure =0 -ve =1 +ve =2	Importance scale (1: lowest; 5: highest)				
		1	2	3	4	5
1. Water accessibility						
2. Land availability						
3. Access to markets for new crops						
4. Access to credit for materials/tools and services						
5. Availability of family labour force						
6. Access to information						
8. Access to social networks (other farmers)						
9. Access to external support and extension services						
10. Access to irrigation systems						
11. Availability of new rice varieties						
12. Reliability of irrigation systems						
13. Family support						
14. Roads and other infrastructure						
15. Agricultural mechanization						
16 Costs of production						
17 Market prices						
18. Farmer group support						
19. Others (specify)						

Note: +ve = positive; -ve = negative

We can use: - 5, -4, -3, -2, -1 (negative), 0, 1, 2, 3, 4, 5 (positive)

D: Farmer group, social capital, activity of farming, community, and externality of farmer group

D.1 When did you involve in farmer group?...............

D.2 How many percentage of share have you contributed to farmer group?

D.01. Benefits after involvement of farmer group

Activity	Impact level on farming system Importance scale (1: lowest; 5: highest)						
	Yes = 1; 0 = No		1	2	3	4	5
	Internality (*)	Externality (**)					
01.1. Access training							
01.2. Access internal credit							
01.3. Good irrigation							
01.4. Seeding service							
01.5. Reducing cost of production							
01.6. Stable output							
01.7. Harvest machine supply							
01.8. Access good pesticide							
01.9. Other activity (specific)							
01.10. Other activity (specific)							

Note: 1=low important, 2 = slightly important, 3 = important, 4 = very important, 5 = extremely important
(*) Internality: self-organisation of farmer group; (**) Externality: farmer group invites outside agencies

D.02. Social capital and activities of farmer group

Social capital	Relevant activities to social capital	1	2	3	4	5
Social cohesion (bonding)	02.1. Members will share new knowledge with their members					
	02.2. People are friendly in the organisation					
	02.3. Members usually agree to begin crop at the same time					
	02.4. Members are willing to work together to protect crops					
	02.5. I regularly participate working groups					
Social trust (bonding)	02.6. I believe that the farmer organisation supplies good services of irrigation and draining of water out of farms					
	02.7. I am confident that the organisation assists members to get harvest machines in time of crop seasons					
	02.8. I am confident that the organisation supplies seeding in time in internal rule of farmer organisation					
	02.9. I am confident that organisation lend money in time in internal rule of farmer organisation					
	02.10. I believe that organisation's members are willing to spend their time to upgrade dyke, prevent salinity, and help each other when it rains in harvest seasons					
	02.11. I confident that members will pay back money to					

	the organisation in time					
Social commitment (bonding)	02.12. Organisation's members inform other members and the community about pest and diseases their crops get					
	02.13. Members will inform other members and community of the time they discharge waste water outside to the community					
	02.14. Farmer organisations are active and inform to all members every time they have training (with outside agencies)					
	02.15. Farmer organisation is willing to protect members in transactions with output companies					
	02.16. Members have good duty to their contract with companies					
	02.17. Members of organisation respect the rules of organisation (follow seasonal calendar of organisation)					
	02.18. Leadership of organisation is pair and transparency					

5= completely agree; 4= agree; 3=Neutral; 2=disagree; 1= completely disagree

F. Suggestions for improving working together in increasing capacity of climate change adaptation

F.01. How will farmer group and members improve their relationship throughout production and social activities? Such as attending training together, working in group to deal with flooding, salinity, sharing rice varieties, and irrigation

F.02. How will farmer groups and members improve their relationship with community and outside stakeholders throughout services, buy and sell products, and other activities?

F.03. What should government support farmer groups to improve working together of farmer group in the coming years?

F.04. Could you suggest any ways to improve or develop your farmer group or working together in coming years?

Surveyor notes:

End time	
Length (time) of interview	
Data checked by	
Data input checked by	
Spreadsheet file name	
Interviewer initials and signature	

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