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DYNAMICS OF AGRARIAN SYSTEMS IN HAI DUONG PROVINCE, NORTH VIETNAM

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Abstract

In Vietnam, the agrarian systems have evolved considerably during the socio-economic transformation period initiated in the late 1980s with the political reform (Doi Moi). In a region around the capital, where the process of industrialization, urbanization, and international integration has been accelerating, a number of questions about the sustainability of agrarian systems are raising. By diagnosing and analysing the dynamics of agrarian systems from 1980 to 2010, this study aims to provide decision-makers with some sectorial and territorial policy options authorizing the sustainable development of agriculture and rural society in the new socio-economic context. Combining the historical, adaptive, and systematic approaches, this study shows that farmers in Hai Duong province adapted effectively to the socio-economic and institutional changes, notably by transforming part of the rice land areas into other agricultural land use purposes such as fish ponds, animal buildings, vegetable fields and fruit orchards. These rapid changes, however, do not go in the direction of improving the sustainability of agrarian systems. Farm holders are now facing with many technical and economic contradictions whereas land issues are not only related to the agricultural purposes. Competition functions in land use, fragmentation of plots, the imperfection of the land market and rising property values are all emerging. The prospects for sustainability of agrarian systems are analysed under different scenarios which highlight the complexity of policy options. The recommendations are made not only for the agricultural sector in general, but also for different agrarian systems in specific regions.

HAN QUANG Hanh (2013). Dynamique des Systèmes Agraires dans la Province de Hai Duong au Nord du Vietnam. (Thèse de doctorat en anglais). Université de Liège – Gembloux Agro-Bio Tech, Belgique. 271 pages, 61 tableaux, 80 figures, 8 encadrés.

Résumé

Au Vietnam, les systèmes agraires ont considérablement évolué au cours de la période de transformation socio-économique initiée à la fin des années 80 avec la politique de réforme du Doi Moi. Dans une région proche de la capitale, où les processus d'industrialisation, d'urbanisation et d'intégration internationale s'intensifient, la durabilité des systèmes agraires soulève de nombreuses questions. Basée sur le diagnostic et l'analyse des dynamiques agraires entre 1980 et 2010, cette étude vise à fournir aux décideurs un éclairage sur les options de politiques sectorielles et territoriales autorisant le développement durable de l'agriculture et de la société rurale dans le nouveau contexte régional. Combinant les approches historique, adaptative et systématique, cette étude montre que les agriculteurs de la province de Hai Duong se sont effectivement adaptés aux changements socio-économiques et institutionnels notamment en transformant des rizières à la faveur d'autres utilisations des terres agricoles telles que des étangs de pisciculture, des bâtiments d'élevage ou des plantations fruitières pérennes. Ces modifications rapides ne vont cependant pas dans le sens d'une amélioration de la durabilité des systèmes agraires. En effet, les agriculteurs sont désormais confrontés à de nombreuses contradictions techniques et économiques alors que l'enjeu lié au foncier dépasse la logique d'une mise en valeur agraire. La compétition des fonctions dans l'occupation des sols, la fragmentation du parcellaire, l'imperfection du marché foncier et la hausse des valeurs immobilières sont autant de problèmes émergents. Dans un exercice de prospective, les perspectives de durabilité des activités agricoles sont analysées selon différents scénarii. L'auteur constate que les options stratégiques ainsi que leurs implications politiques sont complexes. Il adresse des recommandations de portée générale pour le secteur agricole mais aussi spécifiques pour les différents systèmes et territoires analysés.

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LIST OF ABBREVIATIONS

ADB:	Asian Development Bank
e.g :	For example
etc:	et cetera
FAO:	Food and Agriculture Organization
GDP:	Gross domestic product
GP:	Gross Product
GSO:	General Statistical Office
ha:	Hectare
HHs:	Households
HSO:	Hai Duong Statistical Office
IC:	Intermediate Consumption
NFI:	Net farming income
NGOs:	Non-governmental Organizations
No:	Number
Sao:	equal to $360m^2$
PRRS:	Porcine reproductive and respiratory syndrome
SD:	Standard Deviation
SR :	Sub-region
USDA:	United State Department of Agriculture
VA:	Value-added
VAC:	Vuon, Ao, Chuong (Garden, Fish Pond, Animal Shed)
VND:	Vietnamese dong

1. INTRODUCTION

1.1 Problem statement

The Red river delta, which is known as one of the two largest deltas in North Vietnam, is very advantageous for agricultural production thanks to its favourable agro-ecological and socio-economic environments. The soil of the delta has been enriched annually over a long period by the deposits of alluvium layers from the Red river. The availability of water supply also favours the cultivation of diverse crops such as rice, vegetable and fruits. The monsoon climate, which is characterized by four seasons per year, enables farmers to diversify their production systems. On the socio-economic side, the delta is a populous region, because a number of migrants from surrounding regions look for works in the industrial zones and urban areas. This creates a great demand for agricultural products. Moreover, the rural infrastructure system, which has been improved significantly according to the industrialization process, facilitates the development of a commercial agricultural production. The diversified agrarian system, which is featured by pigs, poultry, fish, rice, vegetable and fruits, has been applied widely in the different provinces of the delta like Hai Duong province.

Over few last decades, agrarian systems in the Red river delta have been evolved significantly from a subsistence farming to a market-oriented production system under the economic reform or Doi Moi since the year 1980s. The two significant contributions to the reform policy were the redistribution of production factors to farmers and the domestic and external market liberalisation (Anh, 2003). The economic transition from a central planning economy to a market-oriented one officially approved the households as the independent economic units and ensured their self-determination of how to develop the agricultural production. During this transition period, the socio-economic and institutional environments of the region have been changed notably towards a strong integration into the regional and international market, facilitating and encouraging the development of the intensive and diversified agrarian systems.

The evolution of agrarian systems in the Red river delta was analyzed by several authors (Anh, 2003; Ton, 2003; Anh et al., 2005). Most of the studies, by employing the systematic and historical approaches, indicated that agrarian systems in this region have evolved significantly from one mode of environmental exploitation to another since 1980s, differing among the geographical locations such as in the plain delta, hilly and mountainous regions. In the Red river delta, for instance, Ton (2003) reported a transformation from rice land into fruit crops and fish ponds in Cam Hoang commune during the economic transition time. Meanwhile, Anh (2003) observed that there were four main types of agrarian system dynamics in this region, including (1) “dynamic 1: Specialization in the culture of bonsai and fruit cultivation on the rice land ; (2) dynamic 2: Diversification of activities by commercial activity and maintain pig production; (3) dynamic 3: Agricultural diversification of rice and pigs; (4) dynamic 4: Retired households with poultry production”. However, these above studies only referred to the changes of agrarian systems from the Doi Moi (1980s) to the early 2000s. In fact, during the period between 2000 and 2010, the socio-economic and institutional environments in Vietnam have changed rapidly due to the acceleration of industrialization and urbanization process and the highly international integration. These changes have both positive and negative effects on the evolution trend of the agrarian systems. The proportion of the agricultural-forestry and fishery households in the Red river delta reduced significantly from 77.26% in 2001 to 60.48% in 2006 and to 42.63% in 2011. The number of agricultural labours in the delta region in 2011 declined by 1.16 million workers or 27.3% compared with

that in 2006. The agricultural land area of the delta in 2011 was approximately 780 thousand ha, decreased by nearly 36 thousand ha (or 4.3% of reduction) in comparison with that in 2006 (General Statistics Office, 2012). The rural wage labours move to the industrial zones, while the households around the urban areas become landless farmers. Under these changing conditions, farmers will have different strategies of agricultural production to adapt better to the new environmental conditions. Therefore, the diagnosis of agrarian system dynamics during the economic transition and industrialization period (from the Doi Moi up to present) is of great importance for policy planners to design the appropriate agricultural and rural policies, schemes and projects for sustainable development in the future.

Located at the centre of the economic triangle of the delta (Ha Noi – Hai Phong – Quang Ninh), Hai Duong province has many advantages for the economic development, especially agricultural production. Like many other provinces in the delta, the agri-sector has developed well and played a critical role in the economic growth of the province. During the period of 2006-2010, the annual growth rate of agriculture was 2.1%, and 5.6% in 2011 (Duong, 2011). As the leading centre of agricultural production of the Red river delta, the provincial government will give priority to the development of agri-sector in the future.

Over the last few years, the structure of the agricultural sector of Hai Duong province has changed remarkably with an increase in aquaculture and livestock production and a decrease in cropping area. The proportion of cropping cultivation of the total agricultural output value dropped from 75.8% in 2000 to 65.7% in 2008. The contribution of livestock and aquaculture production to the total agricultural output product climbed up from 22.1% to 31.4% in the same period (Hai Duong Statistic Office, 2008). Because of the rapid acceleration of industrialization and urbanization, the agricultural land areas (mostly rice land) reduced significantly by 12,935 ha of paddy land during the period of 2000 - 2008 and put high pressures on the agricultural development. The farming households have to change the mode of agricultural exploitation in order to cope with the more uncertain situations of the socio-economic environments.

In the future, according to the strategic planning of the province, the agricultural production will have become completely industrialized and modernized in 2020 (Hai Duong's People Committee, 2008). However, the process of industrialization and modernization of agriculture is still limited and faced with many challenges related to the land issues, farming practices and management and the ever-changing situations at the marketplace. The limited and highly fragmented agricultural land area makes it more difficult to mechanize the agricultural production. Although the government plans to regroup the small land plots into large ones, it seems to be difficult to conduct this land consolidation program in many regions due to the disagreement of the farmers. In some regions, the transformation from rice land into other agricultural land use purposes is sometimes illegal and excessive, leading to the degradation of price of one certain agricultural production, for example, litchi cultivation. Most of the farmers are now faced with the attacks of many kinds of pests and diseases that caused the extreme losses of crops and animal herds. Moreover, the increase of input prices and the strong fluctuation of output prices also badly affect the economic efficiency and income of many farms. Therefore, finding appropriate solutions to these above problems is of great importance to promote the sustainable development of agriculture of the province and other regions of the delta.

1.2. Objectives

1.2.1 General objectives

Generally, the principal objectives of this study are to diagnosis the dynamic and its driving forces of agrarian systems during the economic and institutional transition period (from 1980s to 2000s) in three districts of Hai Duong province, north Vietnam. This diagnosis is useful for policymakers to set up appropriate interventions towards sustainable development of agriculture and rural areas.

1.2.2 Specific objectives

More specifically, this study has the following objectives

1. To analyse the recent evolution of agrarian systems in different zones during the economic transition period (1980-2010). This understanding of agrarian system dynamics helps to explain the differentiation about the production strategies among farmers in diverse geographical regions;

2. To determine the consequences of the rice land conversion into other agricultural types of land use as the evident lessons for the strategies of continuous land transformation in the coming years;

3. To identify the technical and economic problems of farming management and practices of farmers at the present. This comprehension enables us to formulate the implications for a high productive and environment-friendly agriculture.

4. To identify the evolutionary perspectives of agrarian systems in order to set up appropriate strategies for the sustainable development of agriculture and rural society in the future.

2. Research questions and hypotheses

2.1 Research questions

According to the above objectives, several research questions are addressed in this study as the followings:

- Q1. What is the evolution of agrarian systems in different agro-ecological zones? What are the main factors that conditioning the agrarian system evolution? How do they affect the mode of agricultural exploitation of households?
- Q2. What are the effects of the transformation from rice land into other types of agricultural land on the development of different production systems at the present?
- Q3. What are the major issues of farming practices and management of households when implementing different production systems?
- Q4. What are the evolutionary perspectives of production systems and their development strategies in the next future?

2.2 Hypotheses

Based on the literature on agrarian system dynamics in the Red river delta and other regions of Vietnam and the characteristics of agriculture and rural society of Hai Duong province, the following hypotheses will be tested in this study:

- H1: Under the economic transformation, farming households adapted well to changes in the agro-ecological and socio-economic environments through different ways, including specialization or diversification of the production systems.
- H2: The conversion from rice land into different agricultural land uses in the past has both positive and negative effects on current development of the production systems.
- H3: The farming management and practices of households remain inappropriate and unsustainable.
- H4: The agrarian systems will evolve into a more resilient and sustainable mode of environmental exploitation that better adapts to the ever-changing conditions within the region in the coming years.

3. Structure of the dissertation

Accordingly, this dissertation is divided into six chapters as follows. Chapter 1 provides the literature review on the system theory and its application to the agricultural production. Based on the general system theory, the concepts of agrarian systems are then explained at different hierarchies from the region level to the farm level. The review continues with the literature on the diagnosis and analysis of agrarian system dynamics at both regional and farm level and the typology of agrarian systems, especially the new agrarian systems, in the Southeast Asian countries and in the world as the wider view at the upper system hierarchy. In chapter 2, the research methodology is specifically explained from the conceptual approaches to the operational framework for analysis of agrarian system dynamics. Various steps of the surveys, such as regional stratification and selection of the study sites, farmer classification and production system typology, household sampling and carrying out the in-depth surveys, are described logically and specifically. It then gives a description of the method of analysis, including household economic calculation and data processing used in the study. The following chapter (chapter 3) is designed to introduce the general agro-ecological and socio-economic environments of the study sites. It begins with an overview of the Red river delta and then continues with the circumstances of Hai Duong province and the selected districts and communes. Chapter 4 mainly devotes to the general evolution of agrarian systems in Hai Duong province. The global evolution of the agrarian system at the regional level is, firstly, identified as the basics for a better understanding of production system dynamics of the surveyed households at the following steps. The analysis is organized by the time series according to the evolutionary steps of agrarian systems, from the collective farming (since 1954) to the family production systems in 1980s to 1990s and then 2000s. The last part of the chapter is used for the explanation of factors conditioning these evolutionary series of agrarian systems. In chapter 5, we concentrate on the surveyed results of the current technical and economic characteristics of agrarian systems. The technical operation and economic outcomes of the cropping systems and livestock production systems of different agro-ecological and socio-economic zones of the province, from the upper zone to the medium and then the lower parts are then presented. The final chapter (chapter 6) will give an estimation of the evolutionary perspectives of agrarian systems and the implications for development policies of agriculture and rural areas in the future.

CHAPTER 1.
AGRARIAN SYSTEMS: THEORY AND APPLICATION

A. CONCEPTS OF GENERAL SYSTEMS AND AGRARIAN SYSTEMS

I. GENERAL SYSTEM THEORY

1.1. Definition of the general system

The system theory is used in the almost scientific and technological field with the increasing demand of a more exact understanding of the real world. One of the first authors which were considered as the creator and chief exponent of general system theory is Ludwig von Bertalanffy, a German- Canadian biologist and philosopher. In his famous book published in 1968 (revised edition) named "General System Theory – Foundations, Development, Applications", he defined that "a system can be defined as a set of elements standing in interrelations" (Bertalanffy, 1968).

Recently, based on the basic concept of Ludwig von Bertalanffy, several authors introduced a more complete definition of a system. Kauffman (1980) defined a system as "a collection of related parts which interact with each other to function as a whole". Meadows (2009) concluded that a system is "a set of elements or parts that is coherently organized or interconnected in a pattern or structure that produces a characteristic set of behaviours, often classified as its "function" or "purpose"." In the reality, many things exist as a system in which one part has a strong connection with others so that they can together contribute to their common function. A system is a set of two or more elements or parts. However, not all sets of elements are considered as a system, unless they have strong relations.

1.2 Structure and behaviour of the system

In order to understand the structure and behaviour of a system, three kinds of things must be mentioned, including elements, interconnections and functions.

A system is a well-organized collection of at least two or more elements. The elements of a system are often the easiest parts to notice, because many of them are visible, tangible things. However, elements do not have to be physical things. Some kinds of systems may consist of intangible elements. In fact, most of the elements can be divided into smaller parts or sub-elements, even sub-sub-elements (Meadows, 2009).

Concerning the relationship between different elements or parts of a system, it seems to be more difficult to learn about the relationship than about the elements because many inter-connections are the flows of information that are harder to see (Meadows, 2009). The connections within a system are called the flows. They can be physical flows or information flows. They hold elements together and play an important role in determining how the system operates and how the system behaves. Thanks to these connections, a system is considered as "more than a sum of its parts" (Meadows, 2009)

Each system has its own purpose or function. In order to deduce system's function, it is necessary to identify its operation or behaviour. A system may have more than one function

or purpose. However, it always has a major goal and should be deduced from behaviour, not from rhetoric or stated goals (Meadows, 2009).

Every system often exists in a given environment and separates from the outside by its boundary. This boundary helps us to identify which element belongs to the system, which element belongs to the environment. The exchange between system's elements and the environment determines the openness of a system. This is called input and output flows. Bertalanffy (1968) indicated that an open system is defined as a system in exchange of matter to its environment, presenting import and export, building-up and breaking-down of its material components. The output of a system is in general a direct or indirect result from the input. However, the output is in general quite different from the input because of the transformation due to the throughput (Heylighen, 1998). The inflow and outflow rate determine the openness level of a system (figure 1.1).

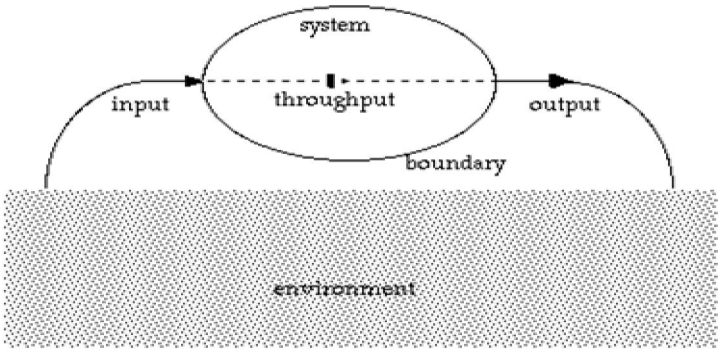


Figure 1.1 A system in interaction with its environment
(Heylighen, 1998)

A system has its mechanism to stabilize and adapt to changes in the environment through a "feedback loop". The feedback loop is formed when changes in a stock affect the flow into or out of that same stock (Meadows, 2009). There are two main types of the feedback loop, including positive and negative feedback loops. Negative feedback loops are the common kinds that stabilize the stock level, and therefore, they are called stabilizing loops or balancing feedbacks. The stock level may not remain completely fixed, but it does stay with an acceptable range. When the stock is pushed too far up, a balancing loop will try to pull it back down and vice versa when it is shoved too far down, it will be brought back up through balancing loop. Therefore, balancing feedback loops are the source of stabilizing and source of resistance to a system to change. Positive feedback loop is amplifying, reinforcing, self-multiplying, snowballing – a vicious or virtuous circle that can cause healthy growth or runaway destruction. Hence, it is called reinforcing feedback loop. It enhances whatever direction of changes is imposed on it. Reinforcing feedback loops are self-enhancing, leading to exponential growth or runaway collapses over time. They are found whenever a stock has the capacity to reinforce or reproduce itself (Meadows, 2009).

In reality, most of systems are complex and formed as a hierarchy organisation. Meadows concluded that hierarchy must balance the welfare, freedoms and responsibilities of the subsystems and total system – there must be enough central control to achieve coordination toward the larger system goals, and enough the autonomy to keep all subsystems flourishing, functioning and self-organizing (Meadows, 2009).

Resilience is also a basic to understand the dynamic of a system. It is a measure of a system's ability to survive and persist within a variable environment. Resilience arises from a rich structure of many feedback loops that can work in different ways to restore a system even after a large perturbation. Systems need to be managed not only for productivity or stability, but also need to be managed for resilience – the ability to recover from perturbation, restore and repair themselves (Meadows, 2009).

The most marvellous characteristic of some complex systems is their ability to learn, diversify, complexity and evolve. This capacity of a system to make its own structure more complex is called self-organization. Like resilience, self-organization is often sacrificed for purpose of short-term productivity and stability. Self-organization produces heterogeneity and the unpredictability. Self-organization, resilience and hierarchy are three of the reasons that dynamic systems can work so well (Meadows, 2009).

In conclusion, the generic properties of systems include a) systems are holistic integrations of interrelated elements; and b) although set within given boundaries, they are open to interaction with their environments (Shaner et al., 1982); (Conway, 1986), (FAO, 1989).

II. CONCEPTS OF AGRARIAN SYSTEMS AT DIFFERENT LEVELS

2.1 Agrarian systems at the regional level

2.1.1 Definition of an agrarian system

Various definitions of an agrarian system were well-introduced by alternative authors. According to Jouve, 1992, an agrarian system can be defined as "the historically constituted, sustainable mode of organisation used by a rural society to use its area and manage its resources. It results in interactions between the bio-physical, socio-economic and technical factors" (cited in Lhopitallier et al. (1999). According to Mazoyer, the agrarian system is "a mode of exploiting the environment historically created and sustainable; a system of production forces adapted to the bio climatic conditions of a given space and responsive to the social conditions and needs of that moment" cited in (FAO, 1999). This is considered as a quite complete concept that covers nearly all aspects of regional agricultural production. Every form of agriculture practiced in a given place, and time appear, first of all, as a complex ecological and economic object, is composed of several categories of production units that exploit different terrains and diverse species of cultivated plants and animals (Mazoyer and Roudart, 2006) .

To clarify more clearly the concept of agrarian system, Sacklokham (2005) explained that the mode of exploitation consists of the farm work, the inert production means (equipments, tools, etc.) and the living production means (crop seeds, reproductive animals, etc.) that perpetuate a cultivated environment. It is a social product, the result from the relations between different actors whose objectives can be identical, complementary and/or contradictory (Sacklokham, 2005).

2.1.2 The structure and dynamics of agrarian systems

2.1.2.1 Agrarian system components

The agrarian system is a complex open system, made of two main sub-systems, including the cultivated ecosystem and the social productive system (figure 1.2) (FAO, 1999; Mazoyer and Roudart, 2006). It includes a biological/ecological activity and an economic activity. In agriculture, biological systems are designed to meet particular economic objectives (John, 1994). The structure of an agrarian system can be seen in figure 1.2.

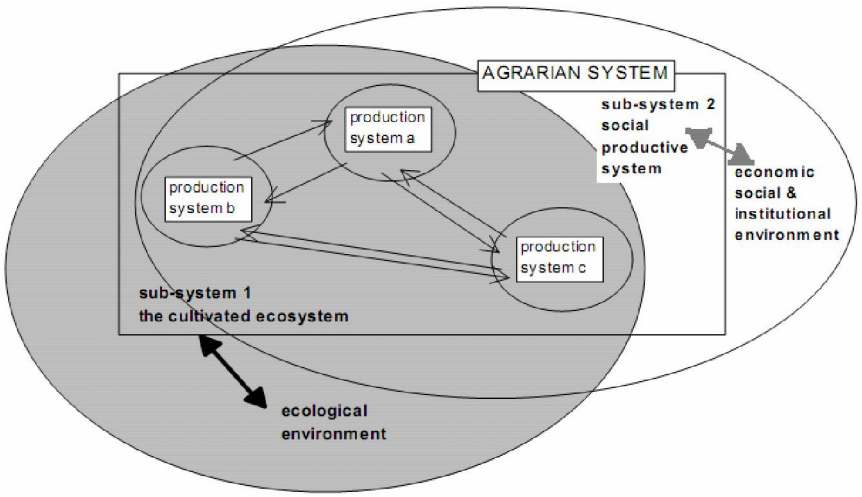


Figure 1.2. The Agrarian System: a complex open system, made of two sub-systems (based on Mazoyer, in Land Reform 1992-93, FAO) (FAO, 1999)

The first sub-system is the cultivated ecosystem which consists of several interacted production systems. These production systems are always strongly related to ecological environment. The social productive sub-system, which can be expressed by three components, including technical, economic and social aspects, is consistent with the socio-economic and institutional environment of the whole region and nation. Some authors may also separate technical elements from others and build a three-component structure of an agrarian system (Sacklokham, 2005) (figure 1.3).

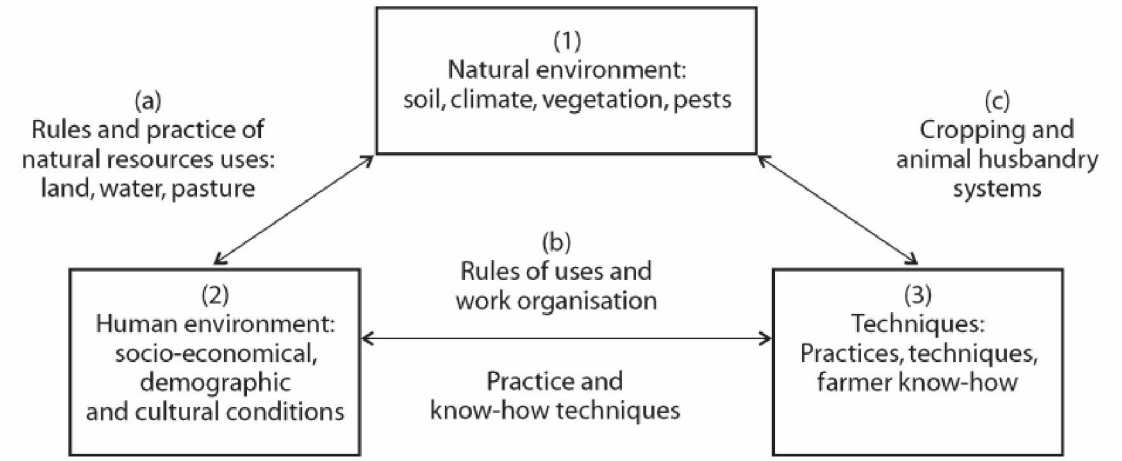


Figure 1.3. Reciprocal relationships between components of an agrarian system (Sacklokham, 2005)

2.1.2.2 The agrarian system hierarchy

The agrarian systems (or agricultural systems) have been conceived at different levels or hierarchical systems (John, 1994; Keith, 1995; Douglas, 1997; FAO, 1999) . These systems can be understood as a hierarchically-nested in one another: 1) from the physical and biological systems at the field level; 2) nested in crop and livestock production systems to a farm household system; 3) nested in a community and infrastructural systems composing the regional and national agricultural systems (Figure 1.4).

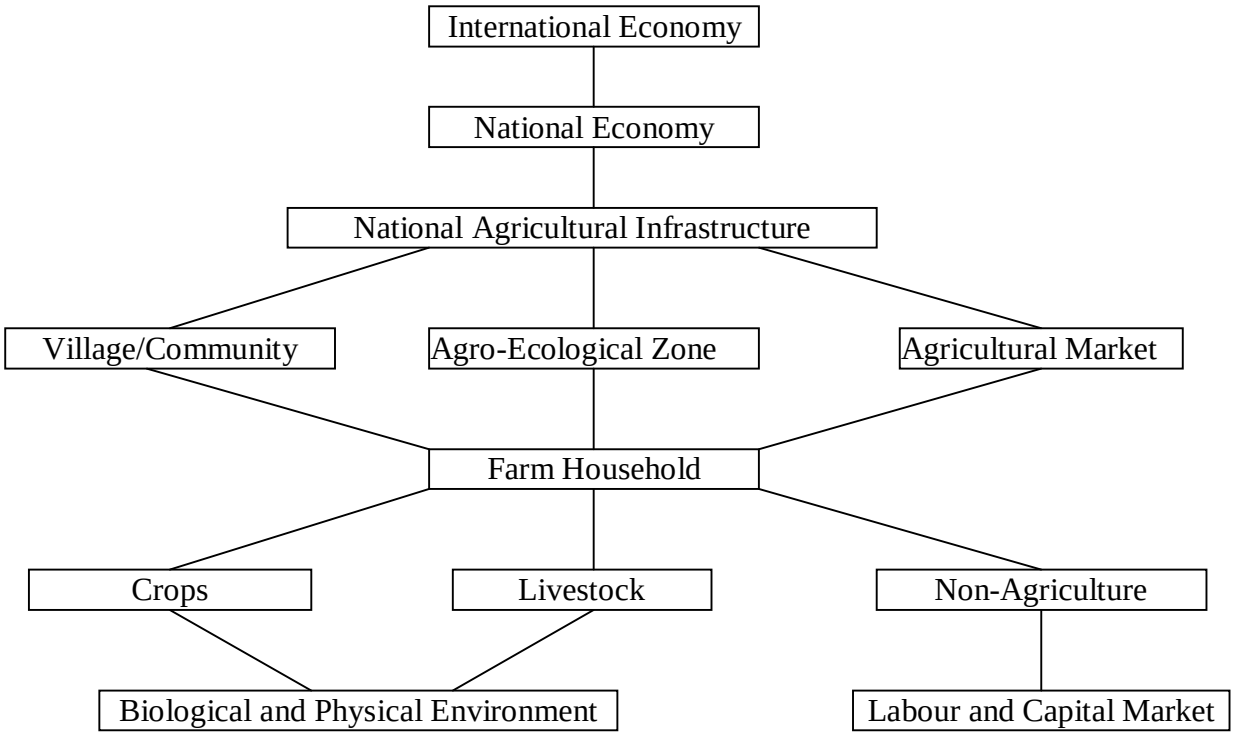


Figure 1.4. Hierarchy of Agricultural Systems (Keith, 1995)

Douglas (1997) divided the agrarian system into many hierarchical orders, encompassing 16 order levels. They are national or regional agricultural sector; sub-sectors as agricultural credit, education, research, production, transport, etc.; commodity-based industry systems; villages or other community units; individual farm-household systems; further lower order level systems related to the agro-economic structure of individual farms and in turn, their component crop and livestock enterprises and to the activities and individual, agro-technical processes which underlie such enterprises. However, this kind of hierarchy of an agrarian system seems to be too complicated and abstract in analysis.

In summary, we can simply classify the hierarchy of an agrarian system into the following levels according to the categorization of Marc Dufumier (figure 1.5).

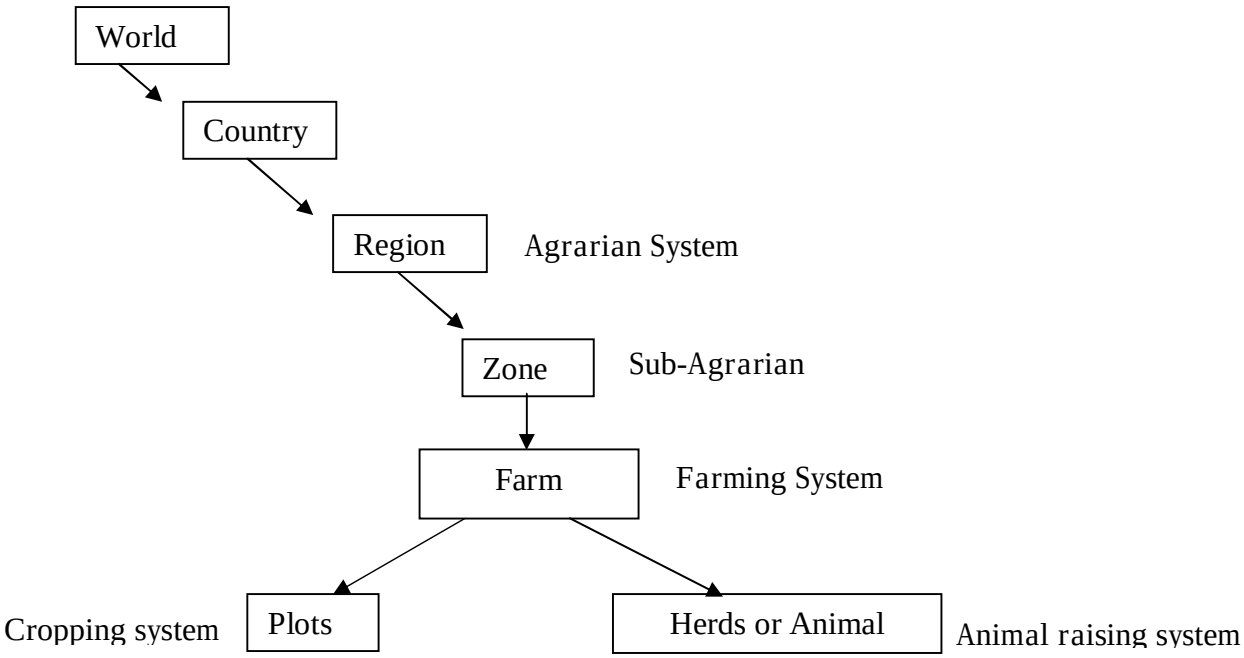


Figure 1.5. Different hierarchy of agrarian system
(Adapted from Marc Dufumier)

2.1.2.3 Dynamics and the adaptation of an agrarian system

As indicated in the above definition, an agrarian system was created historically. It means that over time, every agricultural system is transformed, forming the stages of an "evolutionary series" characteristic of the history of the region. In some cases, farmers who progress are able to adopt new means of production, develop new practices and new systems of cultivation and animal breeding, and thereby, engender a new cultivated ecosystem. In that way, a new agrarian system is being emerged. Such a change in an agrarian system is called an agricultural revolution (Mazoyer and Roudart, 2006).

The analysis of the dynamics of agrarian systems is of great importance to apprehend the transformation of agriculture in time and space. It can be conducted in different geographical regions and at different stages. In the long-term development in time, an agrarian system in a given region can be born, developed, declined, and succeeded from one to another in an evolutionary series (Mazoyer and Roudart, 2006).

This evolutionary series, together with the complexity theory, might be used to inform an adaptive perspective of farm management. The term 'evolution' is used for theories that explain the driving forces requiring the adaptation of the system over time, and the mechanisms through which they operate. In the context of farms, these evolutionary theories try to explain how farms generate, and adapt to change, and how these processes are intertwined with what happens both at the lower level of individual behaviour and the higher level of markets and the farm's environment in general. This evolutionary perspective allows for a definition and assessment of adaptability of the system concerning its ability to perform well according to unknown future conditions (Darnhofer et al., 2010).

In general, adaptation usually refers to a process, an action or an outcome in a system (household, community, group, sector, region, country) in order for the system to better cope with, manage or adjust to some changing condition, stress, hazard, risk or opportunity (Smit and Wandel, 2006). This concept has been applied widely in the theme of climate change. There is a lack of use in terms of socio-economic changes. However, in theory, the adaptation of a system to the socio-economic change is not different from that of climate-change dimension. Both of them refer to the ability of a system to adjust to external changing conditions.

The two concepts involving adaptive capacity and vulnerability are intimately associated with adaptation. The vulnerability of any system at any scale is reflective of (or a function of) the exposure and sensitivity of that system to hazardous conditions and the ability or capacity or resilience of the system to cope, adapt or recover from the effects of those conditions (Smit and Wandel, 2006). Therefore, the adaptation can be understood by the capacity and the ways of a system in reducing vulnerability.

Adaptive capacity or flexibility used in management sciences is seen as a mean to face uncertainty (Reix, 1979, cited in Darnhofer et al. (2010). Tarondeau (1999), cited in Darnhofer et al. (2010) distinguished between operational flexibility and strategic flexibility. Operational flexibility refers to the short-term regulation properties of a system facing hazards. Strategic flexibility refers to long-term choices and to the capacity to change the structure, the resources, and the competences of the enterprise in anticipation of or to react to changes in the environment. Tarondeau (1999) identified three sources of flexibility in production systems: the products (diversity, exchangeability); the processes (the organisation of the technical system authorizes several processes) and the input specification (when different sources of inputs can be combined or substituted instead of depending of one specific input). This concept is used to analyse the adaptive capacity of socio-technical systems.

2.2. Farming systems at the farm level

Various definitions of farming systems have been introduced recently. The farming system or production system is concerned at the farm household level with the combination of livestock production systems, cropping systems and/or non-farm activities (Norman and Gilbert, 1982) (Shaner et al., 1982); Norman, 1995; FAO, 1999; (Dixon et al., 2001) (figure 1.6).

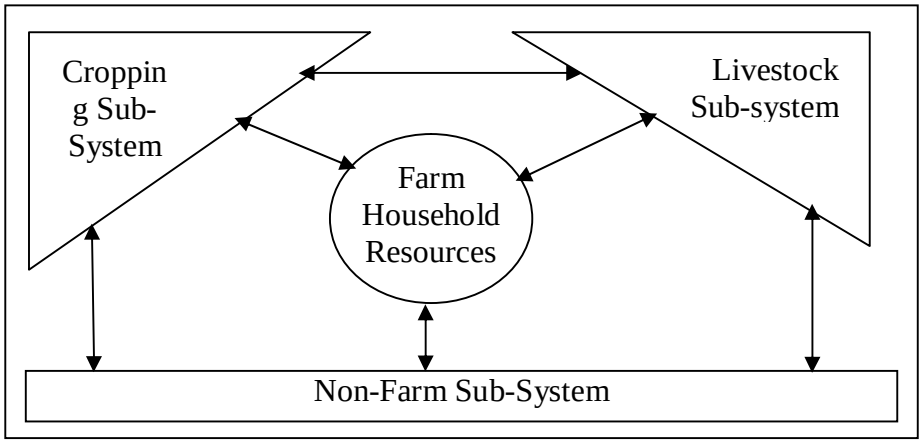


Figure 1.6. The components of a farming system
(Keith, 1995)

2.3. Livestock production systems at the herd level

As a sub-system of the farming or production system, livestock farming system is viewed at the level of animal herds or flocks. It can be referred as "A subset of the farming systems, including cases in which livestock contributes more than 10 percent to total farm output in value terms or where intermediate contributions such as animal traction or manure represent more than 10 percent of the total value of purchased inputs" (Seré et al., 1995).

A livestock farming system is defined as "all the of the elements organized by a society in order to satisfy its needs on a territory, by means of stocking farming " (Beranger, 1993).

2.4. Cropping systems at the plot level

Together with the livestock raising system, the cropping system is the second sub-system of a farming system. A cropping system is defined as "a set of crop management procedures (including variety choice and the crop succession) applied to a given area" (Sebillotte, 1990, cited in (Trébuil, 2000) or "a sequence of technical procedures applied to the identically managed field" (Sebillotte, 1993). Each cropping system is identified by i) the nature of the crops and their order of succession in time (previously known as crop rotation), and ii) the sequences of technical operations applied to these different crops, including choice of varieties (Sebillotte, 1993). In the same farm, there are normally many different cropping patterns proposed by Sebillotte as "a surface of land managed in a homogenous way through different crops with their sequential order and the technical itineraries which have been applied to them". These cropping patterns constitute a cropping system (Mazoyer) (FAO, 1999).

B. DIAGNOSIS AND ANALYSIS OF THE DYNAMICS OF AGRARIAN SYSTEMS

I. PURPOSES OF AGRARIAN SYSTEM DIAGNOSIS

In general, a diagnosis is a rapid assessment of a situation to guide the practice. Diagnosis of agrarian systems provides a methodology or intellectual tool enabling one to understand the diversity and the complexity of agriculture practices as well as construct the characteristic of

the historical transformation and geographical differentiations of a rural society (Sacklokham, 2005). Based on these fundamental understandings, the appropriate agricultural policies, strategies and projects can be designed, managed, followed up and assessed effectively for sustainable development ((Dufumier, 1995; Sacklokham, 2005).

More specifically, the appraisal on an agrarian system aims at the following objectives (Dufumier, 1995):

- To identify and grade the major factors conditioning the evolution of agrarian systems and understand how they affect the transformation of agricultural production and household livelihood;
- To identify characteristics and limitations of different geographical zones;
- To identify and classify the constraints of different categories of farmers and agrarian systems for setting appropriate interventions.
- To assess the economic efficiency of alternative types of farming systems

Therefore, comprehending of the dynamics of agrarian systems at both farm and regional level can enhance sustainable agricultural development (Bontkesa and Keulen, 2003).

II. FARMING HOUSEHOLDS AS THE MAIN UNIT OF AGRARIAN SYSTEM ANALYSIS

2.1 The definition of farming households

A household is defined as a group of individuals who live on the same farm, work together on at least one parcel (for adults) and recognize the authority of a single head of household in major decision relating to the farm enterprise (Bruce and Migot-Adholla, cited in (FAO, 1999). Therefore, the farm household system is considered as a system of three basic sub-systems (habitant, production and consumption) which are closely interlinked and interactive (FAO, 1999).

2.2 The decision-making process of farming households

The decision-making procedure of a farming household may depend on complex elements and be affected by different components of the overall environments (Osty, 1993; FAO, 1999). However, according to Osty (1993), five major fields of the decision-making procedure or decision focuses that should be prior in the analysis are the utilization of land; the choice of enterprise types (crop and livestock) and the mastery of production processes; the management of labour; the allocation and use of income; and the management of investment (figure 1.7).

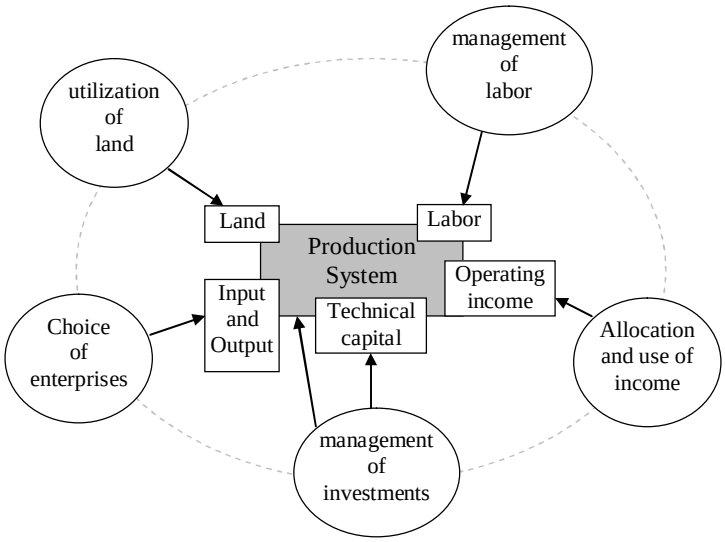


Figure 1.7. An approach to the farm enterprise: The production system seen as a "black box" and five major decision focuses (adapted from (Osty, 1993)

2.3 The analysis of farming household characteristics

2.3.1 Land resources

Land is one of the most important resources for the agricultural production of the farming households. Farmers have access to the resource of land as the basic of their livelihood and long-term security against the hazards of life (Ellis, 1993). Land area and land tenure are two key dimensions, which may relate to the farm technology, the productivity as well as its economic efficiency. The change in land area or scale of household refers very precisely to the simultaneous increase of all productive resources in the same proportion (Ellis, 1993).

Land tenure is defined as an institution, rule invented by societies who define how access is granted to rights to use, control, and transfer land, as well as associated responsibilities and restraints. In simple terms, land tenure systems determine who can use what resources for how long, and under what conditions (FAO, 2002). In many peasant societies, farming families have complex traditional or customary rights of access to land, which prevail over and constrain the operation of freehold land markets (Ellis, 1993; FAO, 2002). Four basic categories of property rights over land are none (or open access), communal, private, and state (or crown) property (Feder and Feeny, 1991; FAO, 2002). In practice, multiple rights can be held by several different individuals or groups. This has given rise to the concept of "a bundle of rights" and different rights to the same parcel of land may be pictured as "sticks in the bundle" (FAO, 2002).

In fact, people often use a wide range of strategies to gain access to land such as purchase, adverse possession or prescription, leasing, sharecropping, inheritance, squatting. Large farmers are able to finance land purchases with loan from formal credit institutions at comparatively low rate of interest. On contrary, small farmers have no financial capacity to finance land purchases and can borrow money at exorbitant rate of interest (Ellis, 1993); others often using capital accumulated while working as migrants in urban areas to purchase land (FAO, 2002). In some societies, small farmers are forced into sale of land by accumulated debt or imminent starvation (distress sale) at its lowest price, and that is the reason why land tends to become more concentrated into large holdings (Ellis, 1993). For

small farmers, many of them have to rent land either as cash tenant or sharecroppers (FAO, 2002), and in both cases, the really effective price for the use of land is above the market-clearing price which would prevail in a more competitive land market (Ellis, 1993). Moreover, farmers can also acquire land by inheritance (Ellis, 1993; FAO, 2002), but often in inadequate amounts due to fragmentation (Ellis, 1993). In some other cases, farmers may squat land as an illegal way to access land (FAO, 2002).

2.3.2 Labour force

The production of farming households strongly relies on family labour, which can be considered as the feature to distinguish peasant farms from capital enterprises. However, it also has an interaction with the wider labour market through both the supply and demand for wage labour, especially at the peak periods such as preparing land, cultivating or harvesting (Ellis, 1993).

The composition of household's members has great influence on their mode of production and often changes through birth, death, marriage, migration, divorce or abandonment. Instability in household structure, which tends to increase under pressures of impoverishment and in periods of social and policy turmoil, has created a relatively frequent phenomenon of women-head households (FAO, 1999).

2.3.3 Financial capital

Financial capital often plays an important role in the process of making decisions of farmers. It may exist under the form of available stocks such as cash, bank deposits and other liquid types like livestock and resources obtained from credit-providing institutions. It depends on the economic efficiency of household production activities as well as their income. The evolution by time series of household income reflects the trend of financial capital and consequently, influences on the decision of reproduction of the family. If the capital accumulation trend is above the reproduction threshold, it means that farmers can save little money, and then they can invest back to the production system to maintain the cycle of production. On contrary, if they lose or get very bad returns in a year, they face big problems in the reproduction cycle. They normally have to borrow money from formal or informal institutions/funds to continue their production activities.

2.3.4 Farmer interests

Farmer's interest or farmer's objective/finality has a great impact on their choice of production method or technique. Dufumier (1995) pointed out that farmers only use the method and technique that accord with their interests and for which they have the necessary resources in sufficient quantity. The interest of farmers may vary largely from one type of farmers to another. Farmers may be interested in minimizing risk, providing food for home-consumption and food security, producing goods for the market, making the most of their existing resources.

The poorest farmers who are in a situation of extremely economic insecurity (few resources, dependence on money-lenders, fluctuating prices) and hesitate to borrow money to pay for purchased input, often show a degree of "risk aversion" and it is not necessary in their interest to maximize the mathematical expectation of output or income (Dufumier, 1995). They have not only few resources, but also little knowledge of risk management. Sometimes, the very

real risk may lead them to be in debt and unable to invest more in the production system. Therefore, in order to minimize the risk of bad returns, they refuse to invest their money and effort in production, just apply the resilient or non certain farming system (Dufumier, 1995).

In the context of unfair and fluctuating market system, farmers are not interested in concentrating their production on supplying products to the market. They first and foremost produce a wide range of products for home-consumption (Dufumier, 1995). Of course, they cannot produce all types of goods they need for their daily life. That's why they have to exchange goods with others by selling a part of output and buying what is lacked. They tend to minimize the use of purchased input materials and just market the surplus amount.

When the market becomes much more favourable, farmers may be interested in investing more money in new technologies, specializing and intensifying the copping and livestock production system according to the comparative advantages of the region as well as the relative scarcity of each of the available resources. Given the frequent abundance of family labour, small holders can adopt labour-intensive production systems, which involve a tight combination of multi cropping and stock keeping with products, which require a great care and high profitability. By contrast, in an area of low population density and surplus of land, the extensive production system will be applied to maximize their income per unit of labour (Dufumier, 1995).

III. ANALYSIS OF AGRARIAN SYSTEMS AT THE REGIONAL LEVEL

As defined above, an agrarian system is a complex open system formed of two principal subsystems (the cultivated ecosystem and the social productive system). Therefore, the analysis of agrarian systems at a given time and place consists of breaking it down into the two these components, studying the organization and the functioning of each of these subsystems, as well as studying their interrelations (Sacklokham, 2005; Mazoyer and Roudart, 2006).

The cultivated ecosystem has a structure that composed of several complementary and proportionate subsystems, such as gardens, pasture, arable land, etc., which in turn can be split up into different parts. A cultivated ecosystem is also renewed by different activities (clearing and suppressing wild vegetation, fertilization, management of crops and livestock herds). These activities or functions also open the latter to more or less important external exchanges with near or distant ecosystem. Thus, an agrarian system cannot be analyzed and studied in isolation from these distant exchanges and influences (Mazoyer and Roudart, 2006).

The social productive system (or technical, economic and social system) consists of human resources (productive implements and equipment) and living resources (cultivated plants and domestic animals). These means of production and productive activities are organized into an unit of production which in turn characterized by the type of production system they practice and by the social category to which they belong (Mazoyer and Roudart, 2006).

Osty (1993) proposed the following framework to conceive of elements/dimensions relating to the farm enterprise (figure 1.8).

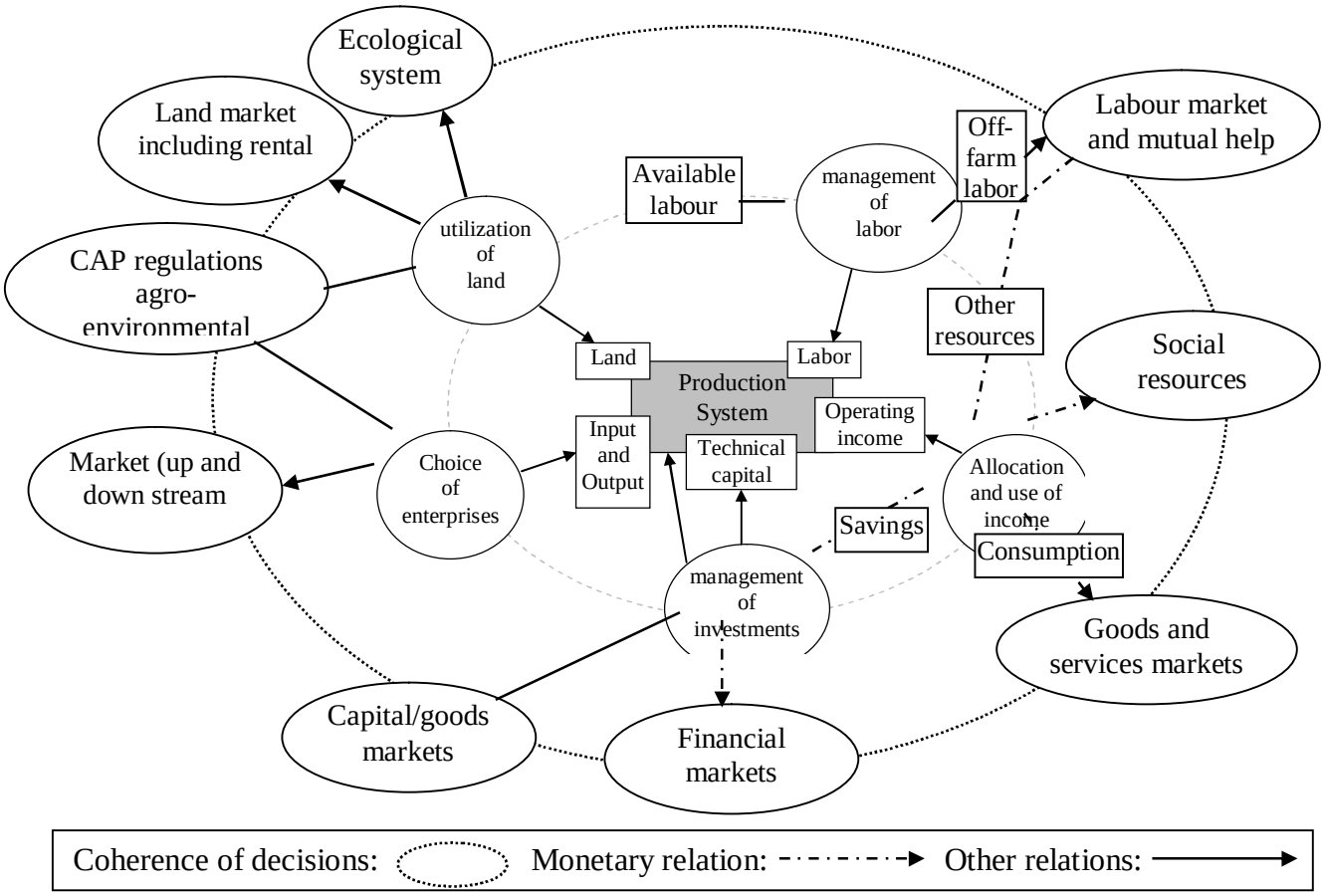


Figure 1.8. An approach to the farm enterprise: A farm/family system in its environment. The different elements in the environment are subject to change and are at least partly interconnected
(adapted from Osty (1993)

In order to understand more clearly the connections between environmental and socio-economic conditions and its impacts on the development trend of agricultural production and food systems, Knudsen et al. (2005) illustrated possible problematic situations as showed in figure 1.9.

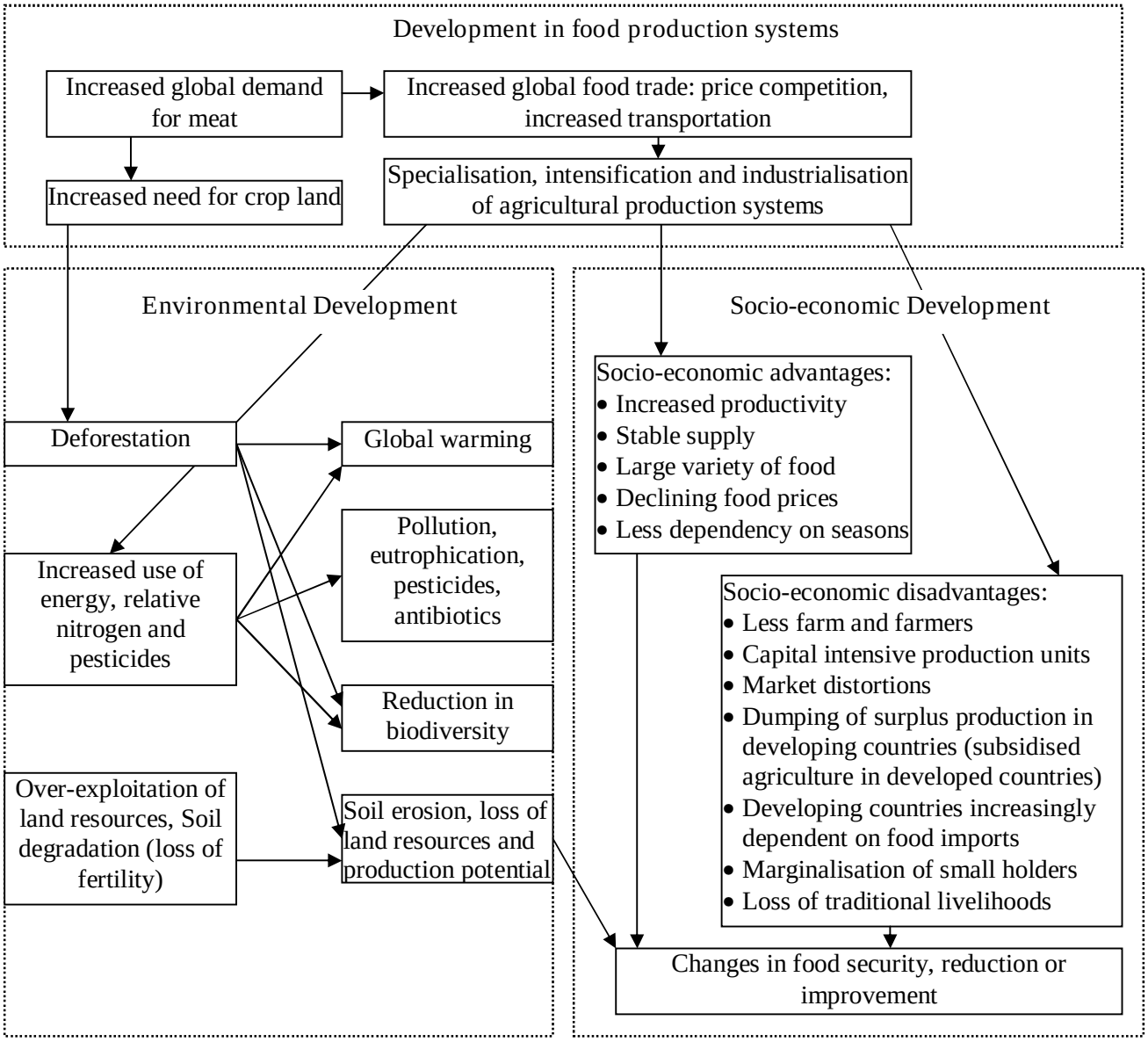


Figure 1.9. Illustration of possible problematic aspects in global food systems sustainability, environmentally and socio-economically
(The arrows indicate possible effects, adapted from Knudsen et al. (2005).

3.1 Analysis of agro-ecological environments

Agro-ecological environments are the integrative study of the interactions among biological, environmental, and management factors in agricultural systems (Patrick et al., 2009).

Agricultural activities require the change in the natural ecosystem to an agricultural system that is oriented towards the human use. In fact, the agro-ecological environments have been changing faster than those of 50 years ago (McIntyre et al., 2009). The environmental degradation and resource scarcity of global ecosystem is now a big problem and has been well concerned (McIntyre et al., 2009; Patrick et al., 2009; Altierl, 1989). Its impacts normally relate to unprecedented loss of biodiversity, deforestation, loss of soil health, and problems of water and air quality (McIntyre et al., 2009).

Land resource is now being more and more limited due to the rapid population growth all over the world, especially in less-developed countries (Mccown et al., 1994) and being lost to non-agricultural uses (FAO, 2002,2003). Availability of arable land in most countries is utilized to the maximum and, in some cases, this has led to degradation (Devendra and Thomas, 2002; FAO, 2003). The land reserve that is potential for agriculture is unavailable, or locked up in other valuable uses such as forests or protected areas. Soil becomes more difficult for farming activities because of poor characteristics (low soil fertility, high soil toxicity, hilly or otherwise difficult terrain, etc.) (FAO, 2002). Land is also much more degraded (about 1.964 million ha in global according to the Global Assessment of Land Degradation, (FAO, 2002). Water and wind erosion are the two main causes. Its level of seriousness varies from site to site and relates much with the farming techniques such as applying an excessive dose of agrochemicals (fertilizers, pesticides, herbicides, etc.) in intensive production systems or changing the crops grown (reduced fallow periods) as well as conducting monoculture (FAO, 2003). Loss of land resources (soil erosion and soil degradation) has secondary negative effects on biodiversity and global warming.

The biodiversity can be potentially affected by developing the monoculture or specialized production through out the reduction on the number of and variability within species (McIntyre et al., 2009). Estimated losses of biodiversity to extinction over the coming decades vary widely, from 2 to 25 percent of all species (FAO, 2002). Thus, the systems may be highly vulnerable to climate change because of the reduction of ecosystem functions and ecological resilience (McIntyre et al., 2009).

Climate change also has very diverse or complex impacts on agriculture, forestry and fishery in both positive and negative ways. In the positive dimension, the increase of carbon dioxide concentration in the atmosphere enables plants to use water more efficiently by narrowing plant stomata, so water losses are reduced, and it will also stimulate photo-synthesis and have a fertilizing effect on many crops. Besides that, the global warming phenomenon caused by climate change may bring benefits for agriculture. The areas suitable for cropping will expand, the length of the growing period will increase; the cost of over-wintering livestock will be reduced; crop yields will be improved, and forests may grow faster. These gains may, however, have to be set against the loss of some fertile land to flooding, particularly on coastal plains. On contrary, various potential negative impacts of climate change on agriculture can occur. Temperature rise will increase the evaporation and decrease soil moisture levels, especially in the tropic, so that some cultivated areas will become unsuitable for cropping, and some tropical grassland may become increasingly arid. Although rainfall is increasing, it is distributed unevenly among regions. Pest population can be expanded and better survived in the winter. Thus, the spring crop will be increasingly attacked. Crop yields will vary strongly between crops because of the increase in the frequency and severity of extreme events such as cyclones, floods, hailstorms and droughts. The mean sea level is projected to rise, leading to the loss of low-lying land through flooding; seawater intrusions and storm surge. Those are some changes that may result from global warming in case of the absence of any other factors (FAO, 2002).

Notably, global warming appears to benefit agriculture in developed countries located in temperate zones but to have an adverse effect on production in many developing countries in tropical and subtropical zones. Hence climate change could increase the dependency of developing countries on food imports (FAO, 2002).

In fact, agriculture also has a vast impact on ecosystem because of unsustainable operations. The heavy application of chemical fertilizers, pesticides, insecticides, herbicides and fungicides in many developed and developing countries are the major sources of water

pollution and loss of biodiversity. Deforestation and burning plant biomass also can cause greenhouse-gas emission, which is not only harmful to the ecosystem but also increases climate change (FAO 2002b). Thus, sustainable practices and improvement of adaptive capacity of agricultural producers will play a central role in reducing the effect as well as in better coping with climate change.

Several measures were suggested by FAO (2002b) to reduce greenhouse-gas emissions relating to technology and policy choices. They comprise the followings:

- Removal of subsidies and introduction of environmental taxes on chemical fertilizers and energy inputs
- Improvement of fertilizer use efficiency
- Development of rice varieties emitting less methane
- Improved management of livestock wastes
- Restoration of degraded land
- Improvement of crop residue management
- Expansion of agro-forestry and reforestation

In order to promote adaptation to climate change, the following measures were advised by FAO (2002b):

- Development and distribution of crop varieties and livestock breeds resistant to drought, storms and floods, higher temperature and saline conditions
- Improvement of water-use efficiency through both no-till/conservation agriculture in rain-fed areas and appropriate water pricing, management and technology in irrigated areas
- Promotion of agro-forestry to increase ecosystem resilience and maintain biodiversity
- Maintenance of livestock mobility in pastoral areas subject to drought

Those recommendations are likely conceptual. It seems to orient the pathways of agriculture and rural development. The solutions should be proposed more detail and suitable for a given context of each region and society. Of course, the well understanding of both the current situations and evolutional process of agro-ecological conditions will be essential for setting up the measures of sustainable agricultural operations. That is also the objective of the agrarian system diagnostic analysis.

3.2 Socio-economic characteristics

There are various socio-economic characteristics that highly relate to the dynamics of agrarian systems. However, analysis of agrarian system evolution often focuses on main factors that have a direct influence on agriculture development of the region. Some of them can be considered in the followings.

3.2.1 Income per capita

The growth of income per capita has a strong relation to the transformation of agricultural production according to the change in human consumption behaviour and labour force. Over the few last decades, per capita income has risen substantially all over the world. In developing countries, the growth rate of income per capita increased from 1 percent per year in 1980s and 1990s to 3.7 percent between 2001 and 2005 (World bank, 2006 cited in

(McCullough et al., 2008), especially in developing countries in Asia. As income per capita rise, labour price becomes more expensive relative to land and capital and more migrants of agricultural producers (Peter and Stanley, 2007). Notably, the rising of income per capita encourages people to diversify their consumption behaviour and demand. Traditional starchy staples such as rice, wheat, potatoes, etc. are consumed less and substituted by higher value and quality food such as livestock products (fat, meat, fish, etc.), fruits and vegetables. The demand of safer and more processed and pre-cooked food also increases rapidly (Nelson, 2005; Peter and Stanley, 2007; McCullough et al., 2008). These changes result in intensification and commercialization of agricultural production systems. Commercialized systems are characterized by specialization at the farm level, greater dependence on purchased inputs and more marketing of outputs (Pingali, 1997 cited in McCullough et al., 2008). By specializing in high-value, by becoming part-time farmers and by adopting more capital intensive technologies, large and commercial production systems can compete better with small ones, causing the disappearance of small farms (Lipton, 2005 cited in Hazell and Wood, 2007).

3.2.2 Market chain

The change in the market chain is also an important factor conditioning the transformation of agricultural production systems due to the change in the capacity of market access and competition of farmers. It offers new incentives and opportunities to farmers who can successfully access and compete in a transformed market, but they are also a serious threat to those who cannot. Many small farmers are particularly under threats from these developments and cannot easily compete with large farms on the basis of cost, quality or volume ((Peter and Stanley, 2007).

Today, marketing chains are changing rapidly all over the world with trade liberalization and globalization as well as the expansion of supermarkets and influence on the specialization and intensification of farming systems. Retail outlets in urban market become more organized and larger scale due to the increasing demand of safe and processed food products (McCullough et al., 2008). Wholesales are more specialized and better positioned to keep track of quality information and meet more exact demand for retailers and processors (Unnevehr and Roberts, 2002; Golan et al, 2004, cited in McCullough et al., 2008). Besides that, procurement systems are more formalized as marketing systems shift from traditional to structured to modern. Therefore, agricultural production systems, especially in developing countries are becoming more commercialized (McCullough et al., 2008). That is also the case of Vietnam where the supermarkets are being rapidly developed to meet increasing demand of urban consumers. It is a great driving force for the movement from the small scale traditional farms to the specialized intensive systems recently.

3.2.3 The rural infrastructure systems

Rural infrastructure plays an essential role for the growth of agriculture. However, it is not easy to define. According to Wanmali (1992), rural infrastructure can be distinguished between soft infrastructure, institutional infrastructure and hard infrastructure. Institutional infrastructure includes the services such as collection, store and analysis of local essential data that is performed by national institutions in collaboration with their regional and local counterparts. This infrastructure plays a significant role in agricultural development planning. Similarly, soft infrastructure is mentioned by services such as transport, credit and banking, input distribution, and marketing of products. Hard infrastructure is can be seen more easily,

including road, irrigation, electrification, telecommunication systems. These infrastructure systems have a strong interrelationship and a great influence on agricultural production and farmer livelihood strategies. Access to hard infrastructure such as road is an important determinant in deciding where to locate soft infrastructural services. Access to soft infrastructural services has an effect on farmers' use of input (supplies of fertilizer, seed and farm credit). The demand for output marketing services is also influenced by infrastructure access (Wanmali, 1992).

The adequate development of all these types of infrastructure is very necessary for the development of agriculture. Better road access to markets, for example, enhances opportunities for high-value agriculture, including production of more perishable products. It can also enhance opportunities for off-farm employment and for engaging in own non-farm businesses (Pender 2004, cited in (Peter and Stanley, 2007). However, poor infrastructure is one of the most binding constraints for many poor countries (Fan & Hazell 2001; Fan & Chan-Kang 2005, cited in Hazell and Wood, 2007).

In Vietnam, the rural infrastructure system has been improving significantly since the last decade. The transportation system, especially the road was upgraded and expanded extremely due to the process of industrialization and urbanization. Agricultural commodities are transported and exchanged more easily and rapidly from the North to the South and vice versa. Many agricultural origin markets or collecting points have been built up since recent years. Farmers also access more easily to agricultural services such as irrigation system, credit resources, etc. The improvement of the rural infrastructure is thus of great significance to the high growth of agricultural production in Vietnam during the economic transformation period.

3.2.4 Social dimensions

Social situation is a very broad concept and not easy to define. In agrarian system diagnosis and analysis, we can narrow this concept into social issues and activities, and concentrate on what dimensions strongly relate to and impact on the differentiation in choosing the environmental exploitation of households in the study region.

According to Conyers (1993), social issues and activities include several related dimensions such as social characteristics, general quality of life, social services and social justice. Social characteristics of an area or society include the demographic structure (e.g. size and density of population, age and sex structure, household structure and composition); ethnic characteristics; social structure (e.g. leadership structures; class; caste or other social divisions); religious and cultural beliefs and practices; and general attitudes. General quality of life in an area or society comprises a number of different factors, including some (e.g. income) which are 'economic' in nature but have wider implications in the sense that they influence other aspects of life (e.g. income affects health, nutrition, access to various goods and services, leisure activities and the ability to choose between alternative lifestyles, all of which are important components of the quality of life). Social services (e.g. health, education, water and sanitation, welfare benefits) contribute to the general quality of life but warrant attention in their own right because they raise particular planning issues. Social justice includes issues related to equity, human rights and participation in decision-making, all of which are again parts of the overall quality of life but also warrant separate attention because they raise special planning issues (Conyers, 1993).

C. TYPOLOGY OF AGRARIAN SYSTEMS IN SOUTHEAST ASIAN COUNTRIES AND THE WORLD

I. CRITERIA FOR THE TYPOLOGY

In an attempt to develop the criteria for the typology of agricultural systems in the world, Derwent Whittlesey (1936), cited in Grigg (1974)) believed that there were five main criteria by which characteristic types of agriculture could be recognized. However, many experts disagreed with the criterion about the ensemble of structures used to house and facilitate the farming operations. They mostly agreed to add more essential criteria to complement Derwent Whittlesey's work. Thus, following elements are widely accepted to be used for agricultural typology (Grigg, 1974).

1) The crop and livestock association
2) The methods used to grow the crops and produce the stocks
3) The intensity of application to the land or labour, capital and organisation, and the out-turn of products and which results
4) The disposal of the products for consumption (e.g. whether used for subsistence on the farm or sold off for cash or other goods)
5) The type of land tenure
6) The size and lay-out of the farm

In order to develop a typology of the agricultural regions of EU-25, a project called SEAMLESS (System for Environmental and Agricultural Modelling Linking European Science and Society) of the Wageningen University, the Netherland discussed that the regions are, firstly, typified based on cluster analysis for each of the three dimensions of the farm typology: farm size, intensity and specialisation/land use. And then, these three dimensions are combined into one typology of agricultural regions, including all combinations of the three dimensions (Andersen, 2009).

II. TYPOLOGY OF AGRARIAN SYSTEMS

Globally, there is a wide variety of types of agrarian systems according to the highly complexity of the ecological and socio-economic conditions. They range from small subsistence farms to the large commercial operations and encompass very diverse production patterns. These can include poly-cultures or monocultures, mixed crop and livestock systems, extensive or intensive livestock systems, aquaculture systems, agro-forestry systems, and others in various combinations. Besides that, these types of agricultural systems also have been changing over time in terms of intensity and diversity due to the transition driven by complex and interacting factors related to production, consumption, trade and political concerns (McIntyre et al., 2009).

2.1 Traditional integrated crop - animal farming systems

Mixed or integrated crop-animal farming systems are popularly applied by small holders in Asia as well as other developing countries (Devendra and Thomas, 2002; Thorne and Tanner, 2002; Lucila and Lapar, 2005). Six of the eleven global production systems are classified as mixed crop–animal systems by Seré et al. (1995). Annual crops (mostly rice crop) and perennial tree crops are grown and integrated with both ruminant and non-ruminant animals in these systems (Thomas, 1999 cited in Thomas et al. (2002); Devendra and Thomas (2002);

Lucila and Lapar (2005). Mixed farming systems have both great socio-economic and excellent environmental advantages as compared with the monoculture ones. They provide farmers with opportunities 1) to reduce risks from monoculture; 2) to use resources (labour, land, machinery, etc.) more efficiently, leading to the reduction of production cost of each commodity; 3) to improve cash flow for purchasing farm inputs; and 4) to add value to crops or their by-products, which may be wasted otherwise (Devendra and Thomas, 2002). Combining crop cultivation and livestock production also helps to maintain the soil fertility by recycling nutrients; sustain the soil biodiversity; minimise the soil erosion; conserve water; provide suitable habitats for birds; and make the best use of crop residues that might otherwise be burnt leading to carbon dioxide emissions (de Haan et al., 1997, cited in Devendra and Thomas (2002)). Examples of integrated annual crop–animal systems are the rice-goat-duck-fish system in Indonesia, the rice-bu alo-pig-chicken-duck-fish system in the Philippines, the rice-vegetable-pig-duck-fish system in Thailand and the vegetable-goat-pig-duck-fish system in Vietnam. Examples of integrated perennial tree crop-animal systems include the rubber-sheep system in Indonesia, the oil palm-cattle system in Malaysia, the coconut-sheep-goats system in the Philippines (Devendra and Thomas, 2002).

In Vietnam, the popular mixed farming system is called "VAC" system, which consists of a combination of a garden, a pond and an animal shed. It is a diverse organisation or combination of different types of crops (such as rice, roots and tubers, vegetables, trees, and other plants), animals (ruminant and non-ruminants) and aquaculture production (Fujimoto, 2001; Luu, 2001; Anh et al., 2005). This kind of system also changes over time and differs across regions (the delta and the mountain region). From a small and traditional mixed system which is primarily home-consumption orientation or self-subsistence, due to the development of a market-oriented economy, farming households have been gradually expanding their production and the "VAC" system, thereby being more commercially oriented. However, numerous traditional systems characterized by low economic efficiency and the use of backward methods still abound (Anh et al., 2005).

Steinfeld et al. (1997) indicated two possible scenarios for the future of crop-animal systems in developing countries. One is grown in unit size and specialized under the market forces and technological requirements. This would present fewer opportunities for on-farm crop and animal integration. The second possibility, as a result of continuing human population pressures, leads to decreasing farm sizes to the point where the system disintegrates (involution). Devendra and Thomas (2002) pointed out that crop-animal systems will be continuously intensified and importantly grown, and that smallholder mixed farms will remain predominant in Asia in the future.

2.2 Specialized production systems

2.2.1 Livestock production systems

There are various criteria for the classification of livestock production systems. Thus, the choice of criteria is necessarily based on the influence and the relation of parameters to livestock production, which create the great differentiation among various types of systems. It is known that livestock production is one of two most important sectors, together with crop production, of household agricultural activities. Therefore, Seré et al. (1995); Steinfeld and Mäki-Hokkonen (1995) suggested using three main criteria, involving the integration with crops, the relation to land, and the agro- ecological zone. Besides that, in his framework, Seré

et al. (1995) also added two more parameters, which are the intensity of production and the type of product. These are also essential for the system typology.

Based on these above criteria, eleven major types of livestock production systems were described in all over the world by Seré et al. (1995); Steinfeld and Mäki-Hokkonen (1995) as follows (figure 1.10).

According to the classification of (Seré et al., 1995); Steinfeld and Mäki-Hokkonen (1995), different types of livestock production systems can be described in detail as the followings.

The Solely Livestock Systems (L) (by Seré et al. (1995)) or industrial production systems (by FAO (2009) are characterised by both a high (more than 90 percent) contribution of animal feed (in dry matter) from rangelands, pastures, annual forages, purchased feeds and a low (less than 10 percent) total value of production comes from non-livestock farming activities. Authors introduced the concept of the livestock units to calculate total stocking rate. A head of cattle or buffalo is allowed one livestock unit (1 LU) and a sheep or goat is recognized 0.125 LU. If the annual average stocking rates of solely livestock systems are above 10 LU per hectare of agricultural land, and more than 10 percent of animal feed is farm produced, they are Landless Livestock Production Systems (LL). Based on the contribution of production value between pig/poultry and ruminant enterprises, they can continuously be divided into two types, comprising landless mono-gastric systems (LLM) and landless ruminant systems (LLR). On the other hand, if annual average stocking rates of solely livestock systems are less than 10 LU per hectare of agricultural land, and also if the farm produced more than 10 percent of animal feed, they will be seen as Grassland Based Systems (LG). These types of systems may be characterised by agro-ecological zones, including temperate and tropical highland (LGT), humid/sub-humid tropics and sub-tropics (LGH), arid/semi-arid tropics and sub-tropics (LGA).

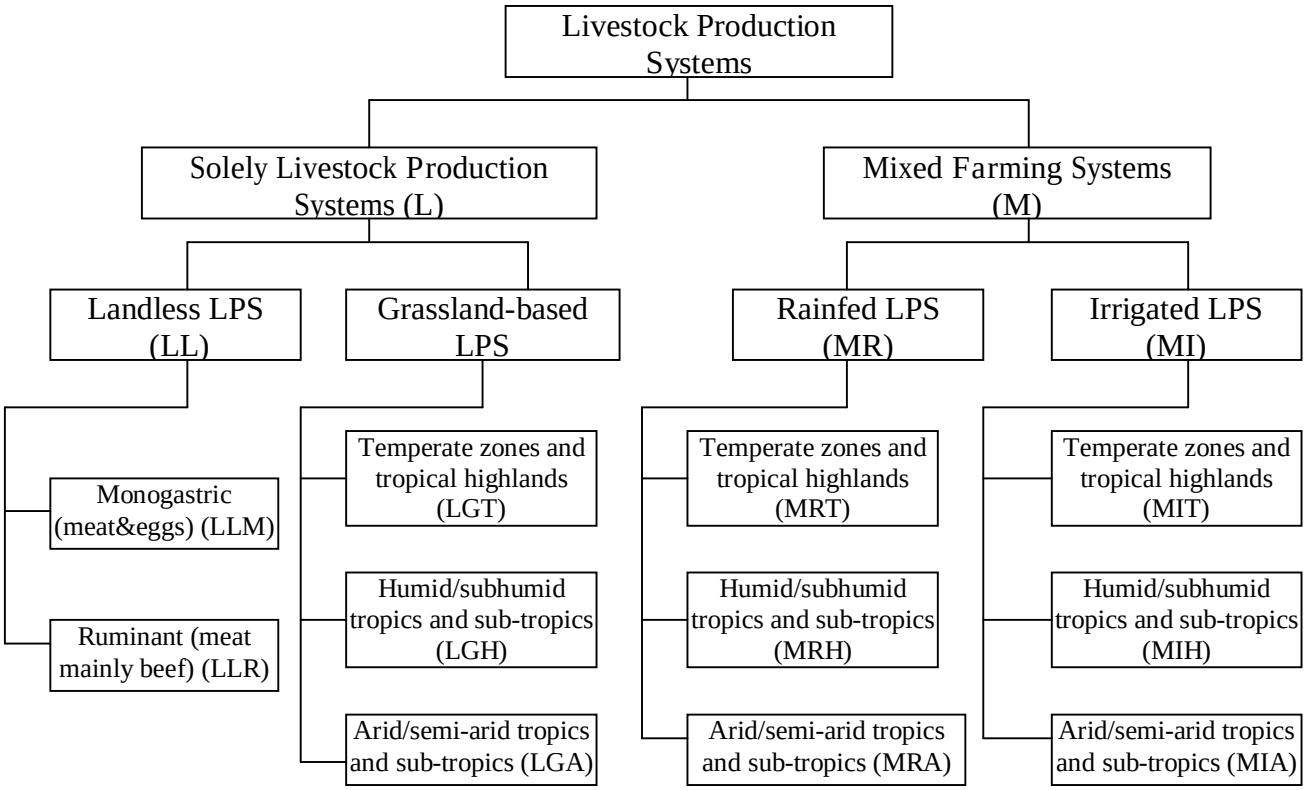


Figure 1.10. Classification of world livestock production systems
(Adapted from Seré et al. (1995); Steinfeld and Mäki-Hokkonen (1995))

Mixed Farming Systems (M) (Seré et al. (1995); FAO (2009) are determined by more than 10 percent of the dry matter fed to animals comes from crop by-products, stubble or more than 10 percent of the total value of production comes from non-livestock farming activities. If more than 90 percent of the value of non-livestock farm production comes from rain-fed land use, they will be considered as Rainfed Mixed Farming Systems (MR) and classified due to agro-ecological zones (temperate and tropical highland (MRT), humid/sub-humid tropics and sub-tropics (MRH), arid/semi-arid tropics and sub-tropics (MRA)). In another case, if more than 10 percent of the value of non-livestock farm production comes from irrigated land use, they are Irrigated Mixed Farming Systems (MI) and also divided by regions (temperate and tropical highland (MIT), humid/sub-humid tropics and sub-tropics (MIH), arid/semi-arid tropics and sub-tropics (MIA)).

Among the above-described systems, landless systems (LL), especially mono-gastric systems (LLM) play the most important role in meat and egg production with the contribution of 36.8% of total meat (for LL) and more than two-third of total egg production (for LLM). Regarding milk production, the rain-fed mixed farming systems in the temperate and tropical highland (MRT) is the largest one in terms of areas and greater than others in terms of output (Steinfeld and Mäki-Hokkonen, 1995). They produce more than half (55.5 percent) of the total milk production from all considered species and 62.6 percent of cow milk production (Seré et al., 1995).

Herrero et al., (2009a, 2010), cited in McDermott et al. (2010) also developed a typology of livestock systems in developing countries in Asia and Africa by integrating a system's natural resource potential, population density, and market access into the classification. This

typology, therefore, provides a measure of intensification potential. Four major types of livestock systems resulted from this typology are:

- Agro-pastoral and pastoral systems are normally found in regions, which have low population densities, low agro-ecological potential and weak linkages to markets. Crop production in these areas is marginal, and livestock predominates as a source of livelihood.
- Extensive mixed crop–livestock systems are presented in areas with rain-fed agriculture, medium population densities, with moderate agro-ecological potential and weak linkages to the market. Farming practices incorporate crop and livestock with a limited use of purchased inputs.
- Intensive mixed crop–livestock systems are characterized by high population densities, irrigation or high agro-ecological potential and good linkages to markets. Farming practices incorporate crops and livestock, but with an intensive use of purchased inputs.
- Industrial systems characterized by large vertically integrated production units and in which feed, genetics and health inputs are combined in controlled environments. These systems account for the largest share of the volume of tradable livestock products.

The evolution of livestock production systems is viewed as a development from a basically grassland-based system to mixed farming systems under the influence of climatic, soil and disease conditions and driven by population density. Wherever urbanization and income exceeded certain levels, landless systems developed in the vicinity of urban centres, capitalizing on the efficiency and supply elasticity of these systems (Seré et al., 1995).

Livestock production systems in developing countries have been changing rapidly towards a more intensive production in response to the increasing demand of animal products. However, the ability to respond to extra demand for livestock commodities differs among systems due to primarily biological characteristics of the production process (reproduction cycle); the size and type of production unit (large or small extent); the consumer demand and the distance to the consumer centres. The gradual transformation from traditional production systems to a modern intensive production system can be viewed in fast reproduction cycle systems (such as industrial poultry meat production systems), in landless systems (mono-gastric) around the urban centre (called peri-urban landless systems). The lesser transformation is normally the case of ruminant production systems, especially in regions where there is a large extent of production units (Seré et al., 1995).

2.2.2 Cropping systems

According to Devendra and Thomas (2002), in Southeast Asia, rice is the major food crop. So, rice-based systems are the most important models in this region. Other systems are associated with maize, cassava, perennial tree crops and secondary crops. Both monoculture and multiple cropping systems (inter-cropping, relay cropping and sequential cropping) are common, with crops being grown for subsistence and cash purposes. The major cropping systems are as follows.

- Multiple rice crop systems are limited to the most favoured areas where rainfall exceeds 200 mm per month for at least six months during the year (e.g. in Indonesia and the Philippines).
- Single lowland rice crop systems are dominant in rain-fed areas during the monsoon period (e.g. in Cambodia, Indonesia, the Lao PDR, Myanmar (Burma), the Philippines,

Thailand, Vietnam). They are associated with low-risk, low-input–output farming systems.

- Lowland rice–upland annual crop systems are common in more favoured environments. An upland annual crop can be cultivated either before or after the main monsoon rice crop.
- Multiple upland annual crop systems are the dominant production systems for the uplands and hilly lands with diverse patterns used between maize, cassava, legumes or vegetables.
- Single upland crop systems are the most common systems in Southeast Asia, where the intensity of rainfall is low, unevenly distributed or adequate for only a few months of the year.
- Annual and perennial crops inter-cropping systems are important in permanently settled hilly lands, especially those with steeper slopes. The perennial crops help to minimise erosion by providing a permanent cover. The most common annual crops are maize, upland rice, sweet potato, cassava and taro.
- Perennial tree crops systems which based on coconut, oil palm, rubbers and fruit trees are particularly important in Indonesia, Malaysia and the Philippines, and provide significant opportunities for the integration of cropping with animal production.

In the Red river delta of Vietnam, according to Anh et al. (2005), crops usually consist of rice, vegetables, fruit trees, and annual industrial crops. Rice is dominant in most farms. Most of the irrigated lands are used for growing rice, vegetables, and fast-growing industrial trees. Highland or alluvial land is used for cultivating vegetables, fast-growing industrial trees, and fruit trees. The cropping system is highly intensive and involves cultivation of several crops within a year. Popular crop combinations include the followings:

- One rice crop with one spring rice crop or one summer crop
- Two rice crops, usually spring rice and summer rice
- Two rice crops and one winter crop: spring rice, summer rice, and a winter crop
- One rice crop and one dry crop: a spring dry crop followed by summer rice.
- One rice crop and two dry crops: a spring dry crop followed by summer rice and then a winter dry crop.
- Dry-crop specialization in rainfed area: spring, summer, and winter seasons have dry crops.
- Four crops: spring rice, summer dry crop, summer rice, winter dry crop
- Spring rice, fish in summer, and fruit trees along the farm border.

(Note: The spring rice crop covers the period of February to June; the summer rice crop, from July to October; the winter rice crop, from October to January; the summer dry crop, from June to August. The spring dry crops usually consist of peanut, soybean, green bean; summer dry crops are soybean; and winter dry crops are potato, maize, sweet potato, and vegetables)

III. SOME EMERGING AGRARIAN SYSTEMS

3.1 Organic agricultural systems

Organic agriculture is a holistic production management system that promotes and enhances the agro-ecosystem health, including biodiversity, biological cycles, and soil biological

activity (Codex Alementarius Commission (2001), cited in McIntyre et al. (2009). It encourages, wherever possible, to minimize the use of external synthetic inputs (such as fertilizer, pesticides, preservatives, pharmaceuticals, GMOs, sewage sludge and irradiation) and deliberately maximize the use of local natural resources so that reduce pollution of air, soil and water (FAO/WHO, 1999, cited in McIntyre et al. (2009). To ensure the standard of organic agriculture, it requires a set of rules and limits, usually enforced by inspection and certification mechanisms. However, it is one of the most important cost items (McIntyre et al., 2009). Thus, few developing countries have national organic standards, regulations and inspection and certification systems (FAO, 2003).

Organic products have a high potential market (McIntyre et al., 2009) due to the increasing interest of consumers in organic crop, livestock and fish products, which is mainly driven by health and food quality concerns (FAO, 2003). Thus, it offers opportunities for farmers to increase income and their livelihood because that organic product normally has a higher price than non-organic ones (in estimated, price premiums range from 10 to 50 percent (FAO, 2003). However, organic agriculture also has negative environmental impacts such as overuse of animal manure, which can lead to nitrite pollution of water supplies; on the other hand, insufficient application of organic manure can lead to soil mining and long-term productivity declines (World Bank, 2004a, cited in McIntyre et al. (2009).

Organic agriculture is well developed in industrial countries, including in Western Europe, Latin America and the United States, where there is an impressive growth rate of land areas under organic management, (about 20 percent p.a. since 1989, in United States and 26 percent since 1985, in Western Europe). On contrary, in most developing countries, very few agricultural land areas are under certified organic production (less than 0.5 percent of agricultural land areas). Some of the traditional farms in developing countries also adopt modern organic management to improve their productivity, especially in areas where pesticides and fertilizers are inaccessible. While a number of industrial countries have action plans for the development of organic agriculture, some Asian countries are now attempting to establish national standards for organic commodities (FAO, 2003).

3.2 Urban and peri-urban agriculture systems

Urban and peri-urban agriculture refers to growing plants and raising animals for food and other uses within and around cities and towns, and related activities such as the production and delivery of inputs and the processing and marketing of products (van Veenhuizen, 2006, cited in McIntyre et al. (2009).

Urban and peri-urban agriculture systems can be a subsistence system of household or a commercialized production system. It produces a wide variety of products, involving food products (such as grains, root crops, vegetables, mushrooms, fruit, poultry, rabbits, goats, sheep, cattle, pigs, guinea pigs, fish, etc.) and non-food products (e.g. aromatic and medicinal herbs, bonsai trees, etc.) (ETC-Netherlands, 2003, cited in McIntyre et al. (2009) to meet the high and diverse requirements of citizens within or surroundings cities. It is characterized by a high degree of specialization (van Veenhuizen, 2006 cited in McIntyre et al. (2009).

The urban and peri-urban agriculture system offers farmers opportunities to increase their income and livelihood thanks to the rapid development of the basic infrastructure system (close to markets). It is now also received more attention of development organizations and national and local authorities because it provides employment for a large number of urban poor, especially women (World Bank, 2004a, cited in McIntyre et al. (2009).

However, it faces constrainsts of land limitation caused by the competition among agricultural production, industrial zones and residant areas. Urban and peri-urban agriculture are also blamed for environmental pollution because of using solid and liquid wastes and other agricultural activities in densely populated areas. It, therefore, poses several critical issues around the development of urban and peri-urban agriculture systems. The potential environmental impacts of urban and peri-urban agriculture should be considered in urban planning.

3.3. Conservation agriculture system

By far, the conventional tillage practices such as ploughing, harrowing or hoeing before every crop have been applied in large extent of agricultural land areas to destroy weeds and loosen the topsoil to facilitate water infiltration and crop establishment. However, these repeated activities can bury any soil covers and destabilize the soil structure, leading to the soil dispersion caused by rainfall, sealing and crusting on the surface or compacting soils, which negatively affect crop productivity (FAO, 2003) .

To prevent these kinds of land degradation, the conservation or zero-tillage agriculture system is introduced and developed by incorporating crop rotations, use of cover crops, and maintenance of plant cover throughout the year (Pieri, et al., 2002 cited in McIntyre et al. (2009). Four major management practices intertwined in conservation or zero-tillage agriculture are: (1) minimal soil disturbance (no plowing and harrowing); (2) maintenance of permanent vegetative soil cover; (3) direct sowing; and (4) sound crop rotation combining different plant families (e.g. cereals and legumes) (FAO (2003); McIntyre et al. (2009)). These features are the essential to protect and stimulate the biological functioning of the soil in order to maintain and improve crop yields and resilience against drought and other hazards (FAO, 2003).

Conservation or zero-tillage agriculture has various economic, environmental and social effects. It is estimated that the yields can be less variable annually and increase to 20 or 50% higher than that under conventional procedures after a number of years. It also helps to reduce labour costs and to distribute labour demand much more evenly over the years. Input costs will be reduced due to fewer initial investments for machinery (such as tractors), fuel and other synthesized materials (such as herbicides, pesticides as well as fertilizers) (FAO, 2003). It would decrease soil erosion and water loss due to runoff and decrease carbon dioxide emissions and increase carbon sequestration, reduce flood and recharge underground aquifers (World Bank, 2004a cited in McIntyre et al. (2009). Therefore, it is known as one of the most important technological innovations in developing countries, as part of Sustainable Land Management approaches (McIntyre et al., 2009).

This type of agricultural production system has been applied by farmers so far on between 50 and 60 million ha worldwide; almost half of this is in the United States, about 23 million ha (USDA, 2001e, cited in (FAO, 2003) where it is, firstly, implemented in large and medium-sized farms. Conservation agriculture then began to be widely practised in diverse farming systems in Brazil and adapted to small farms in the southern part of the country. It is rapidly being adapted to irrigated rice-wheat systems in the Indo-Gangetic Plains, especially in India, where 0.8 million hectares were planted in 2004 using this system (Malik, Yadav and Singh, 2005 cited in McIntyre et al. (2009).

The initial introduction, adaptation, validation and demonstration in representative farms of conservation or zero-tillage agriculture in a new region require the determined and sustained efforts of competent, innovative governmental or non-governmental organizations, an active

learning attitude of some of the most change-minded farmers and farmers' groups as well as the extension staff. Farmers also need professional contacts with each other, and local manufacturers need to be in a position to supply the necessary tools and equipments. During the initial phase, many farmers will need some financial support in the form of loans or grants (FAO, 2003).

CHAPTER 2. RESEARCH METHODOLOGY

A. THE CONCEPTUAL APPROACHES

I. THE SYSTEM APPROACH

Since this study focuses on the dynamic or evolution of agrarian systems, it is, therefore, essential to apply the system approach to understand all parts or elements of a system and their relationships in a given socio-economic context at farm and regional level. This approach emphasises the heterogeneity, complexity and variability of farmers' production environment that need to be attended in the analysis as well as in the policy-setting process. In order to understand well the heterogeneity and complexity of farm household systems, the analysis of the ecological and socio-economic situations at the farm and regional level is required. However, these situations are always changing across the time and vary from one region to another. Thus, understanding its variability and its evolutionary process is necessary to explain the heterogeneity, complexity and variability of farmers' production systems.

As complexity of farm household production is recognized, this approach also takes into account the interdisciplinary approach to identify all aspects of farmers' behaviour and diagnosis their constraints for a better intervention programme. It includes not only the participation of technical scientists but also the involvement of economists and socialists in the framework of farming system analysis. The active and interactive works of these scientific disciplines can be complementary to each other in searching solutions for the sustainable development of agricultural production as well as the rural society.

By applying the system approach, this study, firstly, classifies farmers and farming systems into alternative categories based on several adequate criteria. The study then focuses on the analysis of system elements at the farm level (the livestock production systems, the cropping systems and the non-farm activities) and the interaction among them. Farmers' production environments (natural resources, production means, household characteristics, farmer's objectives or interests, etc.) will be considered in the analysis to explain the differentiation of performance and economic efficiency between farming system categories. Moreover, the analysis will be broadened to the agrarian system at the regional level by taking into account the diversity and variability of the ecological and socio-economic contexts for a better understanding about the complexity of different agrarian system typologies.

II. The historical approach

The agrarian system is well known as a dynamic and evolutionary system. Based on the perception of changes in environmental situations, farmers often adapted or adjusted by changing their production objectives and exploitation modes. Therefore, historical approach is usually employed in system analysis. The historical analysis of agricultural change in a given region helps to identify main types of holdings according to their historical development, with special emphasis on how they relate to the market, capital accumulation trends, technical changes, diversification or specialization of products (Dufumier, 1995).

In this study, the historical development of different types of farming systems will be taken into account in the conjunction with ecological and socio-economic changes at the regional level. At the farm level, the historical approach is interpreted by the change of household resources, involving labour forces, land areas and land use changes, capital accumulation. The

change here is marked by the significant transformation that remarkably impact on the production systems of the households. This change at the holding level is always related directly to broader contexts of regional as well as national transition. Thus, different stages of evolution and important events regarding to ecological, technical and socio-economic situations are indicated in the analysis.

The historical development of each region is a long progress and sometimes difficult to return to the ancient period in the past. Hence, it would be better to highlight the transformation in a given period which directly links to the current situation. The period varies from one region to another one, depending on the data and information availability. However, the starting point of the period should be selected at the time when the situation of most household groups in study sites was relatively homogenous. Here, the study will examine the transformation period from a collective agriculture system to the individual family model. At the farm level, it would be difficult for the farmers to remember the situation which happed long time ago in the past. Therefore, the historical analysis will vary from one household to another, depending on the establishment and development of different households. In this study, the general period is considered since the year 1993, when the new land law was introduced in the whole region.

III. The adaptive behaviour approach

This type of approach is based on the observation that farmers interactively adjust both their objectives and their situations to environmental changes. This was illustrated by studying the patterns of change of farms over long time frames. Against the multi-dimensional background of socio-economic, political and environmental dynamics, changes and adaptations increasingly seem to be essential elements in any approach towards a sustainable farming system. It is therefore necessary to understand the co-evolution of a farming system with its environment and how this on-going change is reflected in the internal organization of the farm and the farm's goals (Darnhofer et al., 2010) .

At the farm level, the adaptive capacity of farming households will be measured by the change in techniques they applied (using new varieties, changing crop rotation or crop pattern, changing input investment, etc.), the change in production means (land, labour, capital) as well as the modification of production objectives (reduce risks, maximize the profit, etc.). At the regional level, the analysis of transformation of policies on agriculture and related sectors will be employed to identify the adaptive strategies.

IV. The participatory or bottom-up approach

Various participatory or bottom-up approaches have been developed and applied worldwide in response to the perception that top-down and supply-driven approaches are the cause of the problems (ADB, 2004). This approach stresses the importance of taking local people's perspectives into account and giving them a greater participation in diagnosing, planning and managing the process of agriculture and rural development programmes. Local people, community organisations, NGOs and other stakeholder agencies will together decide how to measure results and what actions should be followed as this information has been collected and analysed. The participatory rural appraisal technique which was developed in the 1970s and 1980s is considered as a solution to large-scale survey studies. The method encouraged the active involvement of local people with the perspective and knowledge of the region conditions, traditions and social structure in data-gathering activities, using a variety of informal techniques that could be employed within a short timescale.

This approach has various strengths in agriculture research and rural development projects. It is an opportunity for researchers and other local people to share the knowledge and learn from each other so that the basic implications for the sustainable development can be introduced. The diversity and plurality of views and the value of local knowledge alongside other forms of scientific and technical awareness will take effects of the development programme and capture the complexity of the reality. This tool is thus more creative and generative than standardized techniques of assessment.

However, participatory approach remains several challenges and limitations regarding the quality, attitudes and behaviours of involved people. It also requires resources of time, human resources and finances, especially when study in a large region.

In this study, participatory assessment will be applied for the diagnosis and analysis of agrarian system evolution, zoning the region, characterizing system structure and behaviours and identifying the constraints of systems. Local authority, administrative officers from different departments of the villages, communes, districts and province will be involved in these works. The retired people, old farmers and other excellent local people can participate in alternative stages of the diagnosis and analysis process.

B. THE FRAMEWORK FOR ANALYSIS OF AGRARIAN SYSTEM EVOLUTION

I. The framework for analysis of agrarian system evolution at the regional level

The evolution of agrarian systems is greatly affected by the changes in agro-ecological and socio-economic conditions over time. Therefore, the analysis of agrarian system evolution is an investigation of historical transformation of these dimensions. The attention is paid to the interaction of ecological, technical and socio-economic factors in order to identify causal relation and mechanism of differentiation among geographical areas and agrarian systems. Based on these disciplines, a framework for analysis of agrarian system's evolution is developed (figure 2.1). The participatory assessments and secondary material revision are the two main tools in this analysis.

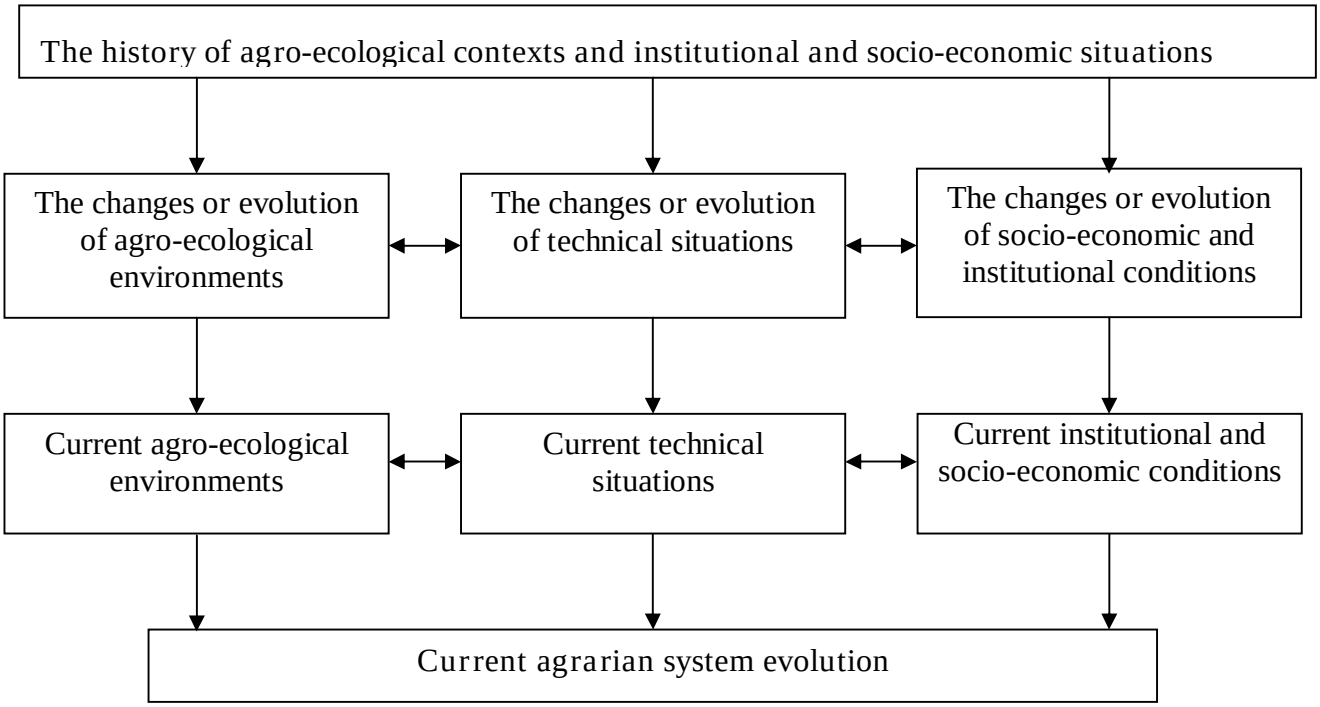


Figure 2.1. Framework for analysis of agrarian system evolution

II. The framework for analysis of production system evolution at the farm level

The agrarian system is a dynamic model which usually adapts well to the changes in environments basing on the perception of their situations and objectives in short-term or long-term. According to Brossier et al. (2003), the change of situation and the modification of objective are the double adaptation of farm households to cope with environmental changes (figure 2.2). Thus, understanding farmers' decision- making process and their practices is the key to measure agrarian system's adaptation.

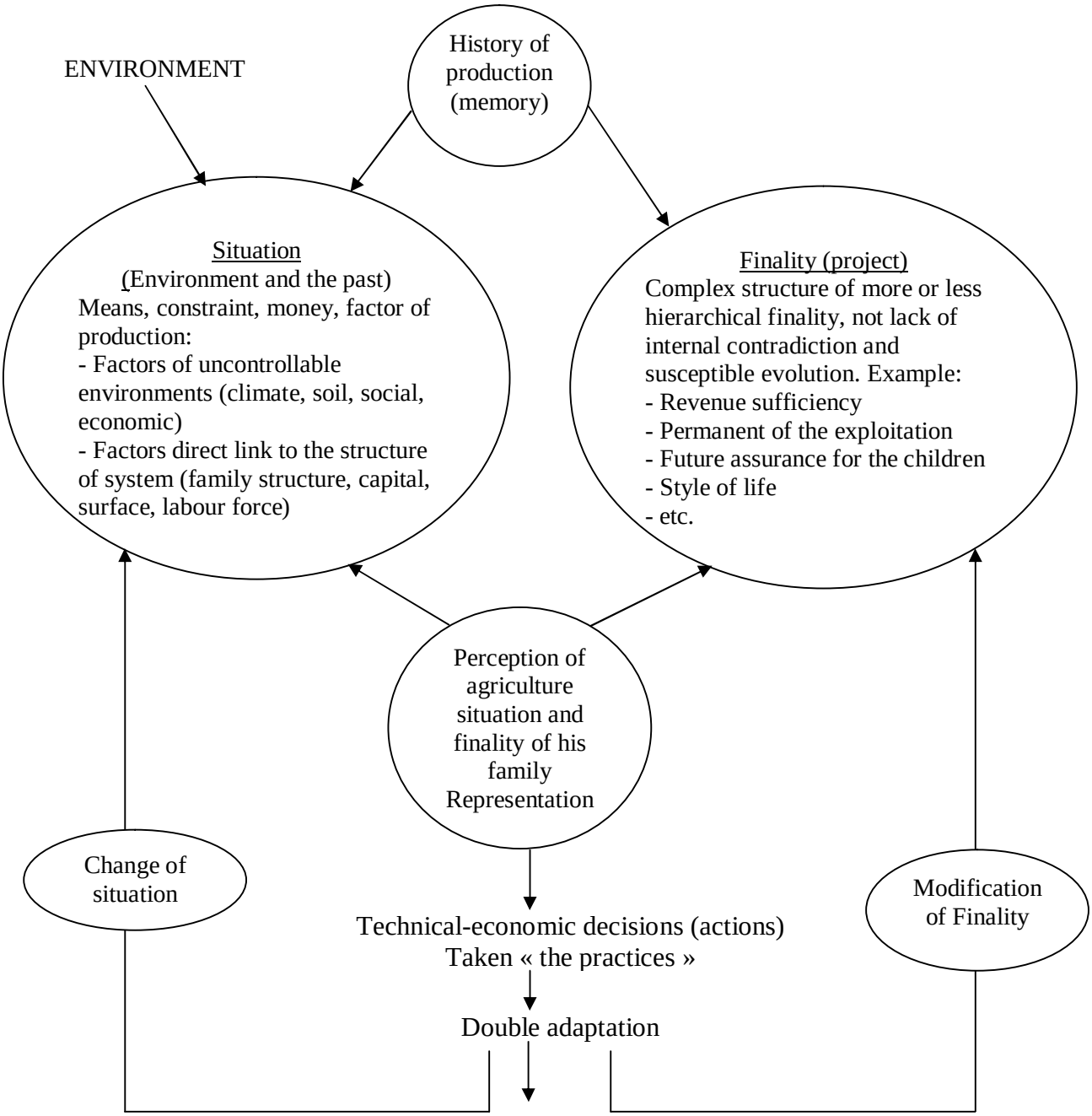


Figure 2.2. Model of adaptive behaviour of a system (Example: family exploitation) (translated and adapted from Brossier et al. (2003)

C. THE OPERATIONAL FRAMEWORK FOR AGRARIAN SYSTEM DIAGNOSIS AND ANALYSIS

Agrarian analysis diagnosis and analysis are often conducted at different levels, beginning with the global view of a large area (country, region, and zone) and ending with a more specific focus (farm, animal herd, or parcel). The agrarian system is evolutionary and dynamic over time. Therefore, the analysis of historical development of ecological, technical and socio-economic conditions is required to identify causal relations and the mechanisms of differentiation (Dufumier, 1995) (figure 2.3)

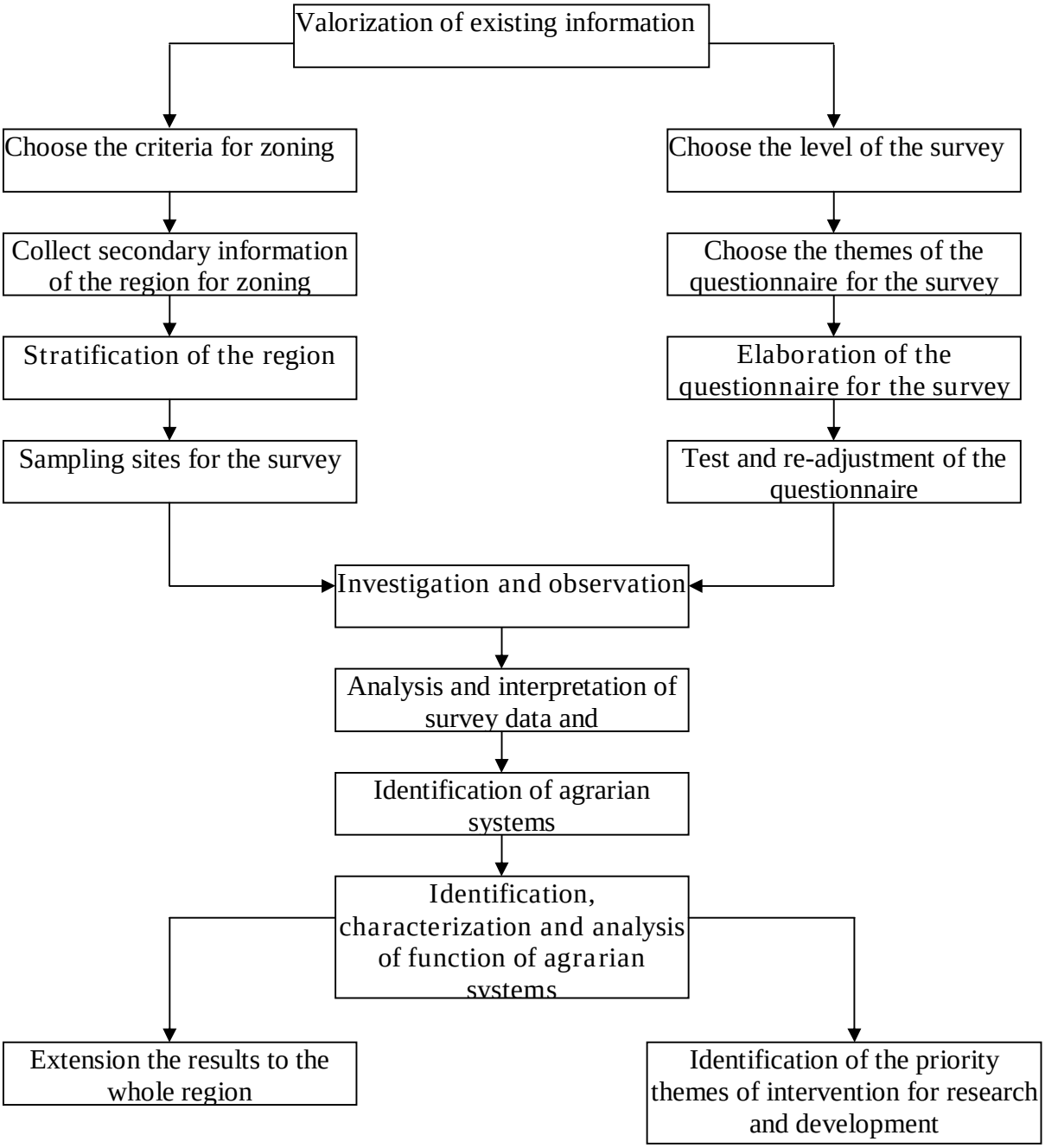


Figure 2.3. Framework for agrarian system diagnosis and analysis
(Translated and adapted from Jouve and Michel (1994)

I. STRATIFICATION OF THE REGION AND SELECTION OF TARGET SITES

1.1. Concept and purpose of the region stratification

Diagnosis and analysis of agrarian systems are often carried out in a large area of the region with a huge number of farming households and diversified ways of agricultural production and management. To reduce the number of household samples and to understand why and how agriculture has been practised in diversified modes, the zoning or stratification technique is developed as a necessary tool for the study. It also helps to avoid making a single proposal for intervention that can be unsuitable for whole region or too many proposals for intervention that can be difficult to implement.

Zoning or stratification of the region is the division of an area into smaller units, which have similar characteristics (FAO, 1999). The large area of the region will be divided into several relatively uniform and contrasted zones according to some key criteria of agro-ecological environments and socio-economic conditions. The assumption applied here is that in a relatively homogeneous zone, the environmental exploitation model of the producers is relatively homogenous. Meanwhile, in a contrasted zone, the mode of production is significantly different from each other. Thus, understanding the comparative advantages and the principal constraints facing producers of each zone is essential for policymakers to set up more appropriate strategies for different group of farmers in alternative micro-regions.

1.2. The provincial stratification and the district selection

1.2.1 Selecting the criteria for the zoning technique

In order to gain the above objectives, the criteria selected for the zoning technique should be directly related to and influenced on the characteristics and evolution of agrarian systems. They comprise agro-ecological elements and socio-economic factors. In theory, the more number of criteria to be selected for the zoning, the more homogenous the small zone seems to be. However, with many criteria employed, the number of zones will be increased and led to a great sample of households. Therefore, several representative criteria which significantly impact on and relate to the behaviours and transformation of agrarian systems should be considerably chosen in order to show the characteristics and constraints (or limitations) of diverse zones.

The sources of information used for the zoning often come from the secondary data about agro-ecological and socio-economic factors of the region and the perception of local people through participatory assessment. These data and information are then carefully processed to identify the relatively homogeneous zones.

In this study, based on the secondary data collected from various departments and participatory meetings with administrative staff at province and district level, the following criteria are selected for the region stratification.

1.2.1.1 Criteria of agro-ecological situations

Hai Duong province is located in the centre of the Red river delta. However, it can be divided into two different types of territory, including the flat or low land area and the high land part. The low land area (from 0.9 to 5 m of altitude) accounts for 84.09% of the total natural area and the high land area (from 10 to 616m of altitude) makes up to 15.91% of the total province area (Hai Duong People's Committee, 2008). This study is only conducted in the low land part which is more representative for the Red river delta.

Agro-ecological environments comprise a wide range of factors which can be considered for the stratification of the region. However, there is little heterogeneity of physical environments among corners within a province. Hence, the choice of variables will focus on some typical characteristics which can help to create uniform and contrasted sub-regions. The following elements are employed as the criteria for the zoning work:

+ Geography: Altitude and terrace

In fact, in the delta of the Red river, the difference about geography among locations is not very significant. However, a slight difference about one of the factors of geography sometimes can result in remarkable heterogeneity of agricultural practices between areas.

According to the secondary data, there are differences about the altitude and the characteristic of terrace among districts of Hai Duong province. Thus, these variables were selected as the important criteria to stratify the region into different zones.

The topography of Hai Duong slightly slopes from the Northeast down to the Southwest. In the plain part of the province, there is little difference about the altitude among the districts. The first area, which is called the upper region, has a higher territory than other plain locations, about 4-5 m above sea level. It includes the districts located surrounding the hills and mountains. It is characterized by the uneven terraces which formed by a number of water surfaces such as pools, ponds, streams, etc. The medium zone which has the altitude of 2-3.5 m is a large plain with the even territory. It has been filled up with alluvium of the Thai Binh river for a long time. The lower region is situated at the south of the province. The low level of territory (about 0.5-2 m) makes it more vulnerable to tidal and flood.

+ Main agricultural features: Cultivated areas of main crops and fish ponds, the number of households that engaged in aquaculture production.

Agricultural production is often managed by diversified ways according to the difference of physical environments and socio-economic conditions among geographical regions. The diversity of crops and animal flocks kept by farmers in different areas can be considered as good criteria for the stratification of the whole region. In this study, we used secondary data of the cultivated area of some crops (annual and perennial crops) and fish ponds as the significant variable for the zoning (Figure 2.4).

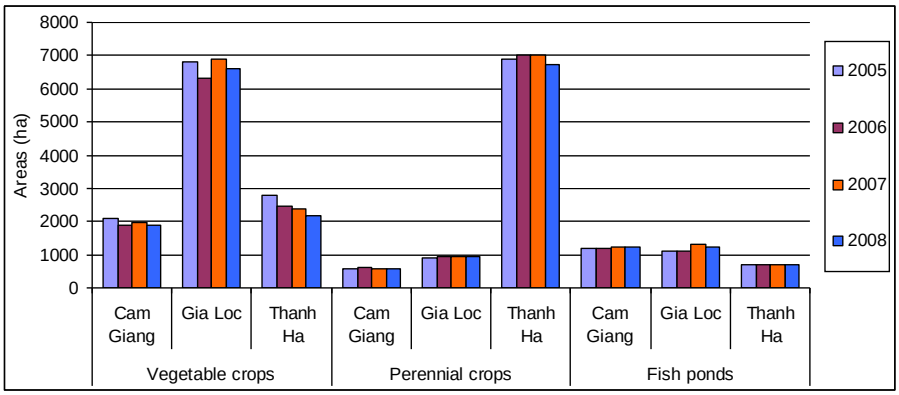


Figure 2.4 Cultivated areas of some crops and fish ponds of three studied districts (source: Hai Duong Statistics Office (2010)

Based on the statistical data from the districts, we can observe the significant difference about the cultivated area of some crops and fish ponds among regions. Firstly, Gia Loc district has the highest planted area of vegetable crops as compared with others. Thus, it was chosen as the representative site of the medium zone. Secondly, Thanh Ha district was selected for the lower part, where has the largest perennial crop field, especially fruit gardens of the province. As for the fish pond areas, although there is not a significant difference among districts, Cam Giang was selected representatively due to both large water surfaces and the rapid increase of

a number of households engaged in aquaculture production. In comparison with the year 2001, number of fishery households in Cam Giang in 2006 was 3.5 times higher (Figure 2.5).

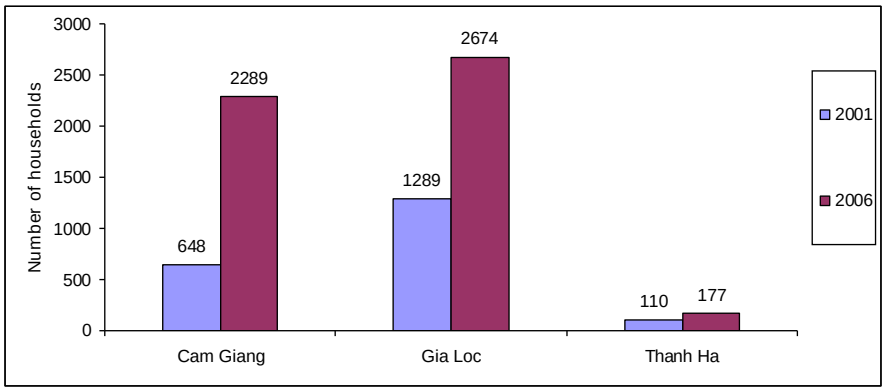


Figure 2.5 Number of households engaged in aquaculture production of three studied districts (source : Hai Duong Statistics Office (2008)

1.2.1.2 Criteria of socio-economic characteristics

Socio-economic characteristics play an important role in shaping the evolution of agrarian systems. A wide variety of socio-economic factors that are linked with the transformation of agriculture can be chosen for the zoning technique. Normally, the development of the industrial sector is strongly associated with the improvement of the basic infrastructure system (such as road, electricity, supermarkets, etc.) and the change of social characteristics (non-farm work opportunities, population density, consumption demand of food, etc.). Therefore, it will be used as one of the variables for the stratification.

In the situation of Hai Duong province, industrial development is simply measured by the number of industrial zones and their land areas. The province will be divided into different sub-regions according to this industrialized level (table 2.1). In the northern part of the province, the industrialization process has been accelerated significantly since recent years. Most industrial parks were located along the highway number 5, which connected two biggest cities in the North of Vietnam (Hanoi and Hai Phong). Cam Giang is one of the representative districts for this zone in which number of industrial zones accounts for more than 30% of total provincial industrial parks. In the medium zone, Gia Loc district, which is situated at the south of Hai Duong city, is in progress of industrialization. The two large industrial parks will be constructed here in following years. Therefore, the rural infrastructure system has been also well-developed recently. By contrast, Thanh Ha is one of the most disadvantageous districts for the development of the industrial zone. The district is separated from the highway number 5 by the long railway from Hanoi to Hai Phong. Thus, it is unattractive for the investors to build industrial companies here because of this unfavourable location. Moreover, the district is also bordered by streams and rivers surrounding it. It seems to be an isolated island that makes it more difficult to connect with other parts of the province. Therefore, it is fairly difficult for this district to develop industry and service sectors.

At the district level, the facility of basic infrastructure (mostly based on the development of road systems and market accessibility) will be applied for the stratification of the district and selection of the commune for the surveys.

Table 2.1. Development of industrial zones in Hai Duong province

Districts	Industrial zones	Land area (ha)	Year
Cam Giang	1, Phuc Dien	87	2003
	2, Tan Truong	199.3	2005
	2, Tan Truong (expanded)	112.6	2009
	3, Cam Dien – Luong Dien	183.96	2007
	4, Lai Cach	132.4	2008
Hai Duong city and Cam Giang	5, Dai An	174.22	2003
	5, Dai An (expanded)	433	2006
Hai Duong city	6, Viet Hoa – Kenmark	46.4	2007
Gia Loc	Hoang Dieu	250	Under a plan (2010-2011)
	Gia Loc	198	
Chi Linh	7, Cong Hoa	357.03	2007
Nam Sach	8, Nam Sach	62.42	2003
Kim Thanh	9, Phu Thai	21.7	2009
	10, Kim Thanh	164.98	2010
	11, Tau Thuy Lai Vu	212.89	2007
Total of province	11	2,187.9	-
Cam Giang	4	715.26	-
Cam Giang/ province	36.4%	32.7%	-

(Note : Calculation without industrial zones under a plan; Source: Hai Duong Industrial Zone Authority (2011)

1.2.2 Zoning techniques

The zoning technique is a participatory work because it is based on a permanent dialogue between the local people and the technicians (FAO, 1999). It includes several major techniques as follows.

1.2.2.1 Map-based analysis

Several kinds of the map are collected and applied for zoning mechanism. The map then be marked and drawn to identify contrasted zones under the participation of staff of Department of Natural Resources and Environment and the Department of Agriculture and Rural Development of the province. A sketch map will be drawn under the advice of informants to indicate the boundary of each zone. It will be corrected more exactly after the rapid field observation of the region.

Existing topographic maps are one of the most important survey tools. These can be used to sketch thematic simplified maps (FAO, 1999). A topographic map is used in this study in order to stratify the province into alternative sub-regions due to soil and landform. In the plain areas of Hai Duong province, there are three types of terrace based on the altitude and landform. Thus, three sub-regions called “upper”, “medium” and “lower” zones can be marked in the topographic map of the province (figure 2.6). A brief description is also illustrated in table 2.2

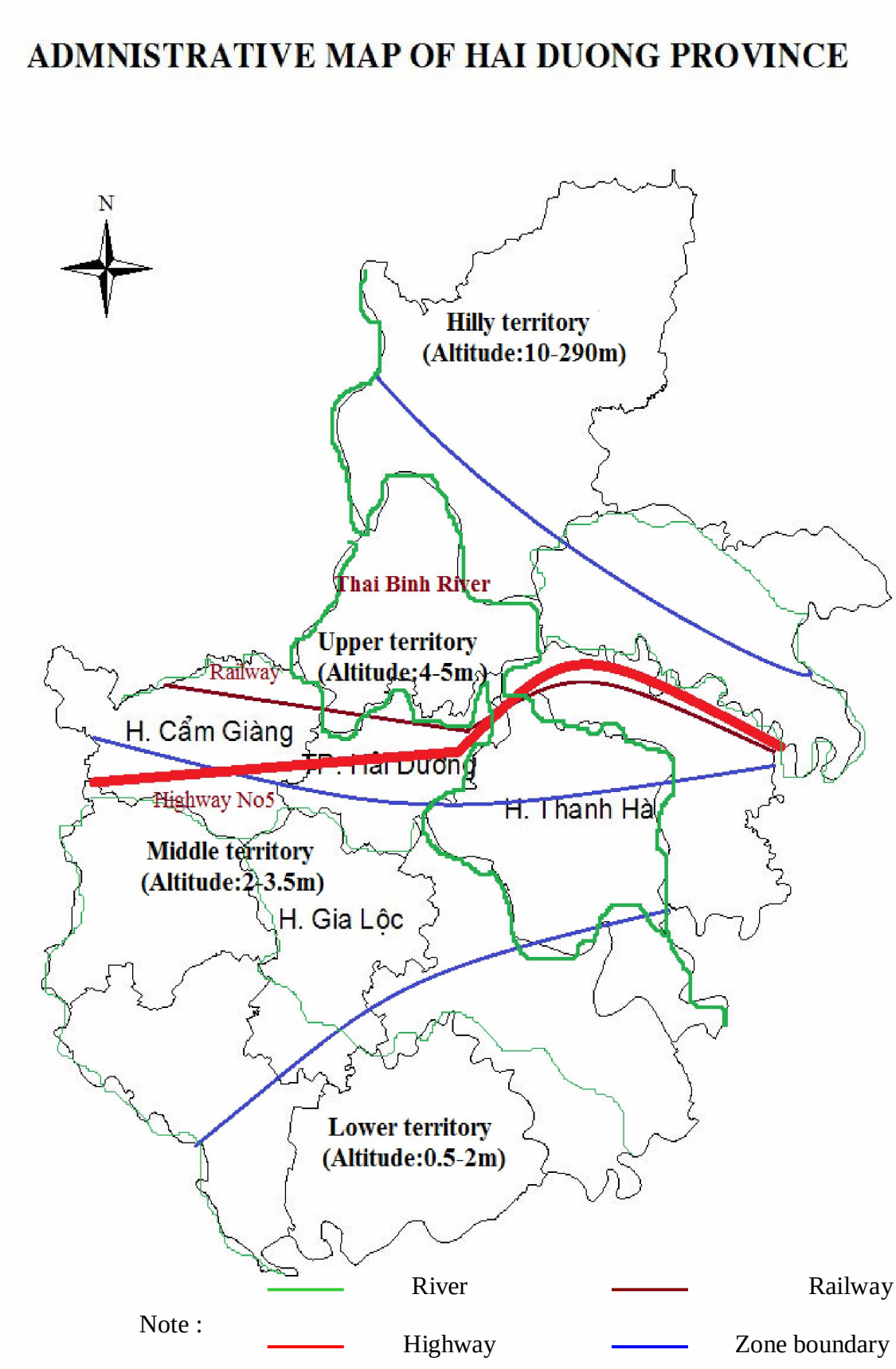


Figure 2.6. Sketch map of Hai Duong province
(source: Secondary data and participatory works, 2010)

Another land use is used to show the distribution of different land-use patterns in the region. Here, we use the land use map in 2010 to identify different zones. Rice is cultivated in large areas in nearly all districts. Fruit tree gardens, especially litchi and guava are widely cultivated in Thanh Ha district, where the territory is “low”. Large annual vegetable crops have been grown for many years in the “medium” areas, mostly in Gia Loc district.

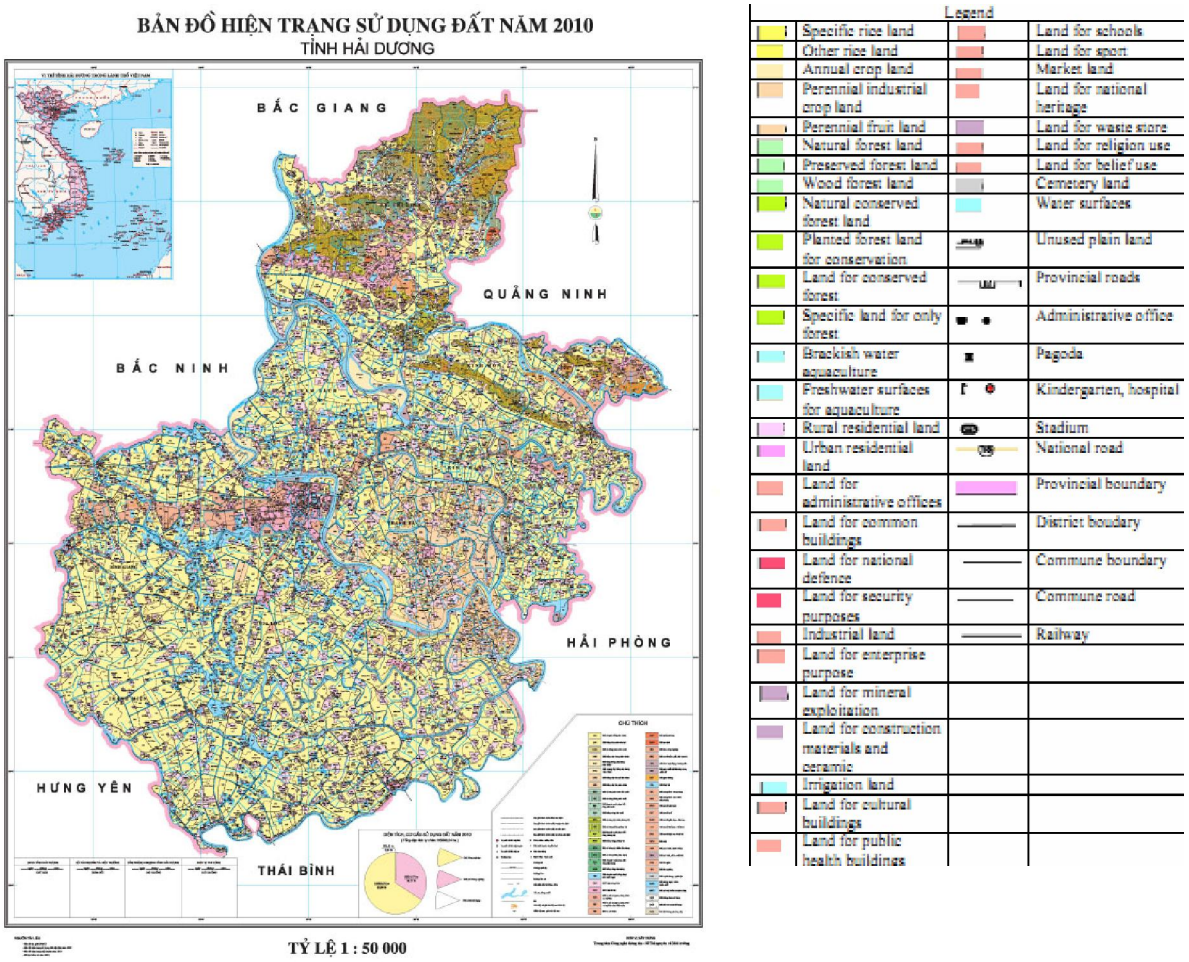


Figure 2.7. Land use pattern of Hai Duong province in 2010
(source: Hai Duong Natural Resources and Environment Department (2010)

Based on the number and the area of industrial zones, three sub-regions are identified in the industrial map. The industrialized sub-region is located in the “higher” areas, mostly along the highway number 5, including Cam Giang, Hai Duong city, Nam Sach, Kim Thanh district. The second zone with some small industrial companies is situated dispersedly in the province, mostly in some districts: Gia Loc, Binh Giang, Nam Sach, etc. The “lower” area has difficulty in developing industrial sector as well as the basic infrastructure system, involving Thanh Ha, Thanh Mien, Tu Ky, Ninh Giang district.

These maps were then overlapped each other in the same way and direction to create relatively homogenous sub-regions. Finally, three main zones are identified due to map-based analysis.

1.2.2.2 Field observation

Field observation was implemented by a transect walk through the whole province. The purpose of this step is to organize and refine spatial information and to summarize local conditions in the area. It is also useful to recognize the exact boundary of each zone in the reality and select the representative target sites for the study.

The task of transect walks is to verify the agrarian landscape of different locations. The information about agro-ecological and socio-economic elements was gathered and recorded as much as possible from direct observation while walking straight line through the investigated area. Therefore, the selection of a pathway should be considered carefully in order to gain the best efficiency of field trips. It would be more appreciated if several short discussions with local people (farmers, old people or local officers, etc.) are made during the trip. Some impressive information was collected from these dialogues.

In this study, thanks to the previous result of the provincial stratification by map-based analysis, two main directions were chosen for the transect walk through the target site. The trip started from the Northwest to the Southeast of the province. The first walk began at the frontier between Hai Duong and Hung Yen province (in the west), went straight along the highway number 5 through Cam Giang district and end at Hai Duong city, the centre location of the province. The journey continued with another provincial road called 17A and 39, which started from Hai Duong city through Gia Loc district. The last trip was from Hai Duong city to Thanh Ha district along the national road number 190A which cut cross this district.

Various important features are marked on the map during these field surveys such as the concentrated areas of large animal and aquaculture farms in Cam Giang; the big original markets (Thack Khoi fish market and Gia Xuyen melon market) and large fields of vegetable crop in Gia Loc district; the large litchi gardens and diversified fruit tree plantations (guava, kumquat) in Thanh Ha district.

The field observation is also the supplementary work for commune selection described later.

1.2.2.3 Exploratory surveys

The exploratory survey is also an important technique in the region stratification. It includes informal interviews with key witnesses about the transformation of technical, ecological, institutional and socio-economic conditions in the history of the target site. The key respondents were chosen among the people who have a deep understanding of the agrarian system evolution of the area. They are the eldest people living in the area and the staff of local authority. A number of people, including experienced farmers, agricultural commodity collectors and retailers, input material suppliers and the administrative staff (village, commune, district, province level) were invited for the discussions at different stages of this study.

These interviews aim to identify and obtain more detail understandings of the main agricultural development periods of the region. Therefore, they should be less structured and more opened so that the respondents can freely talk and share their knowledge. The investigator tried to control the procedure of the dialogue by preparing some main topics before interviewing. During the conversation, the respondents were encouraged to interpret clearly not only the history of technical, ecological, institutional and socio-economic changes, but also their influences on the agricultural production and rural community.

In conclusion, three relatively uniform sub-regions were identified. In each zone, one representative district was selected for the study, including Cam Giang, Gia Loc and Thanh Ha district (table 2.2).

Table 2.2. Characteristics of three zones in Hai Duong

Criteria	Zone 1	Zone 2	Zone 3
Altitude	High territory (4 – 5 m)	Medium territory (2 – 3.5 m)	Low territory (< 2 m)
Terrace	Uneven location with many natural pools	Relatively even plain	sloped down to the southeast, tidal and flooded areas
Agriculture features	Animal and aquaculture –based production (578.2 ha of rice converted to fish pond in 2001-2005)	Vegetable-based cropping system (vegetable land was increased 2,421 ha in 2000-2008)	Perennial-based cropping system (converted 3,000 ha into fruit gardens in 2000-2005)
Rural infrastructure	Well-developed	Well-developed	Undeveloped
Industrialization	Large industrial zones (4 big zones; 150-650 ha/zone)	Some industrial zones (2 zones; 200-250ha/zone)	No industrial zones
Selected districts	Cam Giang	Gia Loc	Thanh Ha

(Source: Hai Duong People's Committee, 2008 and Department of Natural Resources and Environment of Cam Giang, Gia Loc anh Thanh Ha district)

1.3. The district stratification and selection of the target communes

Basically, the variables and methods of the district stratification are similar to those at the provincial level. However, the diversity varies from one district to another. Therefore, the selection of criteria for division is based upon given conditions of each district. Then, a representative commune will be selected in each stratified area. Based on these works, six representative communes were chosen for deep surveys (table 2.3).

Table 2.3 District stratification and commune selection

Districts	Sub-Regions	Brief characteristics	Locations	Selected commune
Cam Giang	SR1a	- Less areas of agricultural land (<50% of total areas) - Rapid development of industry (3 large zones, 4 medium parks, occupying 715ha in total)	In the Centre of district, along highway No 5	Tan Truong
	SR1b	- More areas of agricultural land (>50% of total areas), especially water surfaces - Less development of industrial zone	In the North and South of the district, away from the town	Cam Hoang
Gia Loc	SR2a	- Higher territory, plain areas (3-3.5m of altitude) - Better development of basic infrastructure (large roads, 2 large agricultural markets)	In the North of the district, near Hai Duong city	Gia Xuyen
	SR2b	- Lower land (2-2.5m of altitude) - Less development of basic infrastructure (small roads, far from markets or collecting points)	In the South of the district, away from Hai Duong city	Thong Kenh
Thanh Ha	SR3a	- More facilitated infrastructure (roads, agricultural markets) - Dynamic transformation from litchi into different fruit cultivation (guava, kumquat, etc.)	In the Northeast of the district	Lien Mac
	SR3b	- Less facilitated infrastructure system - Slow transformation from litchi into other fruit production, large areas of litchi	In the Southwest of the district, away from the town	Thanh Son

(Data source:Hai Duong People's Committee (2008) Hai Duong Industrial Zone Authority (2011) and participatory meetings with staff at the Department of Agriculture and Rural Development of Cam Giang, Gia Loc anh Thanh Ha district)

II. CLASSIFICATION OF FARMERS AND PRODUCTION SYSTEMS

2.1 Concept and purpose of farmer classification and production system typology

In the rural area, one group of farmers may differ from others due to the disposal of production means (e.g. land, labour, and capital), the social relationships within which producers operate (e.g. land tenure, access to markets, social organisations, etc.) as well as their production interests (e.g. produce food for self-consumption or for the market). Thus, it is a mistake to consider that all farmers are one homogenous group (Dufumier, 1995). In reality, there may be big differences existing between production/consumption units even within a limited geographical area (FAO, 1999). Different types of farmers in the same agro-ecological region will practise alternative production systems according to the availability of

resources and their interests or experiences. Thus, not all of them will face with the same economic and social problems. Therefore, to understand the complexity of the rural community and to set up appropriate solutions for the future development, it is essential to categorize farmers into different groups and typify the production systems in which they apply.

2.2 Method of farmer classification and production system typology

2.2.1 Criteria for the classification

According to (Dufumier, 1995), criteria for the farmer classification should involve different kinds of resources, social relations and the farmers' interests. In this study, two main criteria were employed for the farmer and production system classification. They are the farm size and production objectives.

The farm size was identified by the total agricultural land area and/or the population of animal flocks. The first group was defined as the large farm with big production scale. The second one included households having small to medium land areas and production scale. This criterion varies from one commune to others according to their specific conditions.

The production objectives were taken into account through the specialization or diversification trend of households. One can specialize into one or two crops or animal species while others are seeking for a diversified crop or animal production system. It means that they tend to specialize in their production system and maximize income per area unit or to minimize risks of bad returns.

2.2.2 Techniques of farmer typifying

2.2.2.1 Informal surveys

The farmer and production system classification was carried out at the commune level by the informal surveys with several key informants who have a good perception of local conditions. They are chief of people committee, chairman of the agricultural cooperative, head of veterinary division, head of the farmer union, etc. In these meetings, different types of producers were, firstly, identified according to their farm size and production objectives. Then, the mechanism of differentiation among farmers was examined by synthesizing the exploratory discussions with these witnesses. The differentiation among farmers was mostly described by the wealth evolution; the capital accumulation trend; the integrative process to the market economy; and the specialization and diversification of crop and animal production system. This information would be essential to classify producers into alternative categories, which often apply one similar type of production system.

2.2.2.2 Secondary data analysis

Apart from these above meetings, several sources of documents and data about the farm size and production scale of farming households were analyzed to check and correct the classification results made previously by local respondents. This secondary information was collected from different sources, such as annual statistic books, annual reports of the commune and the communist party committee, etc. which were published since recent years.

Finally, seven categories of farmers and production systems were identified and presented in table 2.4.

Table 2.4 Classification of farmers and production systems

Districts	Farmer categories		Typology of production systems	Estimated proportion (% of the whole district)
	Production objectives	Production scale		
Cam Giang	Specialized in livestock-fish production	Large land areas (fish ponds), big production scale (big livestock flocks)	Livestock-fish production system	30
	Diversified livestock-fish-crop production	Small to medium farms	Livestock-fish-crop production system	70
Gia Loc	Specialized in cabbage/melon crops	Large areas	Cabbage/melon cropping system	50
	Diversified vegetable crops	Small or medium areas	Diversified vegetable cropping system	50
Thanh Ha	Specialized in guava crop	Large land areas	Guava cropping system	30
	Diversified litchi-livestock production	Large fruit land areas, small to medium livestock herds	Litchi-livestock production system	20
	Diversified fruit plantations	Large fruit land areas	Litchi-kumquat-guava cropping system	50

(Source: Participatory discussions with local witnesses, 2010)

III. HOUSEHOLD SAMPLING AND CARRYING OUT IN-DEPTH SURVEYS

3.1. Sampling the surveyed households

The purpose of household sampling was to understand the diversity and mechanism of dynamics of production systems in the study site. It was a qualitative research based on the case studies to examine in detail the different cropping and livestock production systems of a small number of pre-selected holdings. According to Dufumier (1995), sampling of farming households is not necessarily representative for the whole range of holding types of the study region. The most important things in household sampling is to understand very precisely, for each production unit in the sample, what class of holding it presents. Therefore, the number of households chosen for in-depth surveys may vary from one type of farmers or production system to another, depending strongly on its diversity or uniformity identified in the previous phase.

Hereby, based on the above point of view, the selection of farming households for in-depth interviews was implemented by the stratified and random method as the following steps

3.1.1 Provisional typology of farm holdings

This step was conducted at the commune level with the participation of local informants as described in the previous part. The proportion of each type of farmers and production systems was estimated by the local authority member and then checked with secondary data if it is at disposal at the commune level. A list of farming households of each category was developed by the count of the key respondents.

3.1.2 Informal interviews with some farm holdings

The second step was informal interviews with several farm holdings (two or three ones) of each farm type. These families were chosen randomly from the list made previously by the local authority member. The purpose of these informal discussions is to verify the relative homogeneity of each farm class. If each group is highly homogenous, the final sampling will be done afterward. On the contrary, if there is a significant heterogeneity, the classification work will be revised and checked before selecting samples.

3.1.3 Final selection of household samples

Several farming households of each group were chosen randomly from the list of farmers made before. By analysing the characteristics of these unusual samples, we can understand better the whole situation of a commonplace.

According to the diversity of each production system and the accessibility of each region, the number of selected farm holdings varied from one production system to another. A total of 96 households were interviewed in 2010-2011 as shown in table 2.5.

Table 2.5 Distribution of surveyed households by types of production systems

Agrarian systems	Production systems	No of Households
Animal-Aquaculture based system	Specialized livestock-fish production system	13
	Diversified livestock -fish-crop production system	25
Annual vegetable cropping based system	Specialized cabbage-melon cropping system	17
	Diversified vegetable cropping system	13
Perennial fruit cropping base system	Specialized guava cropping system	8
	Diversified litchi-pig production system	8
	Diversified litchi-kumquat-guava cropping system	10
Total		96

The number of household samples of the perennial fruit based system is smaller than others because of the inaccessibility to regions where the infectious animal epidemic was broken. In 2010, the repeated outbreak of the Porcine Reproductive and Respiratory Syndrome (PRRS)

in pig population caused a huge lost of numerous farms, especially small to medium farms that have little experiences and knowledge in preventing and treating the disease. The travel from one farm to the others and from one region to another seems to be restricted. Moreover, in 2009, litchi growers got a bad harvest with very low productivity and yield. Farmers were thus not interested in the interview talking about litchi cultivation.

Furthermore, several pre-listed households were rejected from the final samples because of unsatisfied requirements of the sampling criteria or unwilling respondents.

3.2. Carrying out in-depth household surveys

In the depth household survey, a semi-structured interview method with a pre-prepared questionnaire was mainly used for this study.

3.2.1 Preparing the questionnaire

The preparation of the questionnaire plays a significant role in achieving the survey result. It is used in the case studies to gather data and information of households and their production system. Therefore, it requires much attention to the construction a questionnaire.

With the requirement of collecting both qualitative and quantitative data, a semi-structure questionnaire will be developed containing alternative “open” and “close” queries. These two types of questions need to be mixed flexibly each other in order to take the most effect of the investigation. The combination of qualitative and quantitative questions will result in a more natural interview rather than a very structured one. Besides that, for the quantitative data, it had better to use the popular or local unit of the measurement because it is easier for farmers to understand and calculate. Moreover, the academic concepts were also translated into normal words or expressed by the way that often used by farmers.

In theory, a questionnaire cannot comprise too many questions which may cause time-consumption of both respondents and investigators. It had better to construct a short questionnaire to ensure the time for each interview not longer than one hour and a half.

The preparation of a questionnaire was, firstly, done by the researcher. It was based on the main contents of the study. The secondary information was also important to make the questionnaire to be more suitable and logical to the reality. Then, testing the questionnaire in some household cases of all sub-regions was carried out to revise or correct it.

Based on the research objectives, the main contents of the questionnaire used in this study are as follows:

+ General current information of the head and other members of the family: name, age, health, job, education, marriage status, etc.

+ Current labour force and its change over time from 1993 up to 2010: main active labour, agricultural labour, non-farm and off-farm works, hired-out, hired-in and exchanged labours, and the reason of changing in the labour force.

+ Land resources and its changes over the year 1993-2010: total land areas, land use pattern for different agricultural activities (rice field, garden, fish pond, animal building); transformed land area from rice land to vegetable, fruit, fish pond; land acquisition method, and reasons for changing land areas.

+ Characteristics of cropping systems and their changes over the period of 1993-2010: Crop calendar, cultivated area, use of intermediate input materials (fertilizer, crop varieties, pesticides, etc.), yield and productivity, marketing the products, and pest management.

+ Characteristics of livestock and fish production systems and their changes over the period of 1993-2010: Animal herd size and its changes; use of intermediate input materials (animal breed, animal feed, veterinary medicine, etc.); growth and reproductive performance; marketing the products, disease prevention and treatment.

+ Access to credit capital: total credit borrowed per year, interest, borrowing period, use of loan

+ Main difficulties facing farming holdings and their strategies: issues related to institutional policy, marketplace, rural infrastructure system, environmental pollution, technology, etc.

3.2.2 Interviewing and observation of farm households

Interviewing farm households was a heavy task of the research. It consumed a great deal of time, finance and human resource. The main investigations were carried out in 2010 and 2011 at 96 households in six communes by direct interviews and observations.

The retrospective method was employed for data collection at the household level. Farmers were, firstly, requested to provide data and information at the current time of the survey (in 2010). In order to calculate the economic outcomes, data was collected by the previous year (in 2009) as a complete production cycle. Then, the data (e.g. land areas, livestock population, etc.) was recalled by farmers across the year, mostly the specific year when significant changes occurred. The year 1993 was considered as the key point for the memory because the agricultural land was redistributed to farm holdings for long-term use according to the land law. Thus, most of them remember exactly their farm size (land area, crops, animal flocks). Afterward, the major changes in agricultural production and farm size can be described by farmers (e.g. the year when they bought more land, the year of land conversion, the year of raising more or less sows, etc.). The data in the past was defined as the average or mean value of that year in the normal condition.

In order to take most effects of the surveys, the logic of the questions should result in a natural conversation between interviewer and interviewee. Thus, it started with general questions about household members and resources to break down the “cold air” of the first moment. Since getting the emotion and willing of farmers, the sensitive issues can then be emerged later. Therefore, these kinds of questions were often added at the last part of the questionnaire and raised at the end of the investigations.

During the conversation, farmers are strongly encouraged to share their experiences and opinions as much as possible. To gain this point, the investigator should explain clearly to respondents about the research purposes and topics. As farmers conceive well what we do and for what, they will be ready to participate and share the information about their situations. However, they sometimes go too deeply or too far within a given topic in which they interested. Hence, the technicians have to control it and skip to the following content.

Taking note farmers’ interpretations and what we observed during the dialogues are also very important to characterize and analyze the production system. After each interview, the questionnaire should be checked for mistakes or for blind information. In some cases, it is necessary to go back to farm holdings to revise and supplement the missing data.

IV. CHARACTERIZATION OF AGRICULTURAL PRODUCTION SYSTEMS

Characterization aims to understand the complexity and the internal coherency of the agricultural production systems at the farm level. It was conducted by describing the characteristics of each sub-system (cropping system, livestock and fish production system) and the combination of them within a whole farm. They included not only technical characteristics but also the economic outcomes of the production system. Moreover, the technical and economic constraints facing farmers was then examined.

4.1 Characterization of cropping systems

The cropping system was described in space and in time at the plot level, mostly regarding the following dimensions:

+ In space, the analysis focused on the cropping associations and their mixed patterns. It shows the diversified level of the cropping system.

+ In time series, it was characterized by cropping rotation or cropping successions through seasonal cropping calendar to identify the crop operational sequences.

+ Input materials were measured due to alternative types of crop to calculate intermediate production cost. Then, the crop yield and gross product were computed to evaluate the performance of the system.

4.2 Characterization of animal production systems

Like cropping systems, the animal production system was also analysed over space and over time, including the following features:

+ Over space, the allotment of animal was, firstly, mentioned as the distribution of different species of animal raised by farmers. Besides, the operational practices and techniques of animal production, especially regarding to the confinement condition, housing circumstance will be described.

+ By time series, the variation of livestock herd size was measured to understand the strategies of farm households. It comprised the change in the number of each species of animals or the replacement one breed by another kind.

+ Intermediate inputs (feed, veterinary medicine, electricity, etc.) and efficiency ratios (sexual maturity, conception rates, calving intervals, level of prolificacy, death rates, growth rates, etc.), meat or egg productivity and economic returns will be calculated to identify the performance of animal production systems.

+ The description then continued with major problems or constraints with which the producers are coping. Those problems are related to animal diseases, feeding systems, animal management, marketing livestock products, etc.

4.3 Characterization of the internal and external relationships

A farming system is a uniform combination in which elements interact regularly and in different ways to achieve its functions. It is also operated in a changing environment that has a great impact on the behaviour. Therefore, the analysis of internal and external relationships is essential to comprehend the dynamics of production systems.

Internal interactions can be a complement process or a competition among cropping systems, animal production systems and non-agricultural components within a given environmental context. The analysis will concentrate on the balance of allocating household resources such as labour, land, credit to different economic sectors, between crop cultivation and animal production, between agricultural practice and non-farm work.

The external relationships can be understood as the exchange between system's elements and external environments. They comprise the input flows and output flows of the systems. In this study, the flow of input materials from outside will be investigated to measure the intensive level of farming systems. For output flows, the distribution of agricultural products to different market chain is also taken into account in the analysis.

To have a better understanding about the characteristics of farming systems, the flow diagram or flow chart method was applied to facilitate the analysis. The material flows (input and output) were drawn among components of the systems and its environments.

V. METHODS OF ANALYSIS

5.1 Economic assessments of the farming income

Farm households often improve their income by diversifying the income sources, involving farm income, non-farm income, wage, remittance and transfer. Therefore, the household economic assessment will focus on these kinds of income within a year which considered as a completed production cycle.

In general, the farm income is calculated separately for individual production activity of the household, comprising crop cultivation, animal and aquaculture production and forestry. It includes the income from sales and the proportion of household consumption. The income from sales is collected through all actual income received from selling products within a year. For the self-consumed proportion, the value is estimated by multiplying total quantities by the local market price at the time of consumption. The total farm income is the sum of these components.

The basic indicator is the Gross Product (GP) which is calculated by multiplying the quantity of each kind of product (Q) by its unit price (P). For the farm household economy, some types of by-products such as manure from pig or chicken production, crop residuals, etc. can be sold as a complementary income. It is calculated by the same rule of main products. The gross product of individual production is calculated as the following formula:

$$GP = Q_1.P_1 + Q_2.P_2$$

Where: GP: Gross Product (VND)

Q_1: Quantity of sold product/by-product (kg)

P_1: Unit price of sold product/by-product (VND/kg)

Q_2: Quantity of consumed product (kg)

P_2: Unit price of product of local market at the same time of consumption (VND/kg)

It is essential to measure the intermediate variable cost (VC) and fixed cost (FC) of each production. The variable cost is calculated by multiplying the quantity of input materials and energy (q) by its unit price (p). The fixed cost is calculated for fixed assets and breeding animal, including cost for depreciation, taxes (T), land rent (L), loan interest (I), paid wage (W). Depreciation Cost (DC) is calculated by the ratio of difference between Purchased Value (PV) and Liquidation Value (LV) to total used years (Y) of fixed asset or total reproductive cycles (RC) of breeding animal.

$$VC = q.p$$

Where: VC: Variable Cost (VND)

q: Quantity of used input materials or energy (kg or kW)

p: Unit price of input materials or energy (VND/kg or VND/kW)

$$DC_1 = (PV - LV)/Y \quad \text{or} \quad DC_2 = (PV - LV)/RC$$

Where: DC_1: Depreciation Cost of fixed assets (VND/year)

DC_2: Depreciation Cost of breeding animal (VND/reproductive cycle)

PV: Purchased Value of the asset (VND)

LV: Liquidation Value of the asset (VND)

Y: Total estimated years of usage (years)

RC: Total estimated Reproductive Cycle of breeding animal

Based on this value, two kinds of farm income are broadly defined as Gross Value Added (GVA) and Net Value Added (NVA) can be easily calculated.

Gross Value Added (GVA) of household is calculated by deducting intermediate Variable Cost (VC) from the Gross Product (GP) as following formula:

$$GVA = GP - VC \quad (VND)$$

Net Value Added (NVA) is calculated by deducting Depreciation Cost (DC) from Gross Value Added (GVA) as below formula

$$NVA = GVA - DC \quad \text{or} \quad NVA = GP - VC - DC \quad (VND)$$

Net Farm Income (NFI) is the income after deducting several fixed costs such as taxes (T), land rent (L), loan interest (I), paid wage (W) from Net Value Added (NVA). If farm

households have subsidies (S), this amount needs to be added to Net Value Added as followings

$$NFI = NVA - T - L - I - W + S \quad (VND)$$

- Net Farm Income per agricultural surface unit = NFI/ASU
- Net Farm Income per family worker = NFI/FW
- Labour productivity per worker: LP = NVA /W

5.2 Data resources and data analysis

5.2.1 Data resources

Secondary data will be collected from different official sources, including annual statistic books published by General Statistic Office (GSO), Hai Duong Statistic Office (HSO), maps, historical books, annual reports and summaries of local authorities at village, commune, districts and province departments. Besides that, several books and documents such as dissertations, project reports, etc. can be used as a complementary source for this study.

Primary data comes from participatory works and household surveys by semi-structured questionnaire.

5.2.2 Data analysis

This research was mainly based on case studies. Therefore, the descriptive statistic method was employed to calculate the mean and the standard deviation of the samples, using Minitab 14 software.

CHAPTER 3. GENERAL AGRO-ECOLOGICAL ENVIRONMENTS AND SOCIO-ECONOMIC CHARACTERISTICS OF THE STUDY SITE

I. INTRODUCTION

The characteristics and dynamics of an agrarian system are often strongly related to the agro-ecological and socio-economic environments of a given geographic region. Under a certain condition of both physical environments and socio-economic circumstances, farm holdings adjust their production mode to meet the demand of the current society. The ever-changing situation of the environment always has an influence on agricultural production in both ways, positive and negative aspects, leading to the evolutionary trend of the agrarian system.

This chapter presents the general agro-ecological and socio-economic environments of the study site. The physical nature and socio-economic situations of the research region will be analyzed to identify the characteristics and limitations for the development of agriculture and rural area.

II. AN OVERVIEW OF THE RED RIVER DELTA

The Red river delta is located in the North of Vietnam and surrounded by mountains, in the East and West, and by hills in the North. It is shaped and deposited by alluvium layers of the two main rivers, namely the Red river and the Thai Binh river and their small streams, which provide much alluvium and water for agricultural production every year. The delta is, therefore, marked by a slight slope from the northwest to the southeast, from 15 meters down to the sea level. Three types of land can be distinguished according to the altitude, involving the lowlands with clayey soil, mainly in western region, the midlands in the coastal, eastern and central zones and the highlands with sandy soil and prevail in the northern and central delta (Devienne, 2006)

As the second largest delta of Vietnam, the Red river delta has a total area of 2,097,300 ha, covers only 6.3% of whole country's area. Large areas of the delta are agricultural land, about 802,600 ha, corresponding to 38.3% of total areas of the delta and 8.5% of total agricultural land areas of the whole country (GSO, 2008). Therefore, Red river delta is considered as one of the biggest agricultural production centres of Vietnam, contributing about 17 to 20% to total rice yield every year of the country.

Table 3.1. Structure of population in Vietnam and the Red river delta (1995-2008)

Year	1995	1997	1999	2001	2003	2005	2007	Estimated 2008
Whole country	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Urban population	20.7	22.7	23.6	24.7	25.8	26.9	27.5	28.1
Rural population	79.3	77.3	76.4	75.3	74.2	73.1	72.5	71.9
Red river delta	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Urban population	18.1	20.2	21.3	22.1	23.2	25.5	26.2	27.3
Rural population	81.9	79.8	78.7	77.9	76.8	74.5	73.8	72.7

Source: (GSO, 2008)

However, the high density of the population is a big challenge for the development of agriculture in the delta. In 2008, it has a population of 19,654,800 people, and the density is 933 people/km^2, much higher than the average of the whole country (86,210,800 people and 260 people/km^2) (GSO, 2008). Rural population still makes up a high proportion of the population structure even it has been decreased recently (table 3.1). The decline of rural population is the result of a regular migration wave of peasants to cities, industrial zones and foreign countries to search non-farm jobs. Thus, the share of agricultural labour in total labour force has slightly decreased, from 62.5% in 2000 to 48.9% in 2008 (GSO, 2008).

The Red river delta comprises eleven provinces, namely Hanoi, Vinh Phuc, Bac Ninh, Quang Ninh, Hai Duong, Hung Yen, Hai Phong, Thai Binh, Ha Nam, Nam Dinh and Ninh Binh. It is one of the biggest economic centres of the country with the strong economic triangle of Hanoi - Hai Phong - Quang Ninh. Thus, the region has great advantages for the development of alternative economic sectors, including agriculture, industry and service. In the recent decade, according to the acceleration of industrialization and urbanization process, large agricultural land areas have been decreasing rapidly because of the transformation into non-agricultural activities such as industrial zones, golf playgrounds, urban accommodations, etc.

Although agricultural land areas have decreased recently, agricultural sector still remains as an important economic activity of the region. Agriculture contributes a huge proportion (about 50%) to the total income of farm households (GSO, 2007). Agricultural sector accounts for about 35% of the GDP, compared to 24% of industry and 41% of services. Thanks to the advantages of natural environments and socio-economic conditions, three main sectors of agricultural production, including crop cultivation, animal production, and agricultural services are well-developed. Crop production normally accounts for the largest proportion of total gross value of agricultural production. However, in the last decade, the structure of agricultural value added has changed regularly with the slight decrease of cropping contribution and the rapid increase of animal and aquaculture sector.

In cropping systems, rice is the major crop as a traditional production that ensures the staple food security. After the renovation or “Doi moi” policy was introduced, the cropping systems became more diversified and intensified, especially in the Red river delta. In this development process, large areas of rice fields have been converted to other agricultural productions to meet the new demand of consumers in the markets. Rice land was transformed into different types of land, including vegetable crops, fruit tree gardens and fish ponds. The conversion resulted in higher income for the farmers at first stage as compared with the rice mono-

cultivation. That is the great incentives for farmers to continue converting rice areas to alternative crop and aquaculture activities. Some regions, nearly all of rice land transformed into other crops or fish pond because of higher profit they gained at first time after converting.

In animal production systems, pig and poultry are widely raised in both small households and large industrial farms. In 2001, there are 72.5% of households raising pigs and 70% of households raising poultry. In the Red river delta, the stocking rate of pig and poultry herds is the highest of the whole nation. Pig density is 339.8heads/km^2 and poultry density is also very high, from 3,900heads/km^2 to 5,000heads/km^2, much higher than other regions of Vietnam. However, cattle (except cow) and buffalo production have decreased significantly due to the mechanization in agriculture and the high density of the population.

III. ADVANTAGES AND LIMITATIONS OF THE AGRO-ECOLOGICAL ENVIRONMENT OF HAI DUONG PROVINCE

3.1 Geography

Hai Duong is located in the centre of the Red river delta, Northern Vietnam. Total natural area of the province is 1651.85 km^2, equals to 7.8% of the total area of the Red river delta and 0.5% of the whole nation (GSO, 2009). The province lies between latitude 20041'10" and 21014'20" north and longitude 106007'20" and 106036'35" East (Hai Duong People's Committee, 2008). It has the boundary with six other provinces, including Hai Phong to the East, Hung Yen to the West, Thai Binh to the South and Bac Giang to the North, Quang Ninh to the Northeast and Bac Ninh to the Northwest. The province has eleven districts, namely Chi Linh, Nam Sach, Kinh Mon, Kim Thanh, Thanh Ha, Cam Giang, Gia Loc, Binh Giang, Tu Ky, Ninh Giang, Thanh Mien and Hai Duong city (Figure 3.1).

Although located at the heart of the Red river delta, the province still has both highland and lowland territories. The province is slightly sloped from the northwest to the southeast with the difference of the altitude ranking from 10 to 616m in the high area and from 0.9 to 5m in the plain delta. The highland part in the North occupies 262.85 km^2, or 15.91% of total province area, including 13 communes of Chi Linh district and 18 communes of Kinh Mon district, which are characterized by not very high mountains and hills. The plain basin in the South shares 1389.00 km^2, equal to 84.09% of total natural areas, which is shaped and deposited by alluvium soil layers of Thai Binh river system.

Based on the geomorphology, Hai Duong can be divided into four regions (Hai Duong People's Committee, 2008):

1) The low mountainous region in the northeast of Chi Linh district: Average altitude is about 200 - 300m to the sea level. This area is difficult for agricultural production.

2) The hilly region in the South of Chi Linh district and some areas of Kinh Mon district: Average altitude is about 40 – 50m, mostly clear hills and being cultivated by new plants.

3) The limestone mountain region in Kinh Mon district occupies small areas

4) The plain delta is the largest regions and suitable for agricultural activities.

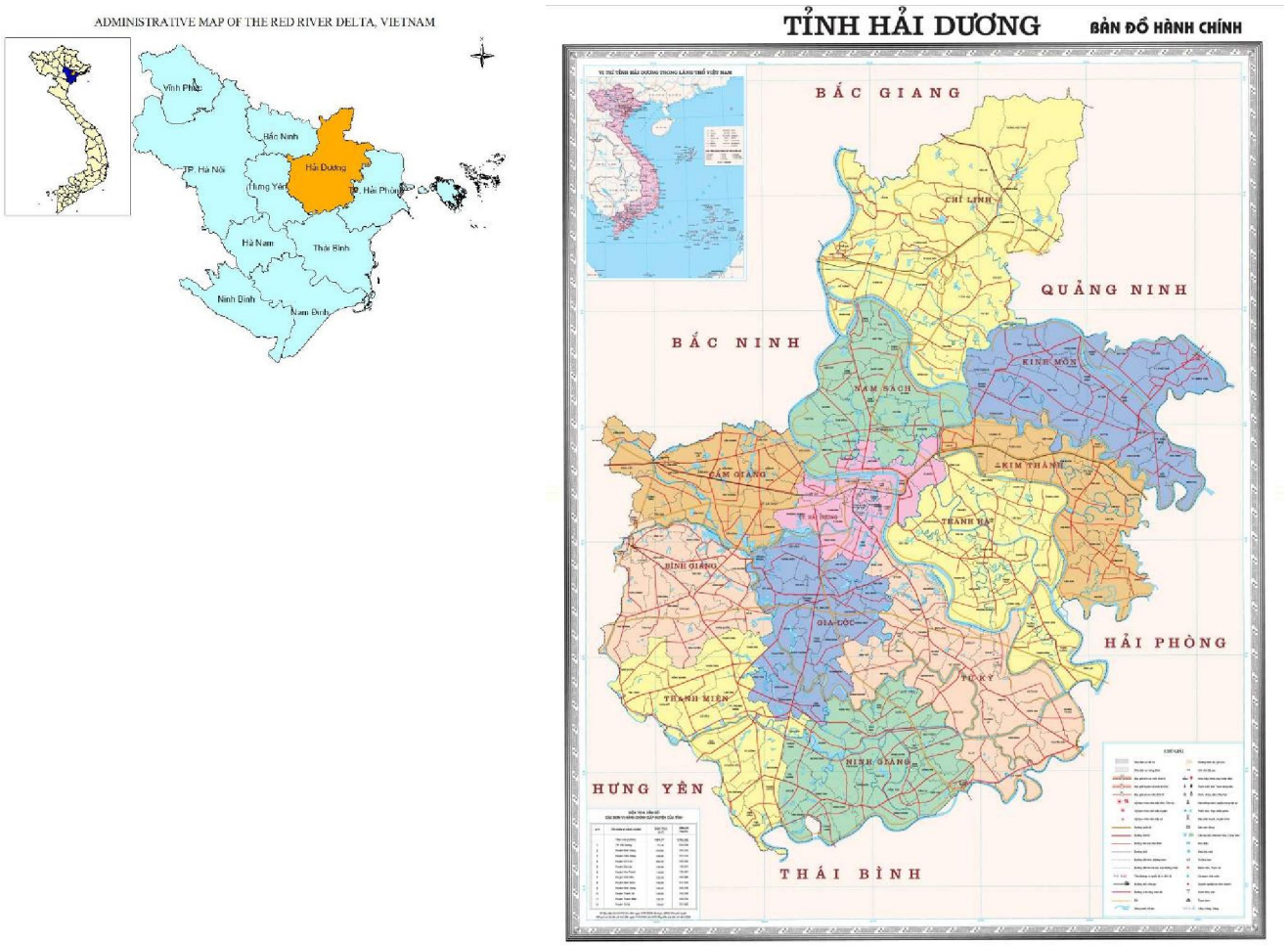


Figure 3.1 Administrative map of Hai Duong province in The Red river delta, Northern Vietnam
(Hai Duong Natural Resources and Environment Department, 2010)

3.2 The Weather

Like many other provinces in the Red river delta, Hai Duong has the tropical monsoon climate with two distinct seasons, comprising the cold winter with little rainfall and the hot and humid summer with much heavy rain. Between these two seasons, there are transforming periods from winter to summer (in April) and from summer to winter (in October). The evolution of the average monthly rainfall and temperature from 1997 to 2009 is presented in figure 3.2 and 3.3.

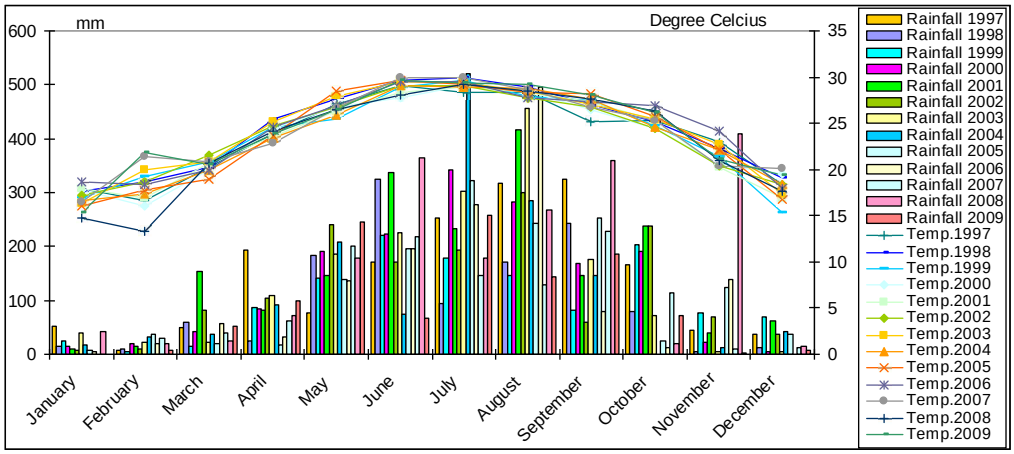


Figure 3.2 Evolution of monthly average temperature and rainfall of Hai Duong province (Hai Duong Statistics Office, 1998,2001,2010)

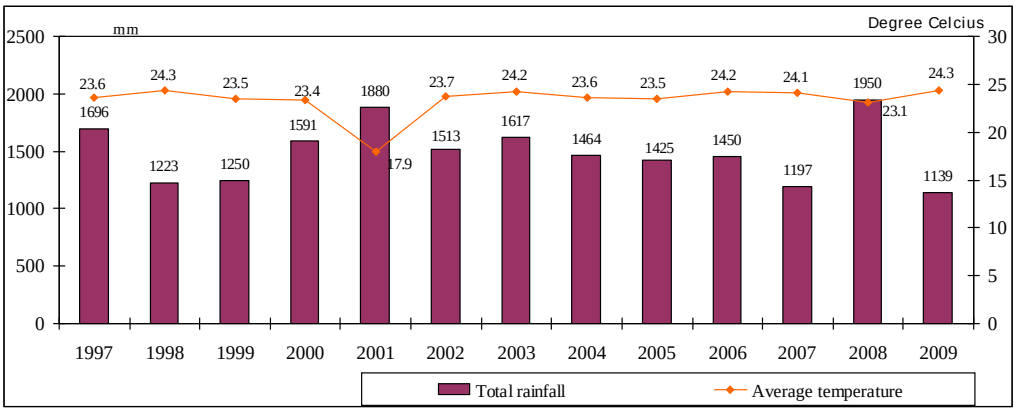


Figure 3.3 Evolution of annual average temperature and rainfall of Hai Duong province (Hai Duong Statistics Office, 1998,2001,2010)

In winter season (from November to March), the average temperature is very low, under 20^{o}C, and the rainfall is so limited, normally less than 100mm per month. So, lack of water for agricultural production is always a big problem during this period. Moreover, in some years, the very low temperature (under 10^{0}C) caused big problems of the seedling rice growth. Farmers, thus, had to re-transplant new seedlings, leading to the change of the crop calendar. The cold weather also affected badly the growth of livestock and fish, even causing the big lost (e.g. a huge amount of tilapia was died because of low temperature in winter 2009).

On the contrary, the temperature and rainfall in summer are much higher than those in winter (e.g. the rainfall is 10 to 20 times higher). From April, they start to increase and reach to the peak in July or August and then decrease at the end of November. Because of the poor irrigation system, some regions may face a lot of terrible damage of storm and flood in rainy season, especially in lowland areas of the south province. This was one of the reasons for the fluctuation of crop yield and productivity. The extremely heavy rain was also blamed for the immeasurable lost of a number of fish farms in recent years.

Recently, the climate change has been more and more concerned because of its obvious influence on crop and animal production. In Hai Duong, the annual average temperature in last 20 years (from 1986-2005) was 23.52^{0}C, which is 0.19^{0}C higher than that of the previous

period (1960-1979) (Hai Duong People's Committee, 2008). The frequent variation of the weather made it more difficult for farmers to manage their production activities. The sudden occurrence of extremely bad weather (storm, flood, etc.) has caused significant failures of many farms recently.

3.3 Water resources

As one of the province of the Red river delta, Hai Duong has a sufficient water resource provided by interconnected stream and river systems. Based on the main water flows, the stream system in Hai Duong can be divided into two main sub-systems, including outside river system (or major natural rivers) and the inside canal system. The outside river is naturally formed and originally flowed from the Northern upstream. Its flows depend largely on the physical environment conditions such as rainfall, flood and the regulation of the reservoir in the upstream. The inside system includes small rivers and canals which the flow regulated by directly pumping from natural rivers.

The natural river systems involve the Thai Binh river and its flows which are mostly located in the southeast of the province. These small rivers are Kinh Thay, Kinh Mon, Rang, Van Uc, Lach Tray, Gua, Mia, Han Mau and Da Vach. They flow down from northwest to southeast and turne around regions.

The small river and canal system may also be divided into two different sub-regions, including the region of Bac Hung Hai irrigation system and the region of left side of Thai Binh river. The region of Bac Hung Hai irrigation system comprises two main streams, namely north stream (62km) and south stream (51km). The canals on the left side of Thai Binh river have been mainly built since 1955. Among these major streams, there are a lot of cross-linked flows that provide enough water for agricultural production of the province.

In estimation, total annual water flow of rivers in Hai Duong is about 35 billion cubic metres, and total amount of alluvium gains 26.6 million tons per year. These rich natural resources are greatly advantageous for agricultural production. However, the distribution of water is not equal throughout the year (85% of total rainfall belongs to summer season, from May to October). Therefore, the flood and drought are widely occurred and terribly damaged crop and animal production, especially in lowland territories, where the altitude is lower than 2m. This kind of territory shares about 55% of total cultivated land areas of the province (Hai Duong People's Committee, 2008).

3.4 Land resources

Land is one of the most important resources, especially for agricultural production. Land use thus needs to be taken great consideration to balance the development of all production activities of the region. The evolution of land use pattern of Hai Duong in recent years is presented in figure 3.4 and table 3.2.

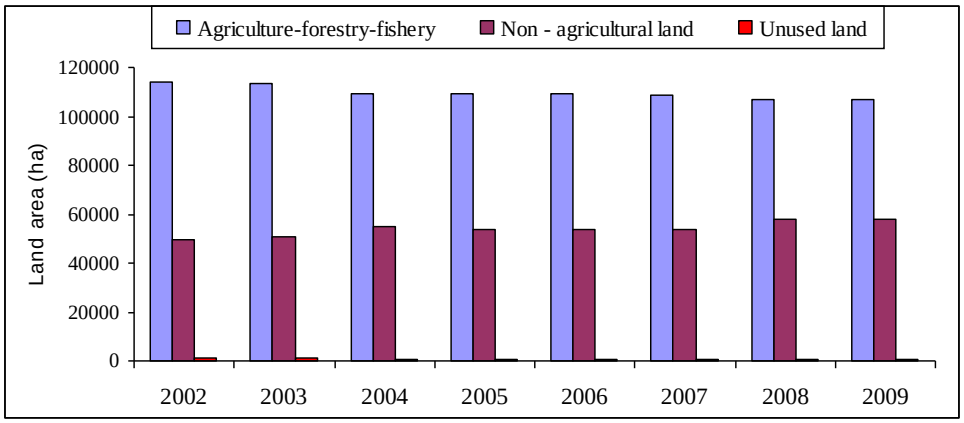


Figure 3.4 Change of land use pattern in Hai Duong
(Hai Duong Statistics Office, 2006,2010)

Basically, Hai Duong is an agriculture-based province where agriculture-forestry-fishery land occupies high proportion of total natural land area. As mentioned in previous part, the plain region where is favourable for agricultural activities shares more than 80% of the entire province. This is an advantage for the development of the agriculture sector.

Recently, the most important change in land use pattern in Hai Duong was the gradual reduction in agriculture-forestry-fishery land area and the slight increase in non-agricultural land area. The proportion of these two items of land in 2002 was 69.2% and 30.1%, respectively. In 2009, agriculture-forestry-fishery land just made up 64.4%, whereas the non-agricultural land accounted for 35.1%. This improvement of non-agricultural land area was derived from the fast increase of the demand for habitation land (in both urban and rural locations) and industrial land. In 2008, the total habitation land area was 14,292ha, or 28.9% higher than that in 2000 (11,089ha) (Hai Duong Statistics Office, 2010). The development of industrial zones has attracted a huge number of workers from surrounding regions to Hai Duong since last decade.

By contrast, agriculture-forestry-fishery land area has been decreasing gradually over this period, especially from 2002 to 2007 (table 3.2). There was a significant decline in the rice land (8.8 thousand ha or 11.3%), mostly because of land conversion into industrial zones and urban areas. Furthermore, the conversion from low rice land into fish ponds and perennial crops resulted in the increase of these land areas (23.8% and 43.8% respectively).

Table 3.2 Change of agriculture-forestry-aquaculture land area in Hai Duong

Land items	2002		2007		Difference (2007/2002)	
	Area (thousand ha)	Proportion (%)	Area (thousand ha)	Proportion (%)	Area (thousand ha)	Ratio (%)
Agricultural land	97.07	85.16	90.93	79.3	-6.14	93.67
- Annual crops	79.95	82.36	72.72	63.4	-7.23	90.96
In which : Rice	71.78	89.78	69.1	60.3	-2.68	96.27
- Perennial crops	17.12	17.64	18.21	15.9	1.09	106.37
Forestry land	9.14	8.02	8.89	7.8	-0.25	97.26
Aquaculture land	7.77	6.82	9.05	7.9	1.28	116.47
Total	113.98	100	108.91	100	-5.07	95.55

(Source: (Hai Duong Statistics Office, 2003); Hai Duong Statistics Office (2008)

IV. SOCIO-ECONOMIC CHARACTERISTICS OF HAI DUONG PROVINCE

4.1 Population and labour force

Hai Duong is a populous province with a high density of population. In 2008, it has a population of 1,732,347 habitants, increased by 101,748 people, equal to 6.24% over the last decade (from 1997 to 2008). A large proportion of population (more than 80%) live in rural areas and the rest one (less than 20%) inhabits in urban regions. However, due to the rapid development of industrialization and urbanization process, the structure of population has been changed over the period of 1997-2008 with the slight decrease in rural residents (from 88.8% in 1997 to 81.8% in 2008) and the corresponding increase in urban inhabitants (from 11.2% in 1997 to 18.2% in 2008) (figure 3.5). Thanks to the achievement of family planning policy, the population growth rate has been reduced annually from 13.12‰ in 1997 to 9.83‰ in 2008 and then stabilized around 9‰. To compare the natural growth rate of population between rural and urban area, the data in figure 3.5 indicates that before the year of 2002, the growth rate of rural population was higher than that of urban inhabitants. However, after 2002, the growth rate of urban population became increased and higher than that of rural people due to the great migration from rural areas to industrial parks and urban cities.

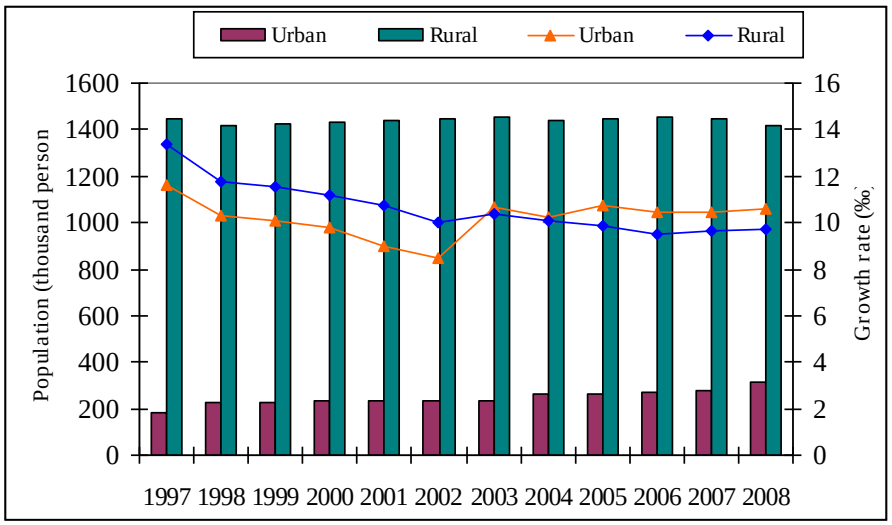


Figure 3.5 Average population and natural growth rate of population by regions of Hai Duong
(Hai Duong Statistics Office, 2001,2010)

The population and population density are different among districts/cities of the province (figure 3.6). Hai Duong city, the capital of the province, is the most populous and dense regions. Chi Linh, a mountainous district, has the lowest population density (548 persons/ square kilometre). Most of the districts have a high population density (more than 1,000 person/km^2), higher than the average value of the Red river delta (933 person/km^2) and of the country (260 person/km^2).

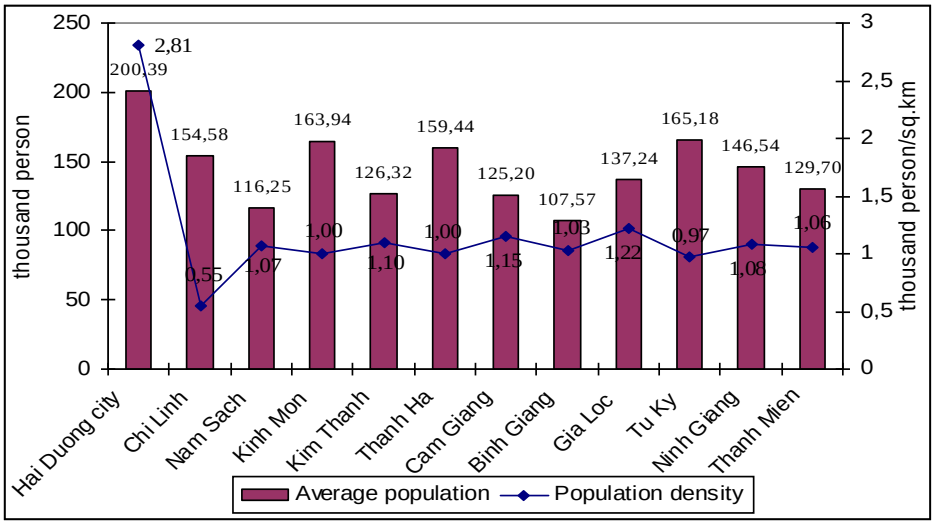


Figure 3.6 Population and population density by districts of Hai Duong in 2008
(Hai Duong Statistics Office, 2010)

Similar to the changing trend of population structure, labour force structure of the province has also changed notably towards the higher proportion of industrial and service labours and lower share of agricultural workers since the year of 2000 due to the acceleration of industrialization and urbanization (figure 3.7). Therefore, the percentage of labour working in

the industrial sector increased rapidly from 8.1% in 1997 to 23.3% in 2008, higher than the increase of service activities. This rising proportion is derived from agricultural workers, leading to the significant decrease labour force of agriculture, forestry and fishery (from 84.5% in 1997 to 59.7% in 2008).

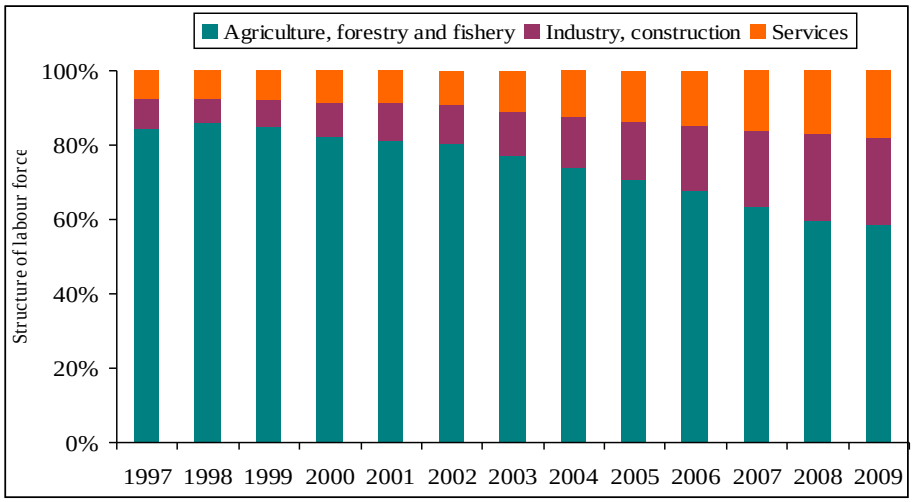


Figure 3.7 Structure of labour force by economic sectors of Hai Duong (source: (Hai Duong Statistics Office, 2001,2006,2010)

4.2 Basic infrastructure system

Located in the centre of the northern economic triangle and highly developed industrial zones, Hai Duong has a better development of the basic infrastructure system than many other provinces in the Red river delta. That is a great advantage for the economic growth.

The traffic system of this province has been well upgraded and rebuilt since recent years, including roads, railways and waterway systems. There are six main national roads going cross here with total 115km of length. The highway No 5 starts from Hanoi to Hai Phong and passes through the province with 44.8km. This is one of the most important roads which directly link to two biggest cities of the North. Along two sides of this road, vast industrial factories and markets were built due to the conversion of large rice land fields. Besides that, the other national roads, namely 10, 18, 37, 38 and 183 also play a significant role in socio-economic development of the province. In most districts, rural road systems have been expanded and upgraded regularly, making it more convenient for traveling and transporting goods among all corners and sites.

Moreover, the waterway and railway system are also important transportation means in the province. Total length of railway is 68.17km, connecting Hanoi and Hai Phong city. A huge proportion of goods and commodities are transported from and to the province by trains and boats every year. They contribute much to the enhancement of the socio-economic exchange between Hai Duong and surrounding provinces. In estimation, the waterway system contributes approximately 43.5% to 47% of total goods' transportation every year (Hai Duong People's Committee, 2008).

Like other provinces of the Red river delta, Hai Duong has a good electricity system. In 2001, all communes (100%) had access to the national electricity system. Each year, a big amount

of national and provincial budget is invested in improving this system in order to enhance the economic development of the province. However, with the rapid increase of demand of industrial factories which strongly depend on electricity system, rural areas are sometimes in shortage of electricity, and agricultural production is also terribly affected by electricity cut-off over long time.

4.3 Economic structure and activities

As one of the most dynamic provinces in the Red river delta, Hai Duong economy has achieved a high growth rate recent years. The average annual growth rate of the GDP over the period of 2001-2005 was 10.57% per year, higher than that of the period 1996-2000 (9.3% per year). The economic structure has changed remarkably towards a higher contribution from industry, construction and service sectors (from 36.6% and 28% in 1997 to 43.8% and 30.5% in 2008, respectively) and a lower proportion from agriculture (from 35.4% in 1997 to 25.7% in 2008) (figure 3.8). The changes have occurred significantly since the year 2000, when the process of industrialization and urbanization were expanded. A wide variety of industrial factories was built and enlarged in large zones attracted a number of agricultural labours as well as agricultural land areas. The service activities, therefore, were encouraged to develop more rapidly due to the development of industrial zones and urban areas.

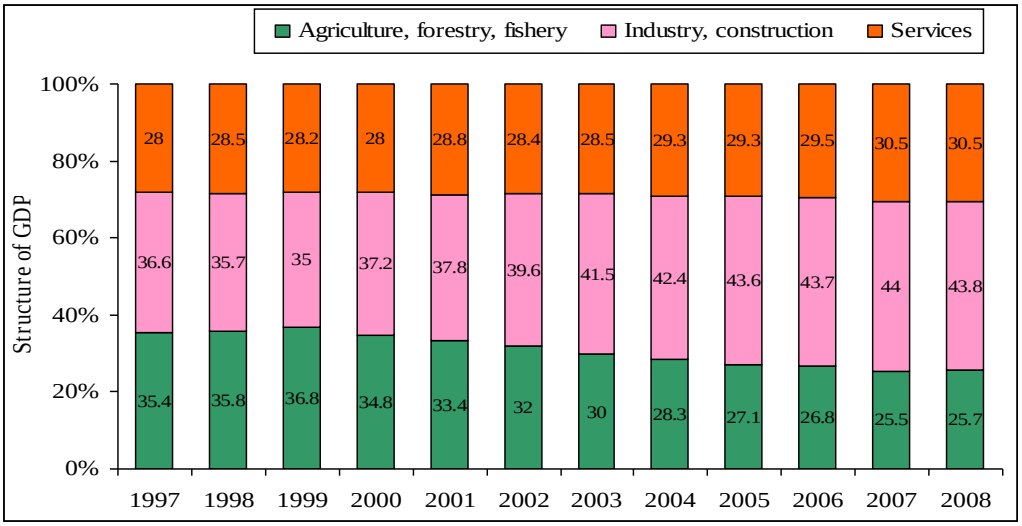


Figure 3.8 Structure of GDP by economic sectors of Hai Duong over period of 1997-2008 (Hai Duong Statistics Office, 2001,2010)

Although the contribution of agriculture to total GDP of the province has reduced recently, this sector is still an important source of income of most rural populations. The crop cultivation remains the highest contribution to total output value of agriculture. However, it has decreased slightly over the period of 1997-2008 (from 77.5% in 1999 to 65.7% in 2008) (figure 3.9) due to the great transformation of large agricultural land areas into alternative non-agricultural activities. The animal production has contributed more to total agriculture output value during this period.

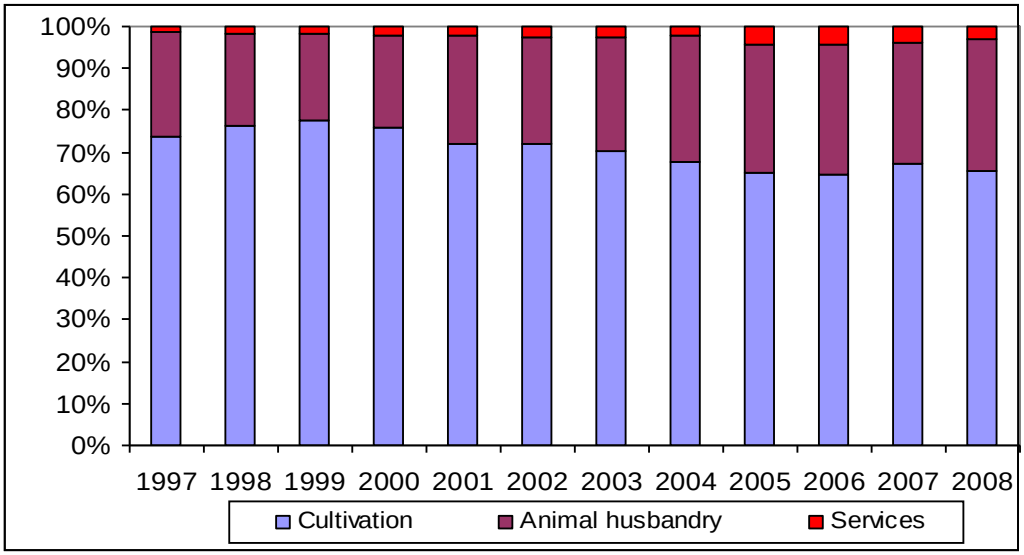


Figure 3.9 Structure of output value of agriculture in Hai Duong
(Hai Duong Statistics Office, 2001,2006,2010)

V. CAM GIANG DISTRICT AND TAN TRUONG, CAM HOANG COMMUNES

5.1 Cam Giang district

Located in the northwest of Hai Duong, Cam Giang is an intersection district of important transportation roads, including the highway No.5 and the Hanoi - Hai Phong railway as the main backbone connected Hanoi, Hung Yen province, Hai Duong city and Hai Phong city. The district has the boundary with other districts of Hai Duong, with Nam Sach to the east, Binh Giang and Gia Loc to the south, Bac Ninh province to the north. The district has 17 communes and 2 towns. Its total natural land area is 10,899.43 ha, equals to 6.62% of total province area. It has a population of 125,458 inhabitants with the population density is 1,151 persons per square kilometre in 2008 (Hai Duong Statistics Office, 2010) (figure 3.10 and table 3.3).

As one of the most industrialized districts of the province, socio-economic situations of Cam Giang have changed significantly since the last decade. The population has risen obviously due to the development of the industrial sector. A total of 6,841 people were increased over the period of 2000 - 2008. The number of labour engaged in industry and service sector has increased noticeably since 2003, about 2.2 times higher than that in 2002, due to the frequent migration wage from agricultural areas to industrial parks. There are many large industrial zones developed in this district and occupying huge agricultural land areas. In 2008, total agricultural land area was 6,272 ha, much lower than that of 2000 (about 7,415 ha).

Although having a rapid development of industrial sector, agriculture is continuously enhanced in this district. Animal and aquaculture production is the dominant production here. Recently, the land consolidation and land conversion programmes were introduced by the district to induce the development of large animal farms in the rice fields, away from the centre villages.

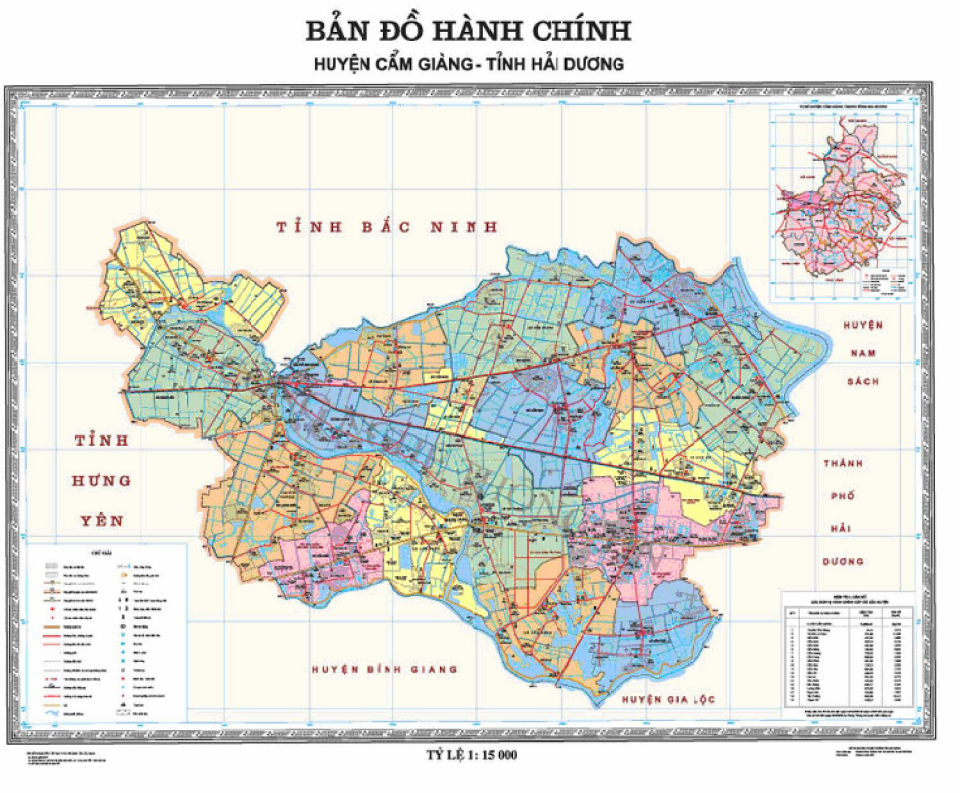


Figure 3.10. Administrative map of Cam Giang district
(Hai Duong Natural Resources and Environment Department, 2010)

Table 3.3 Some general characteristics of Cam Giang district and Tan Truong, Cam Hoang communes in 2008

Characteristics	Total district	Tan Truong	Cam Hoang
Land area			
Natural areas (ha)	10,900	842	736
Agricultural land area (ha)	6,273	146	538
Non-agricultural land area (ha)	4,627	446	202
Population			
Population (person)	125,458	10,617	7,267
Population density (person/km^2)	1,151	1,261	987
Structure of GDP by sector (current price)			
Agriculture (%)	21.37*	31.3	67
Industry (%)	60.3*	25.1	6.6
Service (%)	18.33*	43.6	26.4

Note: *data in 2007
Source: (Cam Giang Statistical Office, 2009; Cam Hoang's People Committee, 2009; Tan Truong's People Committee, 2009)

5.2 Tan Truong commune

Tan Truong is situated at the centre of Cam Giang district, along the highway from Hanoi to Hai Phong. Therefore, the commune has a lot of advantages for economic development, especially industry and service sector. Tan Truong also has a favourable condition for agricultural development, especially animal and aquaculture production due to the long distance of the riverside (Figure 3.11).

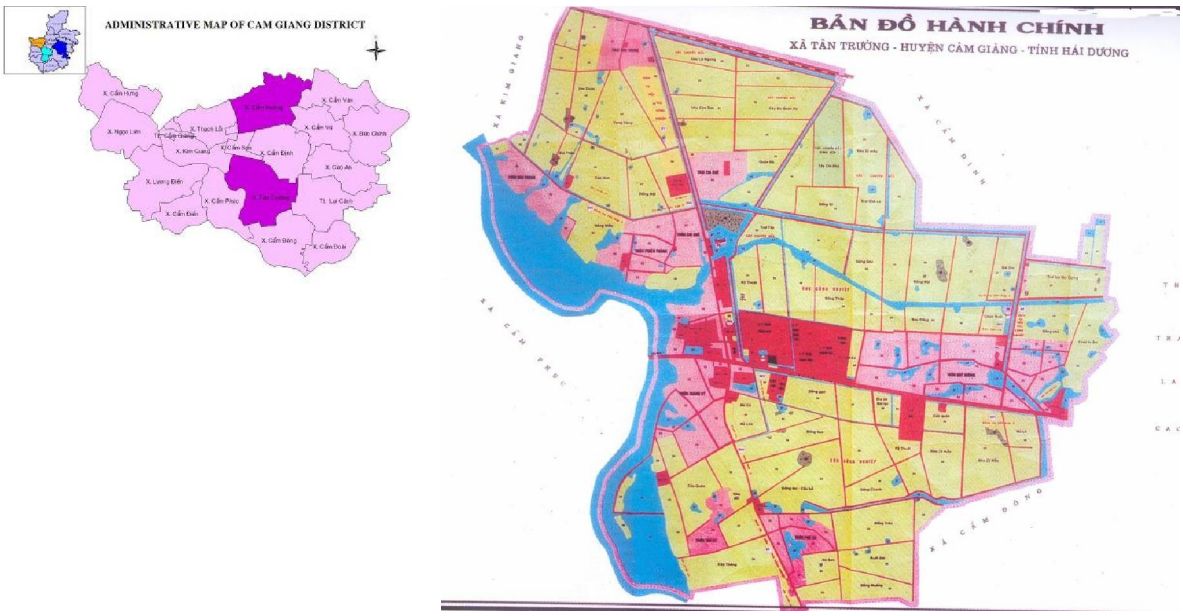


Figure 3.11. Administrative map of Tan Truong commune, Cam Giang district
(Source: Land Administration Office of Tan Truong, 2005)

Tan Truong commune had a population of 10,617 inhabitants in 2008. Which means 939 people higher than that of the year 2002 (9,678 people). This increase is the result of the moving of peasants from rural areas to industrial and urban centres. This was also one of the most densely regions with the population density in 2008 of 1,261 person/km^2, higher than the average level of the district (about 1,151 people/km^2, table 3.3) (Cam Giang Statistical Office, 2003,2009).

Total natural areas of the commune were 842ha in 2008 (Cam Giang Statistical Office, 2009). Tan Truong is considered as one of the communes having the highest level of industrialization of Cam Giang district as well as Hai Duong province. In Tan Truong, a large industrial zone has been constructed and expanded since the last decade, namely Tan Truong Industrial Zone (193ha). In the future, this industrial park will be expanded in an area of 112.6ha according to the plan of the government (Hai Duong Industrial Zone Authority, 2011). The rapid development of industrialization has great impacts on other economic sectors of the commune, particularly agriculture. Agricultural land area has reduced gradually since recent years, from 556.96a in 2002 to 146ha in 2008, equals to 410.964ha (Cam Giang Statistical Office, 2003,2009).

Economic structure of the commune has changed significantly towards increasing the contribution of industry and service sectors and decreasing the share of the agriculture sector in total GDP. In 2005, the contribution of agriculture-industry-service in total GDP is 41%,

21.5 % and 37.5% respectively. This proportion was 31.3%, 25.1% and 43.6% respectively in 2009 (Tan Truong Communist Party Committee, 2010).

Although the contribution of the agriculture sector to total GDP has declined, it still plays a significant role in ensuring food security and generating more income for farmers. In livestock and aquaculture production, several large concentrated areas have been established far away from the commune centre to reduce the impact of animal waste sources on local society. In the cropping system, rice is cultivated as the main crop. The area of winter crop has reduced remarkably since some recent years due to the competition of non-farm jobs.

5.3 Cam Hoang commune

Located at the north of Cam Giang district, Cam Hoang is an agriculture-based commune (Figure 3.12). Its total natural area is 740ha, in which 538ha (equals to 70.7%) was devoted to agricultural production. In 2008, it has a population of 7,267 inhabitants and a density of 987persons/km^2 (table 3.3) (Cam Giang Statistical Office, 2009).

Located near the small stream of Thai Binh river, Cam Hoang has an uneven territory with various natural ponds and pools, which are favourable for aquaculture production. In 2008, total land surface for fish production was 114ha, equals to 15.4% of the total natural area of the commune. Recently, aquaculture has become a more important income source of many farming households in the commune. Fish ponds have been upgraded and expanded annually thanks to its great profit. The animal-garden-fish pond, which so-called "VAC", system became the most predominant modes of farmers' environmental exploitation in Cam Hoang.

Like many other communes in the Red river delta, under the rapid development of industrial sector, agriculture has shown a less important contribution to total GDP of the commune. However, as an agriculture-based commune, the change in economic structure is less noticeable than other industrialized communes like Tan Truong. In 2005, agricultural value contributed 68.9% to total GDP and went down to 67% in 2008. The limited development of industry and service activities resulted from the unfavourable location of the commune. The proportion of industry and service are at a low percentage, about 3.7% and 27.4% in 2005 and risen to 6.6% and 26.4% in 2008 respectively.

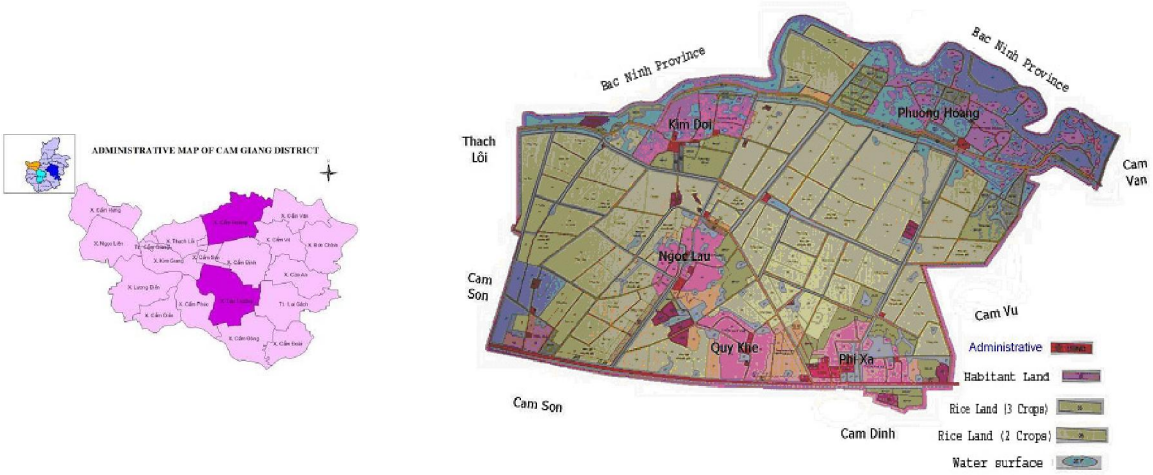


Figure 3.12. Administrative map of Cam Hoang
(Land Administration Office of Cam Hoang, 2005, cited in Thang (2006)

VI. GIA LOC DISTRICT AND GIA XUYEN, THONG KENH COMMUNES

6.1 Gia Loc district

Gia Loc is situated in the south of Hai Duong city and bounded by several districts, including Ninh Giang and Thanh Mien districts to the south, Tu ky district to the east, Cam Giang and Binh Giang districts to the west and Hai Duong city to the north. It has 22 communes and one town named Gia Loc town. The natural area of the district is 11,235.57ha, corresponds to 6.83% of Hai Duong province' area (figure 3.13 and table 3.4). (Gia Loc Statistical Office, 2009)

As an agriculture-based district, agricultural land area of Gia Loc shares a vast proportion in total district's natural area. In 2008, this kind of land covered 7,507.98ha, equals to 66.82% of the total. The left one, 33.18% or 3.727.59ha was devoted to non-agriculture purposes such as habitation land, industrial companies, common land, etc. (Gia Loc Statistical Office, 2009). However, since recent years, due to the prior policy of industrial development, a certain agricultural area has been converted into industrial zones. During the period of 2000-2008, a total area of 82.78ha of rice land was converted into non-farm land. The rice land area declined to 1,126.45ha in the same period (Gia Loc's People Committee, 2009).

In 2008, Gia Loc has a population of 138,760 people, in which 126,072 inhabitants living in rural areas, equal to 90.86%. The population density is very high, about 1,235person/km^2, much higher than the average percentage of the whole province (1,047person/km^2). However, in the centre town and the suburb, the population density ranked the first (more than 1,300person/km^2). Some remote communes have lower density, from 750person/km^2 to 900person/km^2 (Gia Loc Statistical Office, 2009).

The infrastructure system of Gia Loc is in a good condition and continuously improved during some last years. Located nearby the centre of Hai Duong city, the road system is well constructed and upgraded. It includes about 60.4km of national and provincial roads (such as the road No.37, 399, 393, 395, 392, etc.) and various roads connecting among communes. The waterway is also long, approximately 52.9km surrounding the district. Furthermore, several big agricultural markets were constructed and expanded in the district town, making the trading and marketing activities more facilitated. Two main markets, namely Gia Loc agricultural commodity market and Thack Khoi fishy market, are known as the original agricultural trading centres of Hai Duong province.

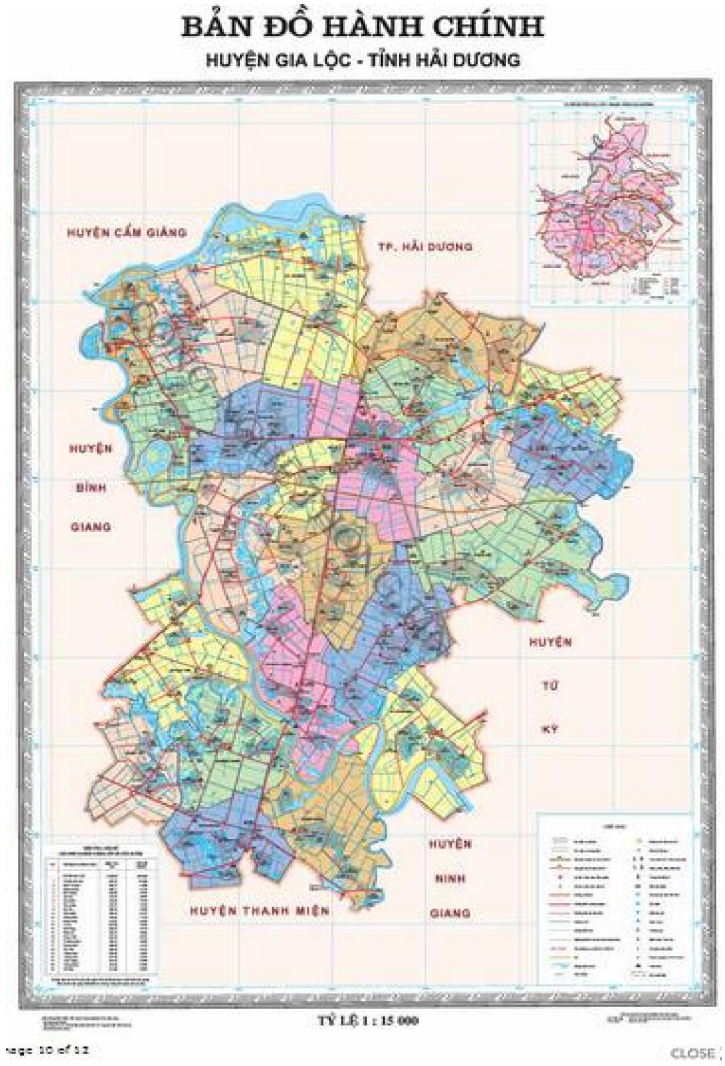


Figure 3.13. Agricultural land map of Gia Loc district
(Hai Duong Natural Resources and Environment Department, 2010)

Gia Loc is one of the most famous districts of Hai Duong for vegetable cultivation. The great favourable conditions such as plain territory and abundant water resources (from several rivers like Sat, Dinh Dao, Dong Trang rivers) facilitate the enhancement of a highly intensive agricultural production in Gia Loc. Crop cultivation is the main production activity with the predominance of annual crops such as rice, vegetable, flowers, etc. Animal and aquaculture production are also important in contributing to household income and total agricultural GDP. The contribution of cultivation to the total agricultural GDP is 70.49% in 2008, little lower than that of the year 2002 (71.62%). Livestock production developed slowly with the share in the agricultural GPD is 23.48% in 2002 and 24.73% in 2008. Aquaculture production has also been well developed recently with large lowland areas converted into fish ponds (about 800ha over the period of 2000-2008). (Gia Loc Statistical Office, 2009).

Table 3.4. Some general characteristics of Gia Loc district and Gia Xuyen, Thong Kenh communes in 2008

Characteristics	Total district	Gia Xuyen	Thong Kenh
Land area			
Natural areas (ha)	11,235.57	492.09	636.25
Agricultural land area (ha)	7,507.98	301.09	405.68
Non-agricultural land area (ha)	3,727.59	191	230.57
Population			
Population (person)	138,760	8,161	6,655
Population density (person/km^2)	1,235	1,666	1,045
Structure of GDP by sector (current price)			
Agriculture (%)	40.21	46.92	60.4
Industry (%)	30.43	23.37	29
Service (%)	29.37	29.71	10.6

(Source: (Gia Loc's People Committee, 2009; Gia Loc Statistical Office, 2009; Gia Xuyen's People Committee, 2009; Thong Kenh's People Committee, 2009)

6.2 Gia Xuyen commune

Gia Xuyen is located in the North of Gia Loc district, close to the centre of Gia Loc town and Hai Duong city as well (about 2km to Gia Loc town and 5km to Hai Duong city) . It is bordered by Thack Khoi commune to the north, Gia Tan and Gia Khanh communes to the south, Tan Hung and Tan Tien communes to the east, Lien Hong commune and Gia Loc Town to the west (Gia Loc's Communist Party, 2005).

Figure 3.14. Administrative map of Gia Xuyen commune, Gia Loc district (Gia Xuyen Communist Party Committee, 2005)

In 2008, Gia Xuyen had 492ha of the total natural area, in which 301ha was engaged by agricultural production, equal to 61.2% (table 3.4). Agricultural land occupies a large proportion, and most of them used for the cultivation of annual crops. However, it reduced since last years (about 37ha in 2000-2008) because of industrial zone installation and other non-agricultural activities such as urban accommodation, markets, common purposes, etc. In 2004-2005, a small industrial cluster, namely Thack Khoi-Gia Xuyen, was constructed in this commune. A total of 13.9ha of agricultural land was transferred to this centre.

The commune has a population of 8,161 people with a very high population density (1,666persons/km^2) in 2008 (Gia Loc Statistical Office, 2009). It has 2,650 households dividing into three villages, namely Tranh Dau, Tang Ha and Dong Bao. The number of total working labours is about 5,200 people in 2008 (Gia Xuyen's People Committee, 2009).

Thanks to the favourable location, Gia Xuyen has many advantages for the development of different economic sectors. In 2009, the GDP structure was contributed by 46.92% from agriculture, 23.37% from industry and 29.71% from services (Gia Xuyen's People Committee, 2009). The share of agriculture in the total GDP slightly declined from 50.6% in 2001 to 46.92% in 2009. It means that agricultural production still plays a key role in Gia Xuyen economy.

In agriculture, annual crops are cultivated largely in the commune. They are rice, melon, cabbage, kohlrabi, cauliflower and some other types of vegetable. Vegetable crops were planted many years ago. However, they have been being expanded remarkably since the last decade due to the rice land conversion programme. Crop cultivation contributes more and more to the total agricultural GDP of the commune (more than 50%) and to household income.

6.3. Thong Kenh commune

Thong Kenh is located remotely in the south of Gia Loc district, about 6km from the centre town of the district. It has the boundary with Hong Hung commune to the north and northeast, Doan Thuong commune to the west, Duc Xuong commune to the southwest, Tu Ky district to the east and Ninh Giang district to the south. The commune territory is naturally divided into two parts by Trang Thua river (3.75km). They include the higher location where has an average altitude of 1.5m to 1.9m and the lower part where has an average altitude of 0.7 to 0.8m. The lowland area is easily flooded in the rainy season (Thong Kenh's People Committee and Gia Loc's Natural Resources and Environment Department, 2005).

The commune has a total natural area of 636.25ha in which 405.68ha used for the agricultural purpose, equal to 63.76%. This proportion of land is stabilized over the years because of low level of industrial development in the commune. Most of the agricultural land areas are cultivated by paddy crop (87.17% in 2005)(Thong Kenh's People Committee and Gia Loc's Natural Resources and Environment Department, 2005).

Figure 3.15. Administrative map of Thong Kenh commune, Gia Loc district
(Source: Land Administration Office of Thong Kenh, 2005)

The commune has a population of 6,655 inhabitants and a population density of 1045persons/km^2 in 2008 (Gia Loc Statistical Office, 2009). It includes five small villages, namely Kenh Trieu, Dong Doi, Lac Thuong, Dong Tai and Dong Duc. It has a total household of 1,792 families in which more than a half engaged in agriculture. The high percentage of agricultural labours makes the unemployment condition more drastic. However, in some recent years, numerous agricultural workers have searched for non-farm and off-farm jobs in the industrial centres in surrounding areas to generate more income.

As an agriculture-based commune, agricultural sector is the main livelihood strategy of most villagers. Because of low altitude, rice is the most dominant type of plants. In some higher areas, diverse vegetable crops are grown in small land parcels. However, vegetable cultivation is sometimes impacted by the flood even though the irrigation system has improved better since some last years. In economic structure, agricultural production contributes a quite high proportion to total GDP. It accounted for 82.83% in the total GDP in 2003 and reduced rapidly to 60.4% in 2008. The increase of construction and some small local industry activities contributed more to total GDP, about 29% in 2008 as compared with the percentage of 11.05% in 2003 (Thong Kenh's People Committee and Gia Loc's Natural Resources and Environment Department, 2005; Thong Kenh's People Committee, 2009). The service sector develops more slowly because of unfavourable location for trading and marketing activities.

VII. THANH HA DISTRICT AND LIEN MAC, THANH SON COMMUNES

7.1 Thanh Ha district

Thanh Ha is situated in the southeast of Hai Duong city, about 20km far from the city centre. The district shares the boundaries with several other districts and provinces, involving Nam Sach and Kim Thanh districts to the north, Hai Phong city to the east, Tu Ky district to the south and Hai Duong city to the west. It has 24 communes and one town, namely Thanh Ha town which is considered as the socio-economic centre of the district (figure 3.16).

Thanh Ha has a total natural area of 159.1km^2 or 15,908.74ha in 2008, shares 9.63% of the provincial natural area (table 3.5) (Thanh Ha's Department of Natural Resource and Environment, 2009). In general, its territory slightly slopes from the northeast to the southwest, and lower than other districts in the northwest of Hai Duong province. Thus, the district is the downstream region of several rivers. It is bordered by a total length of 72.15km of Thai Binh and Rang river around the district. Besides that, the Huong river streams go across over 20km throughout 10 communes in the north parts of the district. This is a great advantage for agricultural production, especially fruit tree cultivation in terms of water and alluvium supply. However, the low altitude makes it more vulnerable to the flood in the rainy seasons.

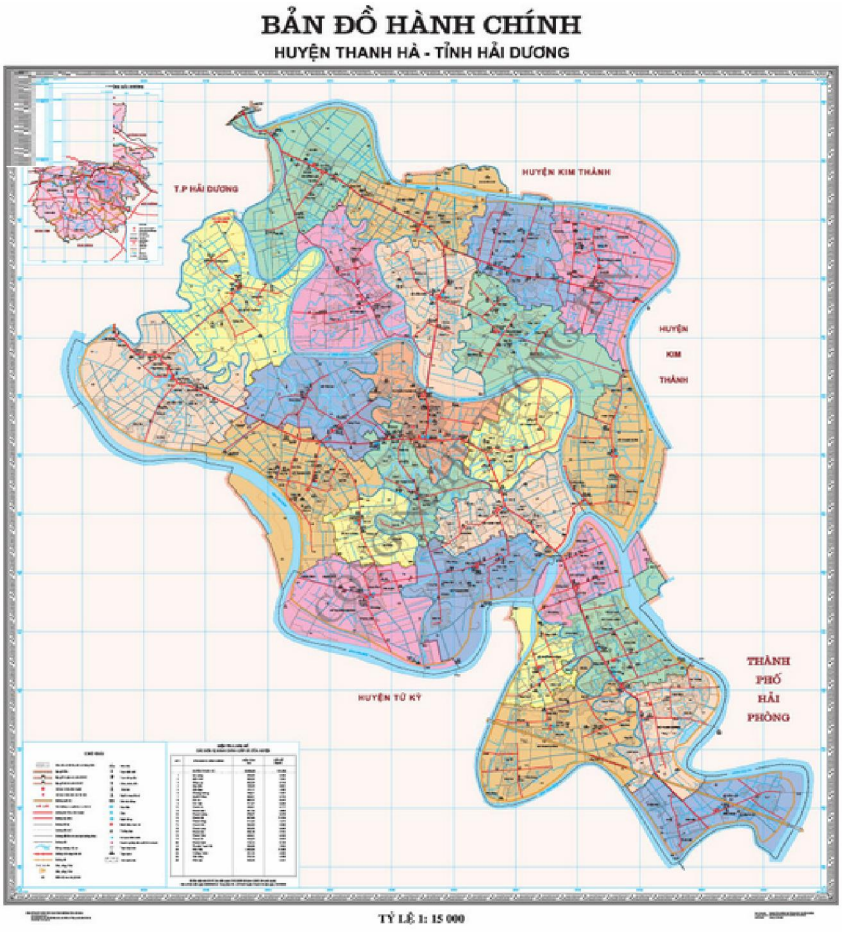


Figure 3.16. Administrative map of Thanh Ha district
(Hai Duong Natural Resources and Environment Department, 2010)

Table 3.5. Some general characteristics of Thanh Ha district and Lien Mac, Thanh Son communes in 2008

Characteristics	Total district	Lien Mac	Thanh Son
Land area			
Natural areas (ha)	15,908.74	747.77	646.19
Agricultural land area (ha)	9,613.29	472.89	377.27
Non-agricultural land area (ha)	6,295.45	274.88	268.92
Population			
Population (person)	159,443	6,456	8,015
Population density (person/km^2)	1,002	863	1,240
Structure of GDP by sector (current price)			
Agriculture (%)	46.1	43	50
Industry (%)	18.7	27	38
Service (%)	35.2	30	12

(source: (Lien Mac's People Committee, 2009; Thanh Ha's Department of Natural Resource and Environment, 2009; Thanh Ha Statistical Office, 2009; Thanh Son's People Committee, 2009)

Thanh Ha is a populous district with a population of 159,443 inhabitants and a density of 1,002persons/km^2 in 2008 (Thanh Ha Statistical Office, 2009). In comparison with the whole province and some other districts like Cam Giang and Gia Loc, Thanh Ha has a lower population density. Most of the people inhabit in rural area and depend on agricultural production as the main livelihood activity. The limited development of industrial zones in this region leads to a big wave of rural migration to other districts and industrial centres for extra-jobs.

Thanh Ha is an agriculture-based economy with a high contribution of the agriculture sector to total GPD of the district (about 46.1% in 2008). It is known as an original region of various types of sweet fruit such as litchi, guava, banana, etc. The district has the second largest area of perennial crops (6,718ha) after Chi Linh, a mountainous district (7,472ha). It shares 30% of total provincial perennial crop area. Litchi is traditionally planted in Thanh Ha as the most special fruit of Hai Duong province. In 2008, litchi planted area occupied 4,924ha, accounted for 71.4% of total district's perennial crop area. (Thanh Ha Statistical Office, 2009). However, because of strong fall of litchi price in recent years, its cultivated areas have reduced dramatically and have been replaced by other fruit crops like guava, banana, kumquat, etc.

7.2 Lien Mac commune

Lien Mac is located in the north of Thanh Ha district, which has a higher territory as compared with ones in the south. It has a boundary with Kim Thanh district and Thanh Xuan commune to the east, Cam Che commune to the west, Thanh An, Thanh Lang communes to the north and Thanh Binh, Thanh Xa communes to the south. There are several rivers and canals flow around the commune, involving Rang and Huong river, as a disposal water resource for agricultural activities.

Lien Mac has a natural area of 747.77ha, in which agricultural land covers over 472.89ha, equal to 63.2% (Lien Mac's People Committee, 2009). Thanks to the deposit process of

alluvium layers from river year by year and the improvement by producers, land territory in Lien Mac becomes higher than that in the past. It, therefore, remarkably facilitates the fruit cultivation.

The commune has a population of 6,456 inhabitants and a population density of 863persons/km^2 in 2008 (table 3.5). The agricultural labour makes up a large percentage in labour force. However, like other communes, as the less development of industrial activities in the commune, many farmers have to migrate to cities.

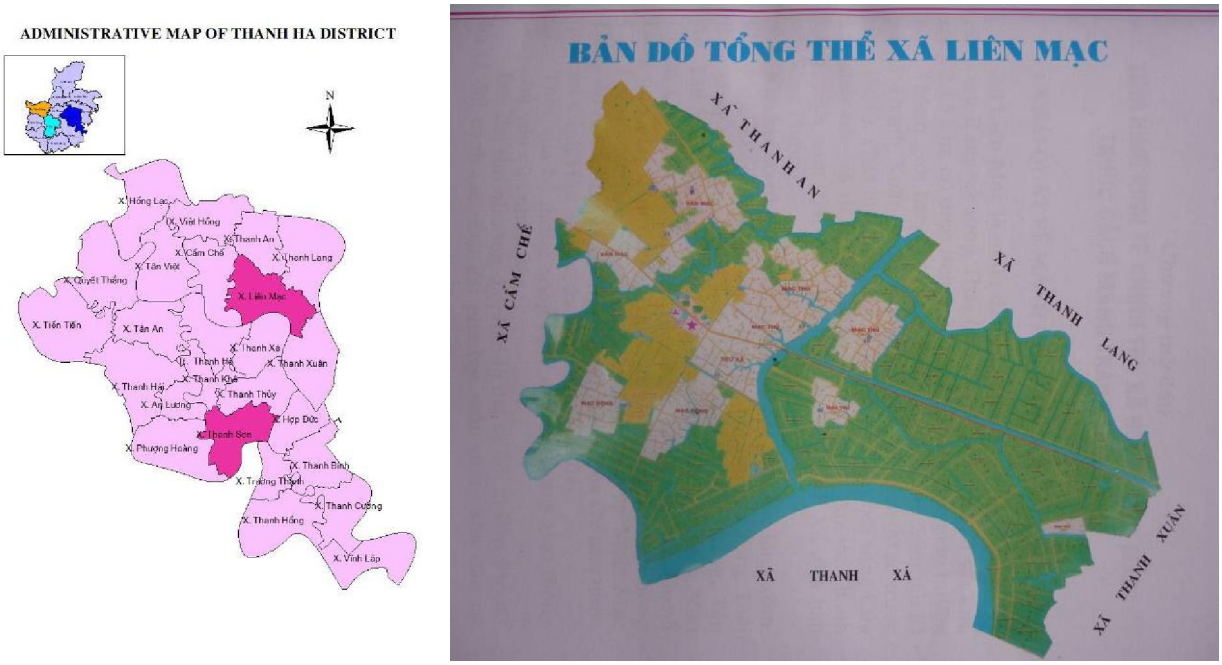


Figure 3.17. Administrative map of Lien Mac commune, Thanh Ha district
(Lien mac's Communist Party, 2009)

Agriculture has continuously been developed and contributed an important proportion to total commune GDP. In 2008, it accounted for 43% of total GDP, higher than that of industry, construction and service activities (Lien Mac's People Committee, 2009). Like other communes in Thanh Ha district, fruit crops are widely cultivated in Lien Mac. Litchi and guava tree are the two main types of fruit in this commune. Recently, many litchi plantations have been cut down and switched to guava crop because of the decrease of litchi price and the increase of guava price since some last years. In estimation, a total of 20ha of litchi gardens has been transformed to other land, in which 15ha is devoted to the guava crop.

7.3. Thanh Son commune

Thanh Son commune is located at the south of Thanh Ha district, away from the district town (5km). It is bordered by Thai Binh river to the south, Thanh Khe commune to the north, Thanh Thuy commune to the east and Phuong Hoang commune to the west. This geographical location makes the commune difficult to develop economic activities.

Total natural area of Thanh Son is 646.19ha, in which agricultural land shares 377.27ha, equals to 58.4% (in 2008) (Thanh Ha Statistical Office, 2009). As an original region of Thieu litchi, all of agricultural land area (100%) is transformed from rice fields to permanent crops, involving 349.1ha (or 94.3%) of litchi garden and other fruit crops. However, several litchi

areas have been being gradually cut and converted to alternative fruit crops (such as kumquat, guava, banana, etc.) due to the rapid reduction of litchi price since some last years.

Thanh Son is a crowded commune with the population density of 1,240 inhabitants/km^2. In 2008, it had a population of 8,015 people, living into two villages, namely Thuy Lam and Trang Liet. As an agriculture-based commune, Thanh Son had a total agricultural population of 7272 inhabitants in 2008, equal to 89.97% (Thanh Son's People Committee, 2009). Because the commune is located away from the city and industrial centres, a number of farmers in Thanh Son have been migrating to neighbouring regions to find off-farm jobs.

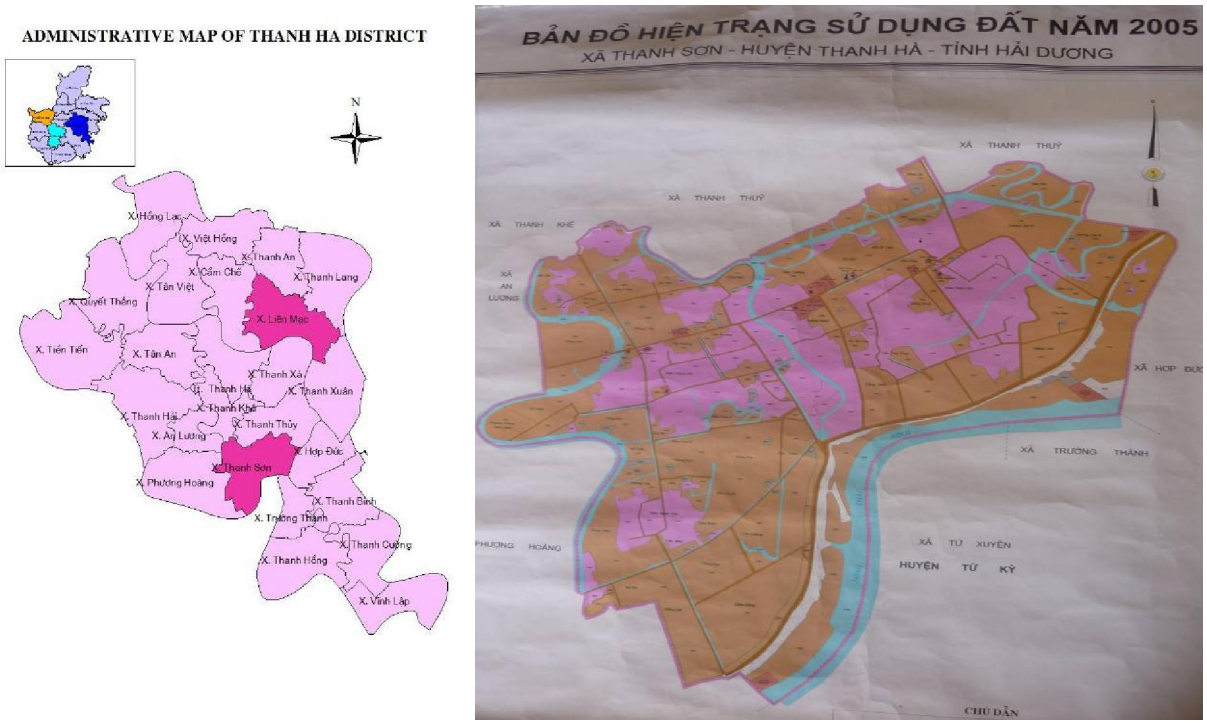


Figure 3.18. Administrative map of Thanh Son commune, Thanh Ha district
(Land Administration Office of Thanh Son, 2005)

Agriculture sector still plays a significant role in the economic structure of the commune, with 50% contribution to total GDP in 2008. The share of industry and service sector was 38% and 12%, respectively (Thanh Son's People Committee, 2009). This structure has changed slowly since recent years due to the poor development of industry and service activities in the commune for a long time.

CHAPTER 4. EVOLUTION OF AGRARIAN SYSTEMS IN HAI DUONG PROVINCE

I. INTRODUCTION

The major purpose of this chapter is to understand the evolution process of agrarian systems and their driving forces. The analysis focuses on the mechanism of changes of agrarian systems under a given context of institutional and socio-economic environments. Then, these transformations are explained by the socio-economic and technical factors at both regional and farm level that shaping the changes.

The first part of the chapter introduces briefly the general evolutionary stages of agrarian systems in Hai Duong over a long period, mostly from the collectivization age to the de-collectivization era. The evolutionary series are relatively divided into different steps according to the significant changes in institutional and socio-economic environments that result in the transition of the exploitation mode of farmers. It is mainly based on the secondary information and exploratory discussions with the key witnesses. These understandings of global changes are essential for setting up the hypothesis of production system dynamics at the farm level.

The following section devotes to the examination of farming system evolution of representative households. Under the similar environmental conditions and socio-economic characteristics of a given region, different categories of farmers may employ alternative types of production systems according to their specific circumstances and interests. The differentiation among household groups and their choice of production systems is interpreted by surveyed data that gathered upon retrospective descriptions of the respondents.

II. EVOLUTIONARY STAGES OF AGRARIAN SYSTEMS IN HAI DUONG PROVINCE

The general evolution of agrarian systems in Hai Duong province during the economic transformation period from 1980 to 2010 is summarized in table 4.1. The agrarian systems have been evolved significantly over three recent decades due to the changes in socio-economic and agro-ecological conditions of the province and the nation as well. In the first decade (1980-1990) when the transition shifted from a centrally planned economy to a market-oriented economy, the agrarian systems have evolved from the collective farming model to the family farming exploitation. Rice cultivation was of great importance for households' food security. The rice productivity thus increased significantly due to the resolution policy in 1988. Other agricultural production sectors such as vegetable, livestock production, etc. grew slowly during this period. The second decade (1990-2000) was known as the period of diversification of agrarian systems. The rice-based production system has been diversified by the development of a wide variety of production, including winter crops, animal husbandry and fish production due to the sufficiency of food security since 1993. Large areas of rice fields, especially the low land areas, have been converted into different crops such as litchi, vegetable, and fish ponds. The integrated crop cultivation - animal husbandry and fish production system was widely applied in the province. Farmers diversified income sources, and per capita food production increased remarkably across the years. The last decade (2000-2009) represented the continuous changes of agrarian systems from a diversified model to a specialized system due to the industrialization and urbanization process and the deep integration into the global economy.

Table 4.1. Evolution of agriculture and rural society in Hai Duong province during the economic transformation period

Date	Ecological conditions	Technical conditions	Socio-economic conditions	Agrarian systems
1980-1985	- Extreme natural vulnerability by flood, storms, pest, weeds and disease	Backward technology - Manual tools - Native breed with low performance	Serious socio-economic crisis - Poor infrastructure, lack of input materials - Weakness of social organizations - Restricted trading systems; unequal distribution of products Directive 100 (contract 100) in 1981	Mono-cultural rice-based agrarian systems (Collective farm) - Rice-based production (native breed and fluctuant yield), two rice crops per year - Underdevelopment winter crops - Extensive livestock production
1986-1990	Less vulnerability - Better control of pest, weeds and flood	Improved technology - Mechanism - Some hybrid crops and animal breed	Transforming to market-oriented economy DOI MOI or Renovation (1988): Land reform, better trading and marketing systems - Little upgrade of infrastructure but lack of input supplies	Integrated cultivation – animal husbandry and aquaculture agrarian systems (Family Farm) - Integrated cultivation, animal and aquaculture systems (traditional VAC system) - Small scale and self-consumption - Continuous expansion of winter crops
1991-1995	Changing in soil and vegetation	More Technical transfer from scientific institutions	More stabilized socio-economic situations New land law (1993) - Better infrastructure (electricity, some small local industrial factories)	Diversified agrarian systems Transforming from rice into specialized production Cam Giang: Animal and aquaculture agrarian system Gia Loc: Annual vegetable agrarian system Thanh Ha: Perennial fruit agrarian system
1996-2000	Great change in territory, soil and vegetation	Higher intensification and application of modern technology	Beginning of industrialization and modernization process District re-establishment (in 1997) - Better development of industrial and service sectors	Intensified and specialized agrarian systems Developing intensive agrarian systems Cam Giang: Animal and aquaculture based agrarian systems Gia Loc: Vegetable-based agrarian systems Thanh Ha: Litchi-based agrarian systems
2001-2010	-Continuous change in territory, soil and vegetation -Environmental pollution	Improved intensification and application of modern technology	Acceleration of industrialization and modernization process - Begin developing of industrial sector -Good development of rural infrastructure system - More off-farm job opportunities - Trade liberalization	Intensified and specified agrarian systems More intensified and specified agrarian systems Cam Giang: Intensive animal and aquaculture based agrarian system Gia Loc: Intensive vegetable-based agrarian system Thanh Ha: Litchi and diverse fruit-based agrarian systems (guava, kumquat, etc.)

III. THE EXPANSION OF COLLECTIVE AGRARIAN SYSTEMS BEFORE RENOVATION (1954-1988)

3.1 Socio-economic characteristics

In 1954, the war was finished in Hai Duong and the North of Vietnam under the Geneva Accords. The province launched a development strategy by a series of programmes, including the primary land reform and the improvement of agricultural cooperatives. In spite of enormous difficulties caused by the war, the provincial economy, in general, and the agricultural sector, in particular, gained significant achievements. However, some policies were inappropriate, and they even hindered the development of the whole economy.

3.1.1 The land reform in 1954 – 1957

The land reform in this age was characterized by the withdrawal of the land from the landlords and redistribution to the peasants.

Before the August revolution in 1945, most of the land areas were owned by the landlords. In Hai Duong, this land owner made up only 4.11% of total households, and 16.42% of total land areas. The rest (77.24% of total land areas) was owned by peasants who occupied 94.46% of total families. Some land areas belonged to other social classes (Hai Duong People's Committee, 2008). Farmers worked on their farms and gave the products to the landlords.

After the war, the government launched the land reform to allocate land to the peasantry. The program was implemented from February to June 1956 in Hai Duong. The aim of this policy was to end the landlord system and distribute the land to farmers. The land areas owned by farmers increased from 69,907.4ha (equals to 77.2% of the total) before the reform to 87,104.3ha (or 96.3% of the total) after the reform. The landlords just shared about 3,366.9ha or 3.72% of total land areas. It was much less than that in the past (about 14,858ha or 16.42% of the total) (Hai Duong People's Committee, 2008).

The important changes were seen in rural areas. Farmers had rights over their land. They had their own land and worked for themselves to survive their families after a long time under the feudal system.

However, the land reform still remained some social issues because of inappropriate implementation. The local authority in some regions was overpowering in eliminating the landlord class. All the rich households were attributed as bad landlords even they had contributed greatly to the revolution in the past. Thus, it resulted in the drastically social conflicts in the rural communities. Then, the government realized the mistake and carried out some activities to correct it and stabilize the social relations. Many people, who had been treated unfairly, were reallocated their land and their properties.

3.1.2 The agricultural collectivization process (1957-1988)

The agricultural collectivization was early implemented in Hai Duong in 1957, one year right after the land reform policy. This process was divided into two main successive stages, including the small-scale and big-scale collectivization. In the first period of 1957-1975, the small-scale agricultural cooperatives were established and developed at the village or group of

village level. Then, the big-scale agricultural collectivization was enhanced at the commune level from 1976 to 1980.

The agricultural collectivization was a successive process from the aid team to the small-scale cooperative at the village level and big-scale cooperative at the commune level during the period of 1957-1975.

3.1.2.1 The development of mutual agricultural aid teams in 1957-1959

In the first period of 1957-1959, the mutual aid teams were developed among small groups of five or ten farmers. Normally, these households lived in the same hamlets as the close neighbours. A representative farmer trusted by the group was voted into the leader position. The objective of this cooperation was to encourage farmers to assist each other during the period of the peak labour demand by jointly working in one another's land plot. The exchange might be regular or irregular, depending on the production activities and the demand of each family. This model of cooperation was strongly encouraged to develop in different regions of the province. In 1958, the number of aid team was the highest, about 11,077 groups, with the participation of 71.18% of total households in the whole province (Hai Duong People's Committee, 2008).

This kind of collaboration was highly efficient at the first period, but poor functions at the last stage. Primarily, the exchange of the labour force and production means helped to solve the difficulties facing most of the household right after the war. It was very important for the smallholders or the poor to develop their production activities and overcome the famine. However, most of these groups could not sustain over a long time because of the poor management and unequal distribution of products. The medium and the rich farm were often regrouped together and separated from the poor one. The social conflicts were emerging among different classes. In 1959, nearly all small agricultural cooperatives were dissolved (Hai Duong People's Committee, 2008).

3.1.2.2 Development of the small-scale agricultural collectivization at the village level in 1957-1963

Since 1957, the government launched a campaign to create the agricultural production cooperatives. In Hai Duong, the first agricultural cooperative was established in October, 1957 in An Bai village, An Lac commune, Chi Linh district. Since then, the collectivization process has been accelerated in nearly all villages of the province.

Under this policy, farming households was obligated to give the land and the production means (plough, harrow, etc.) to the cooperatives and perform collective labour. A small land area (5% of their land area according to the number of family members) was still kept by farm holdings to produce vegetable and raise animals. Thus, the households were forced to sell their animals to the cooperative as their annual obligation.

The agricultural cooperative had a complicated structure. At the cooperative level, there was a management committee, which comprised a director, a vice-director and some other members. Each cooperative had different production brigades or units. Each production unit was managed by a leadership committee, including a chief, a vice-director and a secretary. They took responsibility for the production management of the unit. A point of work was awarded to farmers based on the type of jobs and their working time. These points were then converted into a portion of the annual cooperative's net harvest.

However, the agricultural cooperatives soon failed due to the poor management and bad returns. The quality of work and the record of work point were uncontrollable. The farmer saw no incentive to work harder than others and shirked the collective labour. The administrative bureaucracy was often corrupt. Farmers were paid after the deduction of production cost and state quotas. As a result, a number of farmers were bored with the cooperatives. Many of them would like to get out of the cooperatives.

3.1.2. 3 Renovation and expansion of cooperatives at the communal level in 1963-1988

To overcome the emerging difficulties of most agricultural cooperatives, the provincial government launched a new resolution to renovate the management quality and the production efficiency of the agricultural cooperatives. During the period of 1963-1966, three main campaigns of the agricultural cooperative renovation were implemented in Hai Duong. Thus, the labour productivity and the production efficiency were dramatically improved.

In 1967, the resolution number 04-NQ/TU to consolidate the small-scale agricultural cooperatives at the village level in the big-scale ones at the commune level was approved by the province.

Table 4.2. Number of cooperatives in Hai Duong in the period of 1957-1980

Characteristics	1957	1958	1960	1975	1976	1980
Number of cooperatives	1	334	1710	707	443	409
Number of traditional cooperatives	1	334	1455	-	-	-
Number of improved cooperatives	0	0	255	-	-	-
Total of household joined into cooperative	36	10,586	154,931	361,000	366,000	420,000
Percentage of joined households/total households (%)	0.0031	6.53	91.49	98.7	99.1	99.7
Agricultural land area managed by cooperatives (ha)	28	7,106	85,204	147,000	144,000	148,000

Source: Hai Duong Statistic Office from 1957 to 1980, cited in (Hai Duong People's Committee, 2008)

3.2 Characteristics of agrarian systems

3.2.1 Rice as the basic crop for food security

The agrarian systems in the collective period were characterized by rice-based cropping system. In the first stage (1954-1960), only once rice crop was cultivated per year due to the poor development of the rural infrastructure system, especially the irrigation system, and the backward technologies. In the second stage (1960-1980), the cropping systems were improved significantly from once rice crop per year to two rice crops and once winter crops. The improvement of the irrigation system (the Bac Hung Hai system, for instance) and the

introduction of new rice varieties were the most important reasons for this evolution of agrarian systems. The collective labour management played a key role in building and upgrading the irrigation systems in rural areas. The Bac Hung Hai irrigation system, which irrigated large rice fields of three provinces (Bac Ninh, Hung Yen and Hai Duong), was constructed in 1958. Thus, the crop cultivation was less vulnerable to the drought or flood. Moreover, a number of new rice varieties (e.g. IR-5 and IR-8 varieties), which had a shorter production cycle than the old ones, were introduced and applied widely in most regions of the province. The number of harvest and the productivity were then increased remarkably.

3.2.2 The collective livestock production

In Hai Duong province, during the decade of 1960 - 1970, the provincial government developed a strategy to increase the number of pig raised in the agricultural cooperatives. Then, the pig production in the agricultural cooperative was developed rapidly and there were 336 agricultural cooperatives (equals to 80%) raising pig in the whole province in 1978. At that time, population of pig managed by cooperatives made up about 10 to 15% of total population. The left was fed by individual members of the cooperative with the small farm size, about 2 or 3 heads of pig per family on average. Most families who were the member of the cooperative (about 85%) raised pig by themselves and provided pork to the cooperative as their duty. It means that each family had a duty to raise pig and sell a given weight of pork to the agricultural cooperative for a given price set up by government (Hai Duong People's Committee, 2008).

In 1960, when agricultural cooperatives were rapidly developed in the North Vietnam, all cattle and buffaloes were collected and managed by cooperatives. However, feeding and taking care of cattle and buffaloes were continuously done by each farm household.

3.2.3 Undeveloped fish culture

In the decade of 1960-1970, fish were mostly raised in natural ponds and pools with less investment in the high quality feed. Fishes were fed mostly by agricultural by-products and wild grasses. Therefore, the productivity and profit of fishes were not high. An interesting program so-called “Uncle Ho’s fish pond” was introduced and expanded rapidly in the whole province to encourage farmers to develop the fish production. According to this program, each agricultural cooperative had to build a big common fish pond. All members of the cooperative took responsibility for raising fish. At that time, there were 504 big common fish ponds built in the province. However, the fish productivity was still at a low level, about 700kg per ha. The lack of improved fish variety and high quality feed investment were the major reasons for this slow development of fish production during those years (Hai Duong People's Committee, 2008).

IV. DYNAMICS OF AGRARIAN SYSTEMS DURING THE TRANSFORMATION PERIOD (1980-2010)

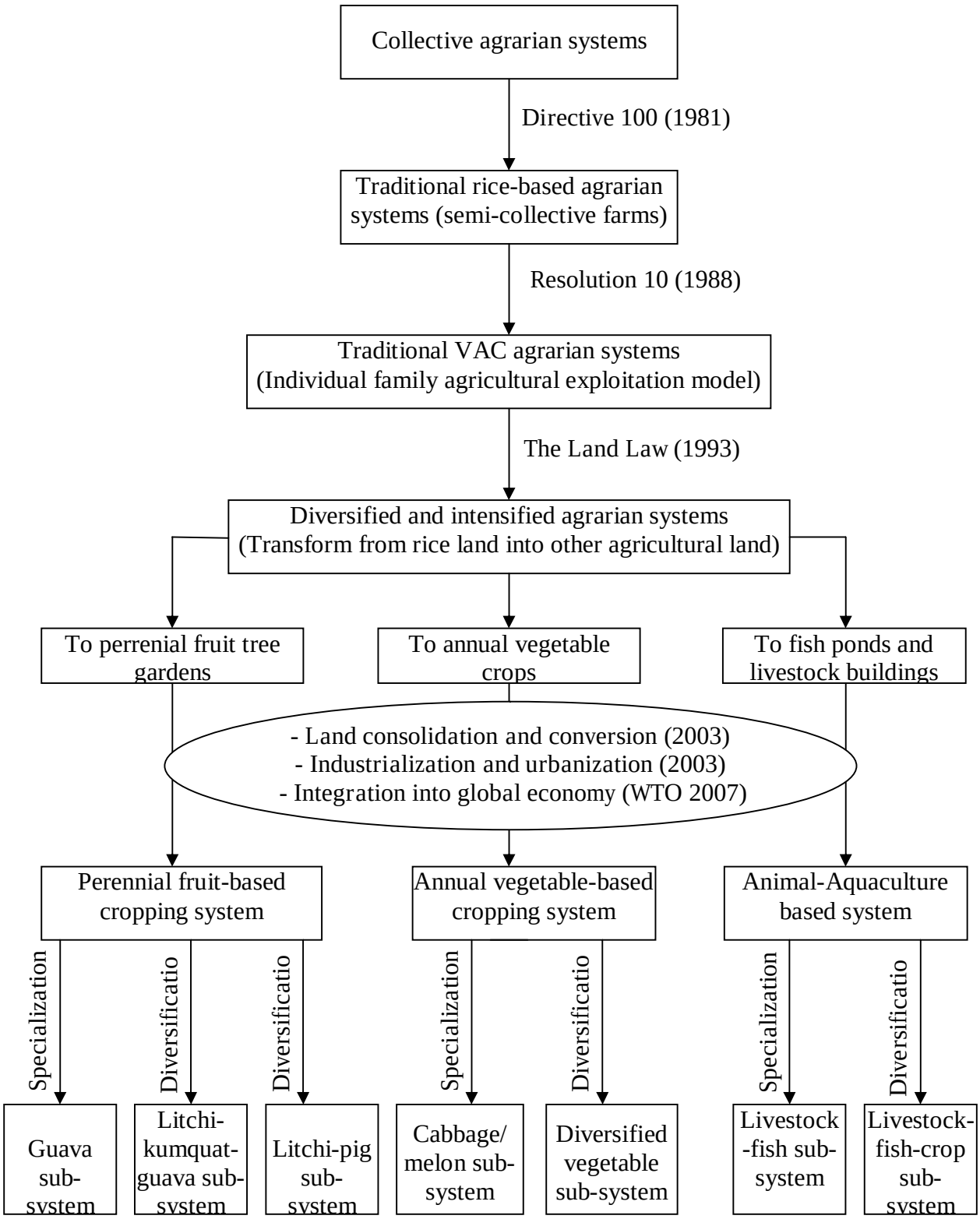


Figure 4.1. Flow diagram of the agrarian system evolution in Hai Duong during the economic transformation period (1980-2010)

4.1 TRADITIONAL RICE – BASED AGRARIAN SYSTEMS DURING THE SEMI-COLLECTIVE PERIOD (1980s)

4.1.1 The changes in institutional environments and socio-economic conditions

4.1.1.1 The introduction of directive 100 (Contract 100) in 1981

In early 1980s, Vietnam faced big challenges after the war. The country was felt into an extreme socio-economic crisis because of the extension of the central planning economy. At that time, the economy was characterized by the role of the state-owned enterprises and cooperatives in the production and the trading systems of goods following plans made by the government. The prices were set by the state pricing committee. However, the inefficiency of these enterprises and cooperatives caused a huge budget deficit, and the inflation reached a level of 100-200%, with hyperinflation of about 300% annually. In 1986, the inflation rate even went up to 700% (Tri Hung Nguyen, 1999, cited in (Hoa Nguyen and Ulrike Grote, 2004).

Under the general context of the country, Hai Duong's economy remained vast difficulties regarding to all economic sectors, especially in the agricultural production. As the major economic activity, agriculture played a key role in ensuring food security and improving household income. However, the socio-economic crisis made it more difficult to develop the agricultural production. In one part, the terrible consequences of the war directly affected the agricultural production due to serious damage of the rural infrastructure system such as road, irrigation, electricity, etc. by bombing during the war. In another part, the management and administration of the local authority systems became less and less efficient according to the strategy of developing bigger collectives at the commune level. Beginning in 1957 with the establishment of the first cooperative, it then had been developed rapidly at all locations over the province. The hasty extension of the cooperative at a larger size (from the village to the commune level with a higher number of households) made it more difficult to manage both the labour force and the financial resource. Although there were several improvements of the collective organisation and management, these efforts did not gain expected results. The agricultural production of all cooperatives fell into a bad situation with a low productivity and inefficiency. The food security of most farmers was not ensured (average food production per capita was under 340kg). The socio-economic crisis was more and more drastic. This type of labour management did not encourage farmers to develop the production activities. Numerous farm households demanded to split from the cooperative to be an independent production unit.

Based on the request of most farmers, on January 13th 1981, a direction so-called "directive 100 CT/TW" was launched by the Committee of Communist Party. The main objective of this directive is to sign a production contract with groups or individuals of agricultural workers. According to this contract, farmers had the right to control several major activities in the procedure of agricultural production, including planting, care-taking and harvesting the product. Other activities such as seed breeding, irrigation, pest control or crop protection, etc. are under the responsibility of the cooperatives (Committee of Hai Duong's Communist party, 2010).

However, after 5 to 6 years of application of the Contract 100 (in 1981), several inadequacies were emerged and started to inhibit the growth of the economy. Under this contract, the production procedure of the farmer continuously depended on the management of cooperatives in five activities (land preparation, seed breeding, fertilizer supply, irrigation and

crop protection). The difference about the production plans between each household and the cooperatives caused the difficulties for farmers in their activities. It was sometimes impossible for farm holders to be active and flexible in the production because of the lack of input materials. On the other hand, the quota of output was adjusted to being higher annually even low productivity of crops. Therefore, it broke down the dynamic of producers to increase the crop productivity and yield. Some households that gain surplus output refused to pay the quota and the other who lost their crop could not effort to pay back. The cooperatives had to implement some forced methods to take the quota back. It created a great social discontent in the rural society. A number of farm households gave the land back to the cooperative and stop cultivating rice.

4.1.1.2 The introduction of resolution 10 in 1988: A Renovation policy (Doi moi)

As discussed above about the serious situations of agriculture and rural society in early 1980s, on 5/4/1988, the politburo of the Communist Party introduced a new policy called resolution 10 (or contract 10) to improve the management of the agricultural production. According to this policy, farm households were considered as an independent economic unit. Agricultural land was transferred to the individual farm holder for a long period (about 10 to 15 years) with a stable quota (fixed for five years if there is no change in technical and socio-economic conditions) (Hai Duong People's Committee, 2008). The role of cooperatives was to make the production plans. In Hai Duong province, the strategy at that time focused on the food programmes to ensure food security, mostly rice cultivation.

However, the policy needs to be continuously reviewed to adjust and to complete it. Several issues were required to take into account, including the duration of land allocation, the farmers' rights over the land (land own right, land use right, etc.), the organisation and management of the new cooperatives, the supply chains of input materials, etc.

4.1.2 Characteristics of the traditional rice – based agrarian systems

In the decade 1980s, the socio-economic crisis had a great impact on the agricultural production and rural society. Food security was one of the biggest challenges faced numerous households and became the most important priorities of the government's strategies. Therefore, the rice production system was seen as the basic mode of the environmental exploitation of farmers at that time. Besides that, other crops and livestock species were also integrated into the production system which was known as the VAC system (a combination of crop cultivation, livestock production and aquaculture production). The characteristics of this type of agrarian system were strongly related to the agro-ecological and socio-economic conditions of Hai Duong province and the nation during the decade of semi-collective agriculture in 1980s.

The characteristics of agrarian systems in the decade 1980s had changed significantly from a collective farm which is managed and practised by agricultural cooperatives to an individual family model. The political changes included the introduction of directive 100 in 1981, and the resolution 10 in 1988 impacted strongly on the development of agricultural systems.

The traditional rice-based agrarian system was characterized by the small-scale and low intensive level of production. Rice was the main crop and cultivated by two harvests per year, namely spring rice crop and summer rice crop.

The major characteristics of traditional rice-based agrarian system were described by the domination of rice cultivation in combination with winter crops, animal production and fish

ponds. Rice, which was cultivated in spring and summer season, was of great importance and developed significantly in terms of planted areas and yield to ensure the food security. Several winter crops, especially sweet potatoes, potatoes and maize, were expanded to satisfy food requirements of most farm households. Diversified animal herds were kept at a small scale in the relation to the crop production.

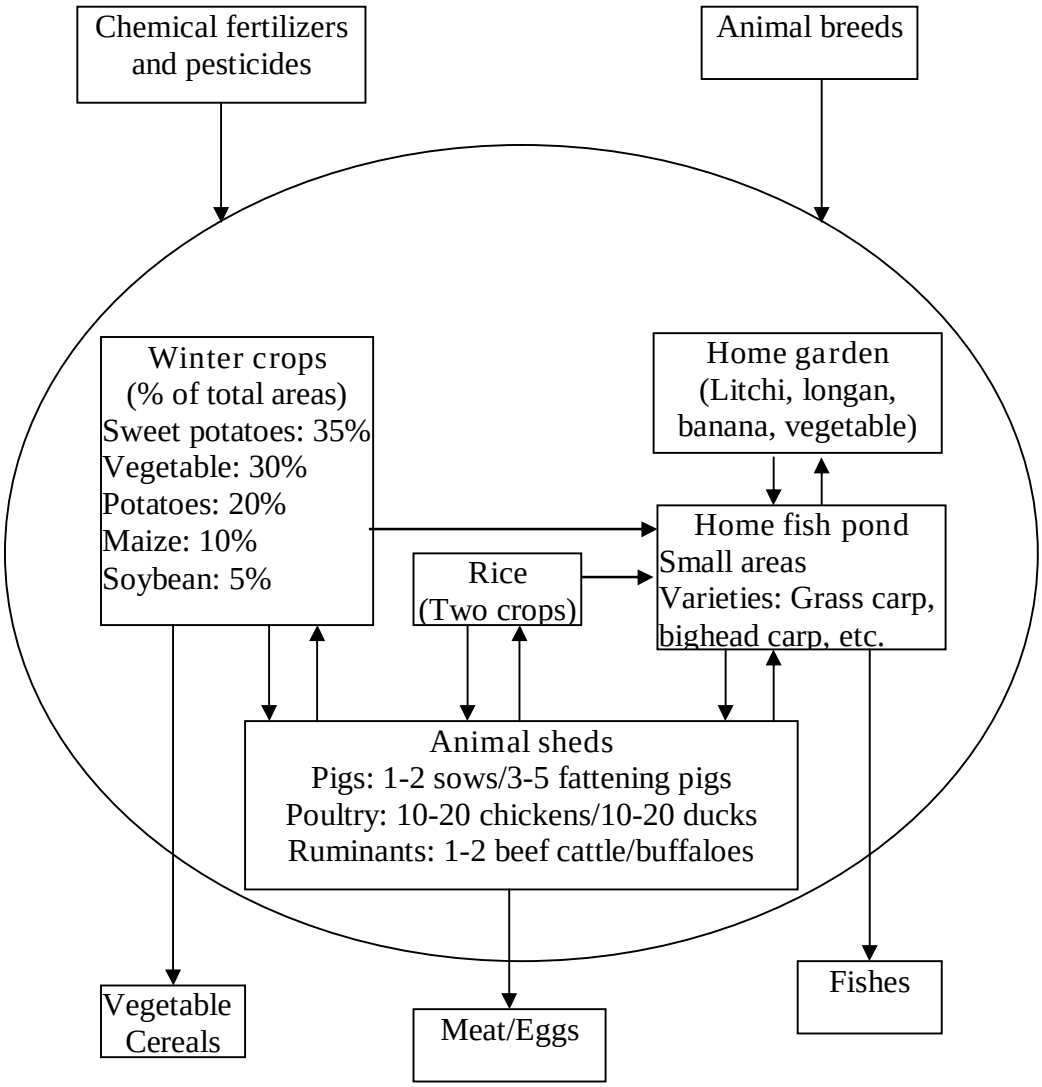


Figure 4.2. Flow diagram of the traditional rice-based agrarian system in Hai Duong in 1980s (Source: Participatory discussions and secondary data)

4.1.2.1 Rice cultivation as the basic crop

As a central province of the Red river delta, rice was largely cultivated in Hai Duong in two main crops, including winter-spring crop and summer-autumn crop, during the years before 1980s. However, since the years 1980s, the rice production fundamentally changed due to the achievements of technical conditions. The development of winter crop made the crop calendar more diverse (figure 4.3).

Before the year 1980s, there were only two paddy crops per year, which were winter-spring crop and summer-autumn crop. The winter-spring crop started at the middle of October when rice was sown or transplanted and harvested at the end of May or early June. Most of rice

varieties grown at that time were traditional low-yield breed, which had a very long life cycle (five or six months). It was, therefore, difficult for farmers to intensify the production. In other words, the cultivated area of rice and its yield were so unstable according to the extreme variation of the weather and the damage of the irrigation system in 1980s. Rice sowing was normally done in the winter that can easily be damaged by the cold weather and the lack of water storage. Rice harvesting was implemented in the middle of the rainy season (May or June) that can be lost by the storm and flood. On average, the total cultivated area of winter-spring rice of Hai Duong province was about 55,000 to 70,000 ha in the period of 1958 to 1970. The productivity was not very high, about 2,000kg/ha. (Hai Duong People's Committee, 2008).

Period	Crops	Months											
		1	2	3	4	5	6	7	8	9	10	11	12
Before 1980s	Winter-Spring Rice	x	x	x	x	x							x
	Summer – Autumn Rice						+	+	+	+	+	+	
After 1980s	Spring Rice	x	x	x	x	x							
	Summer Rice						+	+	+	+	+		
	Winter Crop											*	*

Figure 4.3 The change of the crop calendar in Hai Duong province before and after 1980s (Source: (Hai Duong People's Committee, 2008)

In order to reduce the vulnerability of paddy production, in the period of 1962-1965, several agricultural cooperatives in Hai Duong began to plant the spring rice as an experimental mode. In 1975, the cultivated area of winter-spring rice decreased to 17.58% and the rest (84.42%) was replaced by the spring crop (Hai Duong People's Committee, 2008). In early 1980s, the spring rice completely substituted for the winter-spring crop. This was a great change in the agricultural production that brought with the winter crop, shaping three crops per year (figure 4.3). The movement from the winter-spring crop to the spring crop was achieved thanks to various technical improvements, comprising new rice varieties, better irrigation system and the mechanisation of land preparation. A number of monohybrid crosses and hybrid rice such as IR-5, IR-8, etc. were imported directly from China or Philippines (International Rice Research Institute, for example). And then, these rice varieties were continuously crossbred and produced in some agricultural institutions or universities (for example, Food Crop Research Institute in Gia Loc district of Hai Duong province). The shorter life cycle is a great advantage of these new rice breeds because the production cycle can be shortened.

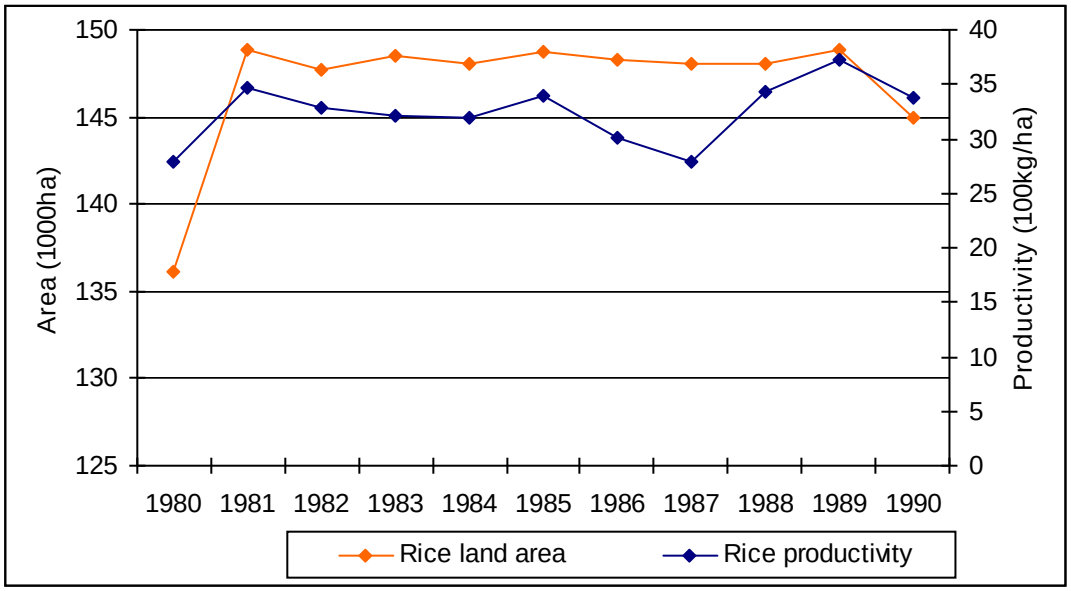


Figure 4.4. Evolution of the rice land area and the rice productivity in Hai Duong province in 1980-1990
(Source:(Hai Hung Statistics Office, 1986,1990)

The spring rice normally had a higher productivity as compared with other crops. Therefore, it became a more and more important crop in early 1980s. In the period 1980-1985, the cultivated area of spring rice made up 70,000 to 75,000ha per year with a contribution to the total annual rice yield of 60 or 63% (Hai Duong People's Committee, 2008).

4.1.2.2 The winter crop as a supplement source of food for household consumption and by-products for animal production

The development of winter crops played an important role in food security because it strongly related to the high demand for foodstuffs of human as well as feed for animal production in 1980s. Many households consumed potatoes and sweet potatoes as the replacement for rice at that time. In the past, some plant varieties were cultivated in the winter season already, but in small areas or specific land such as alluvium land surrounding rivers. Therefore, it could not meet the high consumption demand of local people. The expansion of winter crops was in great demand for the food self-sufficiency.

Hai Duong is one of the provinces having the most rapid development of the winter crop. In early 1980, total areas of winter crop in Hai Duong were 34,200ha. Since 1980s, it became the main crop and was grown largely in the rice land. It included maize, potatoes, sweet potatoes, vegetable, etc. Potatoes and sweet potatoes were two main crops which make up the largest cultivated land areas in total areas of winter crops (figure 4.5).

The winter crop production has changed significantly during the decade 1980s due to the changes in institutional environment and the improvement of irrigation system. In early 1980s, the cultivation areas of most winter crops, especially potatoes, sweet potatoes, and vegetables, were very high thanks to the introduction of Directive 100 (or Contract 100) approved by the state. The contract 100 significantly encouraged farmers to develop their crops through enhancing their independent decision on some farming works and the surplus amount of agricultural products they can have after deduction of quota. Households tried their

best to expand the cultivation areas and increase the productivity of winter crops in order to have more surplus quantity.

However, several years after Directive 100 (from 1983 to 1986), various difficulties faced farmers due to the inappropriate institutional policy, leading to the decline of most winter crops. The ratio of output quota to total yield of agricultural products increased extremely, leading to high deduction. Meanwhile, the crop cultivation was strongly vulnerable to the extreme climate conditions because of limited irrigation and drainage system at that time, causing the instability of crop yields of most households. Farmers failed in their attempts to develop winter crops and gave the land plots back to the agricultural cooperative. The cultivation areas and productivity of most winter crops decreased dramatically during this period (figure 4.5 and 4.6).

The implementation of the Resolution 10 has influenced remarkably on the development of winter crop production since 1987. Thanks to this kind of production contract, producers were more confident about growing winter crops because land plots were allocated to them for a quite long duration (10-15 years) with a fixed quota of output for several years (for 5 years). Then, most households started to invest more in the cropping system in order to ensure the food security.

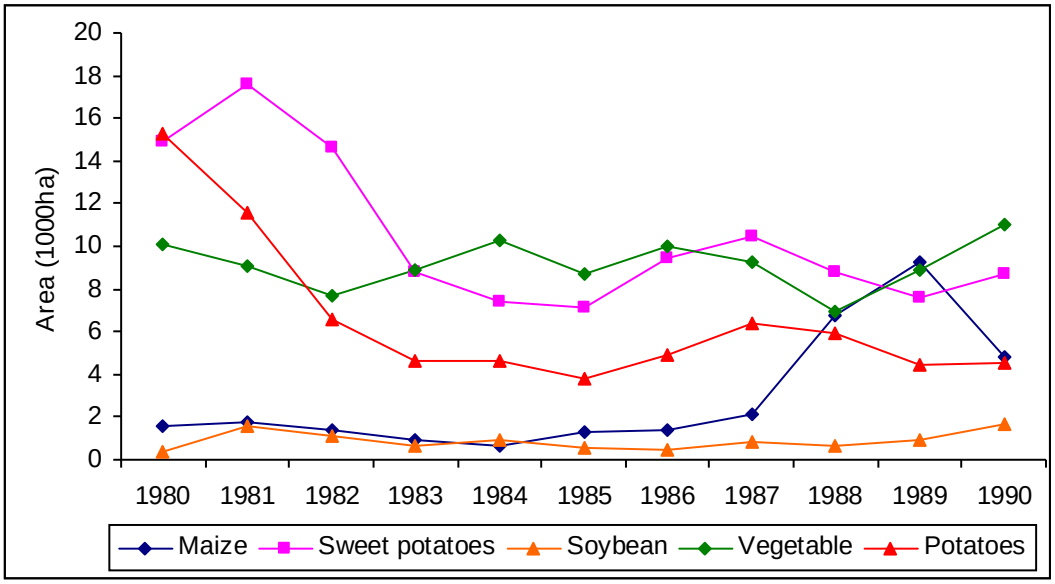


Figure 4.5. Evolution of areas of several winter crops of Hai Duong province in 1980-1990 (Source: (Hai Hung Statistics Office, 1986,1990)

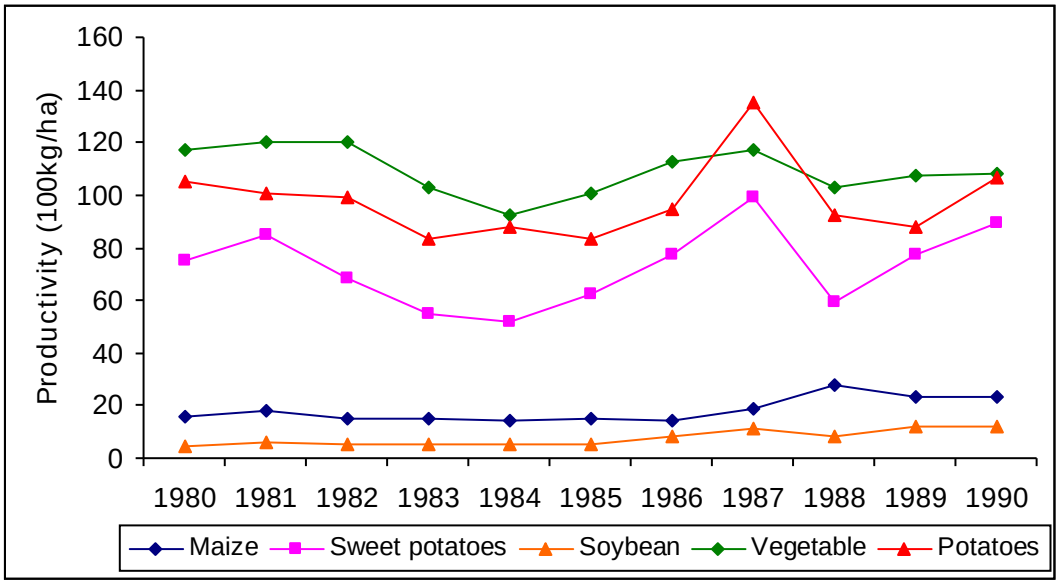


Figure 4.6. Evolution of the productivity of several winter crops of Hai Duong province in 1980-1990
(Source: (Hai Hung Statistics Office, 1986,1990)

In conclusion, production of winter crop in the decade 1980-1990 in Hai Duong province has changed remarkably with the rapid decrease of area of most crops such as potatoes, sweet potatoes, maize, etc., especially from 1980 to 1986. However, according to the introduction of the resolution 10 in 1988, winter crop cultivation started to be increased and played an important role in ensuring food security as well as generating more income for farmers.

4.1.2.3 Small scale of livestock production systems

Table 4.3. Evolution of the animal population of Hai Duong province during 1980-1990

Animals	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Growth rate (%)
Pigs (Thousand heads)	518.8	520.2	522.2	552.4	554.1	528.5	509.9	535.6	520.4	562.1	581	101.1
Buffaloes (Thousand heads)	71.4	69.5	63.3	67.5	65.2	60.0	59.5	61.6	63.3	67.0	65.5	99.1
Chickens (Million heads)	3.6	4.3	4.2	4.6	4.1	4.5	5.1	4.8	4.9	5.9	6.7	106.5
Cattle (Thousand heads)	7.4	8.2	12.1	15.9	18.3	19.8	22.9	26.9	31.5	38.1	41.0	118.7

(Source: (Hai Hung Statistics Office, 1986,1990)

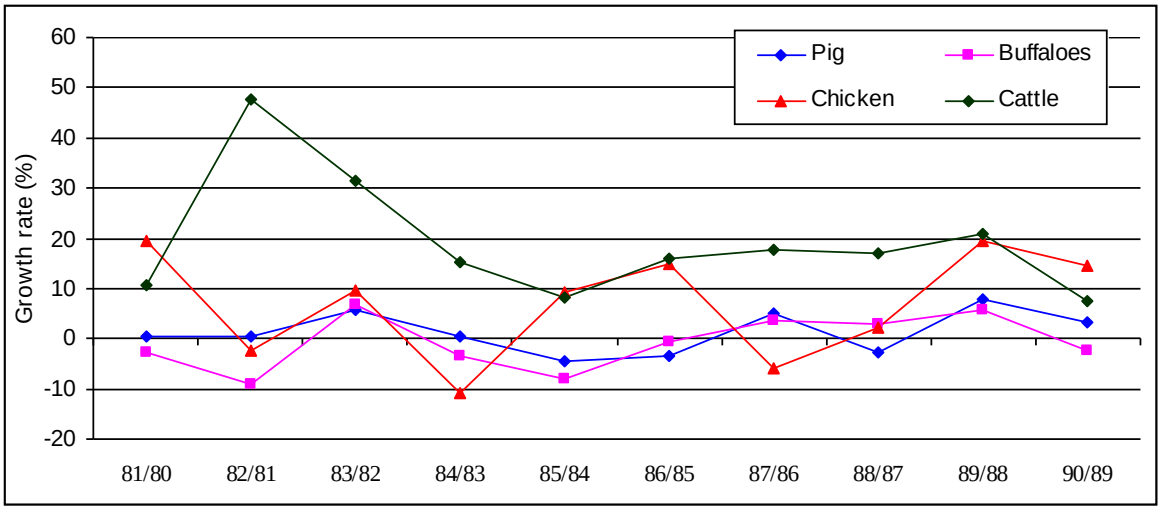


Figure 4.7. The growth rate of livestock populations in Hai Duong during 1980-1990 (Source:(Hai Hung Statistics Office, 1986,1990)

Pig as the most important livestock production

The great importance of pig production in the family economy

Because pork is one of the most favourite foods of Vietnamese people, pig has been reared long time ago in the past. For the farmers, the pig production is the most important activity in the family economy, not only as a savings but also as a source of supplying manure for the crop cultivation. Therefore, raising pig is very popular in most farm families in the Red river delta.

The small-scale pig production

In this decade, the pig production was at a very small scale due to the limitation of financial capital of most households and the strong fluctuation of the input and output market. A survey conducted at 70 households at Nam Thanh district (Nam Sach and Thanh Ha districts now) in 1998 reported that the average size of the pig population in 1988 was 3.7 heads per household (Anh et al., 2000). The pig population was slowly developed because of the feed competition with human. Moreover, there was a high variation of pig price in the market at that time (Anh et al., 2000). Therefore, it was difficult for farmers to expand pig raising during these years.

The native breed and hybrid genotypes of pigs

Before 1960, most pig breeds raised in Hai Duong were local breed, such as, I, Mong Cai, Muong Khuong, etc. with a very low performance and a long life cycle. At that time, the technical knowledge of pig production was still very backward. Pigs were mostly fed by crop by-products with a low quality. In early 1960, Hai Duong is the first province in the Red river delta improving pig genotypes by establishing the station of pig artificial insemination in Lai Cach town, Cam Giang district. A number of exotic pigs with modern genotypes were imported directly from foreign countries, mostly from Russia and China, such as Large White, Landrace, Yorkshine, Tan Cuong etc. These breeds of pigs were then crossbred with local pigs such as Mong Cai, I, etc. to become hybrid pigs with a higher performance as compared with the local one. Thanks to the development of artificial insemination technique, the population of hybrid pigs increased rapidly since then. Various sub-units of the artificial insemination station were therefore built to deliver hybrid genotypes to cooperatives and farm

households. In 1980, more than 60% of the pig population was the hybrid genotype. In some cooperatives, this proportion made up 90% of the total pig population.

Agricultural by-products as the major animal feed

During the period of 1980-1990, the concentrated feed industry was not developed well, and therefore, pigs were fed mostly by crop residuals or by-products such as rice bran, vegetable, corn, sweet potatoes, duckweed, soybean, etc. That is the reason why sweet potatoes, maize and soybean were cultivated largely at that time, not only for the food security but also for the pig production development. In some cooperatives, farmers had a technical innovation in processing the feed for pigs by the fermenting method so that the feed quality was improved and made it easier for pigs to digest. It also helped to save fuel and labour used for preparing and cooking feed for pigs.

The development of beef cattle and buffalo production as the major draught power

In the past, cattle and buffaloes were considered as an important mean of production in agriculture. They served as the major traction power for the crop cultivation as well as a high-protein meat supply source. Cattle or buffaloes were worth a fortune for Vietnamese people.

Buffalo herds

Buffaloes that have the advantage of working hard and resisting well to extreme environmental conditions are popularly reared in the province. The population of buffaloes during the decade 1980s was kept stably, around 50 to 60 thousand heads. Most buffaloes were local breeds, such as re and ngo with the average weight at the mature age of about 250-300kg/head and 350-400kg/head, respectively (Hai Duong People's Committee, 2008).

The rapid growth of beef cattle population

For beef cattle, unlike the buffalo herd, their population increased significantly and gradually during the decade 1980s (figure 4.7). Before 1985, beef cattle flocks in the province were fewer than buffalo herds, accounting for one to two thousand heads (about 1,950 head of cattle in 1985, data of Hai Duong province, not included other districts of Hung Yen province) (Committee of Hai Duong's Communist party, 2010). After that, due to some more advantages compared with buffaloes such as higher reproductive rate, higher meat performance, etc., beef cattle were raised much more than that in the past. Cattle played a more and more important role in ploughing and agricultural traction.

The local breed, which is so-called yellow cattle, was raised popularly with a low live weight (under 300kg/head at the mature age). In 1980, the province implemented a new breeding program to improve genotypes of local cattle by crossing with the Red Sindhi imported directly from India. The hybrid cattle with a higher live weight (about 350kg/head) were reared much more widely and replaced the local one.

The small-scale poultry production

Poultry was raised at a small scale long time ago at farm households in the Red river delta to utilize crop by-products. Before 1970, local breeds were the most predominant strain of poultry in Hai Duong. Although they had good resistance to extreme conditions, their performance showed a low level. Then, a number of modern genotypes with a very high productivity and performance were imported directly from foreign countries and crossed with local types to form various hybrid strains of poultry. In the period 1980-1990, poultry population increased gradually (figure 4.7).

The small-scale and low investments in fish culture

Located in the centre of the Red river delta where various water streams flow throughout the province, Hai Duong has many advantages for the raising fish. However, the water surface for fish production of the province in 1980s was very limited, mostly based on the natural water surface (about 653ha in 1958, for example). The surface and yield of fish production in Hai Duong grew at a low rate and varied notably due to the fluctuation of the weather every year from 1977 to 1990 (table 4.4) (Hai Duong People's Committee, 2008).

Table 4.4. Evolution of water surfaces and yields of fish in Hai Duong in 1980-1990

	1980	1985	1990	Growth rate (%)		
				85/80	90/85	90/80
Water surfaces for fish (Thousand hectares)	4.7	6.6	4.5	3.5	-3.8	-0.2
Yield of fish (Thousand tons)	4.3	5.2	2.1	1.9	-8.7	-3.5

(Source: (Hai Hung Statistics Office, 1986,1990)

Before the year 1960, the development of fish production in Hai Duong was very limited due to the absence of fish breeding technology. Most of the breeding fish were caught from rivers and then brought up in the pond and sold to other fish farms. In 1960, when the breeding fish farm named Phu Tao was established in Gia Loc district, the artificial breeding technology was developed. Many fish varieties were artificially bred and provided to most fish farms in the region. Since then, several breeding fish farms were set up and developed the artificial breeding technology to meet the increasing requirement of fish variety in the market. In 1984, there were 11 state breeding fish farms and 15 breeding fish cooperatives in the whole province. Each year, they provided about 480 million breeding fish for all fish farms in Hai Duong and other surrounding provinces (Hai Duong People's Committee, 2008).

Since 1980, various modern fish varieties such as Indian carp, Chinese common carp, tilapia, etc. were imported directly from foreign countries and crossbred with local breeds to produce diverse fish varieties. The fish production was then developed more rapidly as compared with that in the past.

4.1.3 Production outputs and households' living standard

The decade 1980-1990 was considered as the period of ensuring food security of most farm households (Anh et al., 2000). For a long time, the food production per capita of families in Hai Duong and other regions of Vietnam was very far from the safe threshold. Rice crop was developed gradually by applying new varieties and increasing the intensive level. These efforts enabled the food security to be basically ensured since 1988 when the resolution policy was introduced (figure 4.8).

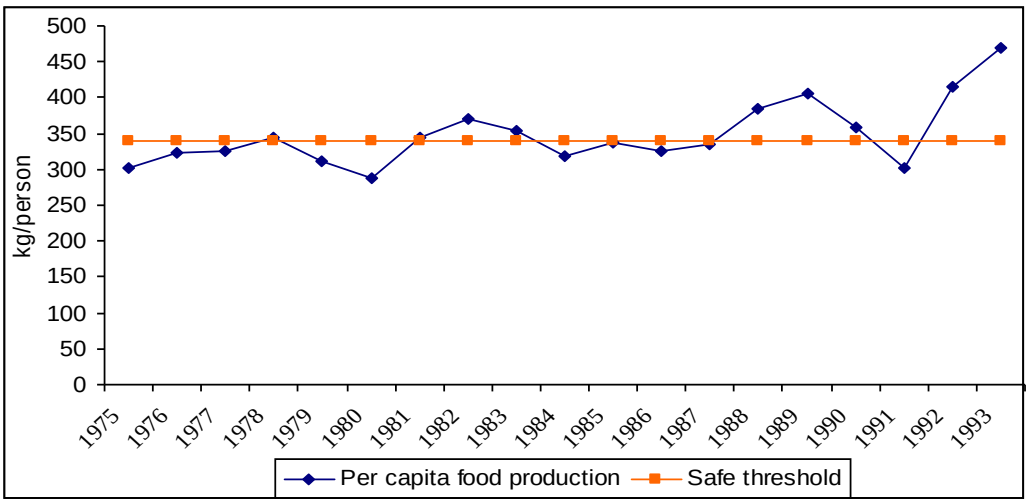


Figure 4.8. Evolution of per capita food production in Hai Duong in 1975-1990 (Source: (Committee of Hai Duong's Communist party, 2010)

The income and living standard of large numbers of farmers were slightly improved but still at a very low level. The main income source of most farm households was from the agricultural production, mainly rice cultivation. However, the price of paddy in the Red river delta was low and decreased across the years. Non-farm activities were not developed well in this period. Thus, farmers had enormous difficulties in diversifying income sources. Moreover, the inflation rate increased rapidly, about 350%. This rate was similar to the growth rate of farm households' income (Dao The Tuan, 1995, cited in (Jesus and Anh, 1998). The increase of inflation rate and the limitation of income sources made the living conditions of most rural households more difficult during this decade.

4.1.4 Factors conditioning the evolution of agrarian systems in 1980s

4.1.4.1 The reform of agricultural institutions and policies

Directive 100 (Khoan 100)

This kind of contract partly stimulated the producers to invest more capital in their production at the initial stage. Farm holders were encouraged to maximize their surplus output over the quota set by the cooperative. Most of the households had a surplus from 15% to 30% of output. The total cultivated land area increased by 6.5%, especially food crop areas (increased by 7.8%) as compared with those in 1980. The total food yield of the whole province gained 87.5 tons, which means 10,000 tons higher than that of 1980 (Committee of Hai Duong's Communist party, 2010).

Resolution 10 (Khoan 10)

The contract 10, which fundamentally meets the demand of owning land of the farmer, had a significant efficiency. Farmers, who had a complete right in making their production decision on their own land, were more active and comfortable to develop the productivity and yield of the rice crop. With a constant quota, they have to pay back to the cooperative and a long time they can own the land, farmers were encouraged to maximize the output surplus because that the more the surplus outputs were produced, the higher product and value they can get. The cultivated land areas were expanded, especially the rice land and the winter crop land. The crop and animal varieties were improved, and new technologies were applied more in

practice. As a result, the productivity and yield of rice increased remarkably, and the food security began to be ensured (figure 4.8). The contract 10 was seen as a new wind blowing into the agriculture and rural areas of the province as well as the whole country.

4.1.4.2 The improvement and expansion of irrigation systems

Besides the introduction of improved varieties, the development of irrigation system and the mechanisation were also important for the change of cropping system in Hai Duong. In 1963, the first electronic pumping station was built in Gia Loc district that facilitated the irrigation activity. Since then, a huge number of pumping stations have been constructed and upgraded to serve the requirements of agricultural production. Moreover, the collective activities of farmers in the cooperative of the commune played a significant role in digging and enlarging the canal systems. Thanks to the collective labour management, the Bac Hung Hai irrigation system, which was known as the largest irrigation system in the North of Vietnam, was constructed in 1964. Then, various small irrigation systems such as An Kim Hai, Nam Sach, Phao Tan – Kim Bai, etc. in Hai Duong were built and upgraded annually.

Regarding the mechanisation process in Hai Duong province, it was marked by the presence of the first electronic plough in the rice field of Nam Sach district. At the end of 1980s, total number of electronic tractors of the province increased to 700 tractors and took responsibility for 55% of total land preparation activity. After the renovation policy introduced, the number of big tractors owned by cooperatives decreased significantly, whereas small tractors owned by private households increased rapidly (Hai Duong People's Committee, 2008). Mechanisation therefore, contributed much to the improvement of agricultural production at that time.

4.2. THE DIVERSIFICATION AND SPECIALIZATION OF AGRARIAN SYSTEMS DURING 1990s AND 2000s

4.2.1 The institutional environments and socio-economic characteristics

4.2.1.1 Stabilization of the province and the nation after the socio-economic crisis

During the beginning of this decade, the socio-economic situations in Hai Duong and in Vietnam were drastically in crisis due to the collapse of the communist political systems in the East Europe and the Union of Soviet Socialist Republics in 1989-1991. Thus, the subsidy and import-export markets from these countries were dramatically diminished. Moreover, the embargo of the United States made the economy faced more difficulties (Committee of Hai Duong's Communist party, 2010).

Under these challenges, the province launched various policies to stabilize and develop the economy. The 7th National Congress of the Communist Party, which was held in June, 1991, issued the “platform for national development in the transition period to socialism”; the “Socio-economic stabilization and development strategies toward 2000” (Committee of Hai Duong's Communist party, 2010). Then, every-five-year development plans (1991-1995) and (1996-2000) were approved and implemented by the nation and the province.

4.2.1.2 The trade liberalization and the integration into the regional and international economy

The decade of 1990-2000 was considered as an important renovation period of Vietnam. The economy was transformed from a centrally planned model into a market-oriented one through the process of de-collectivization of agriculture, liberalization of prices of most inputs and outputs, de-subsidization of state enterprises, privatization, trade liberalization and encouragement of foreign investment (Lebailly et al., 2000).

The trade liberalization was implemented in 1989, when the quota of a number of products was diminished, and the taxation was simplified. In 1991, the importation and exportation activities of the private enterprises were allowed (Anh, 2003).

This decade was also remarked as the active integration of Vietnam into the regional and international economies. At first, after long time of embargo policy, on 11 July 1995, the United States announced the formal normalization of diplomatic relations with Vietnam, and then, the Liaison offices were opened in both countries. Another important partner of Vietnam was European countries. At that time, the first agreement about the economy, trade and technology cooperation was signed on July, 17th 1995 between Vietnam and the EU. At the same time, Vietnam also became the 7th official member of the Association of Southeast Asian Nations (ASEAN) and the ASEAN Free Trade Area (AFTA) on 28 July, 1995 (General Statistics Office, 2001; Anh, 2003). Under this zone, Vietnam had to apply the reduction of tariff and non-tariff barriers of the commerce of most goods (except some agricultural products in Sensitive List and General Exclusion List) to the level below 5% in 2006 (Central Institute for Economic Management of Vietnam, 2010); liberalization of the investment policies and services according to different routes and realization of the regional free trade (Tran Thu Hang, 1999, cited in (Anh, 2003). In 1998, the country joined in the Asia-Pacific Economic Cooperation (APEC) and had to engage in the program called Individual Action Plan to achieve the trade liberalization (Anh, 2003). In addition, in early 2007, Vietnam became the 150th member of World Trade Organization (WTO), which remarked a new era for the socio-economic development of the country.

4.2.2 Spatial dynamics of the agrarian landscape: Chronological diagrams of local transects

As mentioned in the previous parts of the thesis, Hai Duong province was divided into three main agro-ecological and socio-economic zones according to their physical environments, socio-economic conditions and the agricultural features. They are the upper, the middle and the lower regions. The evolution of agrarian landscape during last three decades was conducted by transect walks which based on the participatory discussions with local witnesses and personal observations (figure 4.9).

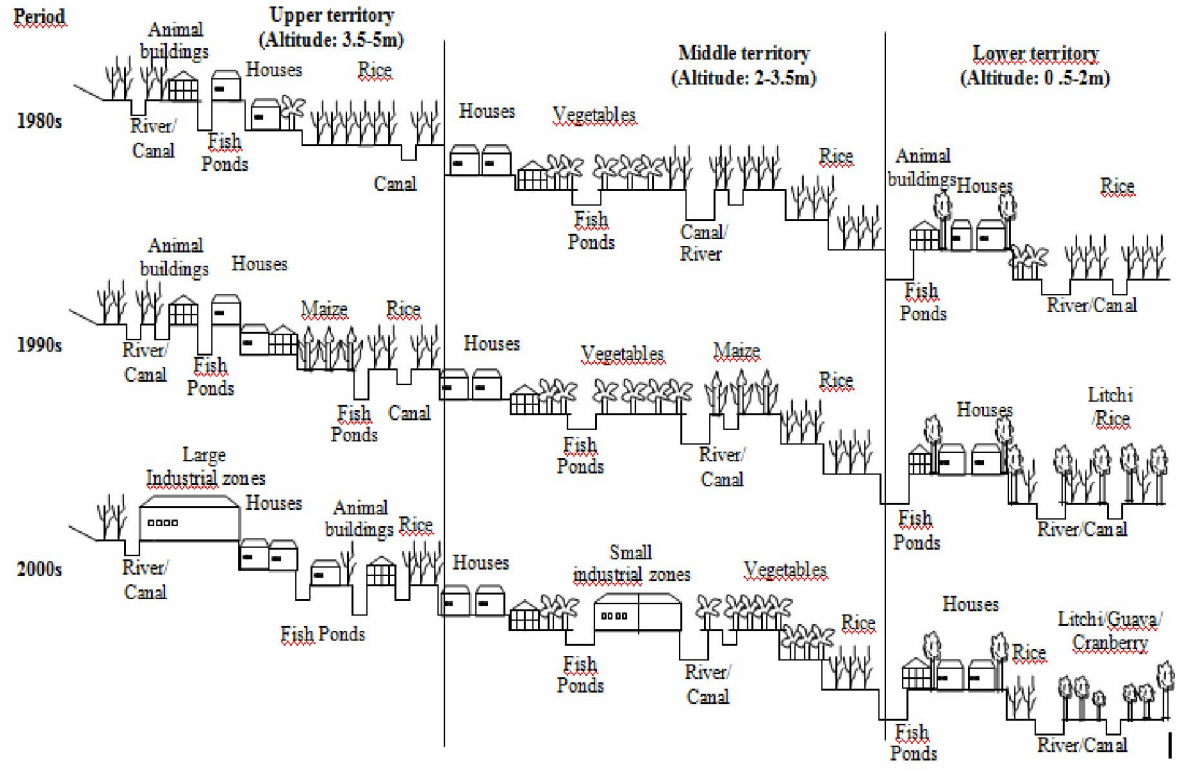


Figure 4.9. Chronological diagram of the local transect of Hai Duong province
(Source: Participatory discussions and personal observations, 2010)

In general, the agrarian systems in different zones were gradually transformed from a traditional rice-based production system in 1980s into a more diversified model during 1990s and a specialized and diversified one during 2000s. However, under a given changing condition of environmental contexts of each region, this evolution had specific characteristics. It resulted in the differences of agrarian systems among geographical zones at the current time.

4.2.2.1 The development of the animal-aquaculture based agrarian system in the upper zone

General characteristics of the upper zone

The upper zone is defined by the higher altitude than other regions of Hai Duong province. On average, the altitude of most areas in this zone ranges from 3.5m to 5m above the sea level. It comprises the districts and communes along the hilly parts in the North of the province. Thus, the region is less vulnerable to the flood in the rainy season than others.

This zone has some favourable conditions for the development of aquaculture. There are plenty of small streams around the regions which come from Thai Binh river. Moreover, the territory of this region is quite uneven with various natural pools and water borders. These water flows are of great importance in supplying water for the agricultural production and fish ponds.

Regarding the socio-economic conditions, the region has many advantages for the economic development. Locating at the centre of the province makes it more convenient to connect to other provinces, facilitating the production and trading activities. Furthermore, the dense installation of industrial parks in recent years leads to the significant improvement of the rural infrastructure system. These improvements are very useful for the economic growth of the region.

The agrarian landscape changes

Over the last three decades, the changes of agrarian landscape in the upper zone have been figured by the gradual replacement of rice field with fish ponds and animal buildings in the lowland rice in remote areas and the industrial parks in the town centre. It was observed that there has been a movement of fish ponds and animal buildings from the homestead land to the rice field in 1990s due to the program of rice land conversion. Some households, especially the young ones, moved from the central villages to the rice field by constructing the small house next to the fish ponds and animal sheds. Then, since 2000s, the animal sheds at the homestead land were diminished gradually according to the increasing demand for habitation of the workers around the industrial factories. A number of animal buildings are now seen on the rice field, away from the centre town.

Furthermore, another change of agrarian landscape was related strongly to the rapid installation of industrial parks since 2000s. These parks are often located in the centre town and along the national highway. During this period, large areas of agricultural land, especially rice land, were switched to the industrial zones. A number of new houses were also built around the factories for renting purposes. The urbanization process increased rapidly according to the acceleration of industrialization in this zone.

In this zone, Cam Giang district and its two communes (Tan Truong in the centre town and Cam Hoang in the agricultural part) were chosen as the representative samples for the investigation.

4.2.2.2 The enlargement of the vegetable- based agrarian system in the middle zone

General characteristics of the middle zone

The middle zone is characterized by the medium territory with the altitude of 2-3.5m. The field has been formed by different layers of alluvial soil came from Thai Binh river across the time. The fertile soil and the availability of water supply are advantageous for the cultivation of annual crops. Thus, vegetable crops have been widely cultivated in this zone for many years. It is considered as the biggest agricultural centre of the province in terms of cultivated land areas and the production output.

Located at the centre of the province, this zone is known as the intersection among different regions. The rural infrastructure system, especially the road system, has been well developed recently together with the development of some small industrial zones. The installation of some big wholesale markets of agricultural commodities in this zone facilitates considerably the development of agricultural production of most households.

Agrarian landscape changes

Unlike the upper zone, the change of agrarian landscape in the middle zone was viewed as the enlargement of several vegetable crops since 1990s. The great advantages of large plain fields, fertile soil and favourable irrigation system strongly encouraged growers to expand their vegetable crops. However, during the year 2000s, a certain area of rice and vegetable land has been used for the installation of some industrial companies. Although they just occupy small land surfaces now, it is forecasted that they will be covered in a wider area of agricultural land in the coming years.

Gia Loc district was selected due to its representative characteristics for this zone. Its two communes, namely Gia Xuyen and Thong Kenh, were involved in the further investigation.

4.2.2.3 The expansion of the fruit -based agrarian system in the lower zone

General characteristics of the lower zone

The lower zone has some disadvantages that hinder the socio-economic development, including industry, services and agriculture. It includes several districts in the southern region of Hai Duong province where has a lower altitude than other parts, about 0.5m to 2m above the sea level. The very low territory causes it to be more vulnerable to the flood in the rainy season. Sometimes, the high tide can lead to the salinity that affects the soil fertility. Moreover, the region is also bordered by various rivers or streams, making it more inconvenient to connect to other surrounding locations. Besides that, the underdeveloped industrial parks limit the expansion of the rural infrastructure system that affects the growth of the economy.

Agrarian landscape changes

In the lower zone of Hai Duong, the significant change of agrarian landscape was caused by the conversion from rice fields into litchi gardens in 1990s and into the diversified fruit plantations in 2000s. In the past, litchi was grown mostly in the home gardens. In 1990s, rice was gradually replaced with litchi trees. The low landscape was considerably changed by the formation of litchi ridges. Then, in 2000s, some certain litchi plantations in this zone were cut and switched to other fruit crops such as guava, kumquat, etc. The annual crop-based land area was basically switched to the perennial fruit-based gardens during these decades.

Thanh Ha was the most famous district for fruit cultivation and taken in the study. The survey was implemented in two communes, including Lien Mac, which located near the centre town, and Thanh Son, which was away from the town.

4.2.3 Dynamics of the animal-aquaculture based agrarian system in the upper zone in 1990s and 2000s

During the two last decades, the agrarian system in the upper zone of Hai Duong has evolved from a traditional rice–based system to a diversified animal-aquaculture-crop production system in 1990s and to a specialized animal-aquaculture based system in 2000s. This process was related mainly to the conversion from rice land into fish ponds and animal buildings. In 1990s, some lowland areas in the rice fields were, firstly, switched to fish ponds and animal buildings. The animal and fish production has developed rapidly since then. At that time, winter crops, especially maize and soybean, were widely planted to provide feed for animals and fishes. The integrated animal-fish-crop production system was the dominant model in this zone. In 2000s, the specialization of the production system was enhanced by the expansion of farm size and the intensification of input use. The farm holdings specialized in pig or poultry production with a large scale and applied the monoculture of fish raising. The following part introduces in more detail this dynamic of animal-aquaculture based agrarian system in the upper zone (figure 4.10).

4.2.3.1 The process of rice land conversion into fish ponds

Identify the rice land area for the conversion

This step played an important role in the transformation program. According to the land use plan, farmers could not convert any rice field into fish ponds. A certain rice land area, which was favourable for two rice crops per year, was sustained for the food security of the region. Only the lowland area that cultivated one rice crop per year with the unstable productivity

(because of flood) can be dug and constructed fish ponds. These surfaces were often uneven and close to the water streams. Therefore, it is more convenient for fish culture than other high land zones.

Exchange or purchase rice plots among farmers

In order to transform from rice land into fish ponds, each farming household was required to have a large land parcel in the converted area. It was an obligation for market-oriented economy that prioritized by the province. However, due to the equal land distribution in 1993, the rice fields were highly fragmented. Each farming holding owned many land plots in different fields, which have diversified characteristics of soil fertility. Thus, they had to exchange their land parcels to form a bigger one in the converted region.

The land exchange was implemented among households by their discussions. For instance, in Cam Hoang commune (Cam Giang district), the minimum area of the land parcel for the transformation was 4 sao (equals to 1440m^2). There were 35 leading households in the conversion program in 1994 (Cam Hoang's People Committee, 2005). They were mostly rich households that well accumulated the financial capital for fish pond construction. However, the exchange process was very limited during 1990s due to the unwillingness of several farm holders who were not interested in the transformation activity. Furthermore, the limitation of financial capital made it difficult for a huge number of farming households to implement the movement.

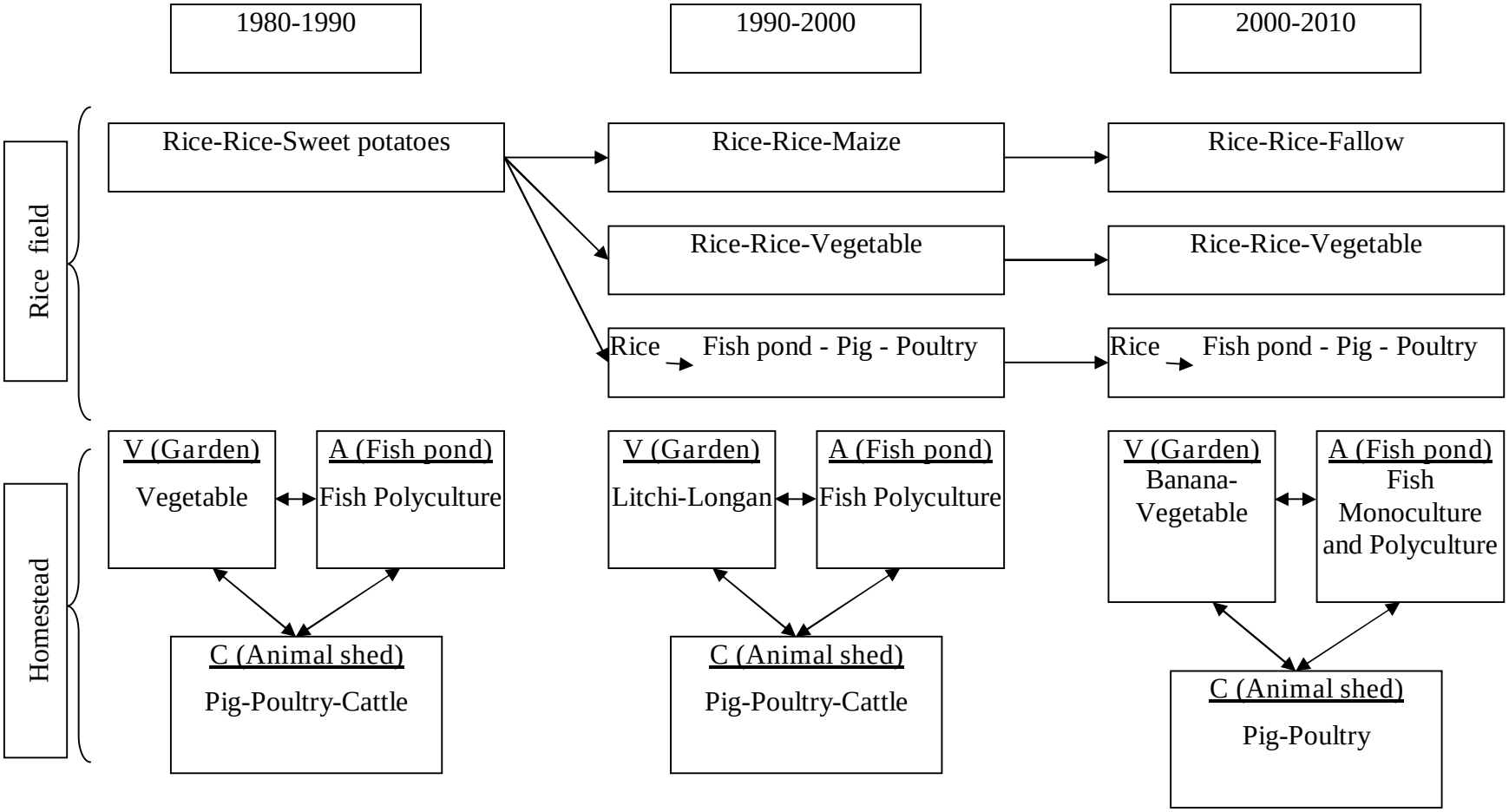


Figure 4.10. Dynamics of the animal-aquaculture based system in the upper zone of Hai Duong
(Source: Participatory discussions and personal observation, 2010-2011)

The land consolidation process was actually conducted in early 2000s when the province implemented the land regrouping program. In February 2002, the directive number 21/TV-TU about land consolidation was approved by the Provincial Standing Party Committee. Then, a specific program about land consolidation was issued by the Provincial People Committee in April 2002. Cam Hoang was selected as one of the representative communes for this program. Thanks to this policy, the land plots of the commune reduced significantly, from 17,740 pieces to 7,145 ones. On average, each household had 3.7 land parcels with an area of 527m^2 per piece (Cam Hoang's People Committee, 2005). This was of great importance for the land conversion into fish ponds.

Besides that, many households expanded their land area by buying more surfaces from neighbours.

Construction of the fish ponds

The construction of fish ponds was a hard work for all farming households. This was the manual work which consumed huge human powers. The soil was dug deeply and removed to the surrounding areas to form the border of the pond and the garden. To do so, many small farmers relied on family labours or exchanging labours with their neighbours. The assistance from their relatives was also of great importance because they could not afford to hire waged labours or machines. Therefore, it took a long time to complete the fish pond systems.

However, one constructed large ponds had to pay an enormous cost for waged labours. Because of manual working method, this transformation was costly since the beginning to the end of the process. Because of the difficulty in loan accessing at the early period of conversion (1993-1995), most of the farming households adopt the gradual conversion strategy. It means that they switched partly their land into fish ponds across the years. The profit gained each year was directly reinvested in the continuous construction. Tuan and Anh (1995) discussed that in the diversification process of 1990s, farming households in Hai Hung (Hai Duong and Hung Yen province) coped with the lack of financial capital. However, they solved this difficulty by using more manual labours or by increasing the profitability and efficiency of their investment.

Box 4.1. My strategy is long-term investment in the fish pond conversion by annual profit

In 2000, I started to convert my rice land into fish ponds. At that time, due to the limitation of capital, my family members had to work hard to dig the soil. Sometimes, I had external assistance from my relatives or neighbours. Normally, I invited them to have meals with my family after work. A total of 5 sao (or 1800m^2) were switched after three years. Then, the annual profit from the VAC production system was invested in expanding more fish pond areas. I had to rent many labours for these activities. In 2006, total water surfaces for fish culture were 25 sao (equals to 9000 m^2). It cost about 200 million dongs in estimation.

(Source: Interview with Mister Do Van Huynh, 48 years old, in Tan Truong commune in 2010)

The fish pond transformation was actually a costly investment. It might include the cost of land purchase, waged labours for digging the soil and building the border. To avoid the landslide, farmers had to pay much money for constructing the pond borders. According to

Ton (2003), the wall and boundary of the fish pond were built from concrete or bricks. Thus, to complete a medium or large model of VAC, farmers had to spend millions VND.

Box 4.2. It is costly to switch from rice land to fish ponds and built up a VAC system

The conversion from lowland area in the rice fields into fish ponds, I had to spend approximately one billion VND for 10 sao (equals to 3600 m^2) from 1997 to 2003. At that time, the total soil amounts which had to be removed from rice fields were about 2000m^3 per 10 sao. The price of waged labours for digging soil was about 6000 to 8000 dong/m^3. Other costs included the land renting fee, construction of pond borders and animal buildings, purchase of tools and equipments, etc. My family had to borrow a lot of money from banks to set up this model.

(Source: Interview with Mister Thu, 50 years old in Tan Truong commune in 2010)

4.2.3.2 The rapid expansion of fish pond surfaces

The fish production has been developed significantly in terms of both water surface and fish yield during 1990-2010. Farmers took the most advantage of water surfaces for fish production by upgrading or rebuilding the natural ponds. Fish pond areas, therefore, increased gradually, especially since 1994, when the program of converting from rice land area into fish ponds approved by the province. In the whole province, a total of 2,856ha was converted into fish ponds until the year 2000 (Committee of Hai Duong's Communist party, 2010). Thus, fish surfaces were raised remarkably from 4,521ha in 1994 to 6,747ha in 2000 equals to 149.2%. Fish yield was then enhanced significantly from 5,215 tons in 1994 to 11,651 tons in 2000 (figure 4.11). Therefore, Hai Duong became one of the biggest fish production provinces in the Red river delta.

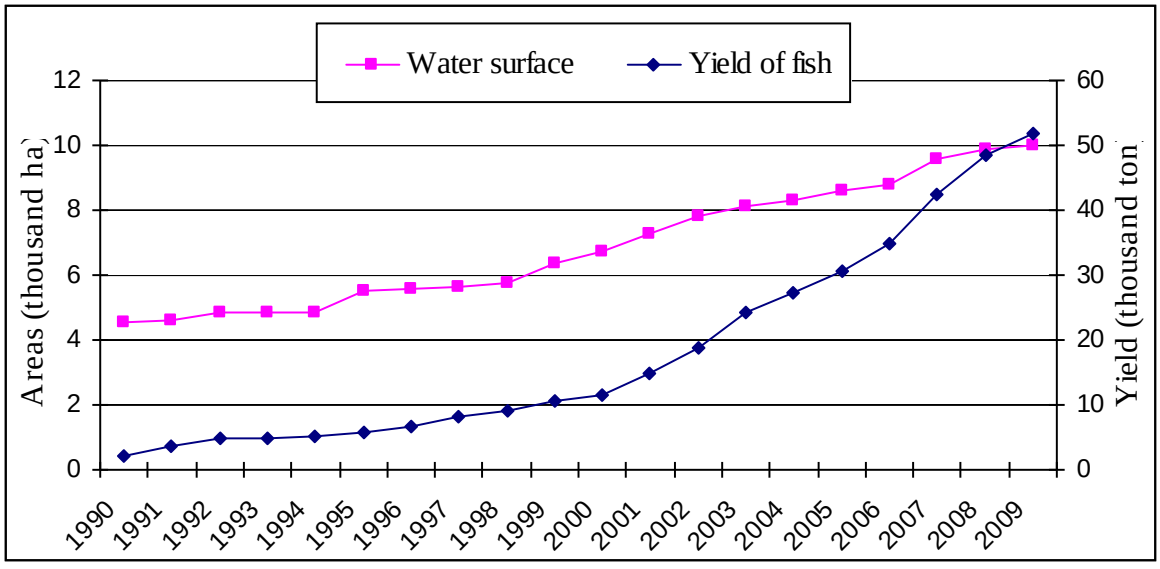


Figure 4.11. Evolution of water surfaces and fish yield in Hai Duong
(Source: Hai Duong statistics Office (1995); (Hai Duong Statistics Office, 1998,2001,2006,2010)

The fish production has been continuously enhanced in 2000s in terms of water surface and yield. In this period, water surfaces for fish production have been continuously expanded across the years due to the program of converting from low rice land into fish ponds implemented in many locations. The total water areas for fish raising of the province have been increased annually from 6,747 ha in 2000 to 10,000 ha in 2009. Similarly, the yield of fish produced each year has also increased rapidly from 11,651 tons in 2000 to 51,800 tons in 2009 (figure 4.11).

The growth rate of fish yield in this decade was much higher than that of the previous year thanks to the intensification of the production. The stability of fish price in the market makes it more favourable for farmers to enlarge their fish ponds and invest more in improved breeds and other purchased inputs. The use of concentrated feed to fatten fish became more popular in farm households. To increase the number of harvesting ratio per year, most farm households applied the production rotation or specialized in other varieties having a shorter production cycle such as tilapia, clariidae, etc. in the monoculture system.

However, the increase of intensive level and the lack of appropriate awareness of culture techniques led to the extreme water pollution and the fish disease infection. Therefore, the economic efficiency of many fish farms was affected strongly by this damage.

4.2.3.3 Changes of agricultural land areas of surveyed households

Rice land areas of most farming households were expanded slightly over two last decades. Nearly all farm holdings still keep a certain area of rice land for food autonomy of their family. Some of them, who are too old or migrated to other regions, may sell or transfer the land to others. Thus, the area of rice land of households in two production systems in 2010 is about 1.2 times to 1.3 times higher than those in 1993 (table 4.5).

On the contrary, the changes of fish pond areas of most households are dramatic across the years (table 4.5). In 1993, the number of households who had fish ponds and their fish pond areas were very limited. Many of them then bought or rent more surrounding surfaces from neighbours or from common water borders of the commune for fish culture. They often rent the common pools of the commune for long-term use (e.g. about 20 years in Tan Truong commune) at a low price (e.g. 70 kg rice/sao/year for water surfaces and 30kg rice/sao/year for the area of pond borders in Tan Truong). Therefore, the difference of fish pond areas between 2010 and 1993 is very high, about 9.2 times in the livestock-fish system and 6.6 times in the livestock-fish-crop system.

Table 4.5. Changes of rice land and fish pond areas of surveyed households

Land items	Livestock-fish system (n=13)		Livestock-fish-crop system (n=25)	
	Areas (m^2)	% HHs	Areas (m^2)	% HHs
Rice land areas				
Rice land 1993	1,384.6	100	1,827.4	100
Rent land	27.7	38.5	79.2	12.5
Bought land	180.0	38.5	292.3	25.0
Inherited land	166.2	15.4	201.6	12.5
Sold land	0	0	273.6	24.0
Rice land 2010	1,758.5	100	2,126.9	100
Difference (2010/1993)	373.8 (1.3)	0	299.5 (1.2)	0
Fish pond areas				
Fish pond 1993	450.0	30.8	440.0	16.0
Rent area	2,232.0	53.8	1,502.0	36.0
Bought area	1,440.0	38.5	944.0	24.0
Fish pond 2010	4,122.0	76.9	2,886.0	72.0
Difference (2010/1993)	3,672.0 (9.2)	46.1	2,446.0 (6.6)	56.0

(Source: Surveyed data in 2010-2011)

Over the two last decades, farmers gradually converted their rice land into fish ponds according to their capital accumulation and the advantages of the institutional and socio-economic environments. The surveyed data shows that most households implemented two stages of transformation (figure 4.12). In the livestock-fish production system, a high proportion of farms firstly switched their land during the period of 1996-2000 and then second time in the last period of 2006-2010. After several years of land redistribution (in 1993), many households began to purchase more land from their neighbours to expand their fish pond size thanks to the higher profit from the fish and animal production than that from the rice cultivation. Then, in the period of 2006-2010, when a number of farms were damaged by animal infectious epidemics (such as bird flu or Porcine Reproductive and Respiratory Syndrome, etc.), farmers sold their land to others. Thus, some farms bought more land from failed farms during this period. By contrast, households in the livestock-fish-crop production system switched from rice land to fish ponds mostly in 1990-1995 and 2001-2003, right after the land reallocation and land consolidation program.

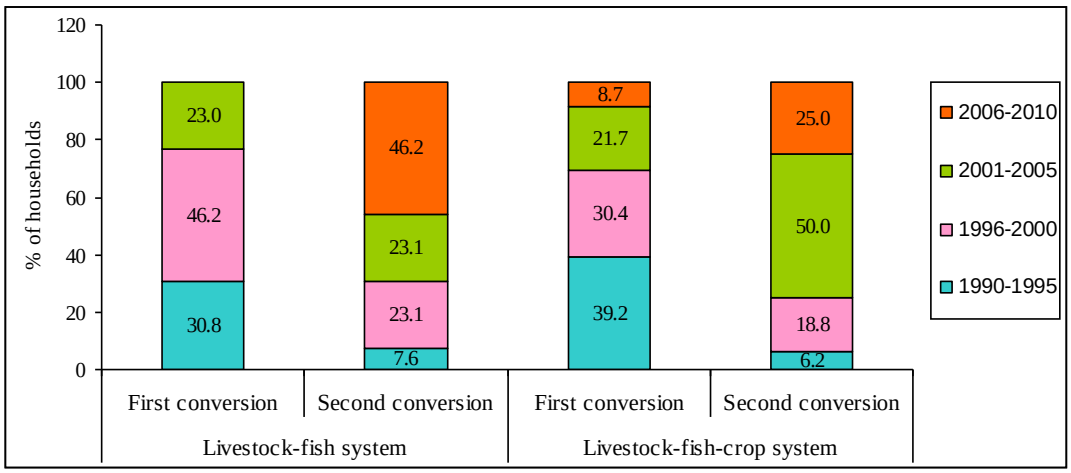


Figure 4.12. Distribution of frequency of households by the period of the land conversion into fish ponds
(Source: Household surveyed, 2010-2011)

4.2.3.4 The rapid growth of animal production

The development of pig production

Pigs are considered as the main animal species which were raised by most families thanks to its multi-function. Pigs can utilize efficiently the crop residuals as well as other by-products of some food processing activities such as rice noodle, wine production, etc. Pig manure is an important organic fertilizer source for the crop cultivation. Moreover, pork is the most favourite meat of Vietnamese consumers. Thus, the pig production plays an important role in the household economy.

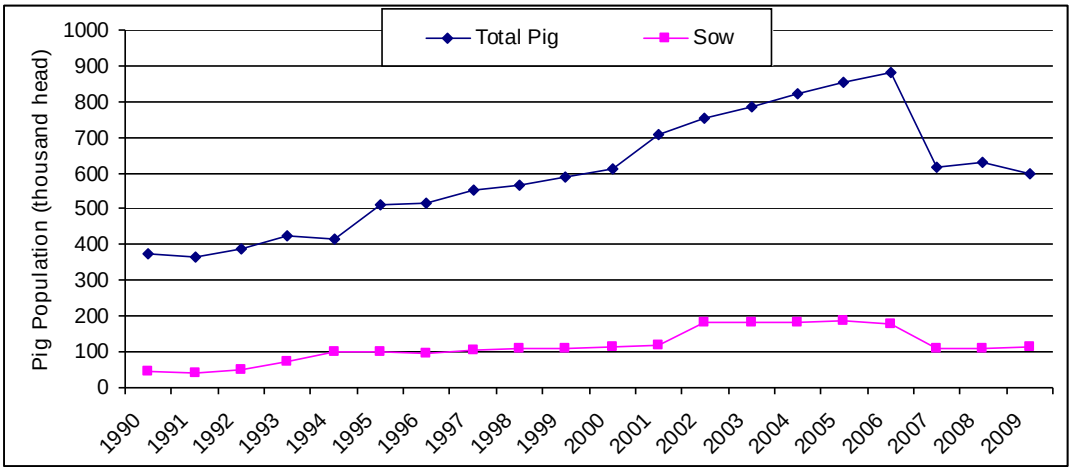
Hai Duong province was known as one of the provinces having a rapid growth of the pig production over the last decade. During the 1990s, the pig population raised significantly from 374,000 heads of pigs in 1990 to 613,500 heads in 2000 (figure 4.13). The considerable growth was seen since 1993 due to the rapid socio-economic development of the region and the country. In comparison with the Red river delta, the pig population also increased gradually from 4,336,200 heads in 1996 to 5,398,500 heads in 2000, equals to 124.4% (General Statistics Office, 2001). The rapid growth of the pig production during this period was strongly related to the expansion of winter crops, especially maize and soybean crops (Jesus and Anh, 1998). These products were produced on farm and fed to the pig flocks as their major foodstuff.

In the first half of the decade 2000s, the pig production achieved a rapid growth. The population of pigs has increased annually from 613.5 thousand heads in 2000 to 883.5 thousand heads in 2006 (figure 4.13). On average, the growth rate of pig population of the whole province during the period 2000-2005 was 6.9% per year. Particularly, the sow population grew at a higher rate, about 11.4% per year in this period. Thus, the total pork yield rose by 11.1% annually in 2000-2005 (Hai Duong Agriculture and Rural Development Department, 2008). This development mostly came from the expansion of farm size due to the policy on encouraging the improvement of intensive animal farms in the rice field, away from the communities. In 2008, there were 100 intensive pig farms in the whole province. Some of them kept about 600 to 1200 exotic improved sows, contributing annually about 30,000 or

35,000 heads of piglets to other farms (Hai Duong Agriculture and Rural Development Department, 2008).

Recently, especially since 2007, the pig population has varied considerably. In 2007, a number of pig flocks were culled because of the infectious epidemics such as Porcine Reproductive & Respiratory Syndrome (PRRS). The continuous outbreak of this disease in the following years (2008-2010) caused huge losses of many farms. A number of small and medium farms diminished their pig flocks size and even stopped keeping pig production. Swine herds were mostly raised in the large and intensive farms and some medium farms.

The quality of pork has been also improved significantly over the year thanks to the breeding selection programs. The priority of pig breeding selection programs was focused on the greater participation of high lean genotypes through crossbreeding. In 2008, the population of purebred sows made up 6% of total sow population. The number of hybrid sows was much higher, occupied 32.4% of total sow heads. For fattening pigs, 100% of the populations were hybrid ones, which have 50% contribution of high lean genetics. On average, the lean percentage of these breeds was 40 to 55% in the ratio of carcass weight (Hai Duong Agriculture and Rural Development Department, 2008). This achievement partly meets the growing demands of consumers in the domestic market.



Figue 4.13. Evolution of the pig population in Hai Duong
Source: (Hai Duong statistics Office, 1995,1998,2001,2006,2010)

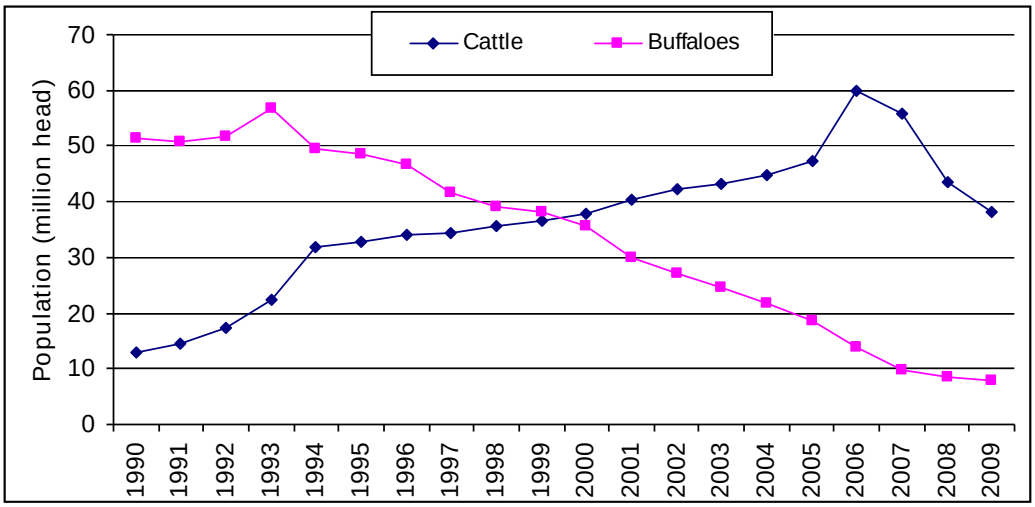
The ruminant population: the growth of cattle herds and the reduction of buffalo flocks

Beef cattle and buffaloes have been kept by most households for many years for several purposes, including land preparation, agricultural traction, calf reproduction and meat production. In the decade 1980s, buffalo herds were much more important than beef cattle. The backward agricultural production required much of animal draught power and buffaloes were the appropriate choice. Buffaloes are known to be stronger than cattle. It is also easier to raise buffaloes than cattle because they can utilize effectively most types of crop residuals. Therefore, buffalo population was much higher than that of beef cattle during that period.

However, after the Renovation, especially since 1993, the buffalo production was gradually replaced with beef cattle population (figure 4.14). The buffalo population decreased steadily from 56,700 heads in 1993 to 35,600 heads in 2000. On the contrary, the beef cattle herds increased notably from 22,500 heads in 1993 to 37,900 heads in 2000. In 2000, the beef cattle

herd was higher than that of buffaloes. The development of beef cattle was strongly related to the increasing demand of beef in the market. Consumers prefer beef to buffalo meat (Anh et al., 2005) and beef price increased across the years. Beef cows were raised popularly by most farm households for both draught power and young calf reproduction. Cows although have less draught power but higher reproductive rate than that of buffaloes (Ton, 2003). Thus, they were raised popularly to produce calves. The young female calf was often sold at a high price to other households as a breeding cow. The male calf was usually fattened within several months and sold to local slaughterhouses or to other farms as a draught ox.

Beef cattle production was continuously developed during some first years of the decade 2000s due to the project of enhancing the beef quality. The beef cattle population achieved the highest amount in 2006, about 60 thousand heads, equals to 58.3% higher than that of the year 2000 (figure 4.14). It grew at an annual rate of 4.8% during the period of 2000-2005 (Hai Duong Statistics Office, 2001,2006; Hai Duong Agriculture and Rural Development Department, 2008; Hai Duong Statistics Office, 2010). They were mostly hybrid ones and fattened mainly for the beef production purpose.



Figue 4.14 . Evolution of cattle and buffalo population in Hai Duong
Source: (Hai Duong statistics Office, 1995,1998,2001,2006,2010)

However, the number of beef cattle has been decreased notably since 2007 because of strong damage of food and mouth disease in 2006 and in the following years. Moreover, their role of land preparation and traction reduced in this period due to the mechanisation. In 2009, its population went down to 38.2 thousand heads, nearly equals to that of the year 2000. The availability of off-farm activities was also related to the decline of the cattle production.

For buffalo herds, the population has shown an annually significant reduction in this period. In 2009, the number of this species was 8,000 heads, about 22.4% lower than that of the year 2000 (35.6 thousand heads). The decline rate of this population was 12.1% in 2000-2005. It decreased more rapidly afterwards, about 22.9% in 2006-2008 (Hai Duong Agriculture and Rural Development Department, 2008). The mechanization and electrification of agricultural production and the threats of several epidemics led to the falling down of the buffalo production. The low productivity rate and carcass weight made it less beneficial to fatten them than the beef cattle. That is why they are less kept by most farm households, especially in a limited land area like Hai Duong province.

The variation of poultry production

Poultry also plays an important role in the farm household economy of Hai Duong province and the Red river delta. Chicken and duck were the two main types of birds raised by most farming families to supplement their income as well as for the household consumption. The population of chicken was much higher than those of duck because local consumers prefer chicken meat and egg to that of duck. Moreover, raising duck normally requires a given water surface or large rice fields where ducks can find the food. Poultry were often kept in the back yard production system which was at a small or medium scale and less intensive. In the Red river delta, about 60% of total chicken population was kept in this production system. The left (40%) was raised in industrial closed systems (Vang and Son, 2006).

In the decade 1990s, the poultry production in Hai Duong developed well across the years. The chicken population increased from 4.5 million heads in 1995 to 5.9 million heads in 2000, equals to an increase of 131.5% (figure 4.15). The growing consumption demand of domestic markets during this period was the major driver for the development of chicken production, especially since 1994-1995. In the period 1988-1998, the growth rate of chicken population in the Red river delta was 5.78% per year, the same rate as the whole country (5.71% per year). The delta was also known as the region which the chicken production made up 24.5% of total chicken herds and 28.39% of total chicken meat of the whole country. The chicken meat production grew at a rate of more than 5% per year over this decade (Vang and Son, 2006).

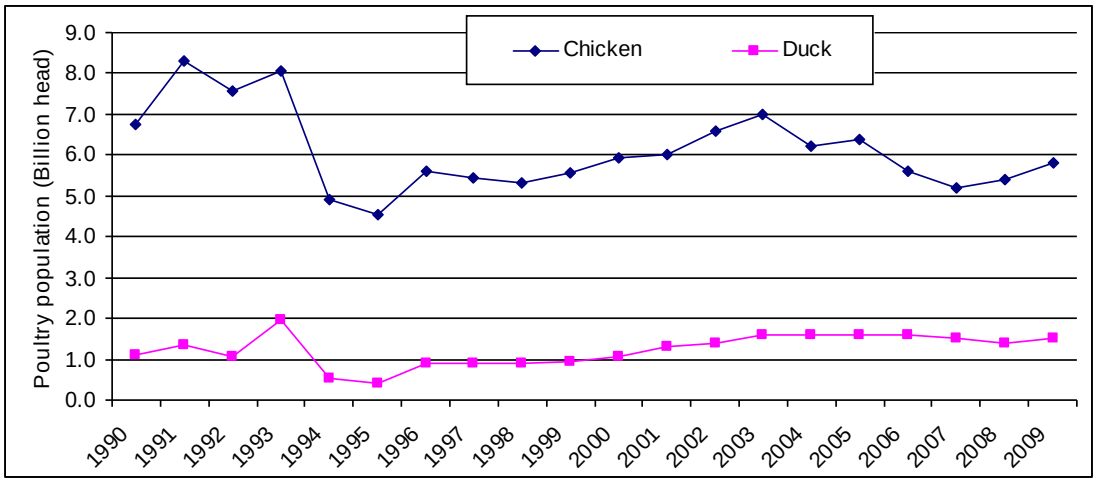


Figure 4.15. Evolution of chicken and duck population in Hai Duong in 1990-2009
Source: (Hai Duong statistics Office, 1995,1998,2001,2006,2010)

In the decade 2000s, the poultry production varied considerably due to the influence of the infectious epidemics. Before 2003, poultry production in Hai Duong has been developed remarkably. In 2003, the poultry population achieved the highest number, about 7 million heads of chickens and 1.6 million heads of ducks. In the first five years (2000-2005), the growth rate of poultry population and poultry meat yield was 2.9% and 8.9% per year, respectively. This development was the result of the increase of farm size of both small and medium households and industrialized farms.

However, most poultry keepers in Hai Duong and other regions of Vietnam faced a terrible threat of bird flu broken since 2004 and afterwards. The poultry production was affected

strongly by this influenza and others. Thus, its population has been gone down since then. The growth rate of population and meat yield of poultry was -5% and -1.9% respectively in 2006-2008 (Hai Duong Agriculture and Rural Development Department, 2008). The number of free-range or back yard poultry farms has then reduced significantly onwards. The industrialized farms in which poultry kept separately from surrounding environments have a higher efficiency in disease prevention. Thus, they were developed more in this period. In 2008, total industrialized poultry farms were 120 farms in the whole province. (Hai Duong Agriculture and Rural Development Department, 2008).

4.2.3.5 The variation of livestock flock size at the surveyed households

In the first period (1993-2003), the diversified livestock production system was widely employed by most farms. This production system was characterized by the diversified combination of livestock species at the medium production scale.

The differentiation between the two production systems was more significant in the second stage (2003-2010) than that in the previous time. During these years, the households in the livestock-fish production system expanded their production scale by increasing the number of animals. Most farms specialized in pig or poultry production with a high density of animal population. Conversely, the smallholders in the livestock-fish-crop production system sustained the diversified production mode by keeping small animal flock size of different animal species.

Table 4.6. Variation of livestock flocks of surveyed households

Livestock flocks (Head/cycle)	Livestock-fish system (n=13)			Livestock-fish-crop system (n=25)		
	1993	2003	2010	1993	2003	2010
Sows	1.2	3.0	12.3	1.7	3.9	2.8
Growing pigs	9.8	23.8	88.3	7.2	32.1	20.7
Chickens	344.0	1,216.7	2,583.3	65.0	153.1	262.5
Ducks	350.0	335.0	1,000.0	20.0	345.0	190.6

(Source: Household surveys, 2010-2011)

In the first period (1993-2003), there was a little difference about the sow population between households in two livestock production systems. At that time, a high percentage of farms practised small scale of pig production (about 1-3 sows and 10-30 growing pigs). Then, in 2010, a number of farms in the livestock-fish production system increased the animal herd size (50% of them kept more than 9 sows and more than 90 growing pigs), while others still maintained a small or medium livestock flock size (76.9% households in the livestock-fish-crop production system had 1-3 sows and 91.7% of them raised 10-30 fattening pigs). Thus, the difference about the pig herd size among households in two livestock production systems was more significant than that in the previous time.

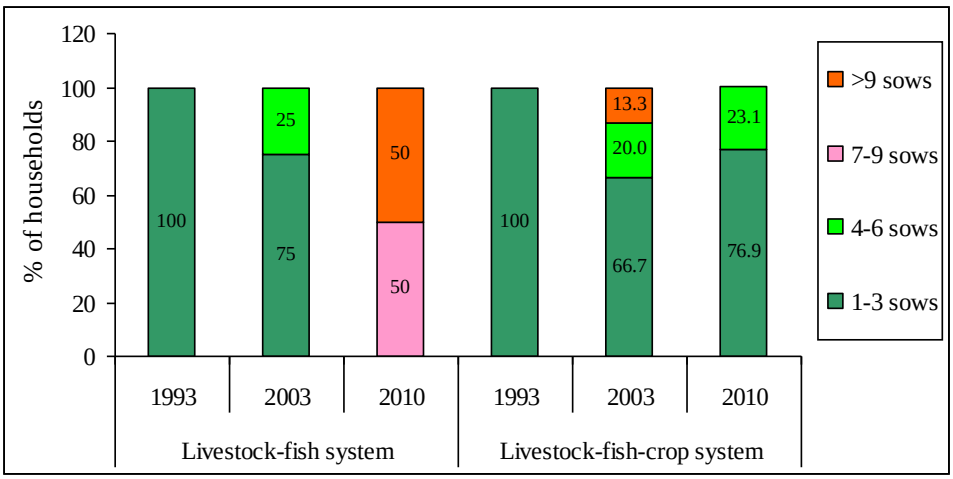


Figure 4.16. Distribution of frequency of households by the sow flock size (Source: Household surveys, 2010-2011)

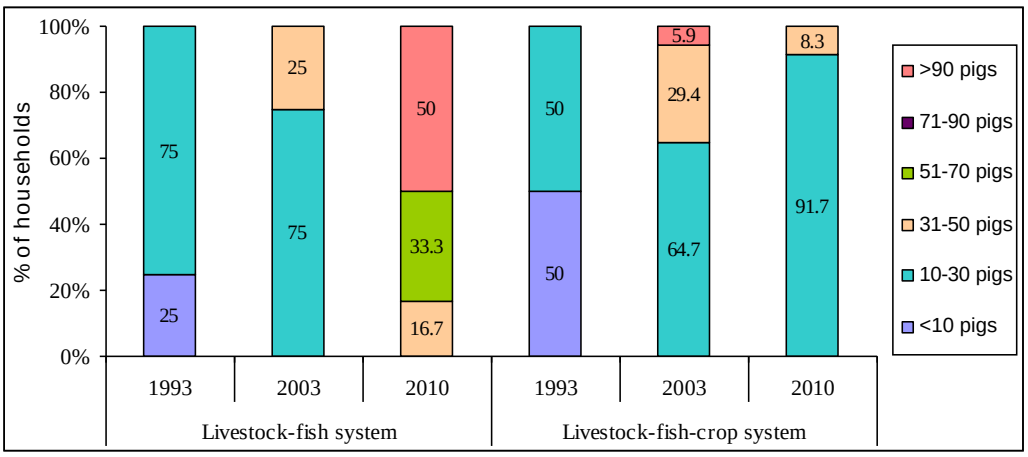


Figure 4.17. Distribution of frequency of households by the growing pig flock size (Source: Household surveys, 2010-2011)

4.2.4 Dynamics of the vegetable-based agrarian system in the middle zone in 1990s and 2000s

Vegetable crops are widely cultivated in the middle region of Hai Duong province, which has many advantageous conditions for this kind of crop. The province is known as one of the largest vegetable supplying centres in the Red river delta. A highly diversified variety of vegetable crops is planted here such as cabbage, kohlrabi, cauliflower, bean, etc. A huge amount of these kinds of vegetable are provided to both local and regional markets every year, not only in the North but also to the South of Vietnam. Over two last decades, the vegetable-based cropping system has evolved significantly as showed in figure 4.19.

4.2.4.1 The expansion of vegetable crop areas at the provincial level

As one of the main cash crops of the province, the cultivation of vegetable crops has been improved notably since recent years in Hai Duong. The cultivated area of vegetable varied dramatically among the geographical locations of this zone and across the years according to the changes in environmental contexts and market demands. In general, the planted areas of

almost vegetable crops strongly increased during the two last decades (1990s and 2000s) (figure 4.18).

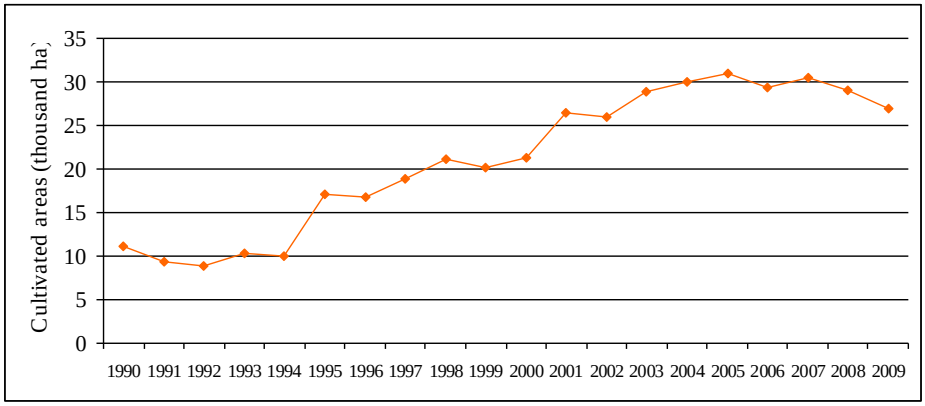


Figure 4.18. Evolution of vegetable cultivated areas in Hai Duong province (Source: (Hai Duong statistics Office, 1995,1998,2001,2006,2010)

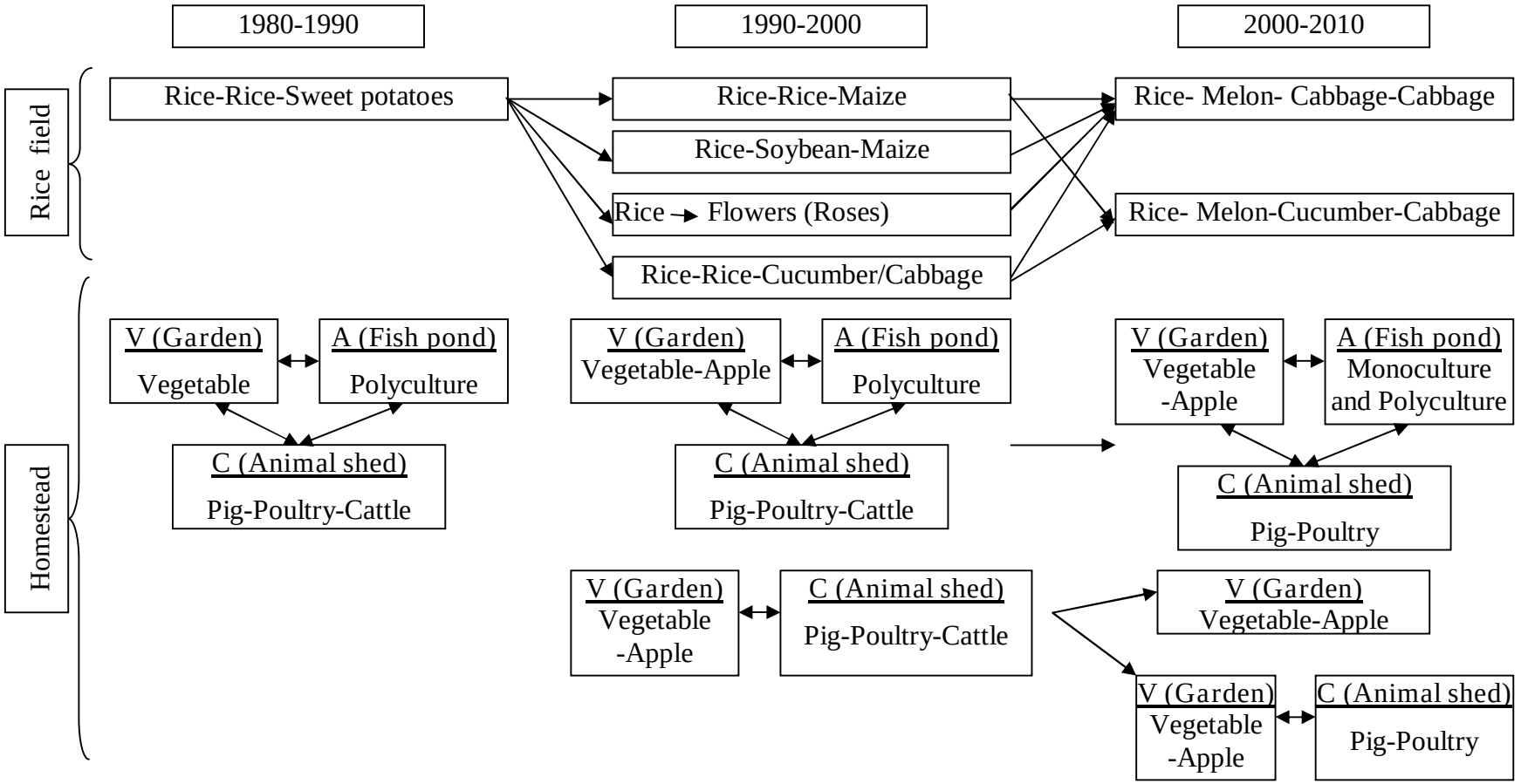


Figure 4.19. Dynamics of the vegetable-based cropping system in the middle zone of Hai Duong
(Source: Participatory discussions and personal observation, 2010-2011)

The expansion of the vegetable crops started in 1993-1995 when the rice land was redistributed to households for a long-term use. At that time, vegetables were mostly grown during the winter season with limited areas. The soybean and maize crops were planted in most land areas as the major source of animal feed. Then, the cultivated surfaces of vegetables increased rapidly. The annual growth rate of vegetable cultivated areas during the period of 1990-2000 was 3.3%, much higher than that of the following decade (2000-2009) (about 1.3%). This was because in 2000s, large areas of vegetable crops were withdrawn for the installation of industrial zones. Moreover, the more available off-farm jobs in 2000s attracted a huge number of vegetable growers. The total vegetable land areas have even slightly reduced since 2007 at the provincial level.

Vegetables were one of the most important winter crops of Hai Duong province, which has many advantages for the development of this crop. Large fertile fields with numerous rivers and canals streaming around created good conditions for the vegetable cultivation. Moreover, locating in the centre of the delta made it easier for farmers to market their products. Thus, vegetables have been cultivated for a long time in the province. However, in the past, vegetables were normally grown at home garden and mostly for family consumption. This crop production had been developed significantly since some certain products were exported some certain products to several Eastern European countries in 1980-1990. At that time, garlic, colza and cucumber crops were grown largely in the rice field for exporting. Farmers, therefore, had more experiences in the vegetable cultivation since then. Winter crops were expanded notably by diverse annual vegetable crops during that decade.

However, in 1991-1993, the production of some major vegetable crops, especially garlic, significantly decreased because of a strong price decline at Eastern European markets. It was a big challenge for vegetable growers in Hai Duong. Thus, cultivated areas of garlic crop were narrowed in some certain regions for the domestic consumption. It was also very difficult for farmers to find new exported markets because of less price competition than Chinese products (for example, garlic price in Nam Thanh district, Hai Duong province was 50% higher than that of China (Anh et al., 2000)). The garlic price depended strongly on the price in Chinese market. The price variation made it more vulnerable for farmers, and they stopped cultivating this crop. Most garlic areas were replaced by other vegetable crops like onion for domestic markets.

In general, the areas of vegetables were greatly expanded after 1993. The cultivated area of vegetable crops increased rapidly from 10.3 thousand ha in 1993 to 21.3 thousand ha in 2000, increased by 207.6%. This was much higher than the growth rate of vegetable and bean cultivated area of the Red river delta (from 475,000ha in 1993 to 662,000ha in 1999, corresponding to 139.4%. In the period 1990-2000, vegetable cultivated areas grew at a rate of 5% per year in the whole delta region (GSO, 2000, cited in International Food Policy Research Institute (2002). The increasing demand for fresh vegetable products around cities as well as domestic markets encouraged growers to develop diverse types of vegetable. Some specific vegetable fields, where the crop rotation practised well, were enlarged in certain regions along river branches. A great amount of different vegetable products such as cabbages, tomatoes, cauliflower, carrot, etc. was provided to local markets and other regional markets every year. Hai Duong province became a more and more important vegetable production centre of the Red river delta.

However, according to Dao The Tuan, 1995 (cited in Anh et al. (2000), the planted area of this crop depended highly on the variation of price in the market. The rich farmers, who accumulated well the financial capital, kept cultivated area stably across the year. For the poor, the decision on the production was made based on the price of products in the previous

year and the price of seeds in the market at the current time. Thus, there was a big variation of planted areas among vegetable crops across the time.

During the period of 2000-2010, vegetable crops have been grown largely due to the increasing demand of consumers in urban areas. Total vegetable areas have been expanded from 21.3 thousand ha in 2000 to 30.5 thousand ha in 2007 with diversified species such as cucumber, cabbage, cauliflower, etc. The extension to the markets in the central and southern regions of the country gave a great opportunity to enhance the vegetable crops. Thus, some large specialized vegetable fields were developed in some districts to provide vegetables to the surrounding regions and the southern markets with a huge and stable amount of vegetable. In these fields, farmers normally practise only one rice crop per year. Two or three winter crops will be rotated to increase the productive capacity of land. In some regions, rice fields were converted totally into specialized vegetable land areas where the production achieves a high level of intensification.

4.2.4.2 The expansion of vegetable crop areas at the district level

Gia Loc district is considered as an important centre and the origin of vegetable cultivation of Hai Duong province due to the largest planted areas and the highest number of vegetable growers in comparison with other districts. Over the last decade, the cultivation area of vegetable in the district has increased significantly and ranked the first of the province. In the period of 2000-2008, the land area of vegetables increased by 2,421ha of the whole district (Gia Loc's People Committee, 2009). Most of these areas were converted from the two rice crop land into one rice crop and one vegetable crop or three vegetable crops per year.

Similar to the development trend at the provincial level, the expansion of the cultivated area of vegetable crop in Gia Loc varied remarkably across the years. In the early year of 2000s, when the industrialization process was underdeveloped, the cultivated area of most vegetable crops had been improved rapidly over the years (figure 4.20). The total vegetable land area increased from 4,006ha in 2001 to 5,064ha in 2003, corresponding to 12.4% of growth rate. It included the expansion of most kinds of vegetables, especially cabbage, kohlrabi and watermelon (16.3%, 22.9% and 26.1% of growth rate, respectively).

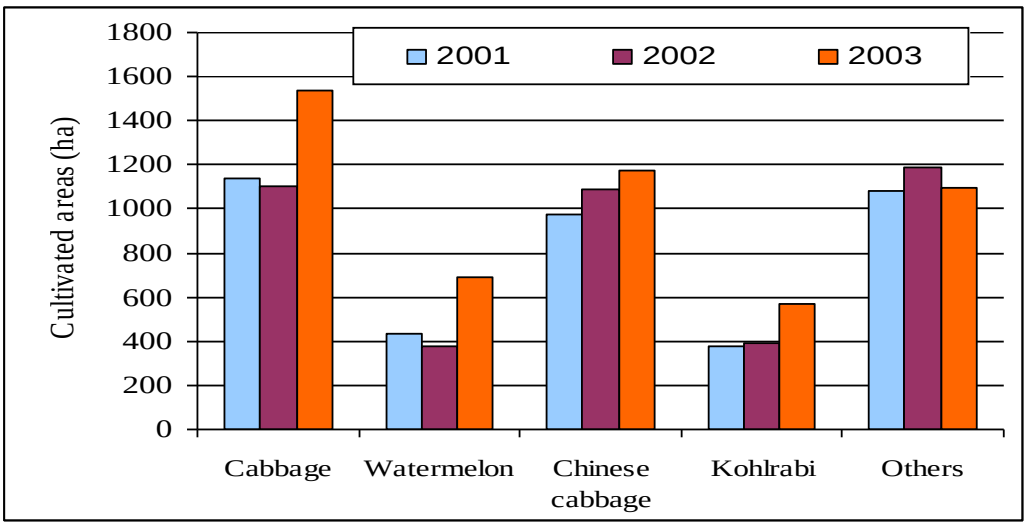


Figure 4.20. Evolution of cultivated areas of some vegetable crops in Gia Loc district in 2001-2003
(Source: (Gia Loc Department of Agriculture and Rural Development, 2004)

However, during the last few years of the decade, the cultivation area of most vegetable crops has slightly reduced across the time. The total surface of vegetable land has declined from 6,486ha in 2007 to 5,691ha in 2010, corresponding to 2.16% of decline rate (figure 4.21). The decrease came from the agricultural land transformation into non-agricultural purposes during the 2000s. From 2000 to 2008, a total of 1,126.45ha of rice land was switched to other kinds of land (Gia Loc's People Committee, 2009). This conversion had a strong impact on vegetable land area, especially in the region which was close to the centre town of the district or the provincial and national roads.

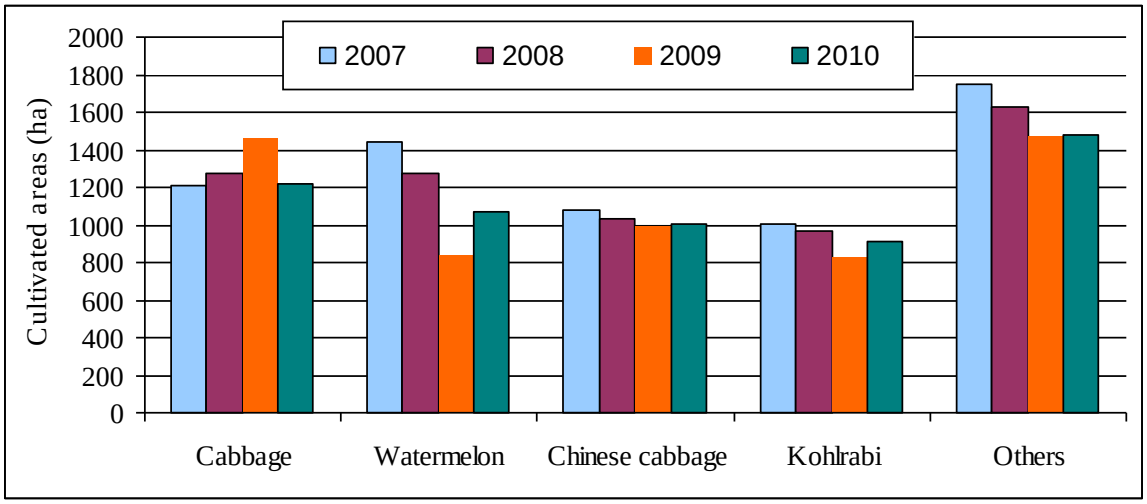


Figure 4.21. Evolution of cultivated areas of some vegetable crops
in Gia Loc district in 2007-2010
(Source:(GIa Loc Department of Agriculture and Rural Development, 2010)

Table 4.7. Change of vegetable and other agricultural land areas in Gia Loc district

Land types	2003		2010		Difference (2010/2003)
	Cultivated area (ha)	Proportion (%)	Cultivated area (ha)	Proportion (%)	
Total agricultural-fishery land	8,465.50	100	7,507.98	100	-957.55
1. Total agricultural land	7,496.74	88.6	6,275.11	83.6	-1,221.63
1.1 Annual crops	7,140.29	84.3	5,902.60	78.6	-1,237.69
1.1.1 Rice land	4,622.9	54.6	1,982.07	26.4	-2,640.83
1.1.2 Rice-vegetable land	2,482.65	29.3	3,423.23	45.6	+940.58
1.1.3 Vegetable land	34.74	0.4	497.3	6.6	+462.56
1.2 Perennial crops	356.45	4.2	372.51	5.0	+16.06
2. Fishery surfaces	968.76	11.4	1,232.87	16.4	+264.11

(Source: Gia Loc Department of Agriculture and Rural Development and Department of Nature and Environmental Resources, 2003, 2010, cited in (Man, 2004; Hang, 2011)

4.2.4.3 The increase of the rotation cycle of vegetable crops

Over the last three decades, the crop rotation has been changed considerably from the rice-based cropping cultivation to a vegetable-based culture. In 1980s, like many other regions of the province, two rice crops were cultivated during the spring and summer seasons. In winter, a sub-crop was developed gradually in a very limited land area, which has some advantages for the vegetable cultivation such as fertile soil, water supply availability, etc. During the year 1990s, the crop rotation was moved from the summer rice to the soybean cultivation. This change came from the increasing demand for animal feed during this time. In winter crop, farmers started to grow the early vegetable crop since October to sell their products at a higher price than the normal price of the main crops. Then, in some last years of the decade 2000s, when the vegetable demand of the local market increased rapidly, most of the farming households grew only one rice crop per year. They invested more in the vegetable cultivation by developing different crop varieties in each harvest.

Period	Months											
	1	2	3	4	5	6	7	8	9	10	11	12
1980s	Spring rice					Summer rice					Winter crop	
1990s	Spring rice					Soybean				Vegetable/maize		
2000s	Spring rice					Melon		Early Cabbage			Main Cabbage	

Figure 4.22 Changes of the crop calendar in Gia Xuyen commune
(Source: Participatory appraisals with chief of Agricultural Office of Gia Xuyen commune, 2010)

Photo 1. Expansion of vegetable in the winter crops in 1990s
(Source: (Hai Duong People's Committee, 2008)

4.2.4.4 Changes of farm size at the farm level

It is observed that the vegetable growers in both two cropping systems have expanded dramatically the cultivated land area since 1993 up to now. In 2010, the total vegetable land area of the households was nearly double as compared with that in 1993. This increase was not caused by the growth of the family size because the land area per capita increased significantly (table 4.8).

These increased areas mostly came from renting land. As the agricultural land was an important property of the farmers, most of them kept their land and rent it out if they could not continue farming. This informal renting contract varied strongly among farming households. Normally, they sign a short-term contract for 3 or 5 years. They may also rent land annually just for vegetable cultivation in the winter crop. They have to give the land plots back to the owners for the next rice crop. The renting price thus varied from not only the lease period but also the location of the land parcels. For instance, the average land renting price in 2010 in Gia Xuyen commune was 100kg rice per sao (360m^2) per year. This return may be received directly in terms of rice or indirectly by converting into cash at the present market price of rice.

Table 4.8. Changes of vegetable cultivated land areas of surveyed households

Periods	Vegetable cultivated areas	Cabbage-melon system (n=13)		Diversified vegetable system (n=17)	
		Mean	SD	Mean	SD
1993-1995	Total areas (m^2/household)	1,035.5	592.0	1,163.1	512.4
	Areas per capita (m^2/person)	384	-	360	-
Transforming period	Expanded areas (m^2/household)	931.8	726.3	960.9	375.7
2010	Total areas (m^2/household)	1,967.3	878.4	2,124.0	475.8
	Areas per capita (m^2/person)	565.2	303.1	490.6	98.9

(Source: Household surveys, 2010-2011)

These kinds of renting contract are very flexible and useful for both land owners and the tenants. The land owners, who were engaged in other production activities or were unable to work on farm, can keep their land while getting a stable return. On the other side, the land tenants who have limited agricultural land can access to land and increase their production scale.

Box 4.3. We have limited land areas and rent more land to develop the vegetable crops

My family has 4 members. However, my two children were not allocated land because they were born after 1993. We have only 2 sao of rice land. Unfortunately, a half of our land area (1 sao) was withdrawn for the industrial installation in 2004. Thus, we had to rent more land from the surroundings to develop the vegetable cultivation. Since 2005, we rent 5 sao of land from my neighbours and paid 150kg rice per sao annually. Now, we do not want to lease more land because my husband and I find off-farm jobs in the district town which provide us a higher and more stable income than that from agriculture.

(Source: Interview with Mrs. Nguyen Lam Hoa, 37 years old in Gia Xuyen commune in 2010)

However, the time of land renting of the households was not the similar among the regions and the production systems, depending strongly on the development of vegetable market channels, in particular, and the socio-economic conditions, in general. The farming households in the cabbage-melon cropping system began to expand their land areas earlier than those in the diversified cropping system. In the cabbage-melon cropping system, a high proportion of farms acquired more land plots during the period of 2001-2005 and 2006-2010 (47.1% and 41.2%, respectively) when the industrialization process was enhanced and accelerated in this region. Meanwhile, producers in the diversified cropping system mostly signed the land renting contract in 2006-2010 (61.5%) when many others leaved for urban locations to find non-agricultural activities (figure 4.23).

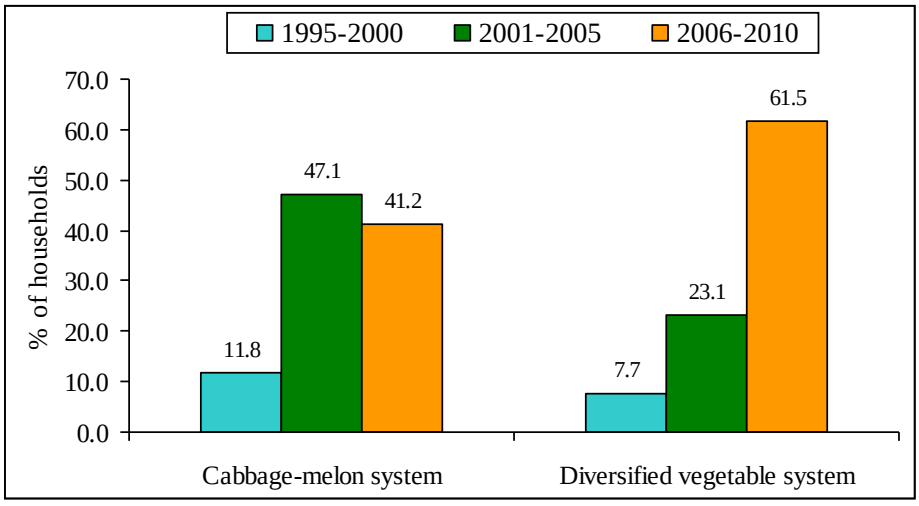


Figure 4.23. Distribution of frequency of household by the period of expanding vegetable crops
(Source: Household surveys, 2010-2011)

4.2.4.5. The small scale of livestock production of the households

Another change was also observed about the animal production among households in different vegetable cropping systems. In general, during the transforming years in early 2000s, most of the farms applied the integrated crop-animal production system. Farmers not only increased the animal flock size, but also practised diversified animal species at that time. Pigs were raised popularly by most farms. In 2003, for instance, the pig herd size and the proportion of households keeping pigs were higher than those of the previous time (1993) (table 4.9). However, most of them stop raising pigs and other animals (such as cattle or buffalo) because of low profit and serious threats from infectious epidemics.

Table 4.9. Evolution of the livestock herd size of pig production at surveyed households

Livestock herd size		Cabbage-melon system (n=17)			Diversified vegetable (n=13)		
		1993	2003	2010	1993	2003	2010
Sows	Head	1.0	1.9	1.7	1.0	1.1	1.3
	% HHs	5.9	47.1	17.6	15.4	84.6	23.1
Growing pigs	Head/cycle	8.3	29.2	36.7	12.0	13.6	10.0
	% HHs	17.6	35.3	17.6	7.7	69.2	23.1

(Source: Household surveys, 2010-2011)

4.2.5 Dynamics of the fruit-based agrarian system in the lower zone in 1990s and 2000s

4.2.5.1 Process of rice land conversion into litchi plantations

Entire conversion: The whole rice fields were completely transformed into litchi orchards

The whole conversion from rice fields into litchi orchards was a significant change of the agrarian landscape during 1990s. The soil layers were removed to form the land ridge and the indented area. Litchi trees were planted in these ridges while the indented holes played as the water borders. Thus, the relatively plain rice fields became the uneven territory due to this activity.

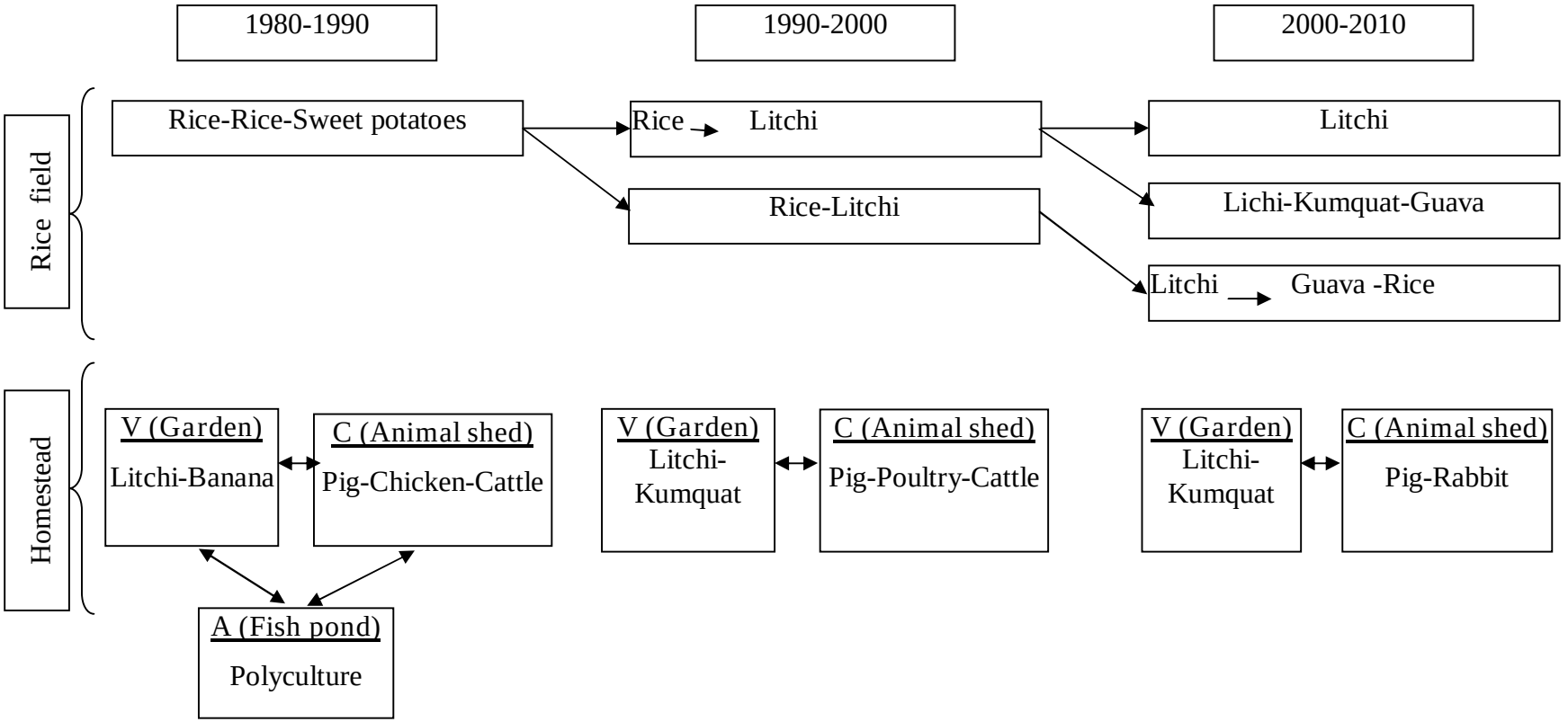


Figure 4.24. Dynamics of the fruit-based cropping system in the lower zone of Hai Duong
(Source: Participatory discussions and personal observation, 2010-2011)

The movement of the agrarian landscape was conducted by different steps during a long time. Firstly, to avoid the loss of fertile soil, the 20cm top layer was dug and loaded up at the corner of the field. Then, the subsoil layers were removed and filled the ridge up to 0.8 to 1m higher than the previous rice field level. The fertile soil was then spread evenly to the surfaces of these land ridges. According to Diepart (1999), to convert one sao ($360m^2$) of rice land, an approximation of $200m^3$ of soil was removed.

The construction of litchi orchards from rice field was actually a hard work which consumed a huge man power. To do so, most farming households not only used their family labours but also hired external waged workers. Because of manual works, it required a collective action of groups of labours. This worker group worked as a complete production line in which each member took responsibility for a specific activity, including soil digging, transportation, and filling the ridge up. Therefore, it took a long time to complete these tasks. For example, Diepart (1999) reported that, it took 3 to 4 days (9 hours/day) for a group of 8 workers to switch one sao of rice fields to the litchi garden.

Moreover, the litchi orchard installation was also a big investment. The price of waged labours varied dramatically from one region to another and increased rapidly across the years. The average price of waged labours at that time was about 4,000 dong to 5,000 dong/m^3 of removed soil. Thus, it cost nearly one million dong per sao to complete the converted model. Some other authors also calculated and reported the same cost of litchi garden installation. For instance, in Thanh Thuy commune (Thanh Ha district), labour expense of removing soil was one million dong per sao (Diepart, 1999; Loc, 1999). Another study at Thanh Thuy and Thanh Xa commune estimated that farmers had to invest 25.22 million dong to 27.3 million dong per hectare to complete the transformation (Loc, 1999). Thus, most of the farms could not afford to invest in the conversion by themselves. They accessed to the loan capital to cope with this difficulty.

Partly conversion: Litchi trees were grown around paddy rice parcels

This type of transformation was widely applied by the poor households who lack credit capital in the lowland areas. Therefore, they applied the mixed litchi-rice cropping system to ensure the food sufficiency and to earn more income from litchi after three to four years of investment. Now, this cropping system is the dominate model in the southern part of the district.

The conversion was gradually conducted by developing different soil mounds inside the rice field. The young litchi trees were grown in these mounds. In the surrounding areas, rice was continuously cultivated two crops per year. When the litchi was grown, the soil mound was regularly filled up with more soil to form a larger one. After several years (about three to five years), these soil mounds were connected to each other and shaped the ridge of litchi.

The cost of this kind of conversion was cheaper than that of the entire conversion. The soil mound was at a small size at primary stage when the litchi trees were very small. Thus, farmers did not invest much in waged labours. In estimation, Loc (1999) pointed out that the average cost of constructing this model was about 17.78 million dong per hectare (Loc, 1999).

Regarding the planting density, the interview with litchi growers in Thanh Son commune indicated that the average planting density of litchi trees of most farms was 6 trees per sao, similar to the reports of other authors. According to Diepart (1999) and Loc (1999), the planting density of litchi trees in Thanh Ha district varied from 6 to 7 trees per sao (or 167 to 194 trees per ha), depending on the planting models (litchi- rice and litchi-pond models, respectively). Hai and Dung (2002) also presented that the litchi planting density in Vietnam

increased from 150-200 trees/ha to 300-400 trees/ha due to the increase of production intensification.

Photo 2. Litchi cultivation in the rice field in 1990s
(Source: (Hai Duong People's Committee, 2008)

There were a wide range of litchi varieties planted in Thanh Ha district, Hai Duong province. However, these varieties have not classified scientifically. They were mostly identified by the appearance and morphology of the ripe fruits, especially their colours (Hai and Dung, 2002). According to Dinh et al. (2005), there were three types of litchi varieties in Thanh Ha district due to their ripening periods, including the early ripening variety (namely U Tham, U Hong, Tu hu, as local name), the medium ripening variety (such as Tau lai, Ma quan tai), and the late ripening variety (the Thieu litchi). The Thieu litchi was the most important varieties, whose areas accounted for more than 75% of total litchi areas of the district (Ton et al., 2006).

4.2.5.2 The rapid increase of litchi cultivation area at the beginning stage of the conversion

At the beginning stage of the conversion process, the cultivation area of litchi increased considerably. Before 1993, the litchi area was very limited, mostly grown in the home gardens for household consumption. Then, due to the rice land transformation project, a number of farming households in almost communes of the district implemented the conversion. Therefore, the cultivation area of litchi was improved significantly. According to the Thanh Ha statistic office, the litchi area of the district was expanded from 241 ha before 1993 to 1,744ha in the period of 1993-1996. There were 17,559 households at 96% of the total number of communes in the district developing litchi orchards during 1993-1996, much higher than those before 1993 (3,433 households at 40% of total communes) (cited in (Anh et al., 2000).

The cultivation surface of litchi was progressively expanded during the period of 1997-2004 but with a less growth rate than that in the previous time. At the whole province, the litchi area increased from 4,485ha in 1997 to 12.6 thousand ha in 2004 because of the rapid increase in not only Thanh Ha district but also others such as Chi Linh district. In Thanh Ha, the litchi area was enlarged from 2,570ha in 1997 to 5,470ha in 2004 (figure 4.25). Meanwhile, in Chi Linh, the litchi area grew from 3,080ha in 2002 to 6,011ha in 2004 (Dieu, 2006). The

excessive development of litchi cultivation not only in Hai Duong province but also in other regions in Vietnam was considered as one of the most important reasons for the serious reduction of the litchi price afterwards.

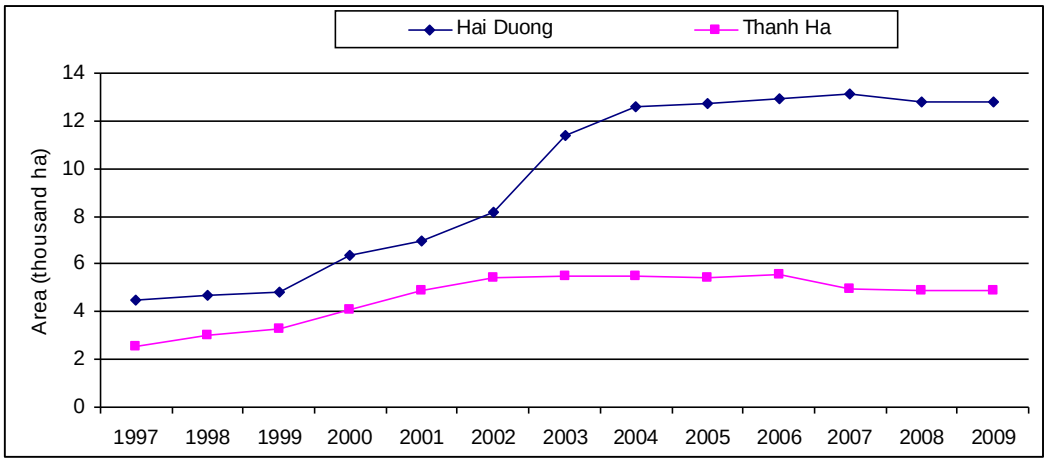


Figure 4.25. Evolution of litchi cultivation area in Hai Duong province and Thanh Ha district (Source: (Hai Duong Statistics Office, 2001,2006,2010)

Consequently, the cultivation area of litchi has not increased since 2004 because of its low price. At both province and district levels, the planted areas of litchi were maintained at a stable level, about 12.8 thousand ha of the whole province and 5.5 thousand ha of Thanh Ha district (figure 4.25). However, it seems to be difficult to keep this litchi area stably because of its degradation. The replacement by other fruit plantations is thus an inevitable process.

4.2.5.3 The gradual transformation from litchi to other fruit orchards at the last stage of the conversion

The movement from litchi to guava trees in Lien Mac commune and other communes

Although litchi was the main fruit crop of most households at the beginning period of the crop conversion program in Thanh Ha district, other fruit varieties such as guava, kumquat, etc. were also grown among litchi trees as the crop succession. Like the litchi, guava and kumquat were planted in the home gardens of the family long time ago for household consumption. In 1993, when the transformation program was conducted, these plants were also grown in the litchi orchards as the secondary fruit crop. Their contribution to the household income was very limited because of low productivity and low price at that time.

The movement from the litchi to guava and kumquat plantations was a gradual progress. This change was reinforced by a long degradation of litchi price and an attractive force of increasing price of guava and kumquat. During the period of 1996-2000, when the litchi price started to decrease, households in Lien Mac and some other communes cut down partly their litchi gardens and developed the guava or kumquat crop. The new guava variety was introduced by the Field Crop Research Institute (in Gia Loc, Hai Duong). This variety has a special taste that is very different from others, and it is therefore, preferable to most people. The cultivated area of guava increased progressively afterwards. It is estimated that in 2001-2002, about two third of litchi gardens were cut down and replaced by guava trees. Now, this process is still in progress when some households continue buying more litchi orchards and switching to guava plantations.

Unlike Lien Mac commune, the fruit tree transformation in Thanh Son commune, which was known as the origin of Thieu litchi, occurred slowly and lately. The kumquat was planted in the home garden of the family long time ago. During the beginning stage of litchi development, this crop was also grown among the distance of the litchi trees. However, this crop contributed little to the household income because of low productivity. The rapid development of litchi trees afterwards caused the low competition of solar energy of the kumquat, leading to the low productivity in each harvest.

Photo 3. Cutting down the litchi trees
(at Lien Mac commune, 12/5/2010)

Photo 4. Growing guava trees in the litchi gardens
(At Thanh Son commune, 23/3/2012)

The considerable transformation from litchi to kumquat was carried out in 2004 when several events happened. Firstly, this was the lowest point of litchi price falling (the lowest price at the middle of the harvest season was 1.700 dong/kg (Ton et al., 2006). Secondly, a large area

of litchi orchards was died of the extreme flood in 2004. In estimation, about 30ha of litchi trees in the lowland region was damaged at that time. Therefore, many households had to cut down the litchi and grew kumquat as the major fruit crop. Since then, the price of kumquat increased considerably. That was an important incentive for farmers to continuously convert their litchi gardens into kumquat and other fruit plantations.

4.2.5.4 The change of rice and fruit cultivation at the farm level

The sudden decline of rice cultivation

The significant change occurred in 1993 when most households in Thanh Son commune implemented the entire land conversion from rice into litchi. At that time, 100% of rice land areas were switched to litchi orchards. Since then, all households in the litchi-livestock system and the litchi-kumquat-guava system in Thanh Son had no paddy rice supply. Thus, they had to buy rice every year for daily consumption. In Lien Mac commune, where was dominated by the guava cropping system, a certain area of rice crops was sustained for food self-sufficiency. However, this area was very limited. Therefore, each household just has a small plot of rice, about 459m^2 per household on average. Furthermore, not all farming households have the rice field at the current time (only 62.5% of total households in the guava system). Many of them have to rent more land from the surroundings to cultivate rice (37.5% of total household's rent land, figure 4.25). Obviously, keeping a stable rice area is of great importance for the food security of farming households, especially in case of increasing price of rice in the market.

Table 4.10. Evolution of rice and fruit land areas of surveyed households

Period	Cultivated areas (m^2)	Guava system (n=8)	Litchi-livestock system (n=8)	Litchi-Kumquat-Guava system (n=10)
1993	Rice	2,227.5	1,980	1,836
2010	Rice	495	0	0
	Litchi	225	3,750	1,314
	Guava	2,691	210	630
	Kumquat	0	0	1,746
	Total	3,411	3,960	3,690
Difference	Total difference	1,183.5	1,980	1,854
	Bought	823.5	1,950	1,800
	Inherit	90	30	54
	Rent	270	0	0

(Source: Household surveys, 2010-2011)

The development of perennial fruit plantations

Over the last few years, there has been a rapid expansion of fruit orchards in the study site. As soon as the land law, which provides farmers with all basic rights over their land, was issued in 1993, most farmers converted completely their rice fields into litchi plantations during the period of 1993-1995. Since then, the strategy of major producers was to access to more land surfaces to develop fruit cultivation. As a result, their farm size in 2010 was 1.5 to 2 times higher than that in 1993 (table 4.10). In the litchi-livestock production system, most of the households still kept their litchi gardens because they invested more in the livestock

production. However, in two other cropping systems, litchi trees have been cut down partly and switched to guava and kumquat plantations.

The increase of fruit land mainly came from the buying land process of the households. The high profitability of litchi in 1990s made it more affordable for litchi growers to buy land plots from other households not only in Thanh Ha district but also in other districts of Hai Duong province and other regions far away from their houses in the mountainous regions such as Quang Ninh, Bac Giang, Thai Nguyen, etc. Because of long-term investment in perennial fruit orchards, farmers preferred buying land to renting it. The percentage of households bought land was about 66.7% to 80%, much higher than that of renting land (figure 4.26). The excessive development of litchi production was the main reason for the price decline afterwards.

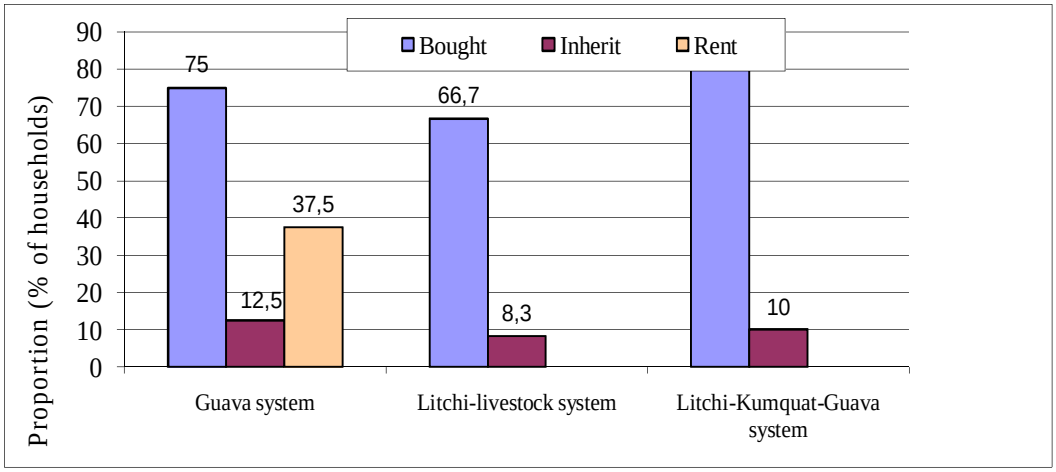


Figure 4.26. Distribution of frequency of households by their land acquisition (Source: Household surveys, 2010-2011)

Regarding the main period of buying more land, there was a remarkable variation among households in different regions. The time division was conducted according to the notable change in socio-economic environments of the region for a better understanding of the adaptive strategy of different farmer groups. The majority of litchi producers in the litchi-livestock production system accessed to the land market earliest, right after the approval of land law (1990-1995) (figure 4.27). These farm holdings were in Thanh Son commune, where litchi trees were grown long time ago in the home gardens. The better experience in litchi cultivation and high profit gained from litchi in 1993-1994 strongly encouraged them to buy more land soon. In two other systems, the main period of buying land was in 1996-2000 (the guava cropping system) and in 2006-2010 (litchi-kumquat-guava system) because these periods were the time when the price of litchi started to decrease and there was a rapid increase of price of other fruits (guava and kumquat). Obviously, the expansion of different fruit crops was strongly related to the variation of their prices in the market. However, the extreme fluctuation of the fruit market caused less economic efficiency of the investment of the farmers because of the long cycle production of perennial fruit orchards. Stabilization of the fruit market was thus of great importance of rural economic development policy.

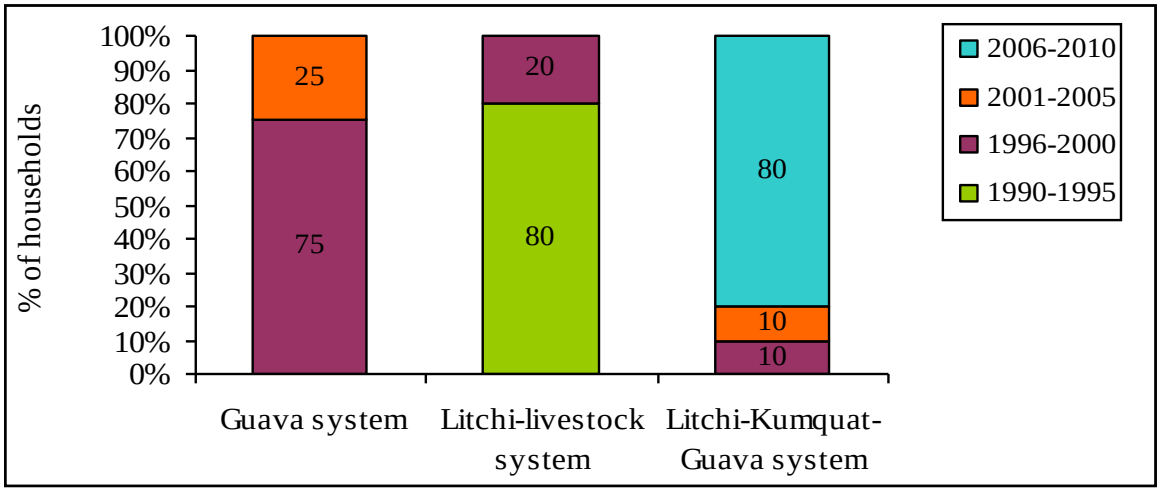


Figure 4.27. Distribution of frequency of households by the period of land acquisition (Source: Household surveys, 2010-2011)

4.2.5.5 The slow development of livestock production of surveyed households

Although the fruit cultivation was the main income source of farm holdings in this region, the livestock production was also employed by some farms, especially in the litchi-livestock production system. Pigs were the most popular species raised by farming households with the small to medium scale. The variation of pig flock size of households in different production systems was examined and showed in table 4.11.

Table 4.11. Evolution of the livestock herd size of surveyed households

Livestock herds		Guava system (n=8)			Litchi-livestock system (n=8)			Litchi-Kumquat-Guava system (n=10)		
		1993	2003	2010	1993	2003	2010	1993	2003	2010
Sows	Head	0.4	1.3	0.5	0.6	3.9	1.8	0.4	1.2	0.5
	% HHs	25	75	37.5	62.5	75	62.5	30.0	70.0	20.0
Growing pigs	Head/cycle	3.8	13.1	5.0	11.5	48.1	66.3	3.5	19.5	4.0
	% HHs	50	87.5	37.5	87.5	100	100	50.0	80.0	10.0

(Source: Household surveys, 2010-2011)

In general, the pig production increased slightly in the period of 1993- 2003, but there was a rapid decline in 2003-2010. In 1993, there was a limited number of households keeping pig flocks due to the lack of capital as well as the grain feed when rice and other annual crops were replaced by perennial plantations. The pig herd size was also small at that time. Then, in 2003, when the litchi production declined extremely, many litchi growers invested more in

the pig production by increasing the flock size. Some households had to cut several litchi trees in the home gardens to construct animal buildings. Both the pig population and the number of farm holders were higher than those in the previous time.

However, the farm holders faced a big difficulty of developing pig production afterwards. The repeated outbreak of different infectious epidemics in pigs caused a huge lost of numerous producers, especially the inexperienced ones. The rapid increase of animal feed price in some last years made it more difficult for them to improve the pig production. Therefore, most households kept the small or medium production scale. The proportion of the farms being engaged in the pig production now is also very low, except in the litchi-livestock production system. Developing the diversified fruit plantation which has a more stable added-value than that of the livestock production is the main strategy of many households in Thanh Ha district at the moment.

4.2.5.6 The consequences of the excessive expansion of litchi plantations

After 1993, when farmers had rights of long-term use over their land, the conversion progress from rice land into litchi areas was implemented rapidly in Thanh Ha district, other districts of Hai Duong province, as well as other provinces. Most of the farm households practised the conversion in the period 1993-1996. For example, in Thanh Ha district (table 4.12), the converted area in this period was 1,744ha, equals to 7.2 times higher than that before 1993. There were 17,559 households in most communes (96%) conducted the conversion program, 5.1 times higher than that of previous years (Anh et al., 2000). At the end of 1997, the total litchi areas of Thanh Ha were 2,040ha, accounting for a half of litchi areas of the whole province. In the period 1997-2000, this crop area continuously increased up to 4,100ha in 2000, accounting for more than 60% of total agricultural land areas of Thanh Ha district. It became the most important income source of most farm households in the region.

Table 4.12. The rice land conversion into the litchi garden in Thanh Ha district, Hai Duong province

Indicators	Before 1993	1993-1996	Difference (times)
Area (ha)	241	1,744	7.2
No of households converted land	3,433	17,559	5.1
Converted areas of each household (m2)	700.7	993.2	1.4
Percentage of communes converted land (%)	40	96	-

(Source: Thanh Ha statistic office, 1998, cited in (Anh et al., 2000)

Litchi gardens have been also well developed in Chi Linh district, Hai Duong province and other provinces in the North Vietnam such as Bac Giang, Quang Ninh, etc. during this period. Most of these provinces were mountainous regions where land areas were much larger than the low land area in Thanh Ha district. It resulted in a rapid development of litchi in the Red river delta particularly and the North region of Vietnam generally. According to International Food Policy Research Institute (2002), litchi, together with longan and rambuttan, was one of the largest and fastest-growing fruit sectors in 1990s in the North Vietnam, especially since 1994. The planted area of these fruits has grown four fold or 37% per year during 1990-1999.

In Hai Duong, litchi gardens have been developed rapidly in the decade 1990s and several early years of the last decade. In the previous time, the increase of litchi price was a great

incentive for farmers to convert rice land areas into litchi gardens. They were enlarged not only in the lowland areas but also in many mountainous regions of the province and other locations in the north of Vietnam. Figure 4.25 shows an increase of litchi land areas from 6,400ha in 2000 to 12,600ha in 2004 at the whole province. However, these increased areas were mostly in mountainous parts of the province. In Thanh Ha district, the original land of litchi, its areas have been expanded slightly from 4,100ha in 2000 to 5,600ha in 2003 (Hai Duong Statistics Office, 2001,2006).

Figure 4.28. Evolution of the yield and price of litchi in Hai Duong province
Source: (Hai Duong statistics Office, 1995,1998,2001)

The rapid and unplanned development of litchi gardens caused the significant reduction of its price and the change of this cropping pattern. The average fresh litchi price in Thanh Ha market has decreased from 15,000 VND/kg in 1995 to 3,500 VND/kg in 2003 and 2,500 VND/kg in 2004 (Dinh et al., 2005). Moreover, its productivity varied strongly across the years (figure 4.28). Thus, litchi growers failed a lot even though the productivity and yield achieved a high level. To adapt to this downward trend, diversification of perennial fruit trees has been implemented by many producers. Guava, kumquat, banana, etc., were grown to substitute for litchi in some gardens of Thanh Ha district. In some rice fields, where litchi was planted by heaping soil, farmers reconverted into the rice cultivation. However, the diversification or conversion from litchi into other crops faced various obstacles and stayed at a slow movement. An enormous number of farm households stopped growing litchi and searched for non-farm jobs outside the villages. There has been a downward trend in the litchi cultivation recently in Thanh Ha district.

4.2.6 The results of the agrarian system transformation in 1990s and 2000s

4.2.6.1 The increase of household income

With the great attempt of the province and the state through a number of socio-economic development policies and programs, the rural economy of Hai Duong has improved significantly over the period 1990-2000. The total GDP grew at a rate of 8.6% per year during

the period 1996-2000. Farm households have diverse income sources due to the diversification of agricultural production and the development of non-farm activities. The conversion of rice land into other crops and animal production resulted in a higher economic efficiency than that of rice cultivation. Thus, agriculture remained the major income source of most farm households. The contribution of non-farm jobs to the household income was still modest. In the Red river delta, the evolution of income per head per month was over 172% in 1994-1994 (GSO, 2000, cited in (Anh, 2003). In the period 1993-1998, the contribution of agriculture in the evolution of household income was greater (about 61%) than that of off-farm jobs (about 21%) (Anh, 2003).

The development of fish ponds and animal sheds resulted in a higher income for farmers. The price of fishes was much higher than that of rice at that time. For instance, in 1993, the price of fish was about 10,000 dong/kg on average, while rice price was 5,000 dong/kg, equals to two times. In estimation, the gross product of fish and animal production in the converted area was about 30.5 million dong/ha, much higher than that from rice cultivation (Cam Hoang's People Committee, 2005). As a result, the combination of fish ponds, animal husbandry and crop cultivation contributed greatly to the total revenue of the farming families. According to Ton (2003), the share of VAC revenue in the total household revenue of the poor, medium and rich farms were 17.65%, 34% and 34.77%, respectively. This was an important income source for farmers that helped to alleviate the poverty rate of the region during these years.

4.2.6.2 Job generating for rural labours in 1990s

The development of fish ponds and animal husbandry was considered as the most important ways to solve the high unemployment rate in rural areas in this region at that time (Cam Hoang's People Committee, 2005). In the previous years, when the monoculture rice-based system was the dominant model, a number of rural agricultural labours were unemployed during the post-harvest period. This was also a crisis time of the year when they had no works to do and could not earn any income while spending enormous money and consuming food for daily life. Thus, the diversification of the agricultural production system by switching rice fields to fish ponds and animal buildings generated numerous jobs as well as income for rural labours. Farmers not only worked on their own farms but also found more off-farm jobs in surrounding regions in free time such as digging and building fish ponds, setting up a new private enterprise as a fish trader or as a group of fishermen.

4.2.6.3 The improvement of the household living condition

The living standard in rural areas has been improved notably across ten years of 1990s. Farm households can afford to build new houses and modern furniture such as televisions, motorbikes, etc. In estimation, the number of household had new houses increased from 88% in 1997 to 98% in 2000. The number of households had access to sanitary pure water increased from 50% in 1997 to 63% in 2000. In 2000, nearly 99% of households had access to public electricity (Committee of Hai Duong's Communist party, 2010). The education and health care systems were improved better than those in the previous years. Rural life has been therefore changed significantly towards a wealthier society.

V. FACTORS CONDITIONING THE DYNAMICS OF AGRARIAN SYSTEMS

5.1 The high productivity of rice production and the food sufficiency since 1993

The land reform due to the resolution 10 and land law 1993 was a great encouragement for farmers to intensify the rice cultivation. Farmers applied more improved rice varieties that have a higher productivity and a shorter life cycle than those of the local genotypes. Some of the varieties such as Bay que, Cham den, Que trieu, Lun 32, etc. were imported directly from foreign countries like China or Philippines. Many others like DT10, Q2, Q4, Xi23, X21, etc. were created and introduced by several scientific institutes and universities like Vietnam Academic Institute of Agricultural Science, Agricultural Genetics Institute, Crop Research Institute, etc. Besides that, some modern techniques of rice production were also transferred to farmers by agricultural extension offices. For example, the technique of young rice plant transplanting and the technique of direct rice seeding, etc. were applied by a number of farmers. The synthesis inputs such as fertilizers, pesticides, etc. were also used more popularly. Therefore, the rice productivity was increased significantly in this period. In the whole province, the rice productivity rose from 4,670 kg/ha in 1993 to 5,130 kg/ha in 1996 and 5580 kg in 2000. Some districts even achieved a higher productivity than the average of province. In Gia Loc district, improved rice varieties were introduced in 1992 and the rice productivity gained 8 tons per ha. In 1993, it increased by 10 tons per ha, much higher than that of other regions (Gia Loc's Communist Party, 2005). In Thanh Ha and Cam Giang district, they reached 10 and 10.6 ton per ha in 1995, respectively (Cam Giang's People Committee, 2000; Thanh Ha's Communist Party, 2004).

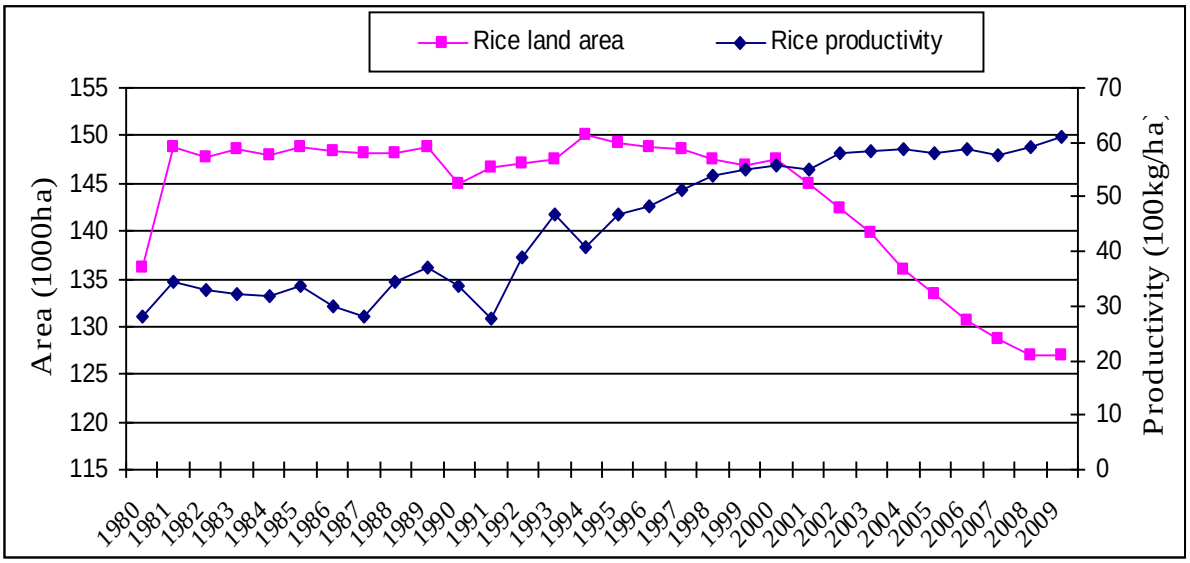


Figure 4.29. Evolution of the rice land area and productivity in Hai Duong
(Source: (Hai Hung Statistics Office, 1986,1990; Hai Duong statistics Office, 1995; Hai Hung Statistics Office, 1996; Hai Duong Statistics Office, 1998,2001,2006,2010)

In the whole province, the food production achieved the great results. The food security was fundamentally ensured since 1993 and the food yield increased steadily onwards from 415.9kg per capita in 1992 to 509kg per capita in 2000 (figure 4.30), far higher than the safe

threshold and than those of the whole nation (from 303 kg in 1990 to 444 kg in 2000 (The Socialist Republic of Vietnam, 2004). The improvement of not only rice production but also diversified winter crops resulted in the rapid increase of total food yield.

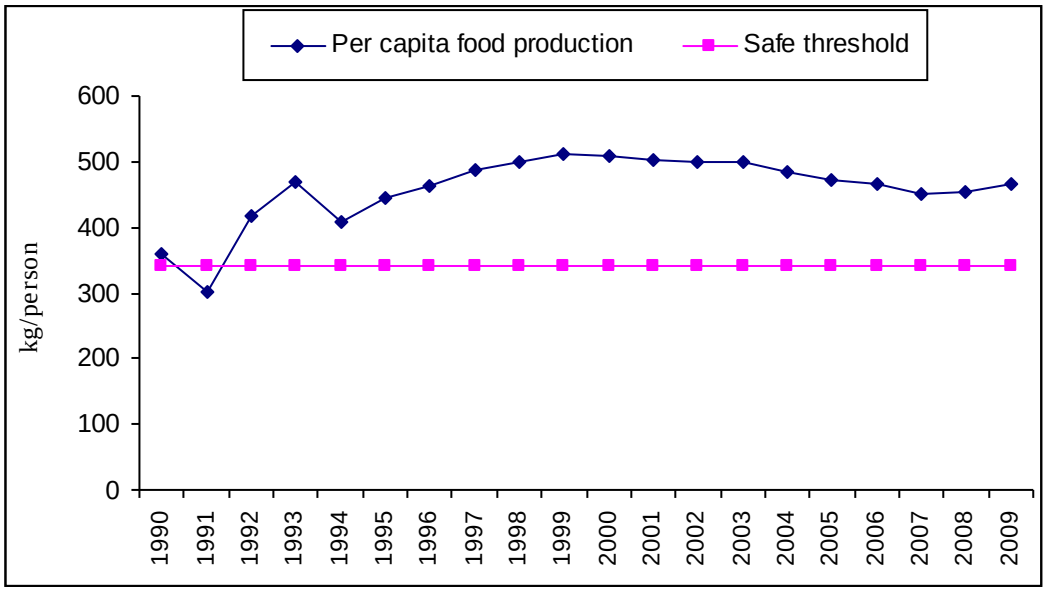


Figure 4.30. Evolution of per capita food production in Hai Duong
(Source : (Committee of Hai Duong's Communist party, 2010)

The increase of rice productivity during this period was the main force for the diversification of agricultural production. Farmers aimed not only to produce enough rice for the basic food demand but also to earn more income. Thus, when the rice yield was surplus, farmers invested more in other crops and animal production. Although the rice crop appeared to be the major crop, it did not provide enough income for households because of rice price reduction since 1997 (Anh et al., 2000). Thus, they had to diversify the agricultural production by developing winter crops, fruit gardens or livestock and aquaculture production. Large areas of rice fields were converted into fish ponds and animal buildings due to the high profitability of fish and animal production.

5.2. The high profitability of litchi, vegetable, fish and animal production during 1990s

In the decade of 1980s, most of the farming households lived under the poverty line with a very low income. The bad spoils from the war and the inappropriate production management of the collective agriculture in the last stage limited the ability of income generation of the households. The food security was not ensured for a long time. The living standard was also at a very low level. Thus, the diversification of income sources by developing different production activities was the most important livelihood strategy of the farm holders.

Furthermore, farmers gave the priority to the diversification of alternative agricultural production activities rather than rice monoculture because of low price of rice. Since 1993, the rice price in the Red river delta region has decreased steadily in line with the decline of the international market (Anh et al., 2000).

The efficiency of the integrated animal-fish-crop production system

Most of the farm which applied the integrated animal-fish-crop production system gained a higher profit than that from the traditional rice-based model in 1990s and early 2000s. The efficient utilization of animal wastes and crop residuals among system elements resulted in a low production cost. The high yield of maize and soybean produced on-farm contributed a significant amount of feed for livestocks and fishes. The animal waste was mostly used for fish ponds and crop cultivation as the important source of nutrition, saving a lot of purchased inputs. Moreover, many households used the by-products of the food processing activities such as noodle making, tofu producing, etc., as a supplement feed for animals. Therefore, many farm holdings earned a high income and saved it for the reinvestment.

The high price of litchi in 1990s

The increasing price of litchi in early 1990s was a great encouragement for farmers to expand this crop. On average, the price of fresh litchi was about 13,000 to 14,000VND/kg and the price of dried products was 80,000 VND/kg in 1993, much higher than the rice price. In comparison with the rice production in the same land area, the litchi cultivation had 6.3 times higher of economic efficiency if the input investment was 4.5 times higher in the first year of plantation (Du Van Chau, 1995, cited in (Anh et al., 2000). Therefore, several low rice land areas in Thanh Ha district were converted into litchi gardens as a practical experiment model due to the project implemented by the district before 1993.

The high added-value of vegetable

Over the last decade, the cultivation of vegetable in Gia Loc district has been improved well thanks to the higher added-value of vegetable than that of rice. The high added-value of vegetable production came from the high productivity per land unit. For example, the productivity of cabbage in early crop is 35 to 40 tons/ha, much higher than that of rice (about 6 to 8 tons/ha), while the price of cabbage and rice is not significant different (about 4,000 to 5,000 dong/kg). Meanwhile, the intermediate cost of vegetable cultivation is little higher than that of rice, leading to the higher added-value of vegetable than that of rice.

The high productivity of vegetable is also achieved by the great rotation and succession of different vegetable varieties. Normally, most of the vegetable crops have been short growing cycles than rice. Thus, producers can improve the yield per unit of land area by practicing more than three harvests per year.

5.3 The land reform

Like the whole country, the socio-economic situation of Hai Duong province during the period of 1990-1995 was so difficult after a long time of cooperative production and central planning economy. Although in 1986-1988, the government implemented the Resolution No 10 as well as the reform policy which greatly encouraged producers to develop the agricultural production, a number of issues relating to the land tenure system and other production facilities were emerged and required to be revised.

5.3.1 The land law in 1993 and its revised version in 1998, 2001, 2003

For the land issue, although land was distributed to farmers for a long-term use throughout Resolution 10 in 1998, the land assignment and inheritance rights was not supported by law yet (Nakachi, 2001, cited in (MacAulay et al., 2006). The objective of 1993 Land Law was to give farmers a better security of land tenure by allocating a given area of agricultural land to

them for a stable and long-term use and issuing the land use certificate. Land was granted for 20 years for annually cropped land and aquaculture surfaces and 50 years for perennially cropped land. Farmers also have five main rights over their land, including the right of transfer, exchange, lease, inheritance and mortgage. The maximum of land area that could be allocated to each household varied between types of land. It was 2 hectares in the central and north provinces and 3 hectares in the southern provinces for annually cropped land. For land planted to perennial crops, the amount was higher and depending on the terrain of the region, about 10 hectares in communes with plain fields and 30 hectares in hilly or mountainous communes (Ministry of Agriculture and Rural Development, 2000 cited in (MacAulay et al., 2006).

In Hai Duong province, the land reform policy was early introduced in 1992 through the resolution 03-NQ/TU issued by the Provincial People's Committee. It was a great encouragement for farmers to invest much more in the agricultural production for a long-term use. Farmers were ready to invest more in their land without any care about the change of the land system. Farmers also had sufficient rights over their land so that they can make decisions independently of what and how to cultivate on their land areas. That is the most important condition for the diversification of farming systems of most households.

However, due to this law, the duration of land allocation was still short and did not make farmers more interested in long-term investments rather than the short-term investment in agriculture. Moreover, the land use was not actually flexible, especially in the rice land area where farmers had difficulty in converting into other crops. Therefore, this land law was continuously revised in 1998, 2001 and 2003. In 1998, two additional land use rights were assigned to farmers, consisting of the right to re-lease land and the right to use the value of land use right as joint venture capital for investment. The revised version land law in 2001 assigned the farmers' right to give the land to their relatives, friends or others as a gift. For the duration and limitation area of agricultural land allocation, there is no change in the New 2003 Land Law.

5.3.2 The program of land consolidation and land conversion

The fragmentation of agricultural land was very common in Vietnam and mainly caused by the equitable allocation process (Research Institute of Agricultural Planning, 2004, cited in (Hung et al., 2006)) and by the failure of land market under the government regulations on land transaction (Bentley, 1987; Blarel et al., 1992, cited in (Hung et al., 2006). The situation was defined by a huge number of small land plots owned by individuals. In estimation, total land plots of the whole nation were 75 millions, and each farm family owned 7 to 8 parcels on average (Hung et al., 2006). In the Red river delta, this number varied from region to region, accounting for an average of 8 to 9 non-contiguous plots due to the report of World Bank in 1998 cited in (Marsh et al., 2006) or 7 parcels due to the data of Land Management Office in 1998 (Land, 2001, cited in (Hung et al., 2006). Similarly, the agricultural land in Hai Duong remained a high level of fragmentation in late decade 1990s. A survey conducted at 2,500 households in 10 communes of 8 different districts in 1998-1999 showed that each family had an average of 10.3 land parcels, and some owned a maximum of 17 ones. Most of these plots, about 92%, were small scale (less than 400m^2). Therefore, nearly all farm households (about 2,300 farms or 92%) desired to exchange and consolidate their land. There were 73% of total investigated families who wanted to have 3 to 5 land plots. Only 27% of households required 1 to 2 parcels (Cat, 1998). It means that farmers do not want too few numbers of land plots which seems to be difficult for them to diversify their crops and to reduce risks.

In the context of commercialization of agricultural production in the decade 2000s, it is necessary to consolidate fragmented land plots to form a larger one. The land consolidation helps to reduce a lot of production cost, border land losses, neighbour disputes and limitation of technical applications. Thus, in 1998, a policy of promoting land exchanges among farms was issued by the government and implemented at about 700 communes in 20 provinces. However, the implementing process still remained slowly (Hung et al., 2006). A number constraint emerged during this process because of diversity of farmers' production objectives and the difficulty in choosing appropriate methods.

In Hai Duong province, based on the voluntary and public principles, the land consolidation program was, firstly, examined in some certain communes due to the directive No 392/2002 QĐ-UBND of Hai Duong People Committee. Different procedures were introduced according to specific circumstances of each region and each community. Three main methods applied in Hai Duong were reported by a scientific project of the provincial economic department (Cat, 1998). They were land area balance, agricultural land use tax balance and land reallocation. According to the balance method, a certain ratio of area or tax will be calculated among fields that have different levels of fertility and geographical locations. Then, if farmers received a better land plot, the total actual land areas would be less than those in the past, or they have to pay more taxes. The surplus areas or taxes would be supplemented to households who got worse areas. Due to the reallocation method, rice fields will be reorganized and then divided into several large fields having similar conditions. Farmers chose randomly their plots in each field. Thus, total land areas of each farm household did not change.

Thanks to this policy, the fragmentation situation of agricultural land in the province reduced significantly. In Tan Hong commune of Binh Giang district, for example, where was chosen to implement this program early as a model, the number of land plots decreased from 2,503 parcels before the consolidation program to 810 parcels afterwards, equals to 32.3% of reduction. The average area of each plot increased from 218.2m^2 to 673.2m^2. Each farm had an average of 5 plots as compared with 10.2 parcels in the past (Cat, 1998). Similarly, a great result was achieved in Cam Hoang commune of Cam Giang district. Total land plots of the whole commune decreased from 17.740 plots to 7.145 parcels. The average number of land plots per household declined from 10.08 to 3.7 plots. The area of each plot was double from 219m^2 to 527m^2 (Cam Hoang's People Committee, 2005). Therefore, it was more advantageous for farmers to develop the commercial agricultural production. Many rice field areas were converted into another agricultural land such as fish ponds, vegetable land, and fruit tree gardens, etc. For example, three main models were expanded with larger scale than non-exchanged farms in Cam Hoang commune, involving rice-livestock production, rice – fish production and garden – fish pond – livestock production (VAC). These production systems achieved a high economic efficiency, and farmers could earn a high income (Ton and Huyen, 2008).

5.4 Renovation of agricultural cooperatives (1994) and the Agricultural Cooperative Law (1996)

Established in 1958, most agricultural cooperatives contributed greatly to the socio-economic stabilization and agriculture and rural development in Hai Duong province. Many basic infrastructure systems such as irrigation system, road and station system, etc. were constructed and upgraded by the cooperatives. The agricultural cooperative also played an important role in transferring the improved technology to the farmers. However, this kind of production management was not suitable to the market-oriented economy, especially when the farm household was legally recognized as an independent economic unit since 1988. The

agricultural cooperative, therefore, needed to be reorganized in both structure and function. The main objectives and strategies were to improve the existing cooperative or to transform from the old cooperative into the new one which focused on service activities in agriculture. The two decisions No 1755-QĐ/UB and 1756-QĐ/UB set up by the Provincial People's Committee were the official documents for the communes to implement the program of agricultural cooperative reorganization. Several communes were selected for conducting this program as the experimental model, then extending to others. In 1995, a total of 316 agricultural cooperatives were improved and transformed into agricultural service cooperatives, including 295 general agricultural service cooperatives and 21 specific agricultural service ones. The major service activities the cooperative taken part in included the irrigation, electricity, plant disease protection, agricultural technical extension, veterinary service, etc. These activities were normally difficult for individual farmers to implement by themselves. It was very necessary for them to have supports from the cooperative which could perform more efficiently. However, there were 66 agricultural cooperatives which had not been transformed at that time. These cooperatives were mostly weak and inefficient and needed to be dissolved.

The process of restructuring and reorganization of the agricultural cooperative in Hai Duong was basically appropriate to the regulation and instruction of the Agricultural Cooperative Law issued in 1996 by the government. The cooperative was set up as a joint-stock organization and functioned as a service for the agricultural production by some individual farmers. Several service activities such as electric provision, irrigation, land preparation and technical transfer were performed by the cooperative. However, farmers did not benefit greatly from these organizations because they have no rights of making decisions about the management and business activities. This exclusive provision was not an incentive for the development of agriculture and needed to be replaced by a more public and optional one which all members had the right to contribute their opinions to the final decision for the overall development.

5.5 The reform of the banking system in 1990s

The financial capital is considered as one of the most severe difficulties of most farm households in the Red river delta after the 10 Resolution in 1988 because financial capital was not allocated to farmers by the cooperatives when they dissolved (Tuan, 1998). The diversification of agricultural production in Hai Duong province in early 1990s required a high amount of fiscal capital. To increase the rice productivity, farmers had to invest more in purchased inputs. To convert into a new mode of agricultural exploitation like VAC system, a big a mount of money needed to be loaned from external agents. Some poor farmers also needed a certain loan to develop non-farm activities or even for daily expenditures. Thus, the reform of the banking system started by the 1990 Ordinance on the State bank of Vietnam was actually a great encouragement for the development of diversified agricultural production at that time.

In early 1990s, the banking reform focused on decentralizing and privatizing financial activities. The state bank was separated and formed different new banks which target at specific sectors of the economy. The establishment of the bank for agriculture and rural development in early 1990s due to this reorganization gradually fulfilled the increasing demand for the fiscal capital of most farm holdings. Particularly, the poor farmers and other vulnerable social groups were assisted significantly with a favourable capital resource due to the development of the bank for the poor (that was now renamed as bank for social policies) since 1995. The privatizing process of the banking system was also remarked by the creation

of local credit funds and other unofficial funds of farmers in 1993-1994. These organizations contributed notably to solve the capital shortage issue of most farmers in the transforming period of agriculture.

In Hai Duong province, the bank and credit fund system was developed rapidly in 1990s. The branches of state own commercial banks and joint-stock banks were expanded to different regions. Farmers could access easier to different capital sources with a favourable agreement. Thus, the number of household had a bank loan increased across the time. In Gia Loc district, for example, the number of household had a loan increased from 14,860 households in 1996 to 24,376 households in 1997. For the poor, these figures were 3,023 in 1996 and 10,335 in 1997, respectively (Gia Loc's Communist Party, 2005). The interest rate also reduced significantly in this period due to the rapid development of different banks and funds. For the unofficial capital (or private lending sources), the interest rate decreased by 3-4% per month. For the official bank, this rate was more favourable than the unofficial one. In Nam Thanh district (now is Thanh Ha and Nam Sach district), the interest rate of the bank for agriculture and rural development reduced from 3.6% per month in 1992 to 2.5% per month in 1995. The average loan of most farms, therefore, increased gradually across the years, from 0.85 million per household in 1992 to 2.6 million dong per household in 1995 (Anh et al., 2000).

Table 4.13. Evolution of loaning activities in Gia Loc district, Hai Duong province

Items	1996	1997	1998	1999	2000
No of households have a loan	14,860	24,376	20,000	20,000	9,284
Total loan amount (billion dong)	28.2	81.5	60	26	32
No of poor households have a loan	3,023	10,335	6,887	4,397	7,500
Total loan amount for the poor (million dong)	2,525	5,474	-	-	10,214

(Source: (Gia Loc's Communist Party, 2005)

5.6 The acceleration of industrialization and urbanization in 2000s

The decade 2000s was known as the period of accelerating industrialization and urbanization process in Hai Duong and other regions of Vietnam. A lot of large industrial zones and clusters have been developed in different locations of the province since early 2000s. In the period 2001-2005, there were 6 large industrial zones, which covered a total of 647.75ha, and 23 small industrial clusters in different districts of the province (Hai Duong People's Committee, 2008). These industrial areas have been then expanded rapidly afterwards. In 2010, there were 10 concentrated industrial centres, occupying totally 2,090ha of land (Hue, 2011). According to the development plan of the province towards 2015 and 2020, total industrial land areas will be increased up to 3,800ha in 18 industrial parks (Thuy, 2011). Hai Duong was therefore considered as one of the provinces which have the most rapid speed of industrial expansion of the Red river delta.

The rapid development of industrial areas has impacted strongly on the evolution of agrarian systems and rural economy of the province during this period. The acceleration of industrialization and urbanization induced the decline of small-scale diversified agrarian systems, especially the small-scale livestock production system in the central village, and the development of intensive specialized agrarian systems.

Firstly, the industrialization and urbanization related to the reduction of agricultural land areas of many households. Large areas of fertile land were withdrawn from farm households for the installation of industrial companies and buildings, causing some groups of farmers to become landless and jobless people. In estimation, every 1ha of agricultural land was converted into the industrial zone, about 10 agricultural labours lost their jobs (Thinh, 2008). Therefore, the number of agriculture-based households reduced remarkably because they had to find non-farm jobs outside. A survey conducted at 819 households in Ai Quoc commune (Nam Sach district) in 2008 showed that the agriculture-based families declined from 59.9% before 2003 to 40.1% in 2007. The number of free labours who did not have a stable job has increased from 13.1% before 2003 to 23.1% in 2007 (Thinh, 2008).

Secondly, the increasing density of population in the industrial parks made it more difficult for farmers to keep the animal herds near their house due to the potential pollution from animal waste and the possibility of disease transmission from animals to human. Therefore, the backyard livestock production system could not be developed by households around the industrial centres. The animal farms were encouraged to move to the rice fields, away from the central town, where they have enough spaces for farming activities and less harmful to the community than in the urban areas.

The third impact of industrialization on the agrarian system evolution was the availability of off-farm job opportunities which strongly attract agricultural labours. There was a wide variety of off-farm jobs around the industrial zones that can absorb a high amount of rural people, including the young and the old labours. Moreover, the local people can also develop some types of service activities such as small business, house renting service, etc. The off-farm works potentially provided local people with a higher and more stable income than that from agriculture. Therefore, many small farms stopped raising animals and other farming activities.

The development of industry also impacted on the degradation of winter crop cultivation of most households, leading to the decline of small-scale animal production because of the shortage of grain feed for animals. There were several reasons for this decline. The participation of a high proportion of local people in off-farm works resulted in the lack of active labours in rural areas and the abandonment of winter crops. Some farmers, who engaged in farming works, explained that they cannot develop their winter crops due to the extreme attack of pests, especially mouse herds, from buildings or factories in industrial zones. They also cannot develop winter crop solely, without neighbours' crops, because of unfavourable irrigation management. Hence, when several households stopped cultivating winter crops, other farms also abandoned their crops as well.

In other words, industrialization process has some effects on the rural infrastructure development that facilitate the intensification of agrarian systems. In Hai Duong province, the infrastructure system, especially the transport and electricity system around the industrial areas, has been improved significantly during the decade 2000s. The farming and marketing activities were more convenient for producers and traders due to the expansion of the road system, the improvement of electricity and media system, and the establishment of big agricultural collecting units or markets. The development of the rural infrastructure system was thus of great importance for the specialization and intensification of agrarian systems in Hai Duong in 2000s.

Besides that, the rapid installation of industrial centres and cities resulted in the growing demand for agricultural products at local and regional market because of the high concentration of workers around the industrial parks. This is a very potential market because the number of workers increases every year due to the great expansion of industrial zones and

cities. The increasing consumption requirement of meat, eggs, vegetable and fruit, is a great encouragement for the development of intensively commercial farming systems in the province. Farmers are required to improve their production techniques and managements to contribute high-quality products to the strict markets at industrial zones and cities.

5.7 The improvement of the rural infrastructure system

5.7.1 The irrigation system

The improvement of the irrigation system was of great importance for the diversification of agricultural production in Hai Duong in 1990s. Most of the old hydraulic works built since 1960 was degraded extremely and did not achieve its expected capacity. The management of irrigating activities was felt into an extreme crisis due to the collapse of agricultural cooperatives. The limited discharges and the inadequate distribution of the irrigation fees were considered as the main reasons for this weakness of irrigation management (Anh et al., 2000). The conflict of water pumping has occurred popularly among farm households within one commune or among neighbouring communes. The improvement of both the hydraulic works and the water management was required by the intervention of the state.

Hai Duong, which was well-known as one of the best provinces in developing the irrigation system in the past, has made great efforts to improve irrigation activities during 1990s. The share of provincial budget to the hydraulic work construction was increasing across the years. Besides that, local people were encouraged strongly to contribute their labour force and finance to the irrigation development. Thus, more and more pumping stations and canal channels were enlarged and upgraded in the whole province. In 1991-1993, a total of 16 big and medium pumping stations were upgraded or rebuilt. In 1997-2000, a total of 14 pumping stations were constructed in the province. Most of the river dikes were also expanded for a better prevention from flood (Committee of Hai Duong's Communist party, 2010). The development of local pumping stations in many communes, which were managed by communal irrigation cooperatives, was more flexible in water supply and charge of the irrigation fees than that of big stations managed by state company. The water requirement for the diversification of agricultural production of farmers was partly met due to these improvements.

5.7.2 Electricity, road and other infrastructure systems

Like other provinces of the Red river delta, the development of the electricity system in Hai Duong was implemented basically in the decade 1990s due to the rural electrification strategy of the state. A lot of electric stations were built in rural areas to provide electricity to farm households. In estimation, in 1993, more than 98% of communes had access to the national electricity system. In 1995, there were 404 of total 405 communes (equals to 99.75%) having electricity.

The great expansion of the electricity system resulted in a rapid transition of rural economy and farm household living conditions. In agricultural production, mechanisation and electrification technologies were introduced more and more to release men power from hard works. The crop productivity was thus increased greatly. The media such as television and radio were developed rapidly in rural regions. Some first mobile phone networks were connected since 1994. Moreover, in 1996, 100% of communes were connected to the phone

networks. It was a really great evolution of rural life and production that peasants can connect better with the outside world.

The road system was also well expanded in Hai Duong in the period of 1990-2000. Both provincial and local roads were enhanced annually due to the fiscal support from the government and the contribution of local citizens. The national highway 5, for example, which connected Hanoi to Hai Phong and passed through Hai Duong by 44.8km was constructed and completed in 1999. This was one of the main roads of the province that enhance the socio-economic exchange between Hai Duong and other surrounding regions, especially the big cities like Hanoi, Hai Phong and Quang Ninh province. Besides that, the internal connections among areas of the province were also developed due to the policy of both state investment and farmer contribution. The rapid improvement of the road system facilitated well the agricultural production as well as other economic activities in the whole province.

5.8 The development of agricultural sciences and technologies

The introduction and application of improved techniques often play an important role in the development of agriculture. The productivity and yield of agricultural production can be increased significantly and rapidly by applying improved varieties and modern techniques. The quality of agricultural products will be therefore improved to meet the increasing demand of consumers. Thus, farmers can sell their products at a better price and get a higher income than that of backward agricultural production.

In Hai Duong province, the application of improved agricultural techniques was highly required by most farmers in the years 1990s. The dense population and limited agricultural land of the province, like other regions of the Red river delta, make it difficult for farmers to develop the agricultural production. The rapid growth of the population during the decade 1990s put more pressures on enhancing the food production. Therefore, increasing the productivity per agricultural land unit was essential to ensure the food security and to improve farm household income during that period. Not only modern genotype varieties but also appropriate technical practices were required by most farmers. It is also necessary for them to be supported from external assistances of governmental offices as well as non-governmental organizations to install a new production model.

During the decade 1990-2000, agricultural sciences and technologies in Hai Duong province have been developed much more rapidly than that in the previous periods. The local plant and animal genetic species, which have a low productivity and a long growth cycle, were gradually replaced by hybrid or modern breeds. Besides that, backward technologies were also improved notably to increase the productivity and product quality. The high growth rate of the agricultural production during that time can be explained by these technical improvements.

In the crop production, the application of new techniques has been implemented rapidly and efficiently during 1990s due to the high demand for cereal products to satisfy food needs. A number of plant breeding programmes have been operated by the province to replace the local genetic resources with modern genotypes due to crossbreeding techniques. Rice varieties, for instance, were diversified by different crossbreeding combinations among two or three varieties to adjust to different cropping seasons and different soil types. Most of modern rice varieties have a higher productivity, shorter growth duration, and a better pest resistance than those of the traditional ones. For example, in the Red river delta, the cultivated areas of modern rice were also expanded rapidly in 1900s, with the adoption rate increased from

78.5% in 1990 to 92.2% in 1998. The yield of modern rice varieties has increased from 3.8 ton/ha in 1990 to 5.3 ton/ha in 1998, much higher than that of traditional ones (2.1 and 3.1 ton/ha, in 1990 and 1998, respectively) (GSO, cited in (Ut, 2002). In the nationwide, hybrid rice areas have been developed remarkably during 1990s, from 11,094 ha in 1992 to 600,000 ha in 2006. New rice varieties have also contributed greatly to the increase of rice production, about 8,000 ton (equal to 0.07%) in 1981 up to 5,088,000 ton in 1996 (equal to 43.7%) (Giao, 2007).

In the livestock production, crossbreeding programmes were also implemented efficiently to improve the quality of animal breeds. Numerous modern animal species were imported directly from foreign countries to be crossed with local breeds. In the cattle production, the Sindhi breed was imported from India to cross with local Vang breed with different blood percentages (50% or 75% of the Sindhi's genotypes). The hybrid cattle (lai sind) have a higher meat performance and more powerful than that of the local one. In the pig production, a wide variety of improved pig breeds have been introduced to farm households during the period 1990s. The increasing demand for the lean pork in the market during 1990-2000 was a great incentive for producers to improve pig breeds towards a higher lean percentage genotype. The development of artificial insemination technique facilitated breeding programs well. The exotic pig breeds were imported from foreign countries for different crossbred combinations.

The technical transfer also played an important role in the development of agricultural production in 1990s. Not only modern varieties but also improved techniques were introduced to farmers by both state offices and private companies. The province made great efforts to implement technical training courses in different regions. A small or medium group of farmers were involved in these trainings for a short period to learn about a given technique of crop or animal production. The farmers who are trained in the application of improved production will play a key role in transferring it to other producers in their village. The course was often supported by the government and farmers did not have to pay for it. This was a good encouragement for farmers to apply new procedures.

Particularly, the agricultural extension activities were also conducted well by private companies. There were many companies engaged in the agricultural extension activity, including seed, insecticide, and the animal feed and veterinary medicine companies. A number of short training courses or exhibitions were normally implemented by these enterprises to introduce their products to farmers. This was not only a kind of marketing activity but also a technical assistance to producers. This was a big evolution of technical extension as compared with the previous decades when the government played a centre role in transferring techniques to farmers. Farmers' awareness of appropriate technical practices has been improved significantly during this period.

5.9 The damage and threats of infectious epidemics

In the decade 2000s, like many other regions in Vietnam, most animal farms in Hai Duong have faced with big damage and threats of different types of virus, including H5N1 avian influenza, the virus of Porcine Reproductive & Respiratory Syndrome (PRRS) in pig flocks and Food and Mouth Disease (FMD) in pigs and cattle. The outbreak and widespread of these viruses make it more difficult for farmers to prevent and treat them. Therefore, these pandemics have been occurred repeatedly and caused big losses of animal population.

The H5N1 avian influenza was, firstly, broken in 2004 and continuously repeated many years onwards, causing the extreme losses of the poultry population. According to the report of Hai

Duong department of animal heath, until 4th, March 2004, a total of 146 communes, which belong to 12 districts of the province, were reported by the infection of avian influenza. A total of 673,378 heads of poultry were infected by this viral disease and 1,333,851 heads of poultry were culled to limit its transmission (Hai Duong Department of Animal Health, 2004). One year later, in 2005, this virus continuously detected in many chicken farms. The outbreak caused the loss of 1,002,396 heads of ducks from 24th November to 19th December, 2005 in 247 communes of the province (Hai Duong Department of Animal Health, 2005). In 2007-2008, the flu occurred sporadically in several communes with less pathogenic than that of previous outbreaks. Then, the influenza pandemic was basically controlled at the provincial level, although the infection was reported in other regions of Vietnam.

Besides the extreme damage of avian influenza in poultry flocks, Hai Duong also continuously suffered from the occurrence of the Porcine Reproductive & Respiratory Syndrome (PRRS) in the pig population. Hai Duong was also known as the first province broken out with this highly pathogenic pandemic in March 2007. About 14,000 heads of pigs were infected by this kind of virus, and 6,000 heads were culled in 2007 (Phong and Hai Hiep, 2010). In 2008, the pig populations in several communes were cured by this viral disease. In 2010, this disease was continuously broken out and spread widely in 64 communes. In estimation, about 9,890 heads of pigs were infected by PRRS virus. Then, a total of 7,391 heads of pigs were culled in that year (Ninh Hai, 2010). A huge number of pig sows infected by this disease and resulted in an extreme difficulty in developing the pig flocks afterwards.

In addition, many other viral or bacterial diseases have occurred in many animal farms in the province during this period. The food and mouth disease, for example, has been detected in 2006 in the province and repeated many years afterwards. A huge number of cattle and pig were infected and culled because of food and mouth virus attacks. This disease is considered as one of the reasons for the decline of the animal population, especially the beef cattle and buffalo herds in recent years.

There are many reasons for the widespread outbreak of many pandemics in animal herds. The increase of intensive level of livestock production defined by high density of animal flocks and short production cycle per year make it more difficult to eliminate the pathogen from previous infections. In addition, the environmental conditions of most animal farms are not hygienic. Thus, the animal flock can be easily infected by a wide variety of bacteria and viruses. Another important reason for epidemic occurrences was the low rate of vaccination in most animal populations. A number of farmers, especially small farm households, were not well aware of the role of vaccination. Thus, animals are easily infected by different pathogens.

The outbreak of above epidemics impacted significantly on the evolution of agrarian systems, especially livestock production systems in the decade 2000s. Many farm households, especially the small and medium scale farms, lost much because of disease damage. The big collapse of animal production made them not afford to re-invest in the production. Moreover, the sudden or unpredictable outbreak of different epidemics in neighbouring regions posed a big threat to them to continue the production. Therefore, the number of small and medium animal farms has reduced remarkably in the province. These farm households were often moved to other economic activities, mostly non-farm jobs in industrial zones and services.

In other words, to prevent the transmission of diseases from outsides, some farms invest more in the closed system in which animals are kept in semi-conditioning air building blocks. The hygiene conditions and the vaccination schedule are strictly applied to control well the diseases. This type of animal production system is well encouraged to develop by the government because of fewer disease risks than the free range or open production systems. Thus, the numbers of industrial animal farms have increased notably in recent years in the province.

CHAPTER 5. THE CURRENT TECHNICAL AND ECONOMIC CHARACTERISTICS OF AGRARIAN SYSTEMS IN HAI DUONG

I. INTRODUCTION

Like the dynamic economy, the socio-economic characteristics of Hai Duong province and other regions of Vietnam are rapidly changing. Under these ever-changing conditions, farming households are confronting with many difficulties in sustaining and developing their agricultural production. To have a better adaptation to the new situations, a wide variety of farm adjustment strategies is employed by farm holdings, depending deeply on both their production resources and the environmental contexts. Thus, understanding of these circumstances and the adjustment strategies of different farmer categories is essential for the estimation of future evolutionary perspectives of production systems and the establishment of the development policies.

This chapter aims to identify the current adjustment strategies of different farming household groups implemented alternative production systems. Firstly, the brief description of different production systems is presented in order to explain the complexity and diversity of agrarian systems in the study sites. This diversity will be interpreted by both production resources of farming households and the external circumstances of the physical and socio-economic environments. Then, the technical and economic problems facing farmers and their adoption of adjustment strategies are analyzed to assess their sustainability. The technical performance and economic outcomes of different production systems will be evaluated as the key points to estimate the future perspectives of system evolutionary series. Finally, some practical implications of intervention to promote the sustainable development of production systems would be formulated.

II. DESCRIPTION OF DIFFERENT PRODUCTION SYSTEMS IN THE STUDY SITES

1.1. Typology of production systems in different zones

The typology of production systems in the research area was conducted by a step-by-step approach from the provincial level to the farm scale. This approach takes the most effective participation of the rural informants who know well about the entire situation of exploitation modes of most farm holdings in the whole region. Moreover, this diagnosis was also combined with the secondary data about the agricultural production of the study sites. Thus, the typology of the production system was highly representative for the province.

At the global level, three major agrarian systems were categorized according to different agro-ecological and socio-economic zones. The animal-aquaculture based agrarian system is predominant in the upper zone, where has high altitude and uneven territory. In the middle zone, which has large and flat fields with medium altitude, the annual vegetable based agrarian system is the most important ones. On the contrary, the perennial fruit-based agrarian system is widely predominated due to the rice land conversion program in the past.

At the farm level, the farm holdings and their production systems were typified mostly by the main animal or plant species and the farm size (land areas or animal flock size). On the whole, there are seven representative production systems in the whole region that were selected for the investigation (table 5.1).

Table 5.1 Typology of production systems in Hai Duong province

Agrarian systems	Production systems	Characteristics			Location
		Diversification /Specialization	Farm areas	Production Scale	
Animal-Aquaculture based system	Livestock-fish production system	Specialized	Large areas (3500-4500m^2/HH)	Big scale (>10 sows, >100 growing pigs, >1000 poultry)	Upper zone
	Livestock -fish-crop production system	Diversified	Small to medium areas (2000-3000m^2/HH)	Medium scale (3-6 sows, 30-60 growing pigs, 300-600 chickens/ducks)	
Annual vegetable-based cropping system	Cabbage/melon cropping system	Specialized	Large areas (>1500 m^2/HH)	Large scale of cabbage	Middle zone
	Diversified vegetable cropping system	Diversified	Small to medium areas (700-1000 m^2/HH)	Small scale of each vegetable	
Perennial fruit-based cropping system	Guava cropping system	Specialized	Large areas (>2000 m^2/HH)	Large scale of guava	Lower zone
	Litchi-pig production system	Diversified	Large areas (>2500 m^2/HH)	Medium scale (2-5 sows, 50-100 fattening pigs)	
	Litchi-kumquat-guava cropping system	Diversified	Large areas (>3000 m^2/HH)	Medium scale of each fruit plantation	

(Source: Participatory discussions with local people, 2010)

In the upper zone, farm households can be classified into two main production systems. The livestock-fish production system is a highly intensive system which specialized in pig or poultry raising with big herd size. In the livestock-fish-crop production system, farmers prioritize to diversify their livestock flocks by keeping several species (pig, chicken, or duck) with medium scale and combining with crop cultivation (mostly vegetable).

The vegetable growers in the middle zone were also grouped into two types of production systems according to the crop association. The first type comprised the households who specialized into cabbage and melon cultivation with large scale. Meanwhile, other farms were interested in a more diversified vegetable cropping system with a strong association of different vegetable varieties such as cabbage, melon, cucumber, and cauliflower, etc. The cultivated area of each vegetable crop varies considerably from household to household and across the year, depending on the production resources (land, labours, etc.) of the family and the trend of price in the market.

In the lower zone, since the degradation of litchi cultivation, farmers have moved to different production activities. In some communes, the guava cropping system has been substituted for litchi gardens. In other locations, a certain area of litchi plantations was switched to animal buildings or to diversified fruit orchards (mostly guava and kumquat). Thus, there are three main production systems in this zone. These differences of production systems come from the diversity of the agro-ecological environments as well as the ability to access to the market of the growers.

2.2 The animal-aquaculture based production system in the upper zone

2.2.1 Structure of the animal-aquaculture based production system

The animal-aquaculture based production system is characterized by the strong integration between livestock herds and the fish pond. This is a reciprocal relationship in which by-products and wastes are extremely recycled. The effective utilization of animal and crop residuals helps to reduce the purchased inputs of fish culture and mitigate the environmental degradation as well, especially when bio-digester plants were built. Thus, it results in a lower cost of production than that of the mono-culture model.

The combination between the animal production and fish ponds can vary among farmer groups due to their interests or production means and among geographical areas. Two main production systems widely applied by farmers in this region are the intensive livestock-fish production model and the semi-intensive livestock-fish-crop production one. Some of the farms who accumulated well the land and capital resources employed the intensive model with highly dense population of livestock flocks, whereas the small or medium farms engaged in the semi-intensive production system which had lower scale of livestock flocks and fish ponds than those of the intensive one.

The farm is often well-structured to facilitate the interaction among components and make it more convenient for workers in the farm operation. Each farm usually has some fish ponds locating around the animal shed so that the wastes (manure and washed liquid) can be discharged directly or indirectly through biogas systems to the ponds. In the big farms, animal buildings are often constructed separately along the fish pond boundaries to allocate wastes to different ponds and prevent the transmission of disease among livestock flocks. Besides that, several plant varieties, particularly grasses, were grown in the pond borders to provide feed for grass carp. The grass plots are also partly fertilized by animal wastes and watered from ponds.

Most of the land areas of the farm are used for fish culture, which be divided into several ponds with different sizes. This helps to adjust the water level and flows among the ponds. It is also convenient for harvesting and rotating the caught fish. The larger ponds are often better for fish growing than that of small ones. Therefore, the farmers in the intensive model often develop large ponds. Conversely, fish pond size in the semi-intensive production system is smaller than that of the intensive one because of limited land areas and capital as well.

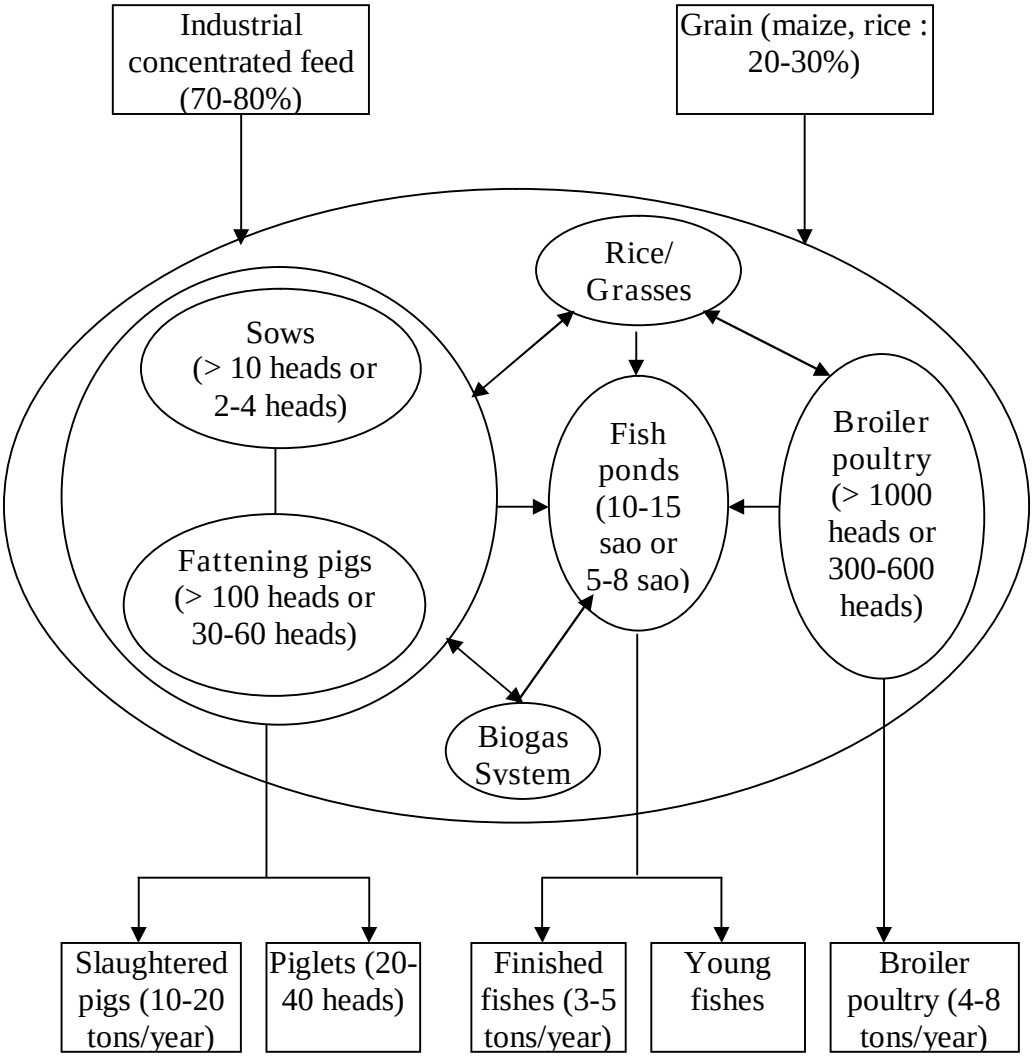


Figure 5.1 The flow diagram of the animal-aquaculture based production system
(Source: Household surveys, 2010-2011)

2.2.2 Characteristics of the animal production and the cropping system

2.2.2.1 The animal and fish production

The animal and fish production is the main livelihood strategy and income source of most households in this kind of production system. However, there is a significant difference about the herd size and the operation between the large farm and the small one. Table 5.2 and 5.3 presented the main characteristics of the animal production of households in two production systems.

Table 5.2 Main characteristics of different animal-aquaculture based production systems

Characteristics	Livestock-fish system (n=13)	Livestock-fish-crop system (n=25)
Farm size	6,660 m^2	4,392 m^2
Water surface	4,122.0 m^2	2,886.0 m^2
Proportion of households have fish ponds	76.9 %	72.0 %
Pig flock size	12.3 sows; 88.3 growing pigs	2.8 sows; 20.7 growing pigs
Poultry flock size	2,583.3 chickens; 1,000 ducks	262.5 chickens; 190.6 ducks
Animal breed	Purebred or crossbred of advanced strains	Crossbred between local breed with advanced strains
Animal feed	Industrially balanced compound	On-farm mixed ration of grain with industrial concentrated compound
Farm locations	Mostly in the rice field or along the riverside	In both rice fields and central villages

(Source: Household surveys, 2010-2011)

Table 5.3. Proportion of types of animal production in the animal-aquaculture based production system

Livestock species	Livestock-fish system (n=13)		Livestock-fish-crop system (n=25)	
	HHs	%	HHs	%
Only pig production	5	38.5	6	24.0
Only poultry production	5	38.5	6	24.0
Pig and poultry production	3	23.0	13	52.0
Total	13	100	25	100

(Source: Household surveys, 2010-2011)

The intensive livestock-fish production system

This kind of production system is often employed by households which accumulated well the land and financial capital and had much experience in animal production. Most households in this system accumulated much more rice land by buying from neighbours or long-term renting from common pools long time ago, mostly since 1993. Having large areas of land is one of the most important factors for them to convert into the integrated livestock-fish production model. Then, the annual profit from animal and fish production was reinvested in fixed assets such as animal buildings or expanding fish ponds. These households also have good knowledge and skills in animal husbandry through technical training and sharing with other producers. The good relation with big output collectors and input suppliers is of great important for the animal keepers to access to the market and intensify their production system.

The livestock-fish production system is figured as an industrial animal farming with a highly dense population of livestock flocks kept in modern housing conditions. On average, the flock size is about 12.3 sows and 88.3 heads of growing pigs. As for chicken herds, an average of 2,583.3 heads of broilers or 1,000 heads of ducks are raised per each production cycle. These are mostly exotic breeds with high lean genotypes (purebred or crossbred between advanced strains). Thus, the industrial concentrated feed, which is considered as a well-balanced compound, is widely supplied to animals. The modern housing system is built by most households to partly control the environmental condition inside the animal building. Other production equipments such as automatic feeding trough or water supplying system, the electric or gas heating system, etc. are also installed in the animal sheds. These good living conditions enable producers to keep an extremely dense animal population.

Most of the farms focus on one specific animal species, either pig or poultry. About 38.5% (5 farms) specialize in pig or poultry husbandry, whereas only 23.0% (3 farms) kept both pig and poultry herds. In recent years, because of huge threats from infectious epidemics and big instability of output price in the market, some intensive farms started to diversify their animal flocks by reducing the population of a given species (pig or poultry) and raising others.

Thus, this type of production system is mostly developed in the rice field or along the riverside, where the water inflow and outflow are more convenient and regular than those in other locations.

Regarding the operation of this production system, it can be characterized by the improved techniques and the good farm management. For the animal breading management, the pure or hybrid sows are often bought from the pig breading stations and crossed with some improved genotypes, which have a high lean percentage and good performance, through natural breeding or artificial insemination methods. Most farms keep one or several pure boars for the natural insemination. The genotype of piglets is often the combination of three or four strains so that they can potentially have the highest meat performance and lean percentage. The on-farm production of piglets for the fattening helps to limit the impact of high price of piglets in the market and prevent the animals from disease transmissions from outside.

Livestock and fish in this production system are fed mostly by the industrial concentrated feed which is considerably well-balanced and adequate for the nutrition requirement of different types of species at alternative growing stages. For the sows and lying hens, producers often manage well the quality and quantity of feed to control their body condition. For the fattening pigs and broiler chicken, feed are provided at liberty (or ad libitum) to improve their growth rate and meat performance. Fishes are also fed two times per day according to the total estimated weight of fishes in each pond. The good feeding management is one of the most important reasons for the high re-productivity and high meat performance of animals in the intensive livestock-fish production system.

Producers also pay much attention to the animal waste and disease management to avoid the risks from epidemics and environmental pollution. The animal disease management is characterized by the appropriate sanitation through regularly cleaning and spraying the disinfectants, limiting visitors, keeping the animal shelters empty during several days after selling the animals, etc. The vaccination program is also well applied to the animal herds to prevent them from infectious epidemics such as PRRS, avian influenza, etc. The animal solid waste is collected everyday and mostly sold to the crop farms. The liquid waste is usually discharged indirectly to the fish ponds through the biogas system. Most farms have one or two bio-digesters constructed near the animal buildings and fish ponds so that the liquid waste will be well-treated before sending out to the ponds. The good hygiene condition helps the intensive farms to reduce the attack of animal diseases.

The semi-intensive livestock-fish-crop production system

Unlike the intensive livestock-fish production system, households in the semi-intensive livestock-fish-crop production system give priority to a more diversified model with medium scale. There is a strong combination between animal husbandry, fish culture and crop cultivation. The association between these components enhances the recycle of materials within the farm and the resilience to the fluctuation of the environmental contexts, especially the market price.

The main features of this system are medium farm size and low investment in fixed assets. Because of limited land area and capital, households often keep a medium size of livestock flocks, about 2.8 sows and 20.7 heads of growing pigs or 262.5 chickens and 190.6 ducks per production cycle. They often keep the crossbred between local breeds with advanced strains, which may have a lower meat performance than that of exotic breeds but adapt better to the conventional production system of small farms. These animals are usually raised in the open-air housing condition with the by-hand working tools. The producer usually mixes the industrial concentrated compound with the grain staple or food-processing by-products in the diet to feed their livestock herds.

One of the limitations of the livestock-fish-crop production system is the poor farm management, especially the disease prevention and treatment. The hygiene condition is not good due to the irregular cleaning and disinfectant spraying. The vaccination program is not applied regularly because of small animal herd size. Therefore, the farms in this kind of production system are more vulnerable to the infectious epidemics than ones in the intensive livestock-fish production system.

This type of system is widely employed by the medium –income households who could not accumulate much land and capital and have little experience in animal production. This group of households often combine farming works with non-farm activities to diversify the income. They spend most of their time on working outside the farm. Therefore, they do not invest much in fixed assets and pay little attention to their animal herds.

This type of system is more flexible to the changes in the environment. Farmers can adjust their animal herds to the change in environmental situations. When the price of a given animal product in the market is higher than that of others, farmers move rapidly to that production enterprise. They also increase the animal population during the high price period of the year, for example, at the beginning and at the end of the year, when the demand of the consumers for animal products is higher than in other seasons. Therefore, there is a high proportion of households who kept a diversified livestock group (pig, chicken, and duck), making up 53.0% of total surveyed households in this system.

2.2.2.2 The cropping system

Rice cultivation as the predominant cropping system

The predominant cropping system is two rice crops per year and a fallow period in winter. Rice is still grown by most farms (100% of surveyed households in two production systems) to ensure the food sufficiency of the family and to produce feed for animals. In recent years, the price of rice in the market has been increasing rapidly. Thus, most households still keep cultivating paddy rice to meet their family consumption. Households who practise the livestock-fish production not only sustain their own rice land area but also rent more land from neighbours to produce rice as feed for their livestock flocks and fish. However, the renting area is limited, about 2-3 sao per household, because of shortage of labours.

Table 5.4 The crop cultivation in the animal-aquaculture production system

Crops	Livestock-fish system (n=13)		Livestock-fish-crop system (n=25)	
	Quantity	Frequency (% HHs)	Quantity	Frequency (% HHs)
Rice area	1758.5 m^2	100 %	2126.9 m^2	100 %
Distribution of frequency (% of households)				
< 1,800 m^2 (1- 5 sao)	9 households	69.2 %	10 households	40.0 %
2,160 m^2 – 3,600 m^2 (6-10 sao)	4 households	30.8 %	14 households	56.0 %
> 3,600 m^2 (> 10 sao)	0 households	0 %	1 households	4 %
Winter crop area	0 m^2	0 %	835.2 m^2	20.0

(Source: Household surveys, 2010-2011)

In fact, rice cultivation is still an ordinary or traditional farming practice that consumes high human power. Although some of the tasks of rice culture are partly mechanized such as land preparation or harvesting and husking, the production is mainly based on manual techniques that need active labours. However, the active agricultural labours migrate into industrial companies or search for off-farm jobs which have higher income than that of rice growing. Thus, the old and middle-age people, mostly women, take responsibility for rice farming.

The decline of production of rice and winter crops

Rice cultivation is continuously encouraged to sustain in a given area by the provincial government. However, farmers seem to be less interested in growing rice. The decline of cultivation of rice and winter crops is increasingly emerged in Hai Duong, especially around the industrial regions. Since the last two or three years, the abandoned area of the paddy field has been increasing in many communes. In Tan Truong commune, for instance, the total abandoned area of paddy rice in 2011 was 58,195m^2 or 5.8ha, accounting for 2% of total rice land area of the commune (Tan Truong 's Farmer Union, 2012). In Cam Hoang commune, an agriculture-based commune, this abandoned area of paddy fields was about 1ha, equals to 0.3% of total rice land areas (Cam Hoang's Agricultural Cooperative, 2012). The abandoned surface is forecasted to increase when more and more households stop growing rice and winter crops.

There are many reasons for the degradation of the rice and winter crop cultivation. According to the discussion with the chief of Tan Truong and Cam Hoang commune, the most important reasons for this phenomenon is the high cost of rice cultivation, especially the cost of input materials and other agricultural services such as land preparation and harvesting. Most of the technical practices in rice cultivation are hired in from waged labours or services such as land preparation, transplanting, harvesting and plucking. The waged salary and the price of some agricultural services are increasing rapidly. Thus, the production cost is too high (table 5.5), causing the low profit of the rice cultivation. In estimation, the price of rice in the market in 2010 was about 6,000 dong per kilogram, farmers can get about 1,320,000 dong per sao

(average productivity in crop 2010 was 220kg/sao). So, the intermediate cost shares about 30-40% of total gross product.

Table 5.5. The production cost of rice cultivation in the animal-aquaculture based system

Cost of production	Livestock-fish system (n=13)		Livestock-fish-crop system (n=25)		P-value
	Thousand dong/sao	%	Thousand dong/sao	%	
Chemical fertilizers	204.9[a]	41.9	155.7[b]	35.4	0.03
Breeding seed	46.3	9.5	47.4	10.8	0.42
Land preparation	77.5	15.8	76.5	17.4	0.43
Pesticides and herbicides	67.1	13.7	62.1	14.1	0.98
Harvesting and Plucking	101.8	20.8	101.7	23.2	0.62
Total cost	489.1	100.0	439.1	100.0	0.08

([abc] Means in the same row without common letter are different at $P<0.05$
Source: Household surveys, 2010-2011)

Moreover, the paddy field is often seriously damaged by pests, especially by mouse herds from surrounding animal farms and other industrial buildings. Each commune set up a group of controllers who take responsibility for the mouse and other pest management every year. The rice growers have to pay little for this kind of service. In spite of their efforts, many rice crops have been attacked considerably by pests. Consequently, many farm holdings do not want to continue cultivating rice. Their rice land plots are for rent. Besides that, the shortage of agricultural labours influences considerably on the development of rice cultivation, especially for ordinary production method.

The winter crop has been considerably diminished since the industrialization era. In the last decade, winter crop was developed strongly in this region, especially maize, soybean and different types of vegetable. At that time, crop products and residuals were effectively used as important feed resources for animal flocks of the households. And now, a few numbers of households continue growing winter crops, particularly in the intensive livestock-fish production system. Only 20% of total surveyed farms in the livestock-fish-crop production system practise cultivating several annual crops such as cucumber, tomato, chili, etc. in winter season to supply to local markets around the industrial zones. However, the development of these crops is facing some difficulties. The small cultivation area in different fields, normally in upper territory locations, sometimes makes it inconvenient for irrigating activity. Furthermore, the increasing pest attacks also caused huge losses and threaten other crops. Farmers spend their time on working non-farm jobs rather than on-farm activities, which are more and more vulnerable to physical and economic environments.

2.2.3 The management of production resources of households

2.2.3.1 The land resource

Table 5.6. Land areas of households in the animal-aquaculture based production system

Characteristics	Livestock-fish system (n=13)	Livestock-fish-crop system (n=25)
Farm size	6,660 m^2	4,392 m^2
Distribution of frequency (% of households)		
<3,600 m^2 (<10 sao)	30.8 %	40 %
3,600 m^2 – 7,200 m^2 (10-20 sao)	38.4 %	48 %
> 7,200 m^2 (> 20 sao)	30.8 %	12 %
Water surface	4,122.0 m^2	2,886.0 m^2
Distribution of frequency (% of households)		
<3,600 m^2 (<10 sao)	40 %	72.2 %
3,600 m^2 – 7,200 m^2 (10-20 sao)	50 %	27.8 %
> 7,200 m^2 (> 20 sao)	10 %	0 %

(Source: Household surveys, 2010-2011)

The importance of fish ponds in the animal-aquaculture based system

There is a significant difference of farm size between the livestock-fish system and the livestock-fish-crop model, especially the water surface for fish culture. The intensive livestock-fish production system is, firstly, characterized by large farm size. The average farm area is about 6,660 m^2, in which the water surface for fish culture is 4,122 m^2, equals to 61.9% (table 5.6). This farm size is higher than the average size of the fish farm of the whole province in 2006 (about 4,440 m^2, (Hai Duong Statistics Office, 2008). Meanwhile, most of the households in the livestock-fish-crop production system have smaller land area than that of the intensive one. The average fish pond area of these farms is about 2,886 m^2, equals to 65.7% of the total farm land area. The limited land area makes it more difficult for them to develop the intensive production system.

Photo 5.1 The intensive livestock-fish production system
(Cam Hoang, 4/2011)

The difference about farm size between these two production systems comes from the land consolidation process in the past. Over the last decade, farm holdings in the intensive livestock-fish production system have consolidated the land and expanded their farms by buying more land areas from the surroundings or long-term renting the common pool from the commune for fish culture (about 15-20 years). It is a big investment in constructing permanent fish ponds and animal houses. Therefore, they have to sustain and develop the production activities for a long time to reduce the high depreciation of these fixed assets. Conversely, most of the farming households in the semi-intensive livestock-fish-crop production system could not afford to buy or rent large land areas from the neighbours because of limited financial capital. Some of them may consolidate more land but with few amounts. Thus, they exchanged their land plots with other farms and converted into fish ponds and animal sheds.

Photo 5.2 The open-air chicken building in the livestock-fish-crop production system
(Cam Hoang, 4/2011)

The profit from fish and animal production is also a significant capital source for farmers to invest in farm land expansion, especially water surfaces. Fish culture makes up an important proportion in the total income of many households because of its high profit in recent years. Moreover, raising fish plays a significant role in recycling the crop residuals and animal wastes that help to reduce the production cost. Therefore, the profit from fish production is of great importance for producers to invest more in an intensive production system, especially in enlarging fish ponds and animal buildings. The farm holdings in the livestock-fish-crop production system earn less than the intensive ones because of small fish ponds. Some farms even have narrow fish ponds naturally formed near the houses that are unsuitable for growing fish.

Today, buying more land for fish pond conversion seems to be less common in this zone. The acceleration of industrialization and urbanization causes the rapid decline of agricultural land, especially rice land. The current industrial zones will be expanded to surrounding areas. Some new industrial parks are planned to be built up in this region. Thus, farmers try to keep their land plots with different purposes such as for self-food sufficiency as the security in the increasing trend of rice price in the market. In case of land withdrawal for industrial installation, they can receive considerable compensations.

2.2.3.2 Labour force

The family size of households is different between the two production systems. The households in the intensive livestock-fish production system have smaller family size as well as potential wage labour than those of the semi-intensive one (table 5.7). The number of active labours in these two production systems are 2.2 and 2.6 persons, respectively, similar to that of the average number of fish farms of the whole province (2.22 persons in 2006, (Hai Duong Statistics Office, 2008).

Table 5.7 Family size and labour force in the animal-aquaculture based production system

Parameters		Livestock-fish system (n=13)		Livestock-fish-crop system (n=25)	
		Mean	SD	Mean	SD
Mouths to feed		3.9	0.3	4.5	1.0
Potential wage labours		2.2	0.4	2.6	1.0
Dependency ratio		1.8	0.3	1.8	0.5
0-1 active labour (%)		0	-	0	-
2-3 active labours (%)		100	-	84	-
4-5 active labours (%)		0	-	16	-
Proportion of family labour (%)	Only on-farm	76.9	24.0	-	
	On and off-farm	23.1	76.0	-	

(Source: Household surveys, 2010-2011)

There is a difference about the management of family labour force of farm holdings between the two production systems. Most active labours of the family in the livestock-fish production system are working on their farm (76.9%) because of a load of work. Some farms also have to hire in more waged labours from outside for specific tasks. The number of waged workers and

the modality of working contract vary from one farm to another and depend on the load of work. The extreme large farm often hires one or two permanent labours to work full-time on pig or poultry farms. The seasonal workers are also employed daily for several tasks such as cutting grasses for fish or harvesting fish.

Meanwhile, households which apply the semi-intensive livestock-fish-crop production model can combine on-farm works with off-farm activities (76.0%). They can spend little time on their farms to feed the animals or clean the sheds. They spend most of the time working outside as the waged labours in intensive farms or in industrial companies. In some big households that have many active labours (e.g. about 4-5 persons), the older workers engage in farming jobs and the younger members go out for off-farm activities. Thus, the off-farm income makes up a high proportion of total household income.

In order to understand well the operation and performance of the production system, the heads of the households are also taken into account in the analysis because they often play a central role in setting up the livelihood strategy of the family. In rural area, men are often considered as the chief of most families. However, in this study, the person who mostly works on farm and makes the decision on the management of production resources is identified as the head of the household.

Table 5.8 Characteristics of the household heads in the animal-aquaculture based production system

Parameters	Livestock-fish system (n=13)	Livestock-fish-crop system (n=25)
Male (%)	92.3	76
Female (%)	7.7	24
Average age of household heads (years)	46.3	47.2
<35 years old (%)	0	8.0
35-44 years old (%)	23.1	24.0
45-55 years old (%)	76.9	56.0
>55 years old (%)	0	12.0
Household heads' education (years of school)	10.4	8.0
Primary school (%)	0	16.0
Secondary school (%)	30.8	52.0
High school (%)	69.2	32.0

(Source: Household surveys, 2010-2011)

In the intensive livestock-fish production system, most of the household heads are men and at middle age, about 45-55 years old. They also have a good education level (69.2% have a high school level). Thus, they are active and well-experienced producers. They can actively participate in the technical training courses to learn new techniques. They also adapt well to the changing conditions, especially at the marketplace.

The household head in the livestock-fish-crop production system is more diversified. Some of them (24%) are women as their husbands go out for off-farm jobs. The average age of these chiefs is about 47.2 years old, a little older than that in the intensive system. However, some family leaders are very young (8.0% are under 35 years old). They often have less experience

in farm jobs and lack of capital. In other sides, some family heads are old persons (more than 55 years old). They often lack of capital as well as slowly respond to the changing environment. In this system, the proportion of households which have primary and secondary education is also higher than that in the intensive one.

Technical skills of animal keepers

Raising animals is really a difficult work that requires specific knowledge and skills about animal sciences. To achieve best performance of animal husbandry, farmers need to be trained with basic disciplines of animal sciences and technical practices. The training seems to be more important when farmers develop big industrial farms with the big animal flock size. Therefore, many training courses have been implemented by not only provincial staff but also private companies, which sell animal feed or veterinary medicine to farmers.

Table 5.9. Proportion of household heads participating in technical training courses

Training participation (% HHs)	Livestock-fish system (n=13)	Livestock-fish-crop system (n=25)
No training	15.4	56.0
Training but ineffective application	7.7	12.0
Training and effective application	76.9	32.0
Total	100	100

(Source: Household surveys, 2010-2011)

However, the big farms seem to be the most important targets of these training programs with high proportion of farmers engaged in these activities (table 5.9). Most of them state that their understanding of animal production is much improved after the training, and they can apply well to their farms. On the contrary, the small farm holdings are left behind the training programmes. The proportion of household heads in the livestock-fish-crop production system did not participate in the training courses is much higher than that in the livestock-fish system (56% compared with 15.4%). These farm holdings often practise raising livestock by their own experiences or learn from the neighbour's advice. The training program is often designed for industrial animal systems, which means that it seems inappropriate for small and diversified farms. Thus, many small farms fail to apply the new techniques from these kinds of technical training courses. It is important to diversify the technical training program as well as to adjust its content to the context of small farms for the efficient application.

2.2.3.3 Financial capital

Most of the animal farms have a high requirement of financial capital for both fixed assets and annual consumptions of the animal production. Although the farms were constructed long time ago, farmers still need capital for annual repairs of fish pond borders or animal buildings. The intermediate consumption of animal feed and other inputs is also very high. Most of animal keepers thus have to apply for a loan from banks or other sources (table 5.10).

Table 5.10. Access to loan of farmers in the animal-aquaculture based production system

Sources	Livestock-fish system (n=13)		Livestock-fish-crop system (n=25)	
	Amount (thousand dong)	% of HHs	Amount (thousand dong)	% of HHs
Banks	139,230.8	84.6	26,800.0	52.0
Local credit funds	0	0	1,520.0	8.0
Others	2,307.7	7.7	4,000.0	12.0
Total	141,538.5	92.3	32,320.0	72.0

(Source: Household surveys, 2010-2011)

Three main sources of capital that farmers can get a loan are commercial banks, local credit funds and unofficial sources such as from friends or relatives. The bank loan plays an important role since a huge number of farms get a loan from different commercial banks such as bank for agriculture and rural development, bank for the poor, etc. Farmers can borrow a higher amount of money from banks than that from local credit funds or unofficial resources. However, to apply for a bank loan, farmers need to have a mortgage such as land certificate or other properties. Therefore, some households, especially the small and medium ones, have a loan from local funds or from their relatives.

2.2.4 The agro-input management system

2.2.4.1 The animal breeding program

The pig breeding program

In Hai Duong and other regions in Vietnam, the exotic purebred or crossbred pigs are now more and more popularly kept by most farms due to the increasing demand of lean pork of the domestic consumption. The breeding program has gained great achievements recently thanks to the direct import of some high-performance breeds from foreign countries. These strains were crossed each other or with local breeds to produce hybrid genotypes which had a high growth rate and reproductive performance.

In the intensive livestock-fish production system, the exotic purebred or crossbred sows were carefully selected by farmers. These sows are often inseminated directly with the boar raised on farm or by the artificial method. The artificial insemination method is more commonly used by most farms. The good quality of frozen semen is supplied directly to the farm from the animal breeding companies or from the provincial pig breeding farm through the local veterinarian staff. Some big farms keep one or two exotic purebred boars for direct insemination. Thus, the sows of most farms have a high reproductive performance.

The artificial insemination was also widely applied to the crossbred sows in the livestock-fish-crop production system. The supplying service of the frozen semen functions effectively to provide good-quality semen doses to the farm. The exotic purebred or crossbred genotypes of two or three strains are commonly used to cross with local or hybrid sows. The piglets are thus the high lean genotypes which have a good growth rate.

However, some households which do not keep sow herds have to buy piglets from surrounding farms. In recent years, the price of piglets has been increasing quickly, especially

after the PRRS epidemic because this disease affects directly the reproductive ability of the sow. Increasing piglet's price causes the high intermediate cost and thus many farms stop to raise growing pigs during the peak period. On the contrary, when the price of piglets decreased, even right after the disease outbreak, they buy more piglets because it is forecasted that the price of slaughtered pigs will be higher the next months. However, it is a threat to the animal population because of disease transmission.

The poultry breeding program

Poultry breeds kept in the intensive livestock-fish farms are often provided by the breeding companies (such as CP group) or by the national poultry breeding station (e.g. Thuy Phuong, Cam Binh centre, etc.). These birds are high quality and strictly vaccinated against the major diseases.

Conversely, in the livestock-fish-crop production system, most households buy one-day old chickens or ducklings from small private breeding farms. Thus, it is difficult to inspect the genotypes of the bird population and the application of the vaccination program. They are therefore, more vulnerable to the epidemics.

2.2.4.2 The animal feeding system

An increasing dependency on the purchased feed supply

In general, the industrial concentrated feed is used more and more commonly in the animal production in Vietnam. This kind of feed is considered as a more balanced compound than that of the on-farm mixture. It is also convenient for farmers to feed different livestock species at alternative growing ages. The well-developed supplying system of this animal feed from wholesalers to retailers or even directly to the farm gate encourages producers to use it more for their animal herds.

In fact, the households in the intensive livestock-fish production system used the industrial concentrated feed more often than that of the livestock-fish-crop one. The amount of the industrial concentrated feed shares about 70 to 90% in total ration in the livestock-fish system, whereas this proportion in the livestock-fish-crop one is smaller (table 5.11). The high-performance genotypes of animal herds in the livestock-fish system require a nutritious and well-balanced diet which is believed to be sufficiently provided by industrial concentrated compounds. In the livestock-fish-crop production system, the crossbred animal can adapt to the unbalanced ration mixed between grain products and industrially concentrated ones. Thus, farmers utilize a maximum amount of the on-farm produced cereals or the food-processing by-products in the animal diet.

Table 5.11. Proportion of different types of the animal feed used in the ration

Animals	Livestock-fish system (n=13)		Livestock-fish-crop system (n=25)	
	Industrial concentrated feed (%)	Grains or food by-products (%)	Industrial concentrated feed (%)	Grains or food by-products (%)
Sows	72.9	27.1	26.5	72.9
Growing pigs	88.9	11.1	52.7	47.3
Poultry	96.7	3.3	83.3	16.7
Fish	71.1	28.3	38.8	61.3

(Source: Household surveys, 2010-2011)

The problem is that producers depend more and more on the purchased animal feed, including the industrial concentrated feed and the grains such as maize, rice, etc. The decline of cereal crop cultivation, especially maize and soybean, causes the limitation of food self-supporting ability of the farms. At the regional and national level, the limited supply of these raw materials to animal feed companies leads to the increase of the imported amount. That is one of the most important reasons for the rapid rise of the animal feed price in the market.

Furthermore, the quality of animal feed varies considerably from one label to others. In Vietnam, the number of animal feed company has increased quickly since the last decade. The quality management system of some factories is not improved, and thus the food quality is under the standard level. Moreover, the animal feed quality sold in the market is sometimes not strictly inspected. Farmers have no ways to evaluate the quality of different food. Thus, it is difficult for them to choose the best-quality foodstuffs for their animal herds.

Table 5.12. Cost structure of the fattening pig production: High cost of animal feed

Cost items	Livestock-fish system (n=13)		Livestock-fish-crop system (n=25)	
	Cost (thousand dong/100kg live pigs)	Proportion (%)	Cost (thousand dong/100kg live pigs)	Proportion (%)
Piglets	541.2	22.8	685.0	28.2
Cereal grain feed	172.9	7.3	842.8	34.8
Industrial feed	1,626.2	68.4	851.7	35.1
Veterinary medicine	25.2	1.1	31.4	1.3
Electricity and others	10.2	0.4	14.3	0.6
Total cost	2,375.9	100.0	2,425.1	100.0

(Source: Household surveys, 2010-2011)

The rapid increase of animal feed prices

Animal feed price has increased remarkably during 2000s, especially since 2007 when the economic crisis occurred. From 2007 to 2008, the price of most raw materials and concentrated feed for animals have increased rapidly, about 18.7% for maize, 80% for soybean meal, 27.7% for lysine, 125.9% for methionine and 33.1% for pig's concentrated feed (Thuy Phuong Pig Research Centre, 2009).

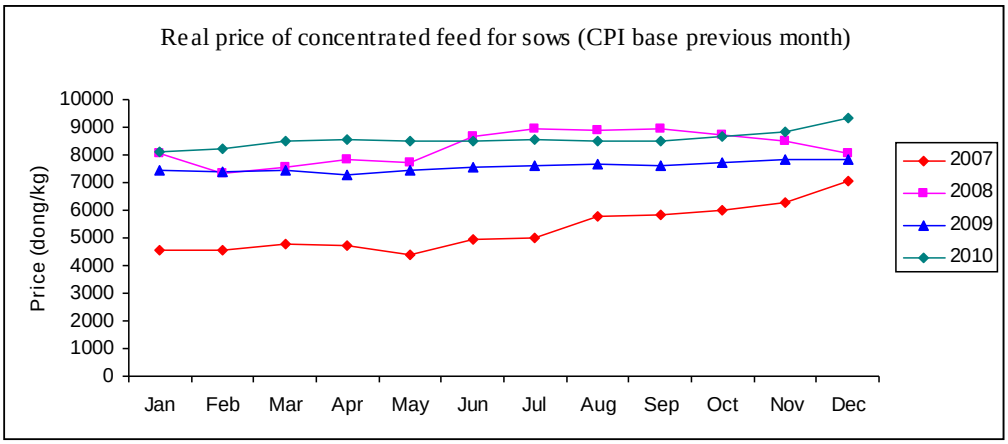


Figure 5.2. The variation of price of the concentrated feed for sows
(Source: Annual records at the animal farm of Mrs. Pham Thi May, Cam Hoang commune)

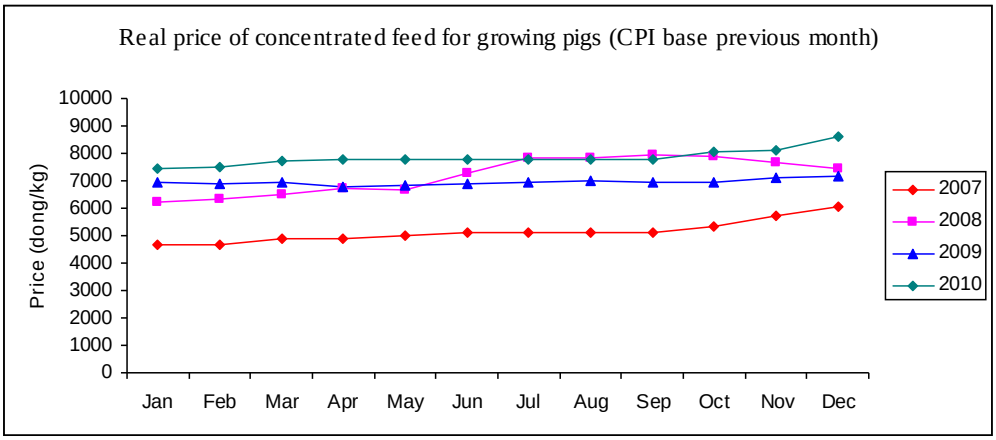


Figure 5.3. The variation of price of the concentrated feed for growing pigs
(Source: Annual records at the animal farm of Mrs. Pham Thi May, Cam Hoang commune)

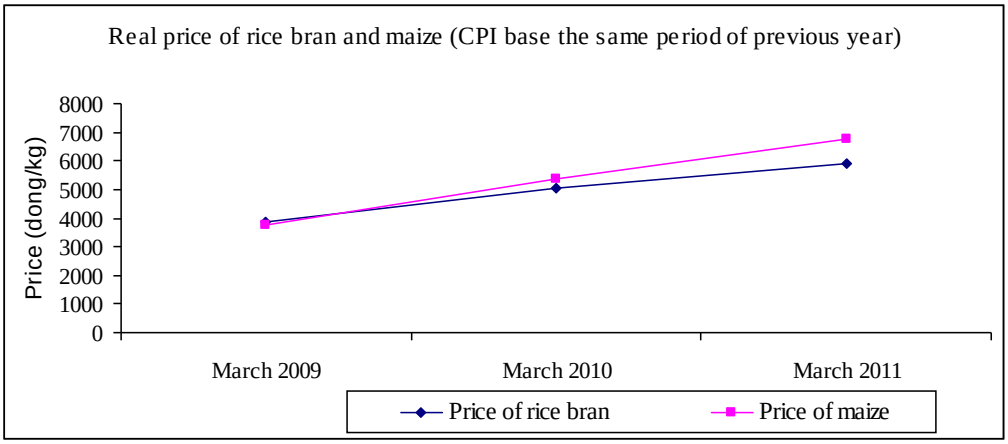


Figure 5.4. The variation of price of the rice bran and maize
(Source: Annual records at the retailer store of Mr. Nguyen Van Ngoc, Thanh Son commune)

A number of reasons for the rise of input prices can be identified due to the socio-economic development. The strong dependence of the domestic production upon the import sources of most input materials is considered as the major reason for price variation. As discussed above, most crop productions have reduced significantly during the decade 2000-2010. The decrease of maize and soybean cultivated areas caused the extreme lack of raw materials for industrial animal feed manufacture. Therefore, many animal feed factories had to import a huge amount of most feed components from foreign countries. In 2008, the imported amount of each material was estimated by 40-45% of high-energy food (cereals), 70-75% of high-protein food, 95% of minerals and vitamins and 95-100% of other feed additives (colourings and flavours). Therefore, the price of most animal feed in Vietnam was 5-8% higher than that of neighbouring countries (Giao, 2009).

The responses of the producers to the instable feed market

Farmers in the intensive livestock-fish production system are more susceptible to the extreme rise of animal feed in the market as the high amount daily consumed by the livestock flocks. Therefore, to limit the impact of the increase of animal feed price supplied through different market chains, these big farms often enter into the unofficial contract to purchase a huge amount of feed directly from the companies or wholesalers. This is a regular provision of feed from the factory to the farm gate with a more stable price. When buying a high amount of feed during a long period, farm holdings can receive a given discount than that in the market. Based on the feed amount consumed monthly, about 1-2% of total weight will be discounted. Thus, they can reduce a considerable production cost.

Unlike the large farms, to adjust to the high price of the industrial concentrated feed, households in the livestock-fish-crop production system give priority to the mixed diet. This is because the grains or crop by-products are often cheaper than that of industrially produced ones. They are thus partly substituted for industrial compound in the diet. Some farms may also use the residuals from the kitchen of the industrial companies (the surplus food after the meal of the workers) for livestock flocks to reduce the intermediate cost.

The producers often evaluate the quality of animal feed and make a decision of selection based on their own experiments. The quality of one type of animal feed will be assessed by feeding to one or two livestock flocks. If the animals show a higher growth rate and have better health than that of the old kind of feed, the new one will be accepted. It is obvious that the price difference is also taken into account of choosing feed. However, the big farm usually places great importance on feed quality as well.

2.2.4.3 The animal disease prevention and treatment

The extreme damage of animal infectious epidemics

The disease prevention and treatment play an important role in the animal husbandry. The importance of disease prevention is emphasized within the context of serious threats from infectious epidemics and in a dense animal population region like Hai Duong province. Although the vaccination program is frequently implemented by the provincial veterinary department, several infectious epidemics and other diseases have occurred and been transmitted repeatedly in pigs, poultry herds and fish. It causes enormous losses of many farms. This problem relates strongly to the awareness and practices of farmers in preventing and treating diseases.

In the two production systems, farmers are facing with big problems of pig diseases which frequently occur. This is because in recent years, many farms have been terribly damaged by the PRRS (Porcine Reproductive and Respiratory Syndrome) in pig flocks since 2007 (box

5.1). In Tan Truong commune, for example, 205 heads of pigs (mostly growing pigs) were died because of first outbreak of PRRS in 2010, equals to 7.170 kg live pigs. In Cam Hoang commune, about 13.000 kg of live pigs were lost during the first attack of PRRS in 2010 (Cam Giang's Veterinary Department, 2011). Although the government provides the subsidy for these farms (25.000 dong per kg for sows and 18.000 dong per kg for growing pigs), they still lost very much. It is also a dangerous threat for animal keepers that cause the decline of pig production of households, especially the small and medium ones.

Box 5.1 Huge losses of animals because of infectious diseases in chickens and pigs

Case 1. Mr Le Duc Vui, 53 years old, Mai Trung village, Tan Truong commune (livestock-fish-crop system): "This year (2010), I keep 2 herds of broiler ducks. However, these birds were infected by some diseases and lost much. The first cycle, of total 300 heads of ducks, 170 heads of ducks were died gradually because of diarrhoea, accounting for 56.7% of the mortality rate. In the second herd, 500 heads of ducks were continuously raised, but the mortality rate was 38%, equals to 190 heads lost, even though I spent 12 million dongs for the cots of the disease prevention and treatment. Thus, I cannot continue keeping animal production"

Case 2. Mr Mai The Quang, 55 years old, in Mai Trung village, Tan Truong commune (livestock-fish-crop system): "The animal flock of my family is significantly damaged by different kinds of diseases, especially infectious epidemics in both chickens and pigs. In 2003, a total of 1,000 heads of chickens were culled because of influenza H5N1, lost about 50 million dongs. This year (2010), 3 sows and 18 heads of growing pigs were died because of PRRS attacks, equals to about 20 million dongs. Raising animals is strongly vulnerable to infectious epidemics. Therefore, I would better to stop keeping animal husbandry".

Case 3. Mr. Pham Van Viet, 45 years olds, in Mai Chung village, Tan Truong commune (livestock-fish system): "My farm was completely failed because of animal diseases. This year (2010), 10 sows and 100 heads of growing pigs were died because of PRRS. Moreover, fishes were infected by diseases and died significantly. I lost about 100 million dongs. Now, I give up raising animals. I want to sell this farm (100ha), but no one has the capacity to buy it".

(Source: Household interviews in May 2010, in Tan Truong commune)

The fish culture is also increasingly affected by huge losses caused by not only weather hazards but also diseases. Many households explain that they are facing with the climate change and the extreme pollution of water sources. In recent years, the heavy rain in summer caused the terrible flood, and fishes have gone out of the ponds. The fish ponds were also damaged by the flood, and that requires a big re-investment. In winter, for example, in 2011, the temperature decreased significantly, sometimes below 10^0C. Thus, fishes, mostly tilapia, were suddenly died off and farmers had no ways to cure their fishes. Some farms, which applied tilapia monoculture, lost all their fishes.

Furthermore, the fish diseases also occurred widely in many farms because of polluted water. The intensive fish culture which used more purchased inputs, and shorter production cycle seems to be one of the reasons for the disease outbreak. The excessive discharge of animal wastes (manure and liquid wastes) to fish ponds resulted in the pollution. Farmers also pointed out the pollutant from the industry factories around their farms. The water from river

around the industrial zone becomes more and more polluted. Farmers can easily realize the pollution level of the water when it was pumped from the river to the fish ponds.

Box 5.2. Losses of fish because of bad weather and diseases

Mr. Dao Van Hien, 48 years old, in Quy Duong village, Tan Truong commune (livestock-fish system): "Fish production plays the most important role in my family economy. The total fish pond area is 70 sao (or 25,200 m^2), accounting for 70% of total farm size. Every year, I get about 6,000kg fish, equals 120-130 million dong. However, this year (2010) is a bad-harvest year because of bad weather and extreme diseases. In the summer, 2,000 heads of fish were died of diseases. In the winter, 10,200 heads of tilapia (300gram/head) were lost all due to the cold weather (below 10 ^{0}C). Fish culture is riskier to diseases and bad weather condition even though I strictly follow the disease prevention program"

(Source: Household interview in May 2010, in Tan Truong commune)

Farmers in the intensive livestock-fish production system have more experience of animal husbandry and veterinary techniques than those of the livestock-fish-crop production one. They were also trained by the technician from the feed or veterinary medicine companies or staff of veterinary departments. Thus, they prevent the animals from diseases quite well by practising an appropriate vaccination program and a good hygiene condition of the farm. They also can treat effectively some animal diseases by themselves without external assistances. By contrast, farmers in the livestock-fish-crop production system usually learn the treatment methods of the animal diseases from their neighbours or from the veterinary medicine retailers who were trained as the veterinarian. However, their efficiency of the treatment is still low because of inappropriate methods or medicine. They also do not pay much attention to the vaccination program or hygiene condition of the farms. Thus, the animal flocks are more vulnerable to the epidemics.

2.2.5 Analysis of economic outcomes of the animal-aquaculture based production system

The added-value of animal production and crop cultivation

In the livestock-fish production system, the production of pigs, chickens and fishes contributes greatly to the total added-value of the households. Although the gross product of chicken production is very high, the added-value is equivalent to that of the pig or fish production. Most of the chicken farms in this system are the completely closed system which consumes a high quantity of inputs such as industrial animal feed, electric energy, and modern equipments, etc. The ratio of cost to gross product is thus extremely high, about 0.87 or 87%, much higher than that of pig and fish production (about 69.2% and 61.7%, respectively). That is the reason why most farms focus on pig and fish production rather than invest in industrial chicken farms.

Table 5.13. The added-value of the animal production and crop cultivation of households in the animal-aquaculture based system

(Million VND)

Production	Livestock-fish system (n=13)			Livestock-fish-crop system (n=25)		
	GP	IC	VA	GP	IC	VA
Rice	11.6	2.6	9.0	13.5	4.7	8.8
Pigs	149.5	103.5	46.0	76.1	61.4	14.7
Chickens	346.9	301.9	45.0	72.3	60.7	11.6
Ducks	10.6	8.8	1.8	17.8	14.7	3.1
Fishes	145.9	90.0	55.9	37.1	20.0	17.1
Winter crops	0	0	0	5.4	1.6	3.8
Total	664.5	506.8	157.7	222.2	163.1	59.1

(Source: Household surveys, 2010-2011)

In the livestock-fish-crop production system, the gross product and added-value are lower than those of the livestock-fish production system. The fish production, although have a lower level of gross product due to the limitation of fish pond areas, provides a higher added-value than that of the pig and chicken production. The fish production is a highly cost-effective investment because the ratio of cost to gross production is very low, about 0.54 or 54%, much lower than that of the pig and chicken production (80.7% and 83.9%, respectively). The extreme utilization of crop residuals and other agricultural by-products results in a low level of the production cost of fish raising. Moreover, the price of most fish varieties at the market is fairly constant at the favourable price. Fish production is thus of great importance for the household economy in this production system.

However, the gross product and added-value of the animal production in this production system are also strongly affected by the instability of prices of animal products in the market. Recently, the price of pigs and poultry at the farm gate has changed regularly because of bird flu and PRRS pandemics. The occurrence of epidemics caused the sudden reduction of pork demand and the lack of supply as well. The figure 5.5 shows the fluctuation of price of live fattening pigs in Cam Giang district by months. It is clearly that, in the two first quarters of the year, the price is much lower than that in the last ones. The difference between the lowest and the highest point is nearly two times. Therefore, the added-value differs from one farm to another and from year to year.

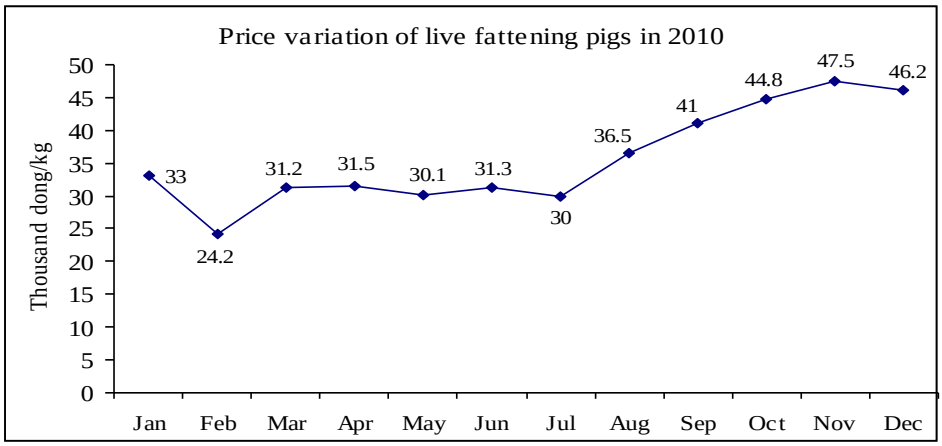


Figure 5.5. Price variation of live fattening pigs in Cam Giang district in 2010
(Source: Farm gate price records of Mrs. Pham Thi May, Cam Hoang commune, 2010)

The agricultural income of households

On average, the agricultural income of households in the livestock-fish production system is 135.6 million VND, 2.5 times higher than that of households in the livestock-fish-crop system (table 5.14). Similarly, the family agricultural income per land unit and per active family labour of households in the livestock-fish system is much higher than that in the other (1.7 times and 3.0 times, respectively). The high-scale production often shows a higher economic efficiency than the small and medium ones. However, households in the intensive livestock-fish production system have to pay much money for fixed costs such as waged labours, land rent, and loan interest.

Table 5.14. The agricultural income of households in the animal-aquaculture based system

Parameters (million VND)	Livestock-fish system (n=13)	Livestock-fish-crop system (n=25)	P-Value
Gross product	664.5[a]	222.2[b]	0.000
Intermediate cost	506.8[a]	163.1[b]	0.000
Added-value	157.7[a]	59.1[b]	0 .022
Paid waged	5.1	0	-
Taxes	0	0	-
Land rent	2.5	1.5	0.46
Loan interest	14.6[a]	3.9[b]	0.003
Family farming net income (FNI)	135.5[a]	53.7[b]	0.024
FNI/sao	12.5	5.3	0.069
FNI/ active family labour	64.7[a]	19.3[b]	0.037

([abc] Means in the same row without common letter are different at P<0.05
Source: Household surveys, 2010-2011)

Although households in the livestock-fish production system gain a high income from large-scale of animal and fish production, it is difficult for small and medium farmers to switch from a diversified livestock-fish-crop system to a specialized livestock-fish system. It is

because developing the intensive animal production system requires big investment in both fixed assets and annual consumption. Moreover, the specialized animal production farms are increasingly risky to the instable context of environments due to the increase of the animal feed price and the threat of infectious epidemics. The small and medium farms diversify their income sources by combining agricultural revenue and off-farm salary. For many farms, the off-farm income contributes greatly to the total family revenue.

2.3 The annual vegetable-based production system in the middle zone

2.3.1 Structure of the annual vegetable-based production system

In the middle zone, the vegetable-based production system is the predominant production mode of most households. A high proportion of households engaged in the vegetable cultivation, which is considered as their main livelihood strategy and an important source of income. The cultivated land area of vegetable crops in this region also shares the largest percentage of the entire province. Thus, an enormous amount of vegetable was produced and supplied to the local market and the southern regions of Vietnam.

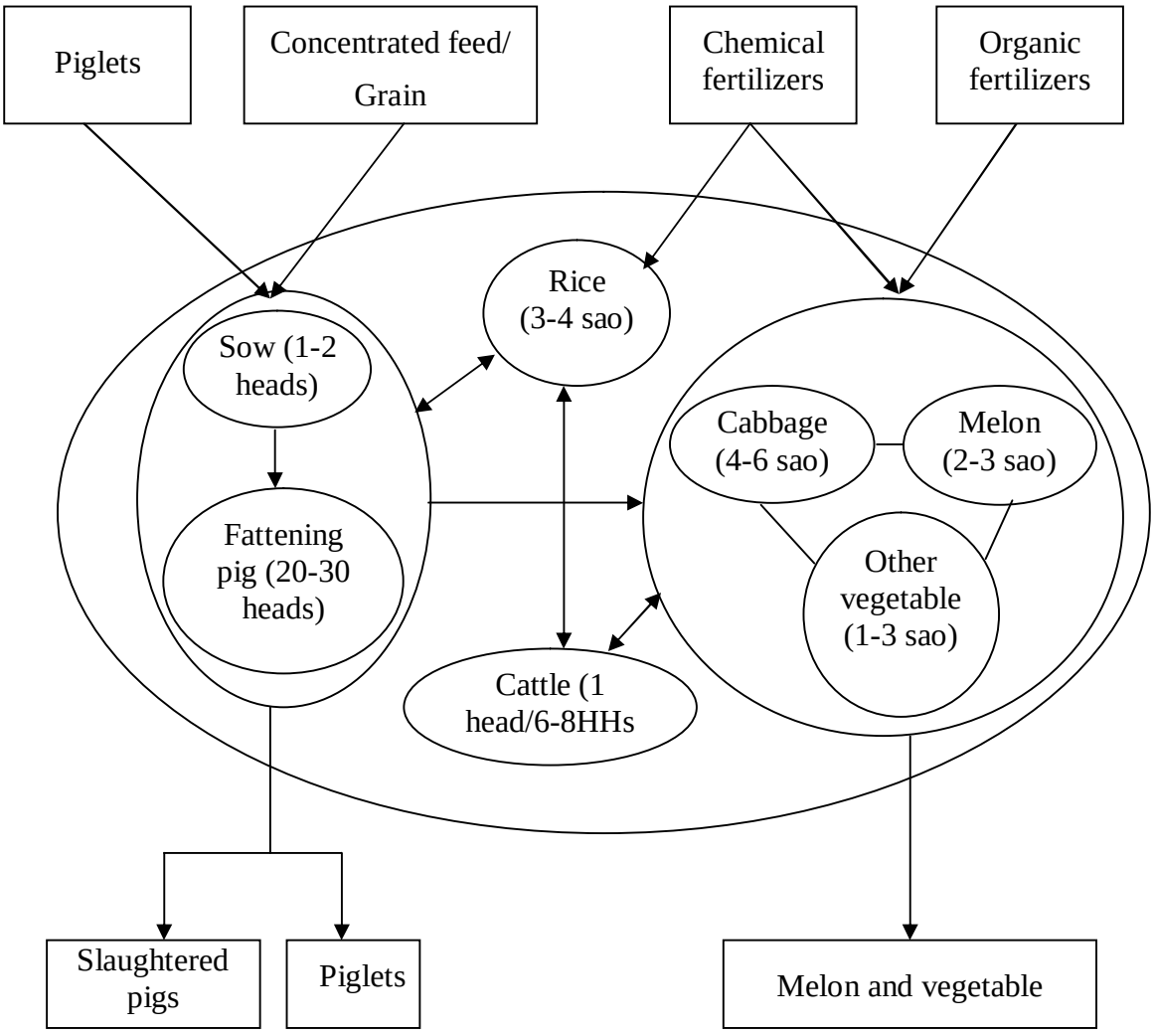


Figure 5.6 Flow diagram of the annual vegetable-based production system

This type of production system is featured by the association and rotation of different vegetable crops, depending on the physical conditions and the demand of the consumers. In the central location, where has a good infrastructure system and easy market access, farmers focus on a more specialized vegetable production system. Cabbage and melon crops are the two main crops and grown largely in the rice field. By contrast, the poor rural infrastructure and market channel in the remote part of the middle zone make it more difficult for farmers to develop the single crop farming. A strong association of different vegetable varieties are practised in order to reduce the instability of the market.

The animal husbandry is also integrated into this production system by some households, especially in the diversified vegetable-based production system. Pigs are the predominant species kept by farm holdings. However, the animal herds are just a secondary production section of families as a supplement source of income. The pig flocks are raised at a small scale, about 1-2 sows and 20-30 heads of fattening pigs. They may keep only sows or growing pigs or both, depending on the economic condition and the experience of raising pigs. At the moment, the production of pigs as well as other livestock species is diminishing substantially in these households due to the high price of industrial concentrated feed and threats from infectious diseases.

2.3.2 Characteristics of the cropping and animal production system

2.3.2.1 The cropping system

The annual crops such as rice, melons, and other vegetables are largely cultivated in this region. In the past, these crops were popularly grown as the cash crop. Farmers also have many experiences in growing different varieties of vegetable. Thus, this region becomes the original area and the largest supplying centre of vegetable in Hai Duong province.

As described above, there are two main types of vegetable-based production system in this zone. They are the specialized cabbage-melon production system and the diversified vegetable one. There are several differences between these two systems in terms of farm size as well as farm structure. The general characteristics of these systems are summarized in table 5.15.

Table 5.15. The general characteristics of the vegetable-based production system

Characteristics	Cabbage-melon system (n=17)	Diversified vegetable production system (n=13)
Farm size (m^2)	1,967.3	2,124.0
Area per capita (m^2)	565.2	490.6
Proportion of households raising pigs (%)	17.6	23.1
Pig flock size	1.7 sows; 36.7 growing pigs	1.3 sows; 10.0 growing pigs
Main crops	Rice, cabbage, melon	Rice, cabbage, melon, cucumber, cauliflower, green bean, etc.

(Source: Household surveys, 2010-2011)

The cabbage-melon production system

This is a specialized vegetable production system in which cabbage and melon are rotated one after the other over the year. Normally, only one rice crop is grown in the spring season. Then, farmers develop one melon crop in the summer season and two cabbage crops during the autumn and winter with large cultivated areas. Cabbage crops become the major cash crop of most farm holdings here.

Photo 5.3 A large field of cabbage in the cabbage-melon production system (Gia Xuyen commune, 12/2012)

Farmers in this vegetable production system often have good technical knowledge and skills in cultivating cabbage and melon crops. They are trained regularly with improved techniques by staff of both the agricultural extension office and the seed or pesticide companies. They have a good relationship with the seed and pesticide companies and the big output collectors. The private companies provide vegetable growers with hybrid seed and pesticides and train them how to grow vegetables and manage the pest attack. Besides that, farmers also share each other frequently about the technical procedure and the pest management. They also access easily to the market due to the well-developed marketing system in the central location. Therefore, they specialize in the cabbage-melon production system.

The cabbage-melon production system is predominant in the central locations, which have largely plain fields and closed to the agricultural commodity collecting units. The development of the original agricultural market in this region, which is so-called Gia Xuyen vegetable market, is a great incentive for producers to specialize in a single vegetable crop with large areas rather than the diversified one. A thousand ton of cabbage were produced and transported directly not only to the local market but also to the markets in the central and south regions of Vietnam.

The diversified vegetable production system

In the lower part of the middle zone, which is far away from the central district town, most farm holdings apply the diversified vegetable production system. The undeveloped marketing system induces producers to diversify their vegetable crops to avoid risks from instable prices in the market. Moreover, because the fields are uneven and low, vegetable crops are mostly grown in the upper fields while rice is planting in the lower locations. The field is also very fragmented due to the equal division in 1993. Therefore, each household has many small land plots in which different vegetable crops are cultivated.

A wide range of vegetable varieties are associated and rotated each other, depending on the price of the previous harvests and the interest of the family. Beside cabbage and melon, cucumber is one of the most important crops in this system due to its high price in recent years. In the past, cucumber and cabbage crops were the two important kinds of vegetable exported to the Eastern Europe and Soviet Union markets. Thus, farmers have many experiences in cultivating these crops.

Photo 5.4. Diversified vegetable crops in the field
(Thong Kenh commune, 12/2012)

However, the highly diversified vegetable production system requires a lot of active labours for different works such as land preparation, pesticide application, watering crops, and harvesting products, etc. This is a big challenge for many households because of the increasing shortage of active agricultural workers now. Many households explain that they will specialize in several major vegetable crops such as cucumber, cabbage, melon in the coming year.

2.3.2.2 The livestock production system

As presented above, the livestock production is only a secondary section of the family economy in the vegetable-based production system. A few numbers of households practised raising animal husbandry, which was characterized by small scale. The rapid increase of animal feed prices and growing threats of animal infectious diseases pose difficulties to the small animal production system. Many farming households stopped keeping animal husbandry for years. The animal flock size and proportion of household applying animal production is shown in table 5.16.

Table 5.16. Livestock production of households in the vegetable-based production system

Animal species	Cabbage-melon system (n=17)		Diversified vegetable system (n=13)	
	Animal heads	% HH applied	Animal heads	% HH applied
Sows	1.7	17.6	1.3	23.1
Growing pigs	36.7	17.6	10.0	23.1
Poultry	30.0	11.8	25.0	15.4
Beef cattle/buffalo	1.0	11.8	1.0	61.5

(Source: Household surveys, 2010-2011)

According to the survey result, there is a small proportion of households engaged in the animal production with small scale, mostly pig raising. They only rear about 1-3 sows to provide piglets to other households or fattening them on farm. However, the pig population varies considerably according to the prices of live pigs in the market and the occurrence of some infectious epidemics. They may purchase more piglets from surrounding farms right after the epidemic outbreak, PRRS, for instance, because of an increasing trend of the pig price in the following months. It makes the system more resilient to the fluctuation of the market price. However, it is one of the reasons for the transmission of diseases from farm to farm, causing the big threats to animal production of the family.

Beef cattle or buffalo flocks are kept by several households, especially in the diversified vegetable system for the drought purpose. In the cabbage-melon system, a few households (11.8%) have cattle or buffalo with a small flock size, mostly one head per farm. These animals play an important role because they are not only used for on-farm works but also being rent out as a service to other farms. However, in the diversified vegetable production system, the producers have a strong cooperation in keeping cattle for land preparation. Generally, about six to eight households keep one cattle or buffalo as a common asset. Each family in the group has to take responsibility for raising the animal for one day after every six to eight days. In the peak period of land preparation for crop cultivation, the animal will work from one farm to another within the farm group according to the tentative schedule. The profit from selling the calf will be equally divided among families in the group. This kind of collaboration helps to solve the shortage of labours in rural areas and save the production cost by reducing the external rented services.

2.3.2.3 Land resource

The limitation of the arable land for the vegetable cultivation

The arable land is becoming scarce in the middle zone where the vegetable production system is predominated. The average farm size of surveyed households is quite small, about 1,967 m^2 and 2,124 m^2 in the cabbage-melon system and the diversified vegetable model, respectively. In the cabbage-melon system, although the land area per capita seems to be higher than that of the diversified vegetable system, a high proportion of household has a small farm size (under 1,800m^2). In this system, farm holdings can combine vegetable cultivation with off-farm jobs easily since the favourable location (near Hai Duong city and Gia Loc town). Most of the farms keep their land areas growing vegetables. Thus, the farm size is smaller than that of other regions.

Table 5.17. Land area of households in the vegetable-based production system

Characteristics	Cabbage-melon system (n=17)	Diversified vegetable system (n=13)
Farm size	1,967.3 m^2	2,124.0 m^2
Farm area per capita	565.2 m^2	490.6 m^2
Distribution of frequency (% of households)		
<1,800 m^2 (1-5 sao)	64.7 %	30.8 %
2,160 m^2 – 3,600 m^2 (6-10 sao)	29.4 %	69.2 %
>3,600 m^2 (>10 sao)	5.9 %	0 %

(Source: Household surveys, 2010-2011)

In the diversified vegetable system, although the land area per capita is low, farm holdings rent more land from their neighbours who go out for off-farm jobs to grow vegetable or rice. The farm size is thus bigger than that in the centre region. Most farm holdings have about 6-10 sao (or 2,160 to 3,600m^2) of land area. Land is accumulated rapidly by some households who stay in the countryside and do the farming.

2.3.2.4 The labour force

In Gia Loc district, the ordinary cultivation of vegetable has a high demand of human energy due to the low level of mechanisation. The active labour is of great importance for families to develop the vegetable production system. The labour force of the households in the vegetable-based production system is shown in table 5.18.

Table 5.18. Labour force of households in the vegetable-based production system

Parameters		Cabbage-melon system (n=17)		Diversified vegetable system (n=13)	
		Mean	SD	Mean	SD
Mouths to feed		3.8	1.1	4.4	0.9
Active labours		2.1	0.6	2.2	0.6
Dependency ratio		1.8	0.3	2.0	0.4
Age of household head		48.5	7.1	46.2	5.9
<35 years old (%)		5.9	-	0.0	-
35-44 years old (%)		17.6	-	38.5	-
45-55 years old (%)		64.7	-	53.8	-
>55 years old (%)		11.8	-	7.7	-
Proportion of family labour (%)	Only on-farm	23.5	-	30.8	-
	On and off-farm	76.5	-	69.2	-

(Source: Household surveys, 2010-2011)

In general, there is not a significant difference about the labour force between households in the two vegetable production systems. The family size is about 3.8 to 4.4 members in which half of them are the active labours. Most families have 2 or 3 active labours working on farm

or combining on-farm and off-farm jobs. The proportion of labours engaging in both on-farm and off-farm works in the two production systems is much higher than that of on-farm workers. It means that, most active labours of the families find off-farm jobs while still working partly on their farms. In some cases, one or two active labours of the households work outside their farms while the others stay at home and take responsibility for farming operations. This helps to diversify the income sources.

Like many other regions in Hai Duong and in Vietnam, the shortage of agricultural labours is increasingly emerged in the vegetable zone. Most of the old people stay and work on farm while the young go out for off-farm jobs. The average age of household heads is about 46 to 48 years old. There is a high proportion of household heads belonging to the age of 45-55 years old. Many of them are women, who have to take responsibility for the housework. They are too old to find an off-farm job. Thus, they lack active workers for agricultural production, especially during some peak periods such as transplanting or harvesting seasons.

To deal with the lack of agricultural labours, several solutions are implemented by vegetable growers in Gia Loc district. The exchange of labours between households is one of the good ways conducted by many households. It means that households in a small group of families, mostly the close relatives or neighbours, help each other to practise farming such as land preparation or harvesting products. However, during the peak time of harvest, many households in the cabbage- melon production system have to rent more seasonal waged labours from surrounding communes such as Lien Hong, Gia Hoa, Trung Khanh, etc. The salary paid to waged labour increases rapidly. The vegetable cultivation needs to be mechanized.

2.3.2.5 The financial capital

Low proportion of households having a loan

In Hai Duong province, the vegetable cultivation is not a big investment enterprise because of limited land area per household and manual works. The average cultivated area per household is about 5.5 to 5.9 sao and divided into many plots, which hinder the mechanization. Thus, farmers do not invest much in fixed assets and modern equipments. That is the reason why most of them do not need much loan capital, about 15% to 17% of total surveyed households, with a small amount of money, about three to ten million dong per household (table 5.19).

Table 5.19. Loan access of farm holdings in the vegetable-based production system

Sources	Cabbage-melon system (n=17)		Diversified vegetable system (n=13)	
	Amount (thousand dong)	% of HHs	Amount (thousand dong)	% of HHs
Banks	9,411.8	17.6	2,923.1	15.4
Local credit funds	1,176.5	5.9	0	0
Others	0	0	769.2	7.7

(Source: Household surveys, 2010-2011)

Post-paid service of chemical fertilizers as a source of loan capital

Although vegetable growers do not have to invest much in fixed assets, they also need much money to pay for intermediate consumption cost of vegetable cultivation, especially chemical fertilizers. The intensification of vegetable production is accompanied by the increasing use of synthesis materials for crops, leading to the high consumption of chemical fertilizers. Moreover, the considerable decline of the family animal raising of most farm holdings causes the less application of organic fertilizers to the crops than that of inorganic products. Therefore, producers highly depend on the purchased input which is observed with a rapid increase of its price. And many farms, especially poor and medium ones, have difficulties in paying for this production cost.

To deal with this difficulty, most of the farm holdings engage in post-paid services in the fertilizer supply. Farmers buy fertilizers directly from stores of the retailer at the commune with an added cost of 10,000 to 15,000 dong per one package (50kg) compared with the current price, but in debt. Then, after harvesting and selling vegetable crops, the bill will be paid to the retailers. This kind of debt service is considered as the loan that helps the poor and medium farms to overcome their lack of financial capital. Some rich farm households that have large areas of vegetable crops buy a huge amount of fertilizers right after harvesting time and store them for the following crops to limit the impact of the skyrocketing price trend. It is a good strategy of producers to adapt to the strongly unstable market. The poor and medium farms may also cooperate with each other in purchasing higher amount of input materials with favourable prices rather than that of the individual action.

2.3.3 The agro-input management system

2.3.3.1 The crop association and rotation

The agricultural land area in the middle zone is becoming scarce due to the industrialization and urbanization acceleration. Thus, taking the most limited resources by implementing the intensive production system is of great importance for vegetable growers. The arable land is used intensively for different crops to meet the growing demand for vegetable products of the consumers. The crop calendar is different from one type of land to another, depending on their fertility and territory as well as the development of the marketing system. Figure 5.7 shows the temporal crop rotation and succession in the middle zone of Hai Duong province.

Production systems	Months											
	1	2	3	4	5	6	7	8	9	10	11	12
Cabbage-melon system												
Upper land	Spring rice					Melon		Early cabbage			Main cabbage	
Diversified vegetable system												
Lowland	Spring rice					Summer rice					Fallow	
Upper land	Spring rice					Cucumber, Melon, Bitter melon, Eggplant					Cucumber, Cabbage, Cauliflower, etc.	

Figure 5.7. The crop calendar of the vegetable-based production system in the middle zone (Source: Participatory discussions at Gia Xuyen and Thong Kenh commune, 2010)

There is a little difference in crop calendar between two production systems, depending on the land type. In the cabbage-melon production system, because most of land areas have upper territory, farmers often implement one melon and two cabbage crops followed by one rice crop in spring. The development of early cabbage crop in autumn (from August to October) is of great importance for producers due to the higher price than that in winter crop. Several cabbage varieties that are well-adapted to the high temperature in autumn were introduced to growers. Thus, the summer rice was replaced by the cabbage crop which provides farmers with much higher profit than the rice cultivation. Rice was only grown in the spring season to meet household consumption and reduce the build-up of plant pathogens and pests from previous vegetable crops.

Moreover, in this system, watermelon which had been cultivated for many years was replaced by muskmelon. The long-term cultivation of watermelon crop caused the degradation and the decease of yield over the year. Farmers observed that the fruit was smaller than that in the past even higher input application. This plant variety consumes a huge amount of fertilizers. It is also riskier than muskmelon because there is only one big fruit per watermelon plant in compared with a number of small fruits per muskmelon plant. Thus, in case of bad harvest, the muskmelon can continue flowering and fruiting for the secondary harvest. That why the muskmelon crop is now widely substituted for the watermelon crop by most farms.

Table 5.20. Crop pattern of the vegetable-based production system

Crops	Cabbage-meoln system (n=17)		Diversified vegetable system (n=13)	
	% of HHs applied	Cultivated area (sao)	% of HHs applied	Cultivated area (sao)
Rice	100	4.5	100	3.7
Watermelon	64.7	2.5	76.9	1.7
Muskmelon	94.1	3.1	23.1	1.5
Cabbage (early crop)	94.1	5.2	0	0
Cabbage (main crop)	88.2	4.1	46.2	1.4
Cucumber	5.9	1.0	92.3	2.3
Cauliflower	5.9	1.3	69.2	1.3
Bitter Melon	0	0	53.8	1.5
Eggplant	0	0	38.5	1.1
Green bean	0	0	23.1	1.1

(Source: Household surveys, 2010-2011)

In the diversified vegetable production system, the crop calendar in lowland areas is different from that of upper land areas. In the lowland fields, two rice crops were developed per year and followed by a fallow period in winter. In the upper parts, the diversified vegetable crops were cultivated during the summer and winter seasons. The selection of vegetable crops depends on the price trend in the market in recent years and the interest of each family taking into account the land, labour and capital resources. Cucumber is the most important vegetables grown by most farms (92.3% of total surveyed households) due to the high price in the market. It can be developed in summer or winter after the spring rice. Cabbage is also grown during the winter as the main crop (76.9% of surveyed households). This system is resilient to the change of the market.

2.3.3.2 Soil fertility management

In horticulture, the soil fertility management plays a central role in maintaining the crop productivity and sustaining the development of the cropping system. The long-term cultivation of annual crops uptakes a great amount of nutrients from the soil that should be offset by different sources, especially from fertilization. However, the fertilization needs to be appropriate with different soil types, crop varieties and other ecological conditions to meet sustainable agriculture development. The inappropriate fertilizer application is harmful to not only crops but also the soil fertility. Therefore, sufficient knowledge of soil and fertilizer management is of great importance for vegetable growers.

The investigation of producers in the vegetable-based production system indicated that inorganic fertilizers are used more common than the organic ones. In comparison with organic fertilizers, the application of inorganic ones seems to be more convenient. Farmers can purchase easily different kinds of fertilizers from a number local retailer. The synthetic fertilizer contains nearly all necessary nutrients that are ready to be used by plants. These components are readily absorbed by plants because they do not need a certain time to be decomposed before usage. Thus, farmers have used this kind of fertilizer more and more popularly for vegetable cultivation recently.

However, the inadequate application of inorganic fertilizers of most producers in the vegetable-based production system over a long time is degrading soil quality. Although there are label instructions about the appropriate amount of fertilizers used for different crop varieties, most farmers often apply it to crops based on their own experiences. They often use an excessive dose of nitrogen and phosphate fertilizers for their crops to expect a higher productivity (table 5.21). The over-fertilization of synthetic products over a long period causes the soil retrogression and degradation. Consequently, to increase the crop yields, farmers apply a higher surplus amount of fertilizers to vegetable crops. Thus, farmers state that the soil fertility is becoming degraded nowadays.

Table 5.21. Application of inorganic fertilizers in cabbage and cucumber cultivation

Fertilizers	Cabbage-melon system (n=17)		Diversified vegetable system (n=13)	
	Early cabbage (kg/sao)		Cucumber (kg/sao)	
	Amount applied	Standard*	Amount applied	Standard*
Urea	19.5	7.4-9.0	8.1	5-6
Phosphate	34.4	13.5	36.4	7.0
Potassium	3.9	6.7	2.2	8.0

(Source: Household surveys, 2010-2011; *standard level for each crop is introduced on the agriculture web page of Hai Duong Department of Science and Technology, (Hai Duong Department of Agricultural Extension, 2009; Thanh, 2009)

Organic fertilizers are considered as a good nutrient source for the vegetable cultivation. They make the soil rich and well-balanced so that is ideal for planting. The compost of animal manure is one of the most important sources of organic fertilizers of most farms in the past. The integration of animal husbandry and crop cultivation in the mixed production system was popular during the previous time. The soil fertility was long-term maintained thanks to the regular use of compost of animal wastes.

However, the application of organic fertilizers to vegetable crops of most farms has declined considerably since recent years. The disappearance of the small-scale livestock production of many farm holdings results in the lack of animal wastes for composting and providing to vegetable fields. Although there is a supply source of animal manure from big animal farms in surrounding regions, few numbers of vegetable producers buy it because of high cost. Moreover, the utilization of this organic substance requires more labour force and takes more time than that of inorganic one. Therefore, organic fertilizers are less used for vegetable crops than the inorganic one.

Table 5.22. Use of the organic fertilizer for vegetable crops of surveyed households

Crops	Cabbage-melon system (n=17)		Diversified vegetable system (n=13)	
	% of HHs applied	Quantity (kg/sao)	% of HHs applied	Quantity (kg/sao)
Rice	11.8	14.7	15.4	22.3
Watermelon	41.2	117.6	23.1	53.8
Muskmelon	41.2	100.0	15.4	23.1
Cabbage (early crop)	35.3	94.1	-	-
Cabbage (main crop)	17.6	35.3	7.7	7.7
Cucumber	-		30.8	50.0
Cauliflower	-	-	7.7	15.4
Eggplant	-	-	0	0
Green bean	-	-	0	0
Bitter Melon	-	-	0	0

(Source: Household surveys, 2010-2011)

The surveyed results showed in table 5.22 illustrate that there is only a small proportion of households applied organic fertilizers to their crops. In the cabbage-melon production system, farmers use the composted manure for their vegetable crops, especially melon and early cabbage, more popularly than those in the diversified vegetable production system. The big farms which have large vegetable fields often purchase animal manure from pig farms through the local collectors. These wastes are then composted and reserved for the vegetable planting. In the diversified vegetable production system, cucumber is the main crop that is supplied with a higher amount of organic fertilizers than others. But, on average, the application of organic fertilizers is very limited. Normally, only households who still keep livestock flocks continue utilizing composted manure for the vegetable growing.

The rapid increase of price of fertilizers

The price of most chemical fertilizers has risen significantly across the years. For example, the price of several fertilizers in 2008 was much higher than those of 2007, including 128% for phosphorous, 80% for NPK, 200% for SA, 200% for potassium, 300% for diamino phosphate (Ha Yen 2008).

The chemical fertilizer industry cannot meet the growing demand of agricultural production. Thus, about 50% of annual demand amounts of most fertilizers are imported from foreign countries, some kinds of fertilizers such as diamino phosphate, potassium, SA, etc. were even imported by 100%. There are many different fertilizers exporting countries to Vietnam. However, China is the biggest exporter which shares 60% of total import quantity in 2007

(Report on Agricultural Communities in Vietnam, 2008, cited in (Rong Viet Securities Corporation, 2008). The strong dependence on import sources makes it more difficult to control the price fluctuation, especially when the exporting countries increase the export taxes like the case of China in 2008. The export tax was increased from 25% to 175% for urea fertilizer, from 100% to 120% or 130% for other fertilizers (Rong Viet Securities Corporation, 2008). The development of domestic production was therefore, of great importance to stabilize price systems.

2.3.3.3 Pest and disease management

Pest and disease damage are emerging in the vegetable-based production system in the study site. Most of the vegetable crops are attacked by a wide range of pests and diseases.

Most of the farmers point out that pests and diseases frequently damage their crops. The early crop is facing with the most attacks of pests and diseases such as bacterial soft rot, root maggot or fungal diseases in the cabbage crop. The occurrence of some new pests and diseases makes it difficult for growers to identify and treat them. Many crops were significantly lost because of these attacks. Farmers find it more difficult to cope with pest and disease damage.

There are various reasons for the outbreak of pests and diseases in vegetable crops. Firstly, according to the observations and explanations of producers, the extreme variation of the weather due to the climate change can be favourable for the fast proliferation of many pests and pathogens. It is why the early crop (such as early cabbage) is more concerned with pest attacks. Secondly, the succession of the same crop (such as two melon crops or two cabbage crops) in the specialized vegetable production system causes the transmission of pathogens from the previous crop to the next one. Thus, farmers have to rotate by one rice crop in spring to better control pests and diseases in vegetable.

Photo 5.5. Manual pesticide application to melon fields
(Gia Xuyen commune, 3/2011)

Another important reason for the emerging pest damage in the vegetable production system is the poor pest management of many producers. The investigation indicates that most of the

farmers prevent and control pests and diseases based on their own experiences or neighbouring shares. They lack of knowledge of pest diagnosis, especially with the new unusual disease symptoms. They mostly depend on the advice of the pesticide retailers according to some brief descriptions of the principal signs. In order to have a better efficiency of the pest control or disease treatment, most vegetable growers mix different types of pesticide or fungicide in one sprayer of each application. The combination of various synthetic chemicals is not only a waste of purchased inputs but also harmful to the ecology and human health. It is partly blamed for the increasing resistance of several types of bacteria. Some farms even use the very toxic chemicals to kill the germ more rapidly and efficiently. Hoi et al. (2006) reported that although these toxic pesticides are not allowed to use, they are still sold in many stores and applied to vegetable crops, accounting for 15-21% of total types of pesticide used. Therefore, the environment and agro-ecological conditions are being more polluted and damaged. The outbreak of pests and diseases is also much more difficult to control.

2.3.3.4 The irrigation and drainage management

The irrigation and drainage management plays an important role in the vegetable cultivation. Vegetables are greatly sensitive to both drought and flood conditions. The crop yield strongly depends on the watering activity. Therefore, the irrigation and drainage management needs to be placed at the central position of sustainable development of vegetable crops.

Although the vegetable fields are mostly developed in the upper location of the middle zone, the irrigation and drainage activities still face many difficulties and constraints. In the central part of the middle zone, which has higher territory than the southern region, households in the cabbage-melon production system are sometimes coping with the flood in the rainy season and the lack of irrigating water in the dry one. That is because of inappropriate irrigation and drainage management.

Regarding irrigation activity, the water supply to the vegetable crops has not met the demand of most farms for many years. The different crop rotation or succession among land plots of farmers results in the alternative requirements of watering. For example, in spring, rice is grown in most of the land parcels while the melon is being cultivated in some others. The water pumping is necessary for rice but may cause the ruin of melon. The irrigation schedule seems to be more difficult due to the diversified crop successions among households. Furthermore, the irrigation is implemented by the private company according to the crop calendar of the agricultural cooperatives. The conjunction between the irrigation enterprise and the agricultural cooperative as well as farmers is sometimes limited because of different goals. The irrigation enterprise tries to reduce the cost for electricity by pumping water during the off-peak time such as at night. However, producers find it difficult to take the water to their land at that time. Therefore, the irrigation activity is less effective.

To solve this problem, a five-year project called “capacity development of the participatory irrigation management system” funded by JICA, Japan was launched in 2005 in Gia Xuyen commune as the experimental model. The project purposes were to promote the participation of leading farmers in the irrigation management and to improve the agricultural productivity. A number of difficulties of the irrigation system were analysed and solved through the discussion between producers and the irrigation company. The pumping schedule was accepted by farmers because there was a small group of young farmers who would take responsibility for supplying water to different parts of the field. Producers had to pay a small fee for this service. Moreover, the project also spent partly the budget to upgrade or built new pumping stations or canals. The public media system, mostly radio, was also equipped for

broadcasting the irrigation schedule and other information related to the agricultural production. Thanks to these supports, the irrigation management is now much better than that in the past and favourable for the vegetable cultivation in the specialized vegetable zone.

On the contrary, the drainage system is still under the unfavourable condition. Most of the vegetable fields are facing the flood damage during the rainy season. For example, the flood occurred extremely in 2004, 2005 and 2008. About 50% to 100% of total vegetable cultivated areas were lost because of extreme floods. Although farmers have to use the mini pump to save their crops, the situation was still bad. This is one of the most difficulties for the specialized vegetable production system.

The change of geographical territory is considered as one of the main reasons for the limitation of drainage activity. In the past, the lowland rice fields in surrounding regions were the important places for holding water in case of heavy rains. However, these areas have been mostly converted into fish ponds with high borders so that water from upper fields cannot be in-flowed. Moreover, the acceleration of industrialization and urbanization caused the disappearance of many natural drainage canals and pools. The construction of numerous buildings with a higher territory than that of the vegetable field not only blocks the out flow but also leads to the cumulative volume of water after raining. The vegetable crop is thus more vulnerable to the flood during the rainy season.

In the lower part of the middle zone, where the diversified vegetable production system is widely dominated, the producers are coping with the regular flood during the summer. This region is the cross point of different streams. Hence, the vegetable crop is very vulnerable to the flood every year. Recently, for example, in 2008 and 2009, nearly all vegetable fields were destroyed by the extreme flood.

In other words, the vegetable growers in the south of the middle zone also have some difficulties in irrigating the crop in winter. The underdeveloped irrigation systems cause the lack of water supply for vegetable cultivation. Farmers have to take the water about two kilometres away from their land plots in other communes (such as Dan Chu commune or Quang Nghiep commune in Tu Ky district). Recently, the irrigation system in the study commune (Thong Kenh) has been upgraded slightly. A new station was built in 2009 to facilitate the irritating activities of many farm holdings.

2.3.4 Productivity of the vegetable crops

Productivity of vegetables varies significantly from one region to another one, depending on many agro-ecological characteristics and the technical itineraries applied by producers. The productivity of some main vegetables in the two production systems is shown in table 5.23.

Table 5.23. Productivity of some vegetable crops in 2009

Vegetable crops (kg/sao)	Cabbage-melon system (n=17)		Diversified vegetable system (n=13)	
	Mean	SD	Mean	SD
Watermelon	874.5	256.6	615.0	206.9
Muskmelon	801.3	228.7	662.5	57.7
Cabbage (early crop)	1143.8	437.4	-	-
Cabbage (main crop)	1543.3	383.1	1132.9	223.9
Bitter melon	-	-	968.6	190.4
Cucumber	-	-	1012.5	120.8
Cauliflower	-	-	694.4	135.7
Eggplant	-	-	1240.0	207.4
Green bean	-	-	716.7	125.8

(Source: Household surveys, 2010-2011)

Cabbage is one of the vegetable crops that have the highest productivity in comparison with others. On average, the productivity of cabbage in the main crop (in winter season) is higher than that of early crop (in autumn season). In early crop, the weather is quite warm and not favourable for the growing of cabbage. Thus, producers have to use more input materials (fertilizers and pesticides) to improve the productivity of cabbage in early crop. The high productivity of this vegetable is one of the reasons why farmers expand and specialize in it for many years.

In the diversified vegetable production system, cucumber is one of the major vegetables widely cultivated by most farming households. The productivity of cucumber is fairly high (about 1012.5 kg/sao), higher than that of some other vegetables. Farmers can grow two cucumber crops per year during the winter season because of its short production cycle. One of the advantages of cucumber cultivation is that the products are harvested in many times. Therefore, it has a high productivity.

However, the productivity of most vegetable crops is highly instable because of the climate change or pest damage. As discussed in the previous part, due to the poor irrigation and drainage system, the vegetable fields are now increasingly vulnerable to the flood or drought. Some vegetables, especially cabbage, are even highly sensitive to the sudden changes of the weather such as hoar frost, heavy rains, hailstorm, etc. Moreover, the crops are also considerably lost because of attacks of various types of pests and diseases. Therefore, many households have a low productivity and a bad return from their vegetable crops.

2.3.5 Analysis of economic outcomes of the vegetable-based production system

High proportion of expense of chemical fertilizers and pesticides in the total production cost

To illustrate the increasing proportion of cost of synthesis materials in the vegetable cultivation, we calculate the actual cost structure of some main vegetable crops in two systems. They include the cost of chemical and organic fertilizers, seed, pesticide and herbicide, land preparation and other costs such as nylon covering land mound of melon or bamboo stick to hold cucumber plants, etc. The production cost structure of several vegetables was presented in table 5.24.

In the two production systems, the cost of the synthesis input accounts for a significant proportion in the total cost. Chemical fertilizers are increasingly applied to most vegetable crops, making up the biggest part, about 40% to 50% of the total cost. The gradual rise of price of inorganic fertilizers in recent years is one of the major causes of this high expense. Besides that, the inappropriate dose of fertilizers applied to vegetables in an attempt to improve crop productivity causes a considerable waste and loss.

Similarly, cost of pesticide and herbicide also makes up a high percentage of the total expense, especially in the early crop. In the cabbage-melon system, the cost of pesticide and herbicide used for early crop is much higher than that of main crop (table 5.24). The overuse of these products not only wastes the money but also harms the ecological environment.

The production cost of most vegetable crops in the cabbage-melon production system seems to be higher than those of the diversified vegetable production system. In this system, producers intensify their production by applying more fertilizers and pesticide to crops. In the diversified vegetable production system, the combination of different varieties of vegetable helps to improve the utilization of fertilizers and reduce the transmission of pathogen. Therefore, they can reduce the production cost remarkably.

Table 5.24. Production cost of some vegetable crops

Cost of production (thousand dong/sao)	Cabbage-melon system (n=17)				Diversified vegetable system (n=13)			
	Watermelon	Muskmelon	Cabbage (early crop)	Cabbage (main crop)	Watermelon	Muskmelon	Cabbage (main crop)	Cucumber
Chemical fertilizer	464.9	301.7	356.1	341.6	563.2	284.4	305.0	369.3
Organic fertilizer	166.4	93.0	81.3	30.7	33.2	65.0	14.3	46.9
Breeding seed	143.9	34.1	174.7	158.7	106.0	53.8	124.3	90.0
Pesticide and herbicide	244.2	155.3	300.3	182.3	196.0	162.5	140.0	164.2
Land preparation and others	37.3	21.9	29.4	0	99.0	43.8	0	120.0
Cost per unit	1056.6	605.9	941.7	713.2	997.3	609.4	583.6	790.4

(Source: Household surveys, 2010-2011)

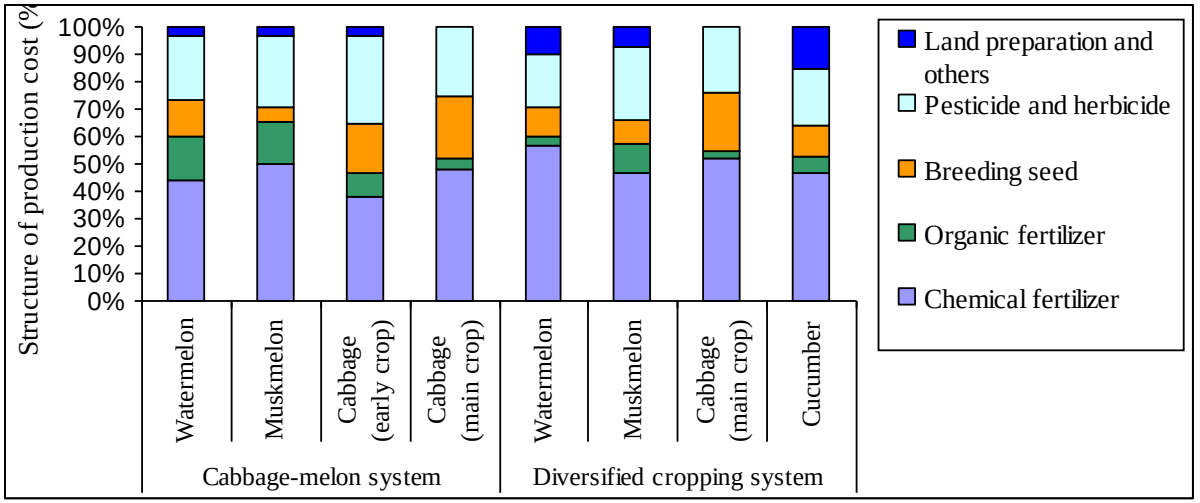


Figure 5.8. Cost structure of vegetable cultivation
(Source: Household surveys, 2010-2011)

The added-value of some crops and animal production

The added-value of several vegetable crops and livestock production of farming households in the two production systems is presented in table 5.25.

Table 5.25. Added-value of several vegetable crops in the vegetable-based production systems

Production sector (million dong)	Cabbage-melon system (n=17)				Diversified vegetable system (n=13)			
	GP	IC	VA	VA/sao	GP	IC	VA	VA/sao
Rice	5.5	1.6	3.9	0.8	4.3	1.3	2.9	0.8
Early cabbage	18.5	4.7	13.8	2.7	-	-	-	-
Main cabbage	9.2	2.7	6.4	1.5	2.0	0.5	1.5	1.0
Musk melon	7.0	1.8	5.2	1.7	0.9	0.3	0.6	0.4
Watermelon	3.8	1.7	2.1	0.8	2.2	1.4	0.8	0.4
Cucumber	-	-	-	-	5.5	1.7	3.7	1.6
Cauliflower	0.3	0.1	0.2	0.1	7.3	1.9	5.4	1.3
Livestock	25.0	19.0	6.0	-	18.1	15.8	2.4	-
Total	69.3	31.7	37.6	-	40.2	22.9	17.3	-

(Source: Household surveys, 2010-2011)

In comparison with the diversified vegetable production system, households in the cabbage-melon production system have a higher total added-value even though they invest more in the intermediate consumption. The difference in the intermediate cost between the two systems is 1.4 times whereas the difference in the added-value is 2.2 times. It is because households in the cabbage-melon system can access more easily to the big collecting units and original agricultural market in Gia Xuyen commune while those in the remote region, where the diversified vegetable system is developed, sell their products to the small collectors or middlemen with a lower price. Furthermore, the productivity of most vegetables in the diversified vegetable production system is much lower than that in the cabbage-melon system. Thus, households in the cabbage-melon production system achieve a higher annual added-value than those in the diversified vegetable system.

In the cabbage-melon production system, the early cabbage crop has the highest added-value among kinds of vegetables. In comparison with the main cabbage crop, for instance, although the early vegetable crop has a lower productivity, its added-value is much higher. Although farmers have to invest more in the intermediate consumption of early cabbage cultivation (1.7 times higher), its added-value is 2.2 times higher than that of the main crop. The added-value per sao of the early cabbage cultivation is also 1.8 times higher than that of the main one because of the higher price of the early cabbage crop.

Similarly, producers are now interested more in the musk melon cultivation than that of the watermelon due to the high cost-effective production of musk melon. These two crops have a similar level of cost of the intermediate consumption, where as the added-value per sao of the musk melon cultivation is 2.1 times higher than that of the watermelon. The higher price of musk melon is one of the reasons for this. Besides that, the musk melon fruits are harvested during a longer period than the watermelon ones. The productivity of musk melon is more

stable than that of watermelon in case of one bad harvest. Thus, the cultivated areas of the musk melon increase rapidly while the cultivated areas of watermelon decline across the time.

The extreme fluctuation of the output price of some main vegetables

The added-value of the vegetable rapidly changes from the early crop to the main crop and from year to year due to the extreme fluctuation of their price. The figure 5.9 presents the fluctuation of some main vegetable from 2009 to 2012 according to the annual records of the representative collectors in the study sites. These average prices give an idea about the instability of the market that affects the economic outcomes of the producers.

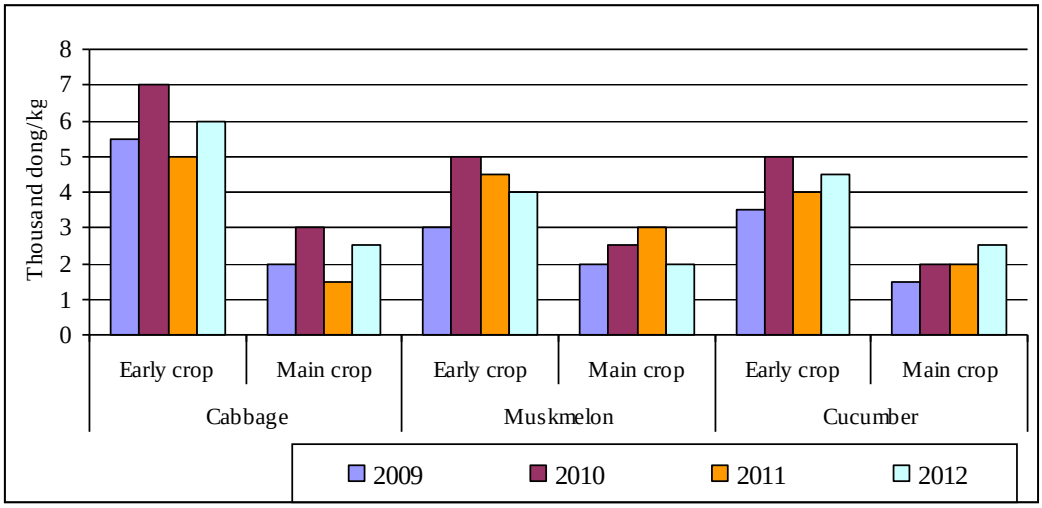


Figure 5.9. Price fluctuation of some vegetable crops
(Source: Annual records of Mr Tang Xuan Truong, a big collector in Gia Xuyen commune and Mr Pham Van Van, a big collector in Thong Kenh commune)

It is clearly that the prices of some main kinds of vegetable considerably change from the early crop to the main crop and among the years. The prices of the early vegetable crop are obviously higher than those of the main crop due to the lower yield or the lower supply than the demand in the marketplace. The price of the early cabbage crop in 2011, for example, was 3.3 times higher than that of the main crop in that year. Similarly, the price of cucumber in early crop of 2010 was 2.5 times higher than that of the main crop. It is the reason why farmers prefer investing more inputs in the early crop to improve the productivity.

Taking consideration of the changes of prices among the years, we can identify that the prices of these vegetables vary remarkably over the period from 2009 to 2012 in both the early crop and the main crop. The price of the main cabbage crop in 2011, for instance, was two times lower than that of the main crop in 2010. The prices of many vegetables seem to decrease across the year, especially for the main crop, due to the oversupply in the market. Farmers explain that it is difficult for them to estimate the demand for vegetable of the consumers. Thus, if the price of one vegetable in the previous harvest was high, many households would expand their cultivated areas of that crop. Consequently, the price will decline rapidly because of the oversupply. Besides that, the price of a specific product is also strongly affected by the sudden change of the weather. The price will rise quickly if the supply chain falls due to the bad weather, the extreme flood, for example. On the contrary, if the weather condition is favourable to the growth of the vegetable, it is likely that the price will mostly decline in that

year. The economic outcome of the vegetable growers is thus strongly influenced by the extreme fluctuation of the price system.

The agricultural net income of households

The calculation of family agricultural net income is shown in table 5.26. On average, the total agricultural net income of households in the cabbage-melon production system is 2.3 times higher than that in the diversified vegetable production system. The income per surface unit and per family active labour of households in the cabbage-melon system is also much higher than that of the other one (about 2.4 times). It is because the productivity and the selling price of vegetables of households in the cabbage-melon system are better than those of the diversified one. In Gia Xuyen commune, where the cabbage-melon production system is widely applied, the marketing channel is developed better than that in Thong Kenh commune, where the diversified system is dominant. Nearly all of cabbage and melon are sold directly to several big collectors and wholesalers in Gia Xuyen commune. These products are then loaded up to the cooling trucks and directly transported to the centre and the south of Vietnam. Therefore, the good development of marketing channel encourages producers to expand and invest more in their production system to improve the productivity and the quality of the products as well.

Table 5.26. Agricultural income of households in the vegetable-based production systems

Parameters (million dong)	Cabbage-melon system (n=17)		Diversified vegetable system (n=13)		P-Value
	Mean	SD	Mean	SD	
Gross product	69.3[a]	55.4	40.2[b]	52.5	0.002
Intermediate consumption	31.7[a]	46.2	22.9[b]	44.1	0.003
Added-value	37.6	18.0	17.3	9.2	0.737
Paid waged	0	0	0	0	-
Taxes	0	0	0	0	-
Land rent	1.4	1.5	1.2	0.9	0.916
Loan interests	0.4	0.8	0.4	0.9	0.850
Family farming net income (FNI)	35.8[a]	17.1	15.7[b]	8.4	0.001
FNI/surface unit (million dong/sao)	7.5[a]	4.4	2.9[b]	4.3	0.001
FNI/ active family labours (million dong/person)	18.0[a]	9.2	7.7[b]	1.1	0.000

([abc] Means in the same row without common letter are different at $P<0.05$
Source: Household surveys, 2010-2011)

Although the households in the diversified vegetable production system have a lower agricultural net income, they appear to face fewer environmental risks than that of the cabbage-melon one. In the cabbage-melon system, the specialized cropping fields are highly risky to the weather disasters or pest damage. The extreme fall of the selling price sometimes causes the very bad returns of cabbage growers. Conversely, in the diversified system, the cultivation of several kinds of vegetable can be less vulnerable to the environmental changes, especially the decline of price or the attacks of a specific pest on one certain vegetable. Under

the context of the underdeveloped marketing channel and unfavourable conditions of agro-ecological environments (lowland, poor irrigation and drainage system, etc.), the application of the diversified vegetable production system, is an appropriate choice of the households. The improvement on the infrastructure system, especially the marketplace and irrigation and drainage system, is thus of great importance to facilitate the vegetable cultivation in this remote region and increase the household income.

Apart from the agricultural income, the households in both vegetable production systems also have another income source from off-farm activities. This source of income also significantly contributes to the total income of the family. The combination of both agricultural income and non-agricultural revenue is essential for farmers to improve their standard of living. The total household income will be less risky to the extreme fluctuation of the agricultural production.

2.4 The perennial fruit- based production system in the lower zone

2.4.1 Typology of the perennial fruit- based production system

The third type of agrarian system largely applied in Thanh Ha district is the perennial fruit-based production system. In the previous period, the fruit tree gardens were expanded largely due to the programme of rice land conversion. Litchi was the major fruit tree cultivated in large areas of this region as the famous product of the district. However, after several years of excessive development, when the price of litchi decreased significantly, the diversification process was started by cutting down litchi trees and developing other fruit crops such as guava or kumquat as well as pig production. Therefore, there are three major production systems in this region now, including specialized guava production system, litchi-pig production system and diversified Litchi-Kumquat-Guava production system. The main components and their relations of these production systems are summarized in the following flow diagram.

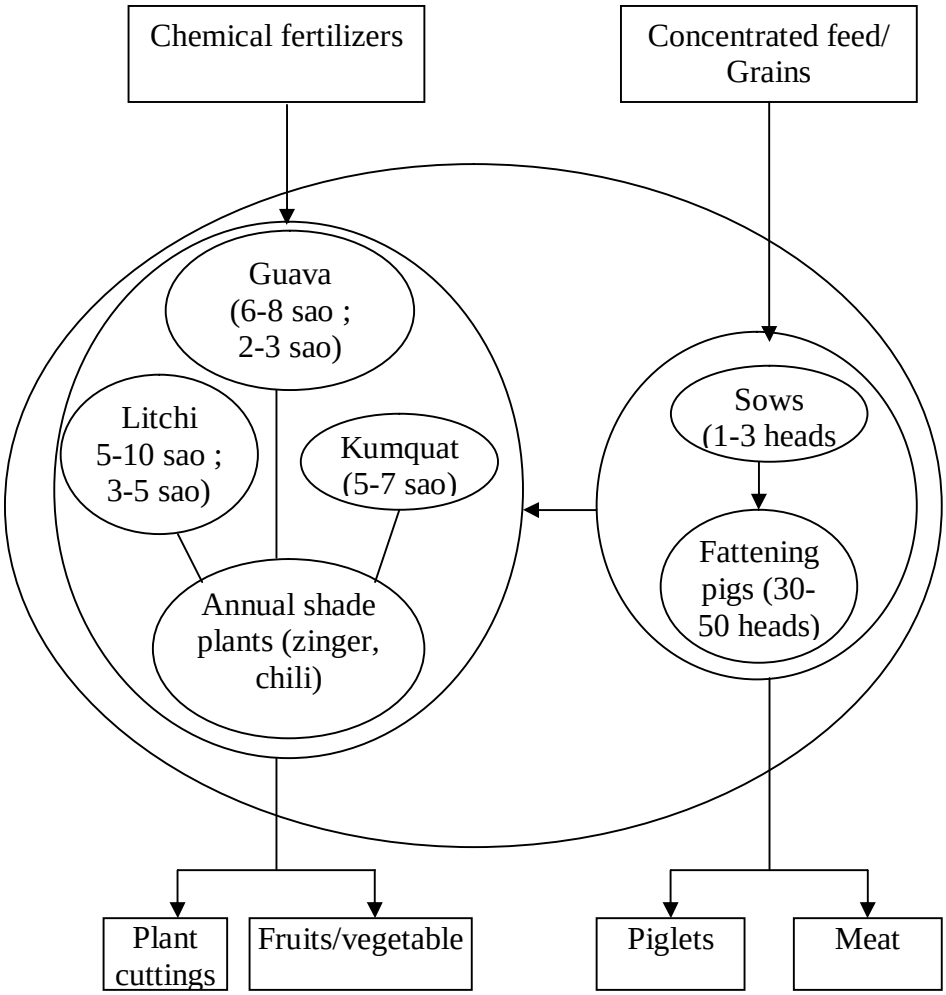


Figure 5.10 Flow diagram of the perennial fruit-based production systems

The typology of the fruit-based production system is mainly based on the cultivated area of different crops of the farm holdings (table 5.27). In the guava production system, guava is the major crops of all families, making up 78.9% of total farm size. Litchi areas are decreasing due to the transformation to guava gardens. Many farms still keep a certain area of rice land according to the strategy of the commune to ensure the food security.

Table 5.27. Cultivated areas of different crops in the fruit-based production systems

Crops	Guava system (n=8)		Litchi-livestock system (n=8)		Litchi-Kumquat-Guava system (n=10)	
	Cultivated areas ($m^{2)}$	% HHs applied	Cultivated areas ($m^{2)}$	% HHs applied	Cultivated areas ($m^{2)}$	% HHs applied
Rice	495.0	62.5	0	0	0	0
Litchi	225.0	25.0	3,750	100	1,314	80.0
Guava	2,691	100	210.0	25.0	630.0	70.0
Kumquat	0	0	0	0	1,746	100
Total	3,411	-	3,960	-	3,690	-

(Source : Household surveys, 2010-2011)

On the contrary, litchi areas are very large in the litchi-livestock production system, accounting for 94.7% of the total cultivated land area. These farms just cut down some litchi trees in the home gardens to develop animal buildings. The litchi areas in the field are mostly sustained, about 3,750m^2 per household. Dinh et al. (2005), reported that the average litchi areas of households in Thanh Son commune was 13.2 sao (or 4,752m^2), higher than that in this study.

Unlike the two first production system, in the last one, farm holdings diversify their fruit orchards by converting partly the litchi plantations into guava and kumquat fields. Cultivated areas of kumquat occupy 47.3% of total farm land area, higher than those of litchi and guava. In the two last production systems, farm holdings do not have any rice land area because of the complete conversion from rice land into litchi gardens in 1993 in Thanh Son commune. The characteristics of these production systems will be introduced in the following parts.

2.4.1.1 The guava production system

This is a specialized production system in which guava gardens have been substituted for litchi plantations since 2000s due to the decline of litchi price. In the past, guava trees were planted in home gardens of most households for family consumption. When the litchi price decreased, nearly all litchi orchard areas in Lien Mac commune have been cutting and switching to guava gardens. In some surrounding communes, guava is also replacing for litchi. Thus, the cultivated areas of the guava increase rapidly not only in Lien Mac commune but also in other communes of Thanh Ha district. This excessive expansion of guava crop may cause the oversupply and the decrease of its price in the future.

Photo 5.6 Watering the guava garden
(Lien Mac commune, 4/2011)

This single cropping system is rapidly developed in regions around the district centre, where farmers can access to the market easier than those of other locations. Because of large cultivation area of guava, the commune becomes one of the biggest collecting units of not only guava but also other kinds of fruit in Thanh Ha. Guava and other fruits are sold to several big collectors and transported directly to big cities in North and South of Vietnam. The development of big collecting units encourages farmers to expand their guava crops by buying more land from surrounding regions to switch to guava plantations.

The transformation from litchi to guava often occurs in favourable land areas, where there are good infrastructure systems, especially irrigation systems. This conversion process has been increasingly implemented in Lien Mac commune due to the water supply from Huong river, a small stream of Thai Binh river. The fertile soil and favourable watering system are of great importance for producers to develop this specialized guava production system.

2.4.1.2 The litchi-livestock production system

The litchi-livestock production system is defined by the combination of animal husbandry with litchi cultivation. Because of low price of litchi, the livestock production was integrated into the family economy. Several litchi trees in the home garden were cut down, and animal buildings were constructed there. Pigs were the most common species kept by the farm holdings. Besides that, some households raise rabbit or chickens with small flock size. The pig production plays the key role in the household economy and shares the major part in the total annual income.

Photo 5.7 Pig sheds were built temporarily under litchi trees
(Thanh Son commune, 4/2011)

This kind of production system was emerged in early 2000s due to the decline of litchi price in the market. In the past, when the traditional rice-based production system was commonly applied, livestock herds were kept by most farm holdings. The complete conversion from rice fields into litchi gardens in 1993 in Thanh Son commune caused the decrease of the animal production of many families. However, since the beginning of the year 2000s, litchi cultivation has declined considerably, leading to the development of animal husbandry, mostly pig production of some farm holdings. Farmers invest much in pig production instead of litchi plantations.

Table 5.28. The animal production of households in the fruit-based production systems

Animal species	Guava system (n=8)		Litchi-livestock system (n=8)		Litchi-Kumquat-Guava system (n=10)	
	Head of animal	Proportion of HHs (%)	Head of animal	Proportion of HHs (%)	Head of animal	Proportion of HHs (%)
Sows	0.5	37.5 %	1.8	62.5 %	0.5	20 %
Growing pigs	5.0	37.5 %	66.3	100 %	4.0	10 %
Chickens	0	0	34.0	37.5 %	0	0
Rabbits	0	0	6.9	37.5 %	0	0

(Source: Household surveys, 2010-2011)

The animal production is mostly practised by households in the litchi-livestock production system. In this system, pigs were reared by nearly all households. They can keep both sows and growing pigs at small to medium flock scale (1.8 sows and/or 66.3 heads of fattening pigs). Growing pigs is more popularly raised by households than sows (100 % households raised growing pigs in comparison with 62.5% of households raised sows). Moreover, some of the farms also have a small flock of chickens or rabbits. However, this is a secondary production activity of the family because only a low proportion of households applied it at a

very small scale (table 5.28). In the two other systems, fruit growers are interested in fruit cultivation (guava and kumquat plantations) rather than in the animal production. Only few households engage in the animal husbandry, mostly pig production. The pig flock size is also very small (about one sow and/or 5-10 growing pigs). Pigs are kept as the complementary component of the family production to utilize food-processing by-products (rice bran, tofu, etc.).

However, the animal keepers in this farming system are facing many difficulties. Like other regions of Hai Duong province, the pig production of households in Thanh Son commune confronts with the increase of price of animal feed. They do not have any rice land areas to produce animal feed on farm because of the complete land conversion into litchi in 1993. Thus, all animal feed are purchased from outside.

Furthermore, the poor management of animal wastes causes the extremely environmental pollution, especially in a very high population density region like Thanh Son commune. The solid waste (animal manure) is sold to fruit growers. The liquid waste is sent out directly into surrounding areas of the farms. However, the change of natural territory, especially the break of canals and streams, obstructs the discharge of liquid waste. The environmental pollution, especially water sources, is increasingly emerged in this region.

Besides that, the occurrence of some infectious epidemics also threatens the pig population. In 2010 and 2011, the PRRS and foot and mouth disease wildly spread and damaged significantly the pig population of many farms. In estimation, 30% of pig farms were lost all their animal flocks because of these epidemics. They stop keeping animal production afterwards.

2.4.1.3 The litchi-kumquat-guava production system

This diversified fruit production system is commonly applied in the riverside areas of Thanh Son commune, which is favourable for the transformation from litchi to other fruit plantations such as kumquat and guava. In the past, kumquat was grown in home gardens or beneath litchi trees. In 2004, when the extreme flood damaged significantly the litchi orchards and the litchi price was very low, kumquat plantations began to be enlarged to other areas. Guava is also increasingly planted by many farms in this region. Most of the litchi areas were cut down and replaced by kumquat and guava gardens. Farm holdings often keep a small area of litchi in the home garden or the location that is difficult to convert to other fruit crops.

The increasing price of kumquat and guava in recent years encourages considerably producers to diversify the fruit production system. The collecting units also appeared in the commune to collect and transport these fruits to the big cities such as Hanoi, Hai Phong, Quang Ninh, etc. The diversified production system is rapidly evolved from the litchi orchards.

Photo 5.8 Kumquat and guava plantations are replaced for litchi gardens (Thanh Son commune, 4/2011)

2.4.2 The management system of production resources of households

2.4.2.1 The land resource

As an agriculture-based region, the farm size of households in Thanh Ha district is fairly higher than that of other parts of the province. The agricultural land area accounts for the highest proportion of the total natural land area because industrial zones are not installed in this region. Moreover, many farm holdings bought more land area from surrounding regions to grow litchi when the litchi benefit was high. The average of farm size and its distribution frequency is presented in table 5.29.

Table 5.29. Land resource of households in the fruit-based production systems

Characteristics	Guava system (n=8)	Litchi-livestock system (n=8)	Litchi-Kumquat-Guava system (n=10)
Farm size	3,411 m^2	3,960 m^2	3,690 m^2
Distribution of frequency (% of households)			
<1,800 m^2 (1-5 sao)	0 %	25.0 %	10.0 %
2,160 m^2 – 3,600 m^2 (6-10 sao)	87.5 %	25.0 %	50.0 %
>3,600 m^2 (>10 sao)	12.5 %	50.0 %	40.0 %

(Source: Household surveys, 2010-2011)

The average farm size of households in three production systems is quite high due to the rapid land expansion of many farm holdings. In the past, households in the litchi-livestock system and the litchi-kumquat-guava system in Thanh Son commune accumulated land by buying land areas from not only their neighbours but also from surrounding communes or mountainous regions to grow litchi. Thus, their farm size is higher than that of households in the guava system. The proportion of households, whose farm land surface is more than 10 sao, is also higher than that in the guava system.

Most households in the guava production system in Lien Mac commune have difficulties in enlarging their farm land due to the rapid increase of land price. The high potential to get a great benefit from guava cultivation causes the increase of the land price in this commune and surrounding areas. Hence, the farm size is smaller than that in the other systems. Most of the households have about 6-10 sao of cultivated land (87.5% of total surveyed households).

Land purchase and the increase of land price in the guava and kumquat regions

The high price of guava and kumquat is one of the most important reasons encouraging farmers to purchase more land areas. A high proportion of annual profit gained from the guava and kumquat crops is reinvested in the land purchase by many farm holdings. Guava and kumquat crops are the permanent fruit trees that do not require big fixed investment. The important part of fixed investment is land resources. Thus, the high added-value achieved from guava and kumquat in recent years is of great importance for producers to accumulate land areas. Some households buy litchi gardens from surrounding communes to switch to guava orchards though high price of land (box 5.3).

It seems to be highly risky to buy more land for guava cultivation because of its excessive expansion. Converting from litchi into guava orchards is common not only in Lien Mac commune but also in many other communes of Thanh Ha district. It may result in the oversupply of guava in the market in the future, leading to the degradation of this crop. The excessive development of litchi in the past is a foreseeable lesson for the development of the guava production.

Box 5.3. The extreme increase of price of guava land in Lien Mac commune

One of the authority staff of Lien Mac commune stated that the land price increases quickly according to the development of guava cultivation. In 2004, the land price of litchi gardens was about 4 million VND per sao. Now (in 2011), its price is 20 million VND per sao for favourable areas (closed to the village, fertile soil, convenient for water intake, etc.) and 16 million VND per sao for less favourable ones. He estimated that, after planting guava, the benefit from the first harvest can be equivalent to the cost of land purchase.

(Source: Interview with Mr. Hau, 57 years old, chief of Mac Thu village, Lien Mac commune, 12/5/ 2011)

The emerging abandonment of litchi orchards and invasion of weeds

In Thanh Son commune, where all rice land areas were switched to litchi gardens in 1993, the abandonment of litchi orchards is now emerging due to the low price of litchi since the early 2000s. Litchi growers do not apply fertilizers and pesticides to litchi gardens. Large areas of litchi are being attacked by various kinds of pests and insects. Weeds and other wild plants are not controlled by farmers, causing the extreme impacts on the growth of litchi. Therefore, litchi fields are being abandoned and non-harvested. This is an extreme waste of the agricultural land resource (photo 5.9).

Photo 5.9. The emerging abandonment of litchi orchards and the invasion of weeds (Thanh Son commune, May 2010)

There are several reasons for this land abandonment. The decline of litchi price since 2000s cannot encourage producers to invest in litchi cultivation. Many of them, especially the young and middle-age farmers, go out to find off-farm jobs in surrounding regions. The litchi areas are still kept by farmers because land is an important property of the families. Moreover, the diversification of litchi fields by converting into other fruit crops is quite difficult due to the collapse of the irrigation system since 1993. Thus, they do not sell their land parcels. These plots are also not for rent because of perennial fruit plantations.

2.4.2.2 The labour force

The labour force plays a key role in the perennial fruit cultivation because many tasks require great manual labours, especially during the peak period such as spaying pesticides or harvesting fruits. The low level of mechanization of fruit cultivation causes the high demand of active labours. The labour force of households in the fruit-based production system is shown in table 5.30.

Table 5.30. The labour force of the households in the fruit-based production systems

Parameters		Guava system (n=8)		Litchi-livestock system (n=8)		Litchi-Kumquat-Guava system (n=10)	
		Mean	SD	Mean	SD	Mean	SD
Mouths to feed		4.1	0.6	3.8	1.3	3.3	0.7
Potential wage labours		2.1	0.4	2.5	0.8	2.2	0.6
Dependency ratio		1.9	0.4	1.5	0.3	1.5	0.5
Age of household heads		47.9	6.2	53.3	7.9	51.1	10.4
<35 years old (%)		0	-	0	-	10.0	-
35-44 years old (%)		25.0	-	12.5	-	20.0	-
45-55 years old (%)		62.5	-	50.0	-	40.0	-
>55 years old (%)		12.5	-	37.5	-	30.0	-
Proportion of family labour (%)	Only on-farm	50	-	75	-	50	-
	On and off-farm	50	-	25	-	50	-

(Source: Household surveys, 2010-2011)

The shortage of active agricultural labours and the mechanization process

The surveyed results in table 5.30 indicate that the shortage of agricultural active labours is an emerging issue in the fruit-based production system. This shortage is explained by the lack of young and active labours who work on farm. Although the number of potential wage labours of the families is equivalent to that in other regions, they mostly migrate to industrial zones to find off-farm works. The old people have to take responsibility for most farming works, even the heavy tasks. The age of heads of the families is about 47.9 to 53.3 years old, fairly higher than that in the animal-aquaculture based production system and the vegetable-based production system. The age of litchi growers seems to be higher than that in the past. A survey conducted in 2005 in Thanh Ha district on the Thieu litchi value chain reported that the average age of litchi growers in Thanh Son commune was about 43 years old (Dinh et al., 2005). The proportion of household heads whose age is over 55 years old is also higher than that in other regions. The shortage of labour force limits the diversification from litchi to other crops of many households. This is also one of the reasons for the abandonment of litchi orchards in Thanh Son commune.

To deal with the lack of active agricultural labours, farm households have various solutions. Some of them who have a very large farm size have to rent more seasonal wage labours during the peak period such as harvesting litchi, or covering guava fruits by nylon bags, etc. However, the increasing demand for active labours of the industrial factories results in the rise in the cost of wage labours. That is the reason why many farms leave litchi orchards.

In the guava production system and the litchi-kumquat-guava production system, farm holdings overcome the labour shortage problem by the mechanization of fruit cultivation. A part of the annual profit will be used to buy some modern equipment such as pesticide power sprayers, electric pruning machine, and delivery vans, etc. These tools facilitate considerably the cultivation and transportation of fruits. Therefore, a small number of family labours can work on a large farm or even help others. The mechanization of agricultural production is one of the essential ways to solve the shortage of rural labours.

2.4.2.3 The capital resource

In general, most farm holdings in the fruit-based production system do not apply for a loan. As indicated in table 5.31, the proportion of households got a loan is fairly low (about 37.5% of total surveyed households have a loan from banks). The loan amount is also lower than that of households in the animal-aquaculture based production system. In the litchi-kumquat-guava production system, nearly all farms have no loan from any financial sources (table 5.31).

Table 5.31. Loan access of households in the fruit-based production systems

Sources	Guava system (n=8)		Litchi-livestock system (n=8)		Litchi-Kumquat-Guava system (n=10)	
	Amount (thousand dong)	% of HHs	Amount (thousand dong)	% of HHs	Amount (thousand dong)	% of HHs
Banks	8,125	37.5	17,500	37.5	0	0
Local credit funds	0	0	0	0	0	0
Others	500	12.5	0	0	0	0

(Source: Household surveys, 2010-2011)

The significant returns from annual harvests of fruit crops are an important financial fund for producers to pay for the intermediate production consumption. Normally, the input materials such as fertilizers were provided by local stores by the post-paid manner. After each harvest, these expenses will be paid with a higher price than the normal price at the time of purchase. This is a kind of loan from the local retailers. Thus, producers do not borrow money from banks or other credit funds.

2.4.3 The agro-input management system and the major constraints

2.4.3.1 The crop calendar

Three main fruit crops which are largely grown by farmers in Thanh Ha district are litchi, guava, and kumquat. The crop calendar of these crops is presented in figure 5.11.

Because these fruit orchards are permanent crops, the crop calendar is characterized by the progress of technical operations during the year. The major technical practices of fruit cultivation comprise fertilization, pesticide application, and harvesting. These operations differ from one fruit crop to another according to their growth periods. It is also necessary to note that these technical procedures are implemented at several certain stages of the month, not at all the time.

In general, technical operations of the litchi cultivation are not very complicated in comparison with those of guava and kumquat production. Under the normal condition of the agro-ecological environments, chemical fertilizers are applied to litchi gardens about three times per year during the blooming, fructification, and budding periods in spring, summer, and autumn, respectively. Litchi is often harvested within two or three weeks in July. The

short time of litchi harvesting results in the oversupply in the market, causing the decline of litchi price.

In the guava production system, producers operate some specific technical methods to control the crop calendar in order to harvest and sell fruits at the time when the price is at the highest level. Generally, guava fruits are harvested during autumn (in August and September). In Lien Mac commune, guava growers try to change the harvest time from autumn to winter and spring season by pruning some branches in May and spreading more chemical fertilizers to the crops. Then, the plants will be carefully protected from pesticides and insects by various methods during budding, blooming and fructification periods. The fruits will be then harvested about two or three times per month in winter and two times per month in late spring, depending on the productivity of each crop.

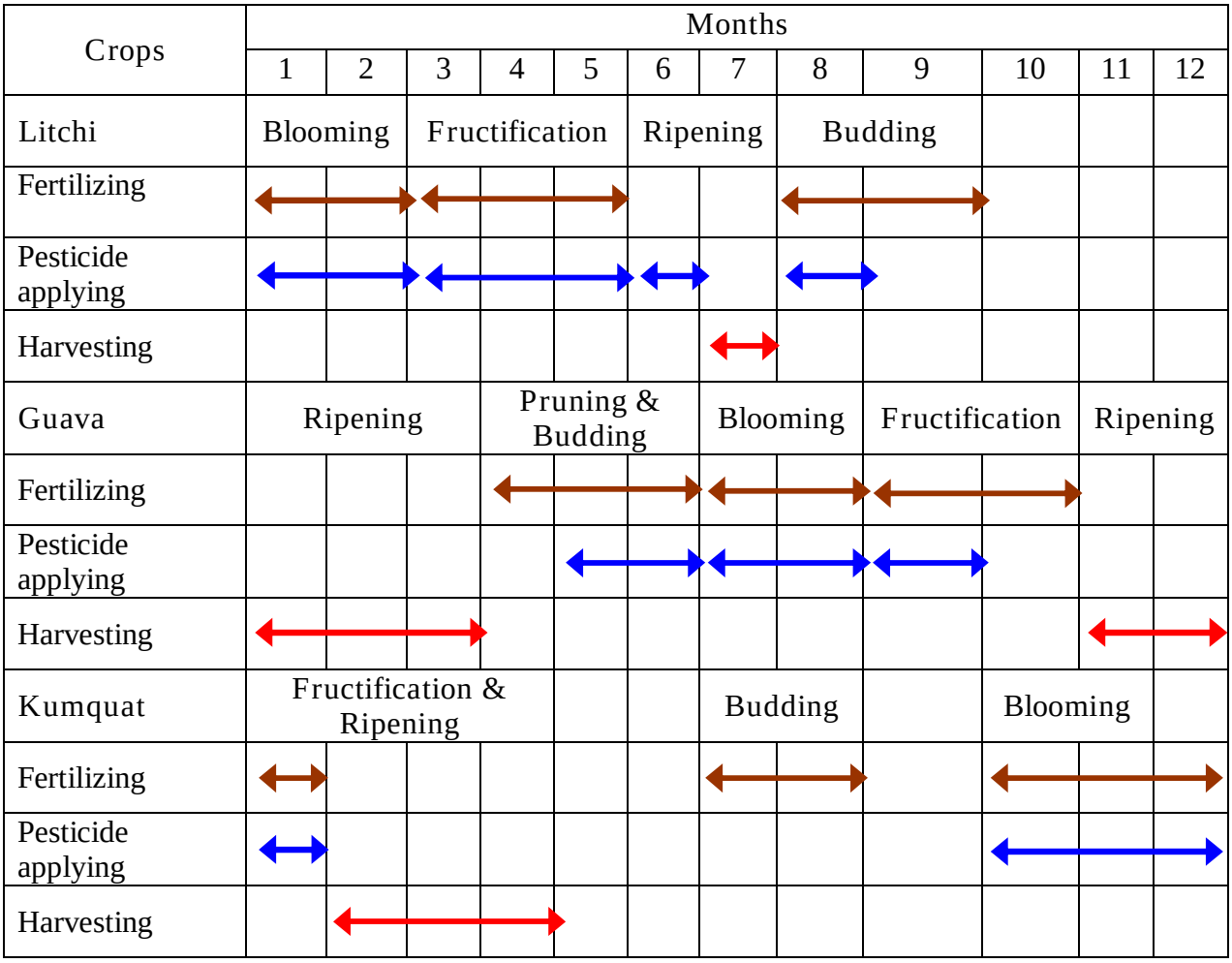


Figure 5.11. The crop calendar of fruit cultivation in Thanh Ha district
(Source: Participatory interviews with local people, 2010-2011)

In the litchi-kumquat-guava production system, in order to get the harvest of kumquat crops in the high-price season in spring, the growers try to promote the blooming of kumquat by several specific technical operations. They, firstly, tie some surrounding branches in a small string to improve the efficiency of photosynthesis of other beneath branches. At the same time, they remove a number of young fruits from the trees. Chemical fertilizers are then

spread to the fruit crops to stimulate the growth of new buds and then the blooming and fructification. The fruits are collected every few days during the spring crops.

There are several advantages of diversification of fruit plantations. The combination of different fruit crops enables them to improve the photosynthesis ability and productivity. These crops are organized adequately by keeping the litchi trees at the edge of the garden, around the guava or kumquat trees. Moreover, the diversification of these fruits enables farmers to diversify their income by harvesting their crops in different seasons within a year. It helps to reduce the risk of bad returns of one of the crops.

2.4.3.2 The plant multiplication

In the previous years, when the price of litchi was high, the plant cutting method was used by many households to multiply litchi. Litchi cuttings were not only grown in the rice fields of the families but also sold to other regions. At that time, because of high profit from litchi cuttings, farmers cut off a huge number of litchi branches and supply to other households. The rapid expansion of litchi plantations due to this plant breeding program results in the oversupply of the fruit in the market in 2000s. Now, because of low price of litchi, they do not implement the plant multiplication program yet.

The guava and kumquat plants are also multiplied greatly by many farm holdings. In the past, when the litchi trees were young, guava and kumquat were grown intermittently with litchi in the home gardens. As the degradation of litchi, growers start to develop these crops.

At the moment, the price of guava and kumquat fruits is higher than that of litchi. Therefore, the plant cutting program is increasingly conducted by most households to provide them to the surrounding communes. The surveyed results show that, 60% households in the litchi-kumquat-guava production system produce kumquat cutting pieces for sale. On average, each farm holding provides more than 2,000 pieces of kumquat cuttings and gains approximately 10 million VND per year (table 5.32). It is a significant income that encourages producers to multiply and sell the cutting pieces of these crops.

Table 5.32. The plant multiplication of kumquat in the litchi-kumquat-guava production system

Parameters	Litchi-kumquat-guava production system (n=10)
% of households applied	60%
Number of plant cuttings sold per year	2083.3 pieces
Average price per cutting piece	4,600 VND
Total gross products	9,479,167 VND

(Source: Household surveys, 2010-2011)

However, this breeding program is taken by farmers, without any control of the district or provincial government. The plant cuttings are popularly sold at the local markets or directly distributed by local traders. It is clearly that the excessive expansion of guava and kumquat crops may affect the sustainable development of these fruits in the future.

Photo 5.10. Plant cuttings of kumquat are distributed to other regions (Thanh Son commune, 4/2011)

2.4.3.3 Soil and fertilizer management

As indicated in the previous section, fertilizers are often sprayed on the fruit orchards in a certain period of the growth cycle, including pruning, blooming, and fructification stage. Both chemical and organic fertilizers are applied to the crops. Organic fertilizers are often applied to fruit gardens as the basal fertilizers and right after each harvest. Inorganic fertilizers are used more widely during the growing period of the trees. Thus, farmers have difficulties in estimating the amount of the chemical fertilizers sprayed on their gardens. In order to evaluate the soil fertility management of the farms, the use of organic fertilizers is investigated by different fruit crops. The data is shown in table 5.33.

The composted animal manure is the most common sources of organic fertilizers used by the fruit growers. However, there is a significant difference among households in the production systems about the application of this kind of fertilizers to different fruit crops. It depends on the available storage of animal manure on farm or the purchased price level at the market.

Table 5.33. Use of organic fertilizers for fruit crops of surveyed households

Crops	Guava system (n=8)		Litchi-livestock system (n=8)		Litchi-Kumquat-Guava system (n=10)	
	% HHs	Amount applied (Kg/sao)	% HHs	Amount applied (Kg/sao)	% HHs	Amount applied (Kg/sao)
Litchi	-	-	25.0	21.3	0	0
Guava	50.0	68.8	-	-	20.0	15.0
Kumquat	-	-	-	-	20.0	35.0

(Source: Household surveys, 2010-2011)

In the litchi-livestock, although a huge quantity of animal manure is produced from pig production, only few households apply this organic fertilizer to litchi orchards (about 25% of total surveyed households). It is because animal manure is sold to other fruit farms with high price rather than spraying on litchi gardens. Farmers do not invest in litchi cultivation any more.

By contrast, in the guava production system, organic fertilizers are widely applied to guava gardens by a high proportion of surveyed households (about 50%). Although the household animal production is not widely developed in the guava production system, many guava growers purchase animal manure from surrounding farms. The manure is then composted completely during several weeks before spraying on crops. This source of organic fertilizers plays a key role in the soil fertility management and the guava productivity improvement.

2.4.3.4 Pest and disease management

The fruit crops may be susceptible to various types of pest and diseases, especially when there is a considerable change of the weather condition. Nearly all parts of the trees can be damaged by specific kinds of pests or diseases. The young buds, flowers and fruits are more vulnerable to the attacks of pests and diseases than other parts. Therefore, pesticides are often sprayed regularly on the fruit crops during the budding, blooming and fructification period to protect them from some certain types of pests and diseases.

Table 5.34. Application of pesticides to fruit crops in the fruit-based production systems in 2009

Parameters	Guava system (n=8)	Litchi-livestock system (n=8)	Litchi-Kumquat-Guava system (n=10)
	Guava crops	Litchi crops	Kumquat crops
Proportion of HHs applied (%)	100%	62.5%	100%
Frequency (times/year)	13.8	7.1	12.6
Cost of pesticide per sao (thousand VND)	225.0	284.0	277.0
Pesticide cost/total cost (%)	18.3%	31.8%	40.3%

(Source: Household surveys, 2010-2011)

In the litchi-livestock production system, farmers are less interested in pest management than in the past. They rarely take the field trips to examine the occurrence of pests and diseases. Hence, the pesticide application is often ineffective in preventing or treating these pathogens. In spite of identification of pests or diseases, some households (about 40% of surveyed households) even do not apply the pesticide to the fruit crops because of low cost-effective production of litchi. The average frequency of pesticides to litchi crops is thus fairly low, approximately 7.1 times per year. Therefore, the litchi crops are significantly damaged by pests and insects, leading to the decrease of litchi productivity.

In the guava production system and the litchi-kumquat-guava production system, the guava and kumquat crops are carefully protected from pest and disease attacks by regular field trips and frequent pesticide application. On average, pesticides are sprayed on guava crops about 13.8 times per year in the normal conditions. To prevent the direct damage of some insects

(such as thaumatomyia notata) and the residuals of pesticides in the fruits as well, every fruit is covered early by nylon bags when they are still small. The appearance of guava fruits looks more attractive and delicious than non-covered ones. Similarly, kumquat crops are also well prevented from the attack of pests and diseases. If there is not any pests or diseases, pesticides are applied frequently every once per month during the budding, blooming and fructification period.

However, the guava growers are now facing the problem of a high mortality rate of the guava trees. According to the estimation of some farmers, the mortality rate makes up from 30% to 40%, sometimes up to 50%. These trees are often died after few years of planting, about 3 or 4 years. In some cases, guava trees die off early, right after being planted. Therefore, most households have to propagate their fruit crops by the plant cutting technique or the marcotting method. The reason for the death of guava trees is not identified by both farmers and scientists. It is blamed for the intensive use of input materials. The overuse of inorganic products to achieve the highest productivity of guava causes the degradation of both the trees and the soil fertility, leading to the high rate of mortality of the crop. The degeneration of the genotype of guava due to the self propagation may also be the reason for this problem.

2.4.3.5 The irrigation and drainage system

In Thanh Ha district, the irrigation and drainage activities are less convenient for agricultural production than those of other zones in Hai Duong province. The district is located in the south region, which has a lower territory than that of the north part. The district is also the destination of many streams from the north of the province. Hence, it is more vulnerable to the flood in the rainy season.

Although the perennial fruit crops resist quite well to the flood or drought conditions, the irrigation and drainage activities are of great importance for the development of the intensive production system such as guava or kumquat plantations. In Lien Mac commune, guava fields lie along the Huong riverside, which is one small branch of the Thai Binh river system, making it more convenient for producers to pump water into their crops or pump water out to the river. Similarly, in Thanh Son commune, the diversified litchi-kumquat-guava production system is also developed along the Me riverside, a small branch of the Thai Binh river system. The soil fertility in these areas is richer than that in other regions. It is thus favourable for the growth of the fruit trees.

However, in the central area of litchi gardens in Thanh Son commune, farmers have a big difficulty in diversifying their litchi crops into other kinds of fruits due to the limitation of irrigation and drainage system. The participatory interviews with the chief of the village and some groups of producers point out that it is difficult to take water from rivers into the litchi field in the centre locations. The litchi orchards are also more vulnerable to the flood in the rainy season because of the poor drainage system. In 2007 and 2008, for instance, the extreme flood caused the high death rate of litchi (approximately 10% of total litchi areas of the commune). Irrigation and drainage system are thus needed to be improved for the sustainable development of fruit plantations.

Regarding the reason for the failure of the irrigation and drainage system, the change of the territory since 1993 due to the complete conversion from rice fields into fruit gardens is believed as the main cause. In the past, when rice is the dominant crop, the irrigation and drainage system in this commune was well-developed. However, in 1993, when all rice land areas were completely switched to litchi plantations, numerous small mounds were built to grow litchi, making different water borders around litchi trees. The irrigation and drainage system such as canals, pumping stations, etc. was not used and being broken considerably.

The commune has not invested in this infrastructure system any more since then. Moreover, because of the decline of litchi price since 2000s, most farm holdings have not upgraded the litchi mounds yet. The soil erosion every year results in the narrowness of the water borders around the fruit crops. Besides that, the illegal construction of houses in the litchi gardens in 1993 made it more difficult for drainage activity (about 600 illegal houses were built in the whole commune) Therefore, the gardens are increasingly vulnerable to the damage of the drought or flood. That's why the diversification of litchi orchards into different fruit crops is very limited in this region.

2.4.4 Productivity of the fruit-based production system

The productivity of litchi is about 650kg/sao in the litchi-livestock production system and 516.7kg/sao in the litchi-kumquat-guava production system, similarly to the survey results reported by Dinh et al. (2005) (about 550-700kg/sao in 2004 in Thanh Son commune). These litchi crops are grown for more than 20 years. At this age, litchi trees reach the peak level of productivity if the weather conditions are favourable, and the nutrition components are sufficiently provided. The productivity of litchi will decrease afterwards (Ton et al., 2006).

Table 5.35. Productivity of some fruit crops in 2009

Fruits (kg/sao)	Guava system (n=8)		Litchi-livestock system (n=8)		Litchi-Kumquat-Guava system (n=10)	
	Mean	SD	Mean	SD	Mean	SD
Guava (spring)	1,472.3	691.9	-	-	800.0	282.8
Guava (winter)	1,672.5	1,880.3	-	-	-	-
Litchi (main)	-	-	650.0	141.4	516.7	129.1
Litchi (early)	-	-	-	-	600.0	141.4
Kumquat	-	-	-	-	470.7	252.8

(Source: Household surveys, 2010-2011)

However, the productivity of litchi varies significantly over the years due to their biological characteristics. Generally, the litchi trees bear fruits every two years if they are not provided with nutrition components. In this case, farmers implement some specific techniques to stimulate litchi to bear fruits every year. Due to the decline of litchi price, farmers do not take care their fruit crops any more. Thus, the litchi productivity is not stable across the years.

The productivity of guava is very high (about 1472.3 kg/sao in the spring crop and 1672.5 kg/sao in the autumn-winter crop). However, the productivity of guava differs from one farm to another, depending on the age of the trees as well as their mortality rate. In many farms, the mortality rate is very high. Farmers have to multiply their crops regularly. Thus, the guava productivity is often lower than that of other households.

For the kumquat crops, the productivity is about 479.7 kg/sao, lower than that of litchi and guava because of small size of plants and fruits as well. The productivity of kumquat crops increases gradually due to the growth of the trees. Although the kumquat crop has lower productivity than that of litchi, the increasing price of kumquat since recent years encourages farmers to continue transforming from litchi to kumquat gardens.

2.4.5 Analysis of economic outcomes of the fruit-based production system

High proportion of cost of chemical fertilizers and pesticides

The cost structure of the fruit production includes the expenses of not only chemical materials (fertilizers and pesticides) but also some others such as organic manure, waged labours, nylon bags, coal fuels for drying litchi, etc. The production cost of different fruit crops is calculated and presented in table 5.36.

Table 5.36. Structure of the production cost of fruit cultivation in 2009

Cost items (thousand dong/sao)	Guava system (n=8)		Litchi-livestock system (n=8)	Litchi-Kumquat-Guava system (n=10)	
	Guava (spring crop)	Guava (winter crop)	Litchi	Litchi	Kumquat
Chemical fertilizer	713.9	450.7	215.8	118.3	299.2
Organic fertilizer	46.3	12.5	2.7	0.0	17.5
Pesticide and herbicide	225.0	202.5	284.0	107.1	277.0
Others materials	242.7	238.9	392.0	290.7	93.0
Total cost per sao	1227.9	904.6	894.4	516.1	686.7

(Source: Household surveys, 2010-2011)

Guava cultivation has the highest levels of the production cost in comparison with other fruit crops. In the spring crop, total cost of guava production in the guava production system is about 1,227.9 thousand VND/sao, approximately 1.4 times higher than that of litchi cultivation in the litchi-livestock system and 1.8 times higher than that of kumquat production. The chemical fertilizer cost makes up the biggest proportion in the total cost of guava production, ranging from 50% to 60% of the total cost, whereas it accounts for about 30% of total cost of litchi cultivation (figure 5.12). The guava production becomes so commercialized as compared to litchi and kumquat cultivation.

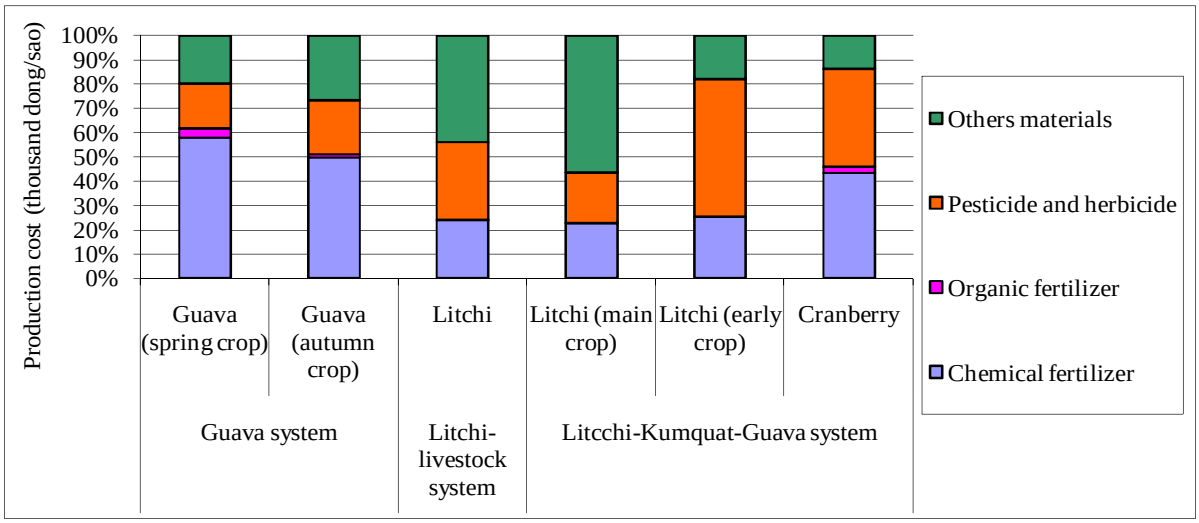


Figure 5.12. Cost structure of the fruit cultivation
(Source: Household surveys, 2010-2011)

By comparison with the winter crop, the guava cultivation in the spring season has a higher cost, especially cost of chemical materials. In the spring crop, in order to achieve a high productivity, producers often apply more inputs to their guava fields, especially chemical fertilizers and pesticides. The cost of these materials in the spring crop is thus much higher than that in the winter crop. For example, cost of chemical fertilizers in the spring crop is 1.5 times higher than that in the winter crop. The higher price of guava in the spring is a great incentive for guava growers to invest more in their gardens than that in the winter season.

The production cost of litchi cultivation is also very high, about 894.4 thousand VND per sao in the litchi-livestock system and 516.1 thousand VND per sao in the litchi-kumquat-guava production system. Notably, the cost of chemical fertilizers and pesticides makes up about 50% of total cost. The rest (50%) is other types of cost such as waged labours, coal fuels to dry litchi, etc. The demand for waged labours in litchi cultivation is very high because many works require active labours such as pesticide application, harvesting fruit, etc. Therefore, due to the low price of litchi at the market, the litchi cultivation is not a cost-effective production. That's why many farms are not interested in the litchi cultivation any more.

The added-value of different crops and the livestock production

The calculation of added-value of different crops and livestock production helps to explain why farmers invest more in one certain production sector, which has the highest added-value than that of others. The results shown in table 5.37 are the total gross product, intermediate cost and added-value of different crops and livestock of the household economy.

Table 5.37. Added-value of different crops and livestock in the fruit-based production systems

Production sector (million dong)	Guava system (n=8)				Litchi-livestock system (n=8)				Litchi-Kumquat-Guava system (n=10)			
	GP	CI	VA	VA/ sao	GP	CI	VA	VA/ sao	GP	CI	VA	VA/ sao
Rice	3.8	1.1	2.7	2.0	-	-	-	-	-	-	-	-
Litchi	-	-	-	-	15.5	9.9	5.6	0.5	8.4	3.1	5.3	2.1
Guava	40.3	16.3	24.0	3.2	-	-	-	-	7.7	1.8	5.9	3.0
Kumquat	-	-	-	-	-	-	-	-	21.9	2.9	19.0	4.4
Other plants	1.9	0	1.9	-	-	-	-	-	0	0.8	2.1	-
Livestock	10.3	8.5	1.8	-	212.2	182.5	29.7	-	7.9	5.2	2.7	-
Total	56.3	25.9	30.4	-	227.7	192.4	35.3	-	48.8	13.8	35.0	-

(Source: Household surveys, 2010-2011)

In the guava production system, guava is the major crop which makes up the highest proportion of the total gross product and added-value of the households (71.6% and 78.9%, respectively). Although the gross product is very high, guava producers have to invest much in the intermediate consumption. The ratio of cost to gross product of guava cultivation is thus quite high, about 0.4 or 40% of the gross product, much higher than that of kumquat crops in the litchi-kumquat-guava system (about 0.1 or 10%). It is important for guava growers to increase the productivity of guava and its quality to gain a higher price and better added-value than those at the current time.

In the litchi-kumquat-guava production system, the cultivation of kumquat achieves the highest level of the gross product and added-value. The added-value per sao is also much higher than that of other crops. Particularly, kumquat cultivation is really a cost-effective investment because the ratio of cost to gross product is very low.

On the contrary, the litchi cultivation in the litchi-livestock production system contributes a small proportion to the total added-value of the households. The low productivity and price of litchi are the reasons for this problem. Litchi becomes the secondary production activity of household economy because most litchi growers invest more in the livestock production. The pig production makes up more than 80% of the total added-value of the family. However, the pig production is increasingly vulnerable to various infectious epidemics and impacted by the increase of the price of the animal feed. Thus, although farmers gain a very high gross product, the ratio of cost to gross product is very high, approximately 0.86 or 86%. The total added-value of households in this system is therefore not higher than that of households in other production systems.

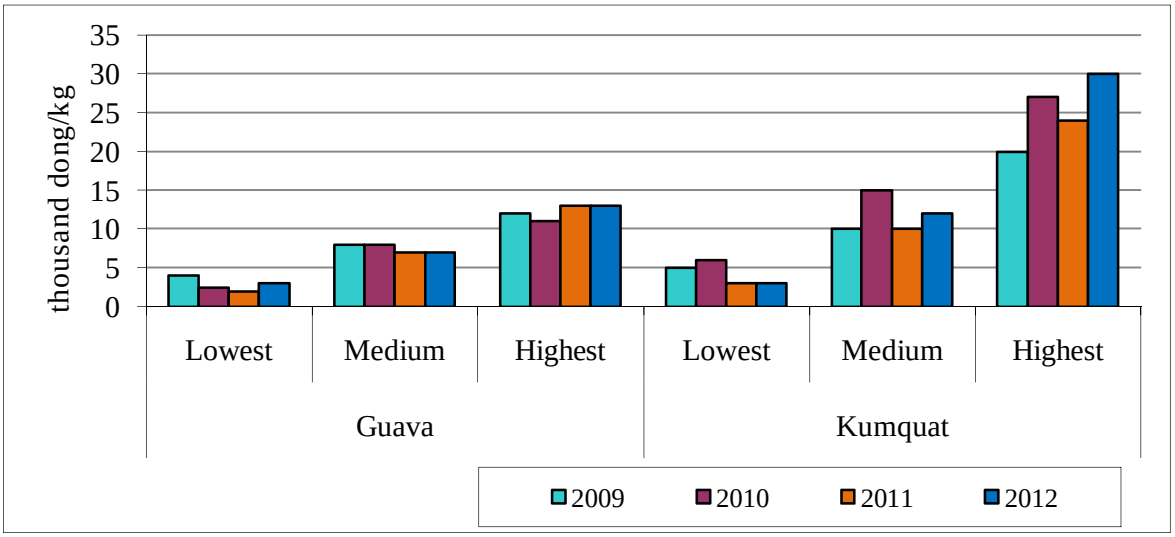


Figure 5.13. Price fluctuation of some fruits in recent years
(Source: Calculated from notebook of collectors at Lien Mac and Thanh Son commune)

However, the gross product and added-value of some fruits vary strongly from farm to farm and from year to year due to the extreme fluctuation of the selling price in the market. The results presented in figure 5.13 indicate that the selling price of guava and kumquat fluctuate rapidly from 2009 to 2012. Furthermore, in each year, there is a significant change of price according to the yield of the fruits. During the main fruit harvesting time, the price is at the lowest level. Conversely, at the beginning and the end of the harvest, when the yield is lower than that of the middle season, the price increases up to the highest point. The difference between the lowest and the highest price is also important, especially for kumquat. Hence, the economic outcome of the households depends considerably not only on the fruit productivity but also on the price at the time of selling their products.

The agricultural income of the households

The agricultural income of the households is the net return after subtracting the fixed expenses such as paid wage labours, taxes, land rent, and loan interest from the added-value. The results show that although households in the litchi-livestock system have a very high level of gross product, their family farming net income is equivalent to that of households in the two other systems because the intermediate consumption is much higher than that of other systems. Most of the farms do not have to pay much for the fixed costs (permanent wage labour, taxes, land rent and loan interest). Thus, the net income is equal to the added-value.

Table 5.38. The agricultural income of households in the fruit-based production systems in 2009

Parameters (million dong)	Guava system (n=8)		Litchi-livestock system (n=8)		Litchi-Kumquat-Guava system (n=10)		P-Value
	Mean	SD	Mean	SD	Mean	SD	
Gross product	56.3[b]	44.1	227.7[a]	111.2	48.8[b]	20.8	0.001
Intermediate consumption	25.9[b]	26.9	192.4[a]	87.6	13.8[c]	6.3	0.000
Added-value	30.4	17.6	35.3	34.0	35.0	18.3	0.640
Paid waged	0	0	0	0	0	0	-
Taxes	0	0	0	0	0	0	-
Land rent	0	0	0.1	0.2	0	0	-
Loan interest	0.1	0.2	0.2	0.3	0	0	-
Family farming net income (FNI)	30.3	17.6	35.1	34.3	35.0	18.3	0.640
FNI/surface unit (million dong/sao)	3.1	1.4	3.0	3.8	3.5	1.6	0.899
FNI/ active family labours (million dong/person)	14.2	5.2	14.0	16.4	15.9	11.9	0.866

([abc] Means in the same row without common letter are different at $P<0.05$
Source: Household surveys, 2010-2011)

However, the family farming net income is influenced by various factors, especially the productivity and selling price of agricultural products. It is observed that the farming net income varies considerably from one farm to another and from year to year, particularly in the litchi-livestock production system. Due to the attacks of some infectious epidemics, many farms loss much their animal flocks. The strong fluctuation of the output price of most agricultural products also causes the unsustainable development of household economy.

CHAPTER 6. EVOLUTIONARY PERSPECTIVES AND DEVELOPMENT STRATEGIES OF AGRARIAN SYSTEMS

I. Introduction

As indicated in the previous parts of the thesis, the agrarian system is an evolutionary series of environmental exploitation modes of farmers. In a certain region, the agrarian system often adapts well to the agro-ecological and socio-economic conditions at a given period. In fact, these environmental situations are not constant over the time. If the agrarian system does not meet the new requirements of the society, it will be replaced with another mode of the environmental exploitation. It means that, the agrarian system evolves from one form to another across the time according to the changes in the agro-ecological and socio-economic environments. This evolution of agrarian systems depends strongly on the changes in the environmental conditions, which are difficult for us to estimate. The diagnosis of the future evolution of agrarian systems is thus essential for the analysis of agrarian system dynamics.

The estimation of evolutionary perspectives of agrarian systems is also of great importance for setting up appropriate policies towards sustainable development of agriculture and rural society. The unsuitable transformation of agrarian systems can be foreseen to prevent their degradation in the future. The limited factors that confront the development of agrarian systems will be analysed. Therefore, these assessments are necessary for policymakers to avoid setting up inappropriate institutions and policies. The priority topics or areas of interventions in development programs can be identified based on the analysis of the agrarian system evolution.

In this chapter, the evolutionary perspectives of agrarian systems will be identified by both the strategic planning of the provincial government and the discussions with key informants and farm holdings. To do so, the continuous changes in the agro-ecological and socio-economic environments of the study sites will be estimated according to their current situations and trends. The comprehension of these changes will provide the basics for the judgment of evolutionary perspectives of agrarian systems.

II. The sustainability of agrarian systems in the new era of industrialization and urbanization

2.1 Emphasis on the vital role of agricultural production in the new era of industrialization and urbanization

Vietnam is on the way to enter a new era of industrialization and urbanization with the strategy of becoming an industrialized country in 2020 (Tuan, 2009). In line with this process, the role of agriculture will be less important in terms of less contribution to the total gross domestic products (GDP). In fact, over the last few years, the contribution of agriculture to the total GDP has been falling steadily (GSO, 2002, 2005, cited in MacAulay et al. (2006). In the next decade (from 2010 to 2020), the agricultural land areas will continuously decrease by 580 thousand ha in comparison with that in 2010 according to the national planning of the agricultural production development towards 2020 and 2030 (Vietnamese Prime Minister, 2012).

However, experiences from developed countries, which ignored the policies supporting for agricultural development during the industrialization, have shown that the national food security cannot be ensured without priority given to the appropriate strategies and policies of agricultural development. Many nations are now increasingly facing with the food insecurity and strongly depending on the exports of mostly staple food from others. Beside the increasing prices of food, the food shortage is growing and leading to the extreme undernourishment and hunger of the vast majority of the population in the world, especially in the developing countries. In the period of 2010-2012, almost 850 million people in the developing countries, out of 870 million in the world, were chronically undernourished (FAO et al., 2012). It is thus of great importance for policymakers to give priority to the agricultural development when formulating the national long-term development policies.

Nowadays, the agro-sector has enormous difficulties in producing enough quantity and quality of food to meet the increasing consumption demand of the society because of numerous reasons. The population still grows at a high rate (for example in 2011, the population growth rate of the whole country, the Red river delta and Hai Duong province is 1.04%, 0.99% and 0.35%, respectively (General Statistics Office, 2012), and needs more and more food as well as other agricultural products. Meanwhile, the rapid development of industrial and urban zones will cause the decrease of agricultural land areas. Moreover, the productivity of agricultural production seems to be at the maximum level and difficult to increase. Agriculture is more and more vulnerable to the serious attacks of infectious epidemics and pests, to the climate change and the degradation of the agro-ecological environments. These emerged problems continue posing a terrible threat to the national food security and the survival of the society. The crisis of food industry is not only a big challenge to the agricultural producers, but also a good opportunity for them to develop their production systems in the new era.

2.2 The sustainability of agrarian systems in the context of industrialization, urbanization, and the workforce mobility

As illustrated in the previous chapters of this thesis, the agrarian systems in Hai Duong province and other regions of the Red river delta have evolved significantly over the last few decades, especially during the industrialization and urbanization period in 2000s. The provincial and national government has recently given priority to the acceleration of development of industry sector. Thus the industry sector has been taking over the importance of agriculture in the national gross domestic product. Although this policy helps to increase the income and living standard of the majority of the population, it also poses some challenges of agricultural land reduction, shortage of active labour, and environmental pollution, etc. to the sustainability of agriculture and rural society. Several questions about the prospect and sustainability of agrarian systems and rural labours in the context of highly accelerated industrialization and urbanization in the coming years are increasingly concerned by the policymakers to formulate an appropriate regional development strategy. For example, what are the potential impacts of accelerating industrialization on the development and sustainability of agriculture? How will the farmers adapt to the increasing urbanization? What is the geographic and sectoral mobility of the workforce between rural regions and urban areas, and between agricultural production and industry sector during the industrialization and urbanization period? Can the agricultural sector re-absorb the surplus workers from the industrial factories if there is a crisis in the industry sector?

Hereby, we will discuss about the possible prospect and sustainability of agrarian systems and the rural society by taking into account three scenarios of industrialization, urbanization and

the employment crisis in the industry sector. The analysis is mainly based on the long-term evolution of agrarian systems in the previous periods that demonstrated in some first parts of this dissertation. Besides that, the literature on experience of other regions of Vietnam and industrialized and urbanized countries in the world will help to better understand about the situation of the study site. The concepts of industrialization, urbanization, and workforce mobility will be presented before taking into account their possible influence on agriculture and rural labours. Then, the analysis will come up with several implications for the sustainable development of agriculture and rural society in the context of acceleration of industrialization and urbanization in the future.

Although the two scenarios of industrialization and urbanization will be taken into account separately to understand the possibility and sustainability of agrarian systems, it is necessary to emphasize the fact that these two processes are co-evolved in North Vietnam, especially in the surrounding regions of Hanoi. The urban and peri-urban areas are often developed around the industrial parks due to the urbanization of surrounding rural regions as well as the movement of the young to industrialized zones. The industrialization of rural regions is often related to the urbanization process.

2.2.1 The evolution and sustainability of agrarian systems for the prospect of accelerating industrialization

Industrialization and its impact on sustainability of agriculture and rural society

Industrialization process is often characterized by the shift from agriculture to industries. It means that the share of agriculture in the total economic activity will decrease while the share of industry increasing.

The industrialization in Hai Duong province and other regions of the Red river delta will be continuously accelerated in the coming years. The existing industrial parks are planned to be enlarged and the new ones will be constructed in the period of 2010-2015 and 2015-2020. At the whole province, a total of 10 industrial parks corresponding to 1,530ha will be constructed and expanded in the period between 2015 and 2020. In Cam Giang district, for instance, the industrialization process ranks the highest rate. Three industrial zones will be expanded or built in a total of 450ha land areas, corresponding to 28.1% of total expanded land areas under the plan of the province (Hai Duong Industry and Trade Department, 2009). Moreover, in the surrounding regions such as Binh Giang district and Hai Duong city, the speed of industrialization is also very rapid. The upper and middle zone is becoming a highly dense industrial centre of the province and the Red river delta as well.

The industrial development during the decade 2000s in Hai Duong indicated an enormous impact on the growth and sustainability of agrarian systems due to the changes in land use system, the labour force, environmental health as well as other socio-economic characteristics. The decrease of agricultural land areas, especially the rice land, is a visible effect of industrialization due to the transformation into industrial and resident land use purposes. In Hai Duong province, according to the general provincial planning towards 2020 and 2030, which was approved on 15th January 2011 by the decision number 3155/QD-UBND of Hai Duong's People Committee, the rice land areas will reduce from 60,000ha in 2015 to 58,000ha in 2020 and will reach a stable level of 55,000ha in 2030. The perennial fruit land areas and the annual vegetable land areas will be kept stable at 22,000 to 25,000ha and 25,000 to 30,000ha; respectively in 2030. By contrast, the industrial land areas will increase rapidly from 4,000ha in 2020 to 6,000 or 7,000ha afterwards in the industrial concentration areas. The areas of small industrial clusters will also be expanded to become concentration industrial

zones, covering about 2,000 to 2,500ha. The increasing urbanization process will occupy a large area of land with an increase from 8,755ha in 2020 to 13,800ha in 2030 (Hai Duong's People Committee, 2011). In step with the industrial enhancement, the number of agricultural active labours will decrease gradually due to the absorption of industrial companies and firms. It will result in the shortage of workforce in agricultural production, especially for the manually conventional farming. Furthermore, industrial expansion will be considered as the major sources of environmental pollution that potentially affects both agricultural production and human health. Therefore, an appropriate strategy of industrialization that will be consistent with the sustainable development of agriculture and rural society is increasingly required.

Evolution and sustainability of agrarian systems in Hai Duong for the prospect of accelerated industrialization

Based on observations during the field surveys in the industrial sites in Hai Duong province, we have found that there is a strong relation between the industrialization level and the intensification and specialization of agrarian systems. The agrarian systems in the industrialized regions have evolved gradually into a specialized intensive system during the industrialization period. The development of industry greatly encourages the intensification of agrarian systems.

In the context of accelerated industrialization in the future, it is believed that the agrarian systems will continuously evolve into a highly intensive and modern system. This evolution includes the farm size expansion and the modernization of farms. The shift from agriculture to industries of many farming households, especially the small and medium ones, induces the land accumulation of the rich farms. Moreover, the big farms often invest more in the fixed assets such as animal buildings, modern equipment, and other infrastructure facilities in order to improve the labour productivity and yield of the agricultural production, taking the advantages of economics of scale. These farm holdings will also intensify their agricultural production systems by intensive use of inputs and applying advanced genotypes of animals or plants. The shortage of active agricultural labours and the increasing cost of waged labours will encourage the mechanization and modernization of the farms.

Besides that, the improvement of the rural infrastructure system, especially the transportation and communication system, during the industrialization period will facilitate the intensification and specialization of many farm holders. To avoid the negative impact on the rural landscape, especially the agricultural land areas, the construction of the rural infrastructure system should take into account of the consolidation of agricultural land and the development of irrigation and drainage systems. The long-term development strategy of the region has to identify the adequate schedule of land use for the installation of the transportation system that is consistent with the presence of irrigation facilities and the consolidation of agricultural land.

Although the number of the small-scale diversified agrarian systems will reduce during the industrial development, it does not mean that they will be eliminated under the context of industrialization. The small and medium farms will be persistent for a long time by combining the agricultural production with the off-farm jobs offered from industrial firms or some kinds of private business. Because they work part-time on their farms, they often do not invest much on fixed assets or expanding the farm size. Therefore, these farms should take the most advantages of a diversified production system by integrating livestock production and crop cultivation into their farming system. The integrated production system helps them to reduce the production cost through highly recycling the waste and residual materials, and to avoid risks of the market price instability through adjusting the production scale to the fluctuation of

the market. The small or medium scale enables them to flexible switch from one type of animal species to another species, for example from pigs to poultry, according to the variation of output prices in the market. Therefore, they can seize the best market opportunities and to adapt well to the environmental changes. They also take account of producing some safe and high-value agricultural products such as organic vegetables, special local chickens, etc. to better fulfil the increasing requirements of high- income consumers in the industrialized regions.

The sustainable development of agrarian systems during the industrialization period will be achieved if several potential problems of industry are basically managed and solved. The reduction of agricultural land is a foreseeable process due to the transformation into industrial parks. It will threaten the food security of the nation if there is no land use master plan at the regional level. The provincial government needs to formulate a long-term land use planning in which specific agricultural land areas, especially the rice land, should be kept stable during the industrialization era. However, it will be difficult for policymakers to implement a master plan of land use if there is a highly fragmented level of agricultural land. Hence, it is in need of land consolidation as the basics for setting up an appropriate long-term land use plan. The land consolidation not only enables policymakers to ensure a given land area for agricultural production, but also to make use of the unfertile or unfavourable land areas for the improvement of the irrigation and drainage system as well as the installation of industrial zones. Besides that, the environmental health is also in great need of protection by good waste management and treatment of the manufacturing companies. The waste management and treatment activities of all industrial factories need to be well controlled and regularly inspected in accordance with the strict environmental regulations approved by the government.

A balanced industrial development among regions is also of great importance to encourage the improvement and sustainability of agriculture and rural society. This is characterized by the equilateral diffusion of industrial zones among regions of the province. It is believed that the development of some small or medium industrial parks in remote locations is an engine of economic growth thanks to the off-farm job opportunities and the rural infrastructure improvement. The development of some light industries such as agro-food processing parks, handicraft industry, etc. can absorb a huge number of jobless people in rural areas and foster the growth of agriculture. These agro-food processing plants can collect a huge and stable amount of agricultural products from farms in surrounding regions. The strong relationship between farm households and agro-food companies in supplying agricultural commodities will be a great incentive for farmers to develop their farming systems.

In conclusion, taking the most advantages of industrial development is significant for farm households to improve their agricultural production systems and generate more income. The mechanized and modernized agrarian system will be the prospective system in the context of highly accelerated industrialization. The development and sustainability of agrarian systems will be possible if an appropriate industrial development strategy is formulated to avoid the excessive conversion from agricultural land into industrial land and to adopt tough regulations to prevent environmental contamination from industry.

2.2.2 Development and sustainability of agrarian systems in the context of urbanization

Urbanization definition and its impacts on agriculture

Urbanization can be defined as the structural and functional transformation from a rural area into an urban region. World Bank (2011) reported that the urbanization includes five major changes in the administration, demography, spatial, economy, and the well-being of the population. Most authors pointed out that urbanization is characterized by the increasing share of the population living in urban areas (Satterthwaite et al., 2010; General Statistics Office, 2011; World Bank, 2011). This is mostly caused by the rural to urban migration flows which are now increasingly popular in developing countries. Besides that, due to the increasing population density as well as the land price in the centre of the city, there has also the influx of people from urban areas to the fringe or periphery areas of the cities. This phenomenon is quite popular in several metropolises in the developing countries. During the urbanization process, there is a significant change from an agriculture-based society to an urban-based one.

The urbanization process has a strong relation with the development and sustainability of the agricultural production and the society. In many developing countries, as the urbanization accelerates, the urban poverty, food insecurity and malnutrition, which is called "urbanization of poverty" by Veenhuizen and George (2007), are the most challenging issues. Many authors indicated both the direct and indirect impacts of urbanization on agriculture (Berry, 1978, Coughlin et al, 1977, cited in (Lopezt et al., 1988). The conversion from agricultural land into urban land uses and the increase in non-farm labours are the visible consequence of urban expansion. The indirect effects of urbanization on agriculture development and sustainability are more diverse and complicated. Andrews and Chetrick, 1986, cited in (Lopezt et al., 1988) divided the indirect effects of urbanization on agriculture into four main categories, including the effect on regulation, technical efficiency, speculation, and market. The regulatory effect is viewed as the decrease of political power of the rural communities. The destruction of crops and damage to the farm facilities will cause the decline of agricultural technical efficiency. The speculative effects of urbanization relate to the reluctance to invest in farm machinery and other farm infrastructure due to the increase of land price in urban areas. Moreover, the urbanization also brings farmers with more favourable marketing system due to the location advantages.

Vietnam has undergone a remarkable urbanization after the reform (Doi Moi), especially since 2000s when the country integrated strongly into international economy. The share of urban population has increased steadily over the last few decades, from 19.0% in 1980 to 29.6% in 2009. In accordance with the urbanization process, the socio-economic environment of the province in particular and the country in general has changed substantially during the last years. In the coming years, the urbanization process will be accelerated more strongly due to the government planning for the period of 2015 - 2020. It is estimated that the urban population will make up 38% in 2015 and 45% in 2020 in the total nation population (General Statistics Office, 2011).

Response to the urbanization process, peasants in and around cities of Vietnam (Hanoi, Ho Chi Minh city, etc.) and in many nations all over the world have adjusted their agrarian systems to an urban agricultural production. Experience of developing the urban agriculture from many cases in Vietnam and the world emphasizes the importance of urban agriculture to the food security, poverty alleviation, environmental protection and human health. However, the urban agriculture may have some potential problems related to human health and environment contamination if producers do not practise properly such as disease transmission from animals to human, heavy metal contamination in agricultural products, etc. The urban agriculture is also faced with a number of constraints related to the socio-cultural biases; the accessibility to resources, inputs and services; some special risks of farming in the cities; the post-production constraints; and organization constraints (Smit et al., 1996). It is likely that the development of urban agriculture will confront with the increasing land price in cities, the

shortage of active labours, the difficulties in increasing the productivity and commercialization.

Sustainability of agrarian systems in Hai Duong province under the urbanization scenario

Hai Duong is also an urbanizing province in which the proportion of urban population has developed from 5.0% in 1989 to 13.8% in 1999 and to 19.9% in 2009 (General Statistics Office, 2011). The province is also located near some big cities such as Hanoi, Hai Phong, Ha Long, etc. Therefore, the urbanization process will be accelerated strongly in some coming years. It poses a question about the sustainability of agrarian systems under the urbanization scenario in the next few years in terms of socio-economic, technical, and environmental dimensions.

Under the prospect of highly urbanized province, the agrarian systems in Hai Duong will evolve into an urban and peri-urban agricultural system like the case of Hanoi and other cities in Vietnam and in the world. The characteristics of urban and peri-urban agrarian systems will be different between agro-ecological zones of the province. In general, the concentration areas of agricultural production will be formulated around towns and cities, whereas the family small-scale farms will be developed in the available spaces in the cities.

Over the last decade, as illustrated in the previous parts of this paper, several agricultural concentration areas have been developed rapidly in different zones of Hai Duong, including the livestock-fish production area in the upper zone (in Cam Giang district), the vegetable cultivation area in the middle zone (in Gia Loc district) and the fruit plantation in the lower zone (in Thanh Ha district). In each zone, the concentration area of rice cultivation has also been identified to ensure the food security. These agricultural concentration areas have provided an important proportion of food and agricultural products to local markets and other regions of Vietnam. We have seen that these specialized agricultural areas are often developed in the central locations, close to the towns or cities. Therefore, under the scenario of a high level of urbanization, the specialized agrarian systems will be improved in the surrounding regions of urban centres.

Although the number of farming households will reduce in accordance with the rapid urbanization, there will be a persistence of family agriculture in an urbanized province in the future. The family agriculture in an urban area is characterized by the small-scale farming in the free spaces of the cities such as backyard gardens, among the intricate networks of roads, railways, buildings, and so on. The plant cultivation (including vegetable and fruit crops) in urban areas is possible and significant for urban citizens. Actually, based on personal observations of vegetable grown in urban areas of Hanoi, the urban dwellers can utilize effectively the available land areas around their houses or free surfaces between streets and buildings to grow different types of vegetable crops for family consumption. Some modern agriculture methods that do need land such as the hydroponic system (or water culture) and the aeroponic system (or growing plants in an air environment) will be the new selection for the urban agriculture. This is an important source of fresh and safe products for urban consumers due to the low-chemical input use.

In fact, as explained by many scientists, the urban agriculture will be faced with some constraints and challenges related to the urban planning. The rapid increase of population density in Vietnamese cities due to the high population growth rate and the extreme migration from rural regions to urban areas will be much more difficult for urban dwellers to do the farming. The price of land is also increasing significantly when the agricultural land areas are switched to the urban land use. The populous and dense cities will have many strict regulations of limiting negative impacts and threats from the agricultural production such as

potentially environmental pollution from animal waste and chemicals, animal disease transmission to human, etc.

In order to develop a sustainable agricultural production under the urbanization situation, it is important for both policymakers to implement an appropriate regional planning and supportive policies for the agricultural sector. The urban land use planning should identify definitely the specific agricultural concentration areas in connection with the urban regions. Keeping stable a given area of agricultural land is significant for the food security and economic growth of the province and the nation as well. It is better to develop a wide range of small and medium towns or cities in different locations of the province rather than the megacity or metropolitan areas. This, on the one hand, enables to avoid the regional migration that leading to the urban poverty, on the other hand, foster the development of agriculture in remote regions. Besides that, maintaining the productive farmland needs to be supported by the government through diversified manners. Reducing some kinds of taxes, especially land tax, is one of the most important supports for producers within the context of high pressure of land in urban areas. Improving some agricultural public services such as irrigation system, agricultural extension, pest and disease management, etc. is also in need of support for the urban agriculture development.

For the agricultural producers in urban areas, the sustainable agriculture development can be achieved if they practise properly. They should improve their knowledge and consciousness of a safe and environmental-friendly agricultural production when implementing the urban agriculture. The farming practices and management need to ensure a healthy ecosystem and environment through low consumption of chemical inputs and highly waste and by-product recycling. The application of biotechnology and information in agriculture is also of great importance for producers to increase the productivity and yield. To increase the family income, producers should take the most advantages of a developed marketing system in the urban areas by accessing to the niche market of the high income consumers such as home delivery of safe products or supplying them to the big restaurants, etc. Furthermore, they should diversify their income sources by developing some non-farm works or engaging in some urban services such as fruit orchard tourism, farm relaxing fishing, etc.

2.2.3 The mobility of the labour force and the sustainability of agrarian systems

The geographic and sectorial mobility of the workforce

The transformation from an agriculture-based economy into an industrial-based one during the period of industrialization and urbanization often relates to the sectoral and geographic shift of the workforce from agriculture to industry and from rural areas to urban regions. The development of industrial parks often generates more non-agricultural works and thus absorbs an enormous amount of agricultural labours. Over the last decade, there has been a substantial movement of workforce from agriculture to industries and service activities in Hai Duong province and other regions of the Red river delta. The labour absorption of industry and service sector is essential to develop an industrial-based economy according to the government strategy towards 2020.

However, a problem that has been emerging over the last industrialization period in Hai Duong and other provinces of the Red river delta is the spontaneous rural-urban migration of the rural residents. The concentration of industrial zones in some central regions which have many favourable socio-economic conditions for industrial development is considered as the major reason for the geographic migration. Furthermore, the slow urbanization in the remote locations causes an increasing gap of income and standard of living between the rural

residents and the urban dwellers, leading to the migration wave into cities and towns of rural people, especially the young.

The mobility of the workforce often impacts significantly on the development and sustainability of agrarian systems. On the one hand, a fundamental shift of labour force from agriculture to industries and service sector will foster the mechanization and modernization of agriculture and thus increase the agricultural labour productivity and salary. On the other hand, an excessive movement of agricultural workers to non-agricultural labours may result in the shortage of active farm labours (aging farmers) and the potential decline of agricultural productivity and yield. This problem will become more serious if the rural-urban migration is substantial. During the last decade, as demonstrated in the previous parts of this report, the intersectoral and geographic shift of the agricultural workforce in Hai Duong province has affected badly the sustainability of agrarian systems. The shortage of active farm labours caused the extreme degradation of winter crop cultivation, especially maize, sweet potatoes, soybean, etc., leading to the increasing dependence on purchased animal feed in the market. The situation becomes more serious when the abandoned agricultural land areas are increasing in many regions of the province, even rice land. Large areas of litchi orchards are abandoned not only because of its low price in the market but also because of an extreme migration wave of litchi growers from Thanh Ha district, where there is no industrial parks, into other surrounding districts and towns. The income and living standard of these migratory farmers have improved slowly because of unstable non-farm jobs in cities or industrial companies as well as high rural-urban transportation expenses.

A sustainable development strategy of both agriculture and industry sectors should be formulated by providing a diffused pattern of industrial parks and urban areas and a low geographic polarization of the population. To do so, the government policy should give priority to the installation of the small and medium industrial clusters in rural areas that can offer agricultural labours non-farm works without leaving for central locations. The sustainable development of these rural industries can be achieved if they have a good capacity to call for external investment, especially the foreign direct investment, through improving the rural infrastructure. Besides that, the government should support for the development of the traditional handicraft villages by implementing a favourable tax policy and developing the marketing system. These industrial jobs will supplement an important source of income to households, reducing the income gap between rural people and urban dwellers.

Another important condition that helps avoid the rural-urban migration is the development of small and medium urban towns in rural areas. This development schedule should take account of improvement of rural infrastructure system such as transportation and communication system to facilitate the economic activities and the rural life. In Vietnam, a “national targeted program on building a new countryside during 2010-2020”, which was approved by the Decision No. 800/QD-TTg in June 4, 2010, is believed to improve the socio-economic conditions and infrastructure systems in rural areas by 2020. It is in great need of both support from the government and the participation of rural residents in implementing this rural development program.

In accordance with rural industrialization and urbanization, the mechanization and modernization of agriculture is also of great importance to release rural residents from manual agricultural works and increase the labour productivity and income. If the agricultural income is not so much lower than the non-agricultural income, farmers will not leave for non-farm jobs in cities. Therefore, the agricultural mechanization and modernization needs to go along with the rural industrialization and urbanization on the way towards the sustainable development of agriculture and rural society.

The employment crisis in the industry sector and the role of agriculture

The scenario discussed here is the employment crisis occurred in the industry sector, leading to the unemployment of enormous non-agricultural labours. The question is that if the agriculture can re-absorb these jobless people from industrial companies or not? What are the solutions for this problem?

In general, the agricultural sector cannot absorb all the jobless non-agricultural labours if the industry sector will be in crisis. It depends on both the development of agricultural production and the ability of the labours. On the one hand, if the agricultural production is highly mechanized and modernized, it does not require much human power and thus takes few numbers of labours. On the other hand, the non-agricultural labours are often the young, who lack of both production means (land, farm equipment, and capital) and agricultural knowledge and skills. Hence, it will be difficult for them to set up a new production system if they lose their jobs in the industry sector. As observed in several industrial zones in Hai Duong province, we have found that, in the 2007-2008 economic crisis, the workers who lost their jobs in the manufacturing factories did not turn back to the agricultural production. Many of them tried to find seasonal non-agricultural works in the "free market" such as housing construction, small private business, housework services, etc. These kinds of works help them to survive during the crisis period.

For the part-time labours, who work part-time in the industrial sector while keeping animal production or crop cultivation, agriculture is really a buffer for them to overcome the economic crisis. Because they have all the necessary production means (land, farm equipment, and capital) and agricultural knowledge, they can turn back easily to their farming works. This is similar to the case of Taiwanese farmers when the oil crises hit in 1974 and 1982. Agriculture helped the unemployed non-agricultural labours to deal with crises and stabilize the society (YU-KANG MAO and SCHIVE, 1995). This is also a livelihood strategy of many farm households in Hai Duong and other regions of the Red river delta to avoid the risks of losing off-farm jobs.

A sustainable strategy of employment creation should be concentrated on the improvement of education program for the young in rural areas, especially the vocational training programmes. The vocational training courses are of great importance for rural people in providing them with education and skills that are necessary for them to prepare for a non-agricultural job in the industrialization era. These programmes should be diversified to meet different needs of the young in rural areas. In order to encourage the participation of the rural people, who often have a low level of income, it is in need of support from the government through charging for a favourable tuition and subsidizing the accommodation cost, for instance. Moreover, the government also needs to help the skilled people to find a stable job or to set up a new private enterprise or manufacture after training. One of the best ways to create more jobs for rural residents is to develop the small or medium industrial clusters in diffused rural locations. By this way, farmers can combine agriculture and non-agricultural works to diversify their income sources and be more resilient to the economic crisis.

III. Evolutionary perspectives of the animal-aquaculture based agrarian systems in the upper zone

3.1 General evolutionary perspectives of the agrarian system at the regional level

3.1.1 The development of the livestock-fish production system

In the next decade, the provincial government will give priority to the development of the large-scale fish and livestock production systems through various programs. On 16th January 2012, according to the decision number 165/QD-UBND and the decision number 166/QD-UBND of Hai Duong' People Committee, two projects on "Development of concentration areas of fish culture with improved quality, big production scale and limited environmental pollution of Hai Duong province in the period of 2011-2015" and the project on "Development of concentration areas of livestock production with improved quality, big production scale and limited environmental pollution of Hai Duong province in the period of 2011-2015" have launched to encourage farm holdings to develop industrial livestock and fish production systems in the specific concentration areas which are away from the centre of the villages. The main objectives of these programs are to increase the contribution of the industrial livestock production to the total output product of the animal husbandry by 45% in 2015, and to improve the share of fish production in the total agricultural output product by 14.4% in 2015. According to these programs, a total of 9 concentration areas of fish production will be constructed over 495ha of water surfaces (about 50ha per each concentration area). Moreover, a total of 66 existing concentration areas of fish culture, corresponding to 1,186.9ha (about 10 to 50ha per each), which were built before 2005, will also be upgraded (Hai Duong's People Committee, 2012). In Cam Hoang commune, for instance, a new concentration area of fish production is planned to be constructed over an area of 70ha. The lowland rice fields will be gradually transformed to livestock buildings and fish ponds. In estimation, the number of large-scale livestock-fish farms will increase in the next few years.

In order to encourage farmers to develop the livestock and fish production in the concentration areas, various kinds of supports are included in the above projects. Each livestock concentration area, which has at least three hectares, 20% of total fixed asset investment will be supported by the provincial budget. This amount of investment will be used for the construction of the infrastructure system of the farms such as main roads, border walls, canal systems, electricity stations, biogas system, etc. and other equipments like cooling system, animal sheds, watering system, feeding system and so on. Moreover, the farm holdings in this concentration area will be free of charge for land taxes under the common policy of the government. In specific, 50% of cost of artificial insemination for sows will be provided by the provincial budget. The households who buy more than 10 exotic sows or more than 5 local sows (Mong Cai breed) will be supported by a loan of 5 million VND or 10 million VND per sow from Vietnam Bank for Agriculture and Rural Development without charge of loan interest during 12 months. The farms that buy more than 100 heads of hybrid or exotic weaning pigs will be free of charge of loan interest for an amount of 500,000 VND per head per each production cycle (about 4 months) from Vietnam Bank for Agriculture and Rural Development (Hao, 2012). These provisions relatively encourage farmers to develop the industrial livestock production system in the specific concentration areas in the future.

3.1.2 The persistence of the livestock-fish-crop production system

It is observed that, over the last some years, there has been a reduction of number of small-scale farm holdings in Hai Duong and other provinces in the Red river delta. Many smallholder farmers have faced enormous difficulties in developing their production systems due to the skyrocketing rise of animal feed price and the extreme threats of various animal infectious epidemics. It is because of the degradation of on-farm animal feed production and the inappropriate animal disease management. Besides that, the development of the small-scale animal production in the homestead land areas is limited due to the human health issues and the environmental concerns. It is observed that the number of small animal farms located in the centre of the villages has reduced significantly since early 2000s, when the urbanization was accelerated in this region. The urbanization of rural areas is at a rapid speed, leading to the conflicts between the villagers and households keeping animal flocks at the homestead areas about the environmental pollution caused by the animal production. Moreover, taking consideration of opportunity cost, many smallholder farmers stopped keeping animal flocks and moved to the off-farm jobs under the context of industrialization. Therefore, many of farm holdings, especially the very small-scale ones, were less interested in developing the animal production, leading to the reduction of number of small-scale farm holdings.

However, the diversified livestock-fish-crop production system will be continuously persistent in the coming years due to their high capacity of resilience and flexibility. Firstly, the smallholder farmers can take the most advantages of an integrated livestock-fish-crop farming system such as low level of fixed asset investment, effective utilization of agricultural by-products and good adaptive capacity to the changes in the consumption demand. The small and diversified production system enables farmers to rapidly adjust the animal flock size and the animal species to the fluctuation in the marketplace. Secondly, farm holders in the integrated livestock-fish-crop production system can benefit from the niche market of the high-income consumers by developing some specific or traditional agricultural products such as local chickens, organic vegetables, etc. Thirdly, the combination of agriculture with the off-farm jobs will help them to better survive in the ever-changing environments. The good organization of the family workforce by engaging in both agriculture and non-agricultural works will promote the mobility of the workforce and diversity of their income sources. Therefore, the integrated livestock-fish-crop production system will persistently exist and develop in the coming years in Hai Duong and other provinces of the Red river delta.

3.2 Specific evolutionary perspectives of the animal-aquaculture production system at the farm level

The evolutionary perspectives of the animal-aquaculture based production system can be extrapolated from the farm circumstances at present and from their production plan. The fish ponds and animal flocks are the two main production enterprises of the households. Therefore, their planning on expanding the fish pond areas and the animal herd size is considered as the main criteria for this evaluation. The distribution of frequency of households by their production plans is showed in figure 6.1.

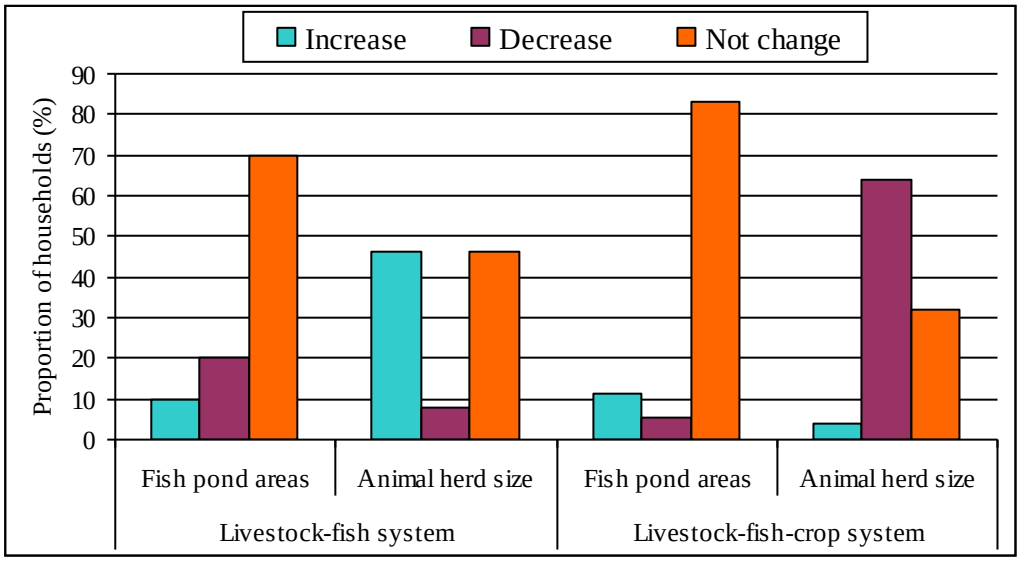


Figure 6.1. The distribution of frequency of households by their production plans (Source: Households surveys, 2010-2011)

In both two production systems, most farm holdings do not intend to change their fish pond areas (70% and 83.3% of total farms in the livestock-fish system and the livestock-fish-crop system, respectively). The transformation from rice land areas into fish ponds seems to be more difficult due to the regulations of the commune and the increase of the land price. According to the law of the commune, the rice land plots, which can be converted into fish ponds, must have a minimum area of 4 sao (or 1440m^2) and be located at the transformed concentration areas. To meet these requirements, farmers have to exchange their land parcels with others to form a bigger plot or buy a new one. However, many households refuse to exchange or sell their land plots. Furthermore, the land transformation to livestock-fish farms is also a big investment. Thus, they prefer investing in input-use intensification rather than enlarging farm size.

Regarding the animal herd size, there are a remarkably difference about the strategy among households in the two production systems. In the livestock-fish production system, a high percentage of producers (about 46.2%) consider increasing the density of their animal populations in the coming years. In order to expand the animal herd size, they will equip their farms with modern furniture and equipments such as cooling system, automatic feeding and water supplying systems, etc. Some of them will also invest more in constructing new animal buildings. Besides that, they continue placing importance on the improvement of the animal genotypes through breeding selection and reproduction programs. The investment in both animal housing systems and the high performance animal breeds enable them to improve the quantity and quality of animal products and to reduce the attacks of the infectious epidemics from outside.

By contrast, in the livestock-fish-crop production system, many respondents said that they may reduce their livestock flock size in the future. These farms have faced extreme losses of their animal herds due to the attack of animal infectious epidemics in several recent years. Furthermore, they have also suffered from the skyrocketing increase of the animal feed price. They cannot afford to invest more in the livestock production. Therefore, 64% of total respondents in the livestock-fish-crop production system intend to decrease their animal populations. They explain that they will adjust their animal flock size to the change of selling price of live animals in the market. According to their observations, the selling price of live

animals, mostly poultry and pigs, often ranks a high level during the high demand seasons such as wedding period in autumn, lunar new year holiday (or Tet holiday), traditional festival in spring, etc. Therefore, they will increase the animal population so that they can sell the products at the peak price time. Another proportion of farm holdings (32% of total samples) state that they will keep a stable size of animal herd at the current level due to the limitation of both the farm area and the financial resource. Their strategy is to search for off-farm works to earn more income while sustaining their integrated livestock-fish-crop production system to better cope with the fluctuation of the market.

IV. Evolutionary perspectives of the vegetable-based production systems in the middle zone

4.1 General evolutionary perspectives of agrarian systems at the regional level

In general, there is a great potential for the expansion of the vegetable cultivation in the future in this region. Beside the favourable agro-ecological environments in the middle zone of the province, the consumption demand for vegetables is surely increasing due to the rapid growth of the population in the industrial zones and urban areas and the growing concerns about the human health of the population. In the past, vegetables were grown in the home gardens for self consumption. However, due to the acceleration of industrialization and urbanization, the demand for vegetables in the market increases significantly. The trend in vegetable consumption is also towards using the safe products. Therefore, the vegetable-based production system is expected to be developed in the coming years. The total vegetable cultivation areas of the whole province has been increasing from 12,296ha in 2011 to 13,673 in 2012 (Hai Duong Statistical Office, 2012).

Over the last few years, the district has launched some projects on the development of vegetable concentration areas in several communes. In 2010, there were 53 vegetable concentration areas in the whole district, including three big centers (more than 20ha per area), 25 medium ones (about 10-20ha per area) and 25 small areas (under 10ha per area). Total surfaces of these concentration centers were 571.16ha with three main types of crop rotation, including rice-autumn vegetable-winter vegetable, spring vegetable-autumn rice-winter vegetable, and spring vegetable-autumn vegetable-winter vegetable (Gia Loc's People Committee, 2011). The supports of these projects through infrastructure investment and technical assistance from the district government significantly encouraged vegetable growers to expand their crops.

In the forthcoming period (2011-2015), another project on “Expansion and improvement of productivity and economic efficiency of the vegetable concentration areas and the rice concentration areas in the period of 2011-2015” has been approved by Gia Loc district government to promote the development of vegetable concentration areas in the district. The objective of this project is to increase the number of large and medium vegetable concentration areas in six target communes, which have favorable conditions for vegetable cultivation. The financial and technical assistance from the district and other organizations will be requested to invest more in the rural infrastructure system and the improved crop varieties. It is expected that the productivity and economic efficiency of vegetable crops will increase significantly in the coming years (Gia Loc's People Committee, 2011).

However, as stated in the previous parts, the vegetable growers in the middle zone of Hai Duong province still have enormous difficulties in expanding their vegetable crops. The intensive input use during a long time has a huge negative impact on the soil fertility and the underground water source. The degradation of soil fertility because of overuse of chemical fertilizers makes it more difficult to increase the vegetable productivity. Moreover, the extremely repeated outbreak of different pests and diseases will continuously cause the big losses of vegetable crops. Besides that, at the marketplace, the selling price of many vegetable crops tends to decrease in some recent years, especially for the main crops, due to the rapid expansion of vegetable areas in most communes in Gia Loc district and other regions of the Red river delta. All above challenges will continuously confront the development of vegetable cultivation in Hai Duong province.

4.2 Specific evolutionary perspectives of vegetable-based production systems at the farm level

4.2.1 Trends in farm size

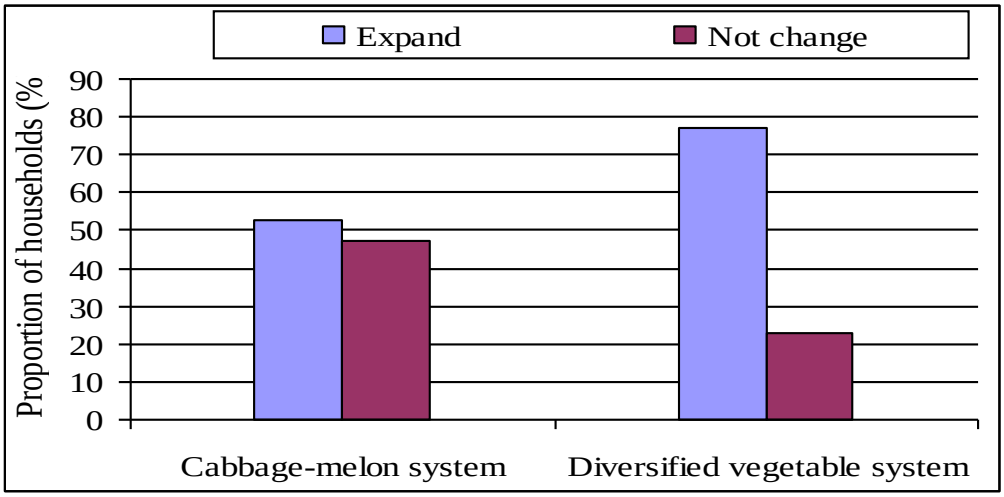


Figure 6.2. Distribution of frequency of households by their farm size trends
(Source: Household surveys, 2010-2011)

Expansion of the farm size is of great importance for vegetable growers to mechanize their production and to increase the yield of vegetables. The productivity of vegetable crops nearly reaches the maximum level due to the high intensification of input use over the last few years. The land use rate, which is calculated by number crops per year, is also very high. Therefore, many farm holdings state that expansion of the farm size is in great demand to increase the vegetable yield. Some of them will sustain the farm size because of the shortage of active agricultural labours. Others desire to rent more land plots for vegetable growing. There are not any households who will decrease their farm size in the next few years.

However, the demand for farm size enlargement is fairly different among households in the two vegetable production systems due to their specific situations. In the cabbage-melon production system, 52.9% of households intended to expand their farm size by renting more land from surrounding areas in a short-term period. The rest (47.1% households) will continue growing vegetables on their own land plots in the forthcoming years. They explained that it is difficult to rent more land because many other producers refuse to lease their land plots.

Living near the industrial parks and towns enables vegetable households to combine the agricultural works with off-farm activities. Moreover, the limitation of arable land areas due to the rapid growth of population and the acceleration of industrialization makes it more difficult for producers to expand the farm size in the region around the industrial zones and cities.

By contrast, in the diversified vegetable production system, a high proportion of households (76.9%) wanted to rent more land parcels for vegetable growing. These farm holdings said that there is high potential to rent more land from households who have small land areas and will look for off-farm jobs. Living away from the industrial zones and cities, many agricultural workers in the south of Gia Loc district are going to cities to find off-farm jobs. Their land areas will be rent-out to other vegetable producers. The land consolidation is now in progress in this production system.

4.2.2 Diversification of the vegetable-based production system

We have observed that, in the middle zone of Hai Duong province, the diversification of vegetable crops is still the major production trend of most households. The producers will diversify their vegetable crops by changing the crop rotation and succession with different crop varieties.

In the cabbage-melon production system, the cabbage crop will be continuously expanded in the coming years because of its high profit and the potential market. Over the last years, the selling price of cabbage, especially the early crop, has been fairly high and stable due to the expansion of the marketing channels in the centre and the south of Vietnam. The high profitability of cabbage cultivation encourages farmers to keep cultivating and investing more in cabbage crops, especially in the early crop.

On the other hand, the cultivation areas of the cabbage in the main crop (in winter season) will decrease because of low profitability. Although the cabbage in the main crop has a higher productivity, its selling price is much lower than that of cabbage in the early season. For many years, the selling price of the main cabbage crop has declined to the very low level, leading to the extreme losses of many producers. They are thus not interested in the main cabbage crop anymore. Farmers tend to diversify partly their land plots into other crops such as cauliflower or the breeding maize crop, etc. in the winter season.

Households in the diversified vegetable production system will concentrate on some major vegetable crops, which have a high profit such as cucumber. While keeping a diversified vegetable production system, they seem to expand the cultivation areas of cucumber and to stop cultivating some others, for example eggplant, bitter melon, etc., that consume high amount of inputs and have a low profit. The highly diversified production system cannot be sustained because of shortage of active agricultural labours.

V. Evolutionary perspectives of the fruit-based production systems in the lower zone

5.1 General evolutionary perspectives of the fruit-based production system at the regional level

5.1.1 The tendency of degradation of litchi cultivation

There is a converse trend of litchi cultivation between the province and district strategy and the operations of litchi growers in Thanh Ha district. According to the resolution of the agricultural production planning towards 2015 and 2020 of Hai Duong province, the government sent out a strategy in an attempt to keep the cultivation areas of the Thieu litchi in Thanh Ha district stable (Hai Duong's People Committee, 2008). A number of supporting programs have been launched by the province and district to ensure a constant cultivation area of Thieu litchi. In some coming years (2012-2014), the project on Vietnamese good agricultural practices (VietGAP) of litchi cultivation will be implemented in some representative communes to increase the quality and the competitiveness of Thieu Thanh Ha litchi in the market.

However, as indicated in the previous chapter, the tendency of degradation of litchi cultivation has been emerging in Thanh Ha district recently. In early 2000s, mostly since 2004, when the selling price of litchi has declined extremely to a very low level, litchi growers were not interested in investing in litchi crops. The abandonment of litchi plantations is increasingly common in many communes of Thanh Ha district. The weeds and pests start to attack on a large spread of litchi crops at a high speed. Many litchi trees have become non-harvested crops since then. In the next few years, the degradation of litchi cultivation is still a noticeable problem.

The strategy to sustain the cultivation of Thieu Thanh Ha litchi, which is well-known as the special product of Hai Duong, is an appropriate policy. However, this plan will only be feasible unless the producers make a big profit from this kind of fruit crop. Thus, the comprehensive assistances and supports from the government are needed.

5.1.2 The excessive conversion from litchi into other fruit crops

In the first visit in 2009 and the frequent trips afterwards (from 2010 to 2012) to the study site (Thanh Ha district), we have observed a rapid conversion from litchi plantations into other crops, especially guava and kumquat crops. The higher profitability of guava and kumquat crops highly encourages farmers to cut down their litchi gardens for the replacement of guava and kumquat. According to the statistical data of the province, the cultivation areas of litchi in the whole province have reduced from 12,695ha in 2011 to 10,989ha in 2012, corresponding to a decrease of 86.6%. The yield of litchi has also declined from 5.27 ton/ha in 2011 to 4.87 ton/ha in 2012. On the other hand, the cultivation of guava crop has increased from 1,290ha in 2011 to 1,328ha in 2012 (Hai Duong Statistical Office, 2012). In Thanh Son commune, for instance, the statistical data in 2012 reported that there were about 45% of total numbers of litchi farms that transformed from litchi into other fruit crops. The total converted land areas from litchi into other fruit crops were 1,138,588 m^2, making up 44.03% of total litchi areas of the commune. Litchi gardens just occupy 1,447,346 m^2, corresponding to 55.97% of the total land areas (in the past, 100% of perennial land areas devoted to litchi) (Thanh Son's People

Committee, 2012). The diversification from litchi into other fruit plantations is in progress in many communes in Thanh Ha district. It is an adaptive strategy of farm holdings against the degradation of the litchi cultivation.

In the coming years, the diversification from litchi orchards into guava and kumquat crops will be in progress out of control of the administrative offices. At the moment, an enormous number of guava and kumquat cuttings is multiplying and providing to surrounding regions. Many farmers continue buying more litchi orchards in other communes outside Thanh Son and Lien Mac commune to transform to guava or kumquat gardens. These excessive conversions will also cause the oversupply of guava and kumquat in the market and badly impact on the farm economy in the future.

5.2 Specific evolutionary perspectives of the fruit-based production system at the farm level

The increase in farm size is in demand of many guava and kumquat growers due to the high profit of these commodities. Farmers try to intensify their fruit production and reach the high level of productivity. They are now looking for extra land areas through buying land from other households in order to increase the fruit yields.

However, the capacity of farm size enlargement is different among households in different fruit production systems. In the guava production system in Lien Mac commune, 37.5% of total surveyed households will buy more land plots to grow guava crops in the near future. These households often have a large-scale production and a well-accumulated financial capital. They buy litchi gardens from households not only in Lien Mac commune but also in the neighbouring regions such as Thanh Xuan, Cam Che, Thanh Thuy commune, etc. Conversely, the rest (62.5% of total surveyed households), who has a limited financial and labour force, is planning to keep their farm size stable. They claim that the price of land in the guava region is increasing rapidly. Thus, they cannot afford to buy more land plots. As for the small and medium farms, it would be better to increase the productivity and the quality of the fruits through improved varieties and modern techniques rather than buying more land areas.

Similarly, the expansion of the kumquat or guava cultivation areas is also under a plan of many households in the litchi-kumquat-guava production system. 40% of total surveyed households intend to buy or exchange the litchi orchards for the transformation into kumquat or guava plantations. The litchi gardens that have favourable conditions for the conversion are the most preferable choices of households. Until now, nearly all litchi plantations along the riverside are switched to kumquat or guava crops. Therefore, many households (60% of total surveyed households) state that it is difficult for them to expand their fruit gardens in the future. Furthermore, the shortage of financial capital and active labours is also the constraints that they are facing in the coming years. Diversification of fruit crops is continuously a production strategy of households in this production system.

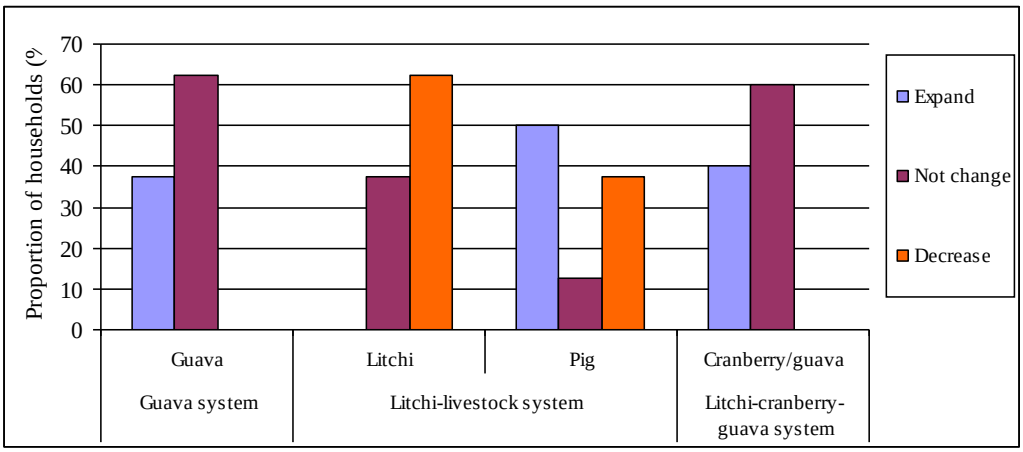


Figure 6.3. Distribution of frequency of households by their production planning (Source: Household surveys, 2010-2011)

In the litchi-livestock production system, 62.5% of total surveyed households said that they will not invest in litchi gardens. Some of them state that they will cut partly their litchi orchards and replace with other crops such as banana, kumquat or kudzu (a kind of root crop), etc. Others will keep their litchi gardens as abandoned crops. If the price of litchi increases in future, they will re-invest in litchi crops. On the other hand, they continue keeping the livestock flocks. However, some of them (37.5% of total surveyed households) find it difficult to expand the pig flocks because of serious threats of infectious epidemics and high price of animal feed. They tend to move to off-farm jobs as their future livelihood strategy.

VI. Policy implications for sustainable development strategies of agriculture and rural society

6.1 General development strategies

6.1.1 Mechanization and modernization of the agricultural production towards market orientation

Recently, according to the national planning on the agricultural production development towards 2020 and 2030, which has been approved by Vietnamese Prime minister, the state aims at developing a commercialized and modernized agricultural production in few coming years (Vietnamese Prime Minister, 2012). Mechanization and modernization of the agricultural production are the central development schemes in order to increase the agricultural productivity and household income.

In Hai Duong province, many tasks in agricultural production have been mechanized and modernized in some recent years. In the rice cultivation, for instance, land preparation, crop harvesting, agricultural product transportation, etc. are the activities performed mostly by engine machine (small to medium size that is suitable to the fragmented rice field). In each commune (for example in Cam Hoang or Tan Truong commune, Cam Giang district), there are several (two or three) farmers who own the tiller machine and rice harvesting-threshing machine. These farmers will take responsibility for the land preparation and rice harvesting for other households as a service. In the fruit cultivation, fruit growers are now buying many

more engine machines such as mini electronic pesticide sprayer, plant engine saw, etc. to save human energy and increase the labour productivity. In the Red river delta, mechanization and modernization of agricultural production by applying mini engine machines are of great importance in the context of acceleration of industrialization and urbanization.

To achieve such goals, it has the need to transfer a large number of labours from agricultural production activities to other sectors such as industry and service (Tuan, 2009). To do so, development of small to medium industrial and urban sites in different remote regions to bring farmers with more off-farm jobs should be taken into consideration. The movement of agricultural workers to non-farm activities will potentially improve the agricultural productivity as well as household income (MacAulay et al., 2006; Tuan, 2009). Moreover, the agricultural land reform is also of great importance to facilitate the development of a commercial agricultural production. Supportive policies will be issued in an attempt to promote the land consolidation (Hung et al, 2004, cited in MacAulay et al. (2006), (Vietnamese Prime Minister, 2012). Land consolidation is essential for the mechanization of agricultural production.

6.1.2 Reorganization of agricultural production and marketing activities of farm households towards market orientation

The agricultural production of farming households and the food marketing system are in great of demand for reorganization. The study of agrarian system evolution in Hai Duong illustrates that farm holdings have gradually integrated into the domestic and international markets over the last decade. However, many farmers, especially the small and medium ones in the remote regions, still face enormous difficulties in the market integration because of shortage of appropriate market institutions as well as the real organizations of farmers which assist them and protect their rights in the marketplace. The unequal trading and marketing system in which huge buying power of the private enterprises allow them to distort the price of agricultural products and to dispossess the selling power of smallholders. Besides that, the small scale of production, which is the common cases of most farm holders in Hai Duong and other provinces, significantly limits their capacity of productivity increase and market integration. Therefore, reorganization of agricultural production of farm holders and marketing activities is in need of development of a market-oriented agricultural industry.

The collaboration between the private enterprises and small farm holders has been emerged recently in some corners of Hai Duong and could be the potential for the development of the contract farming. These private companies have signed the farming contract with producers to collect their agricultural products with a minimum requirement of quality standard. This kind of relationship is an effective tool to integrate smallholders into the market. Moreover, the connection among farm households needs to be enhanced to bulk buy inputs and to bulk sell outputs, against the market superpower of private enterprises. To promote this collaboration, a new type of farmers' organization should be established with appropriate institutions so that it can operate efficiently to help farmers much more.

6.1.3 Developing the agricultural land-use strategy and agricultural service system appropriate to the sustainable development

The evolution of agrarian systems demonstrates the importance of developing an appropriate agricultural land-use strategy and a good agricultural service system. The adequate land use policy would stimulate the growth of agriculture and household income like the case of rice land conversion into fish ponds, vegetables and fruit orchards in 1990s. However, the excessive expansion of a given crop, such as litchi gardens, without appropriate land-use

planning also caused the extreme degradation of that crop cultivation in several following years. This seems to be an evident lesson for the fish pond development and new fruit crop expansion (guava and kumquat crops). Therefore, the development policy of the government should place the emphasis on long-term land-use strategies of agricultural land, taking into account the national food security and the competitive advantages of each region.

For the fish pond development, the local government has to control strictly the conversion from rice land into fish ponds. Firstly, only the lowland areas that have unfavourable conditions for rice cultivation can be switched to fish ponds. Other land areas, which are fertile and often cultivated by two rice crops per year, must be sustained for rice production to ensure the national food security. Secondly, the land use planning should identify the converted concentration areas in each region to facilitate other agricultural production activities. Farm households want to set up a new livestock-fish production model have to buy land in this converted area or exchange the land plots with their neighbours to regroup the land parcels.

For the fruit-based and vegetable-based agrarian system, the government should orientate producers towards a diversified production system at the regional level due to the competitive advantages of each zone and the technical knowledge of farmers. The land-use strategy needs to be based on the agro-ecological environment of each zone in order to plan on growing appropriate types of crops. Hence, there is a diversified agrarian system at the regional level, but a specialized production system at the sub-zone and the farm level. By this way, it is expected to avoid the excessive development of a given crop and its degradation in future.

Besides that, improving the agricultural service system is also very important for the sustainable development of agrarian systems. There is a wide range of services in agriculture that should be improved to facilitate the agricultural production of the farmers. In Hai Duong province, most of the agricultural service activities have been improved quite well over the two last decades. However, in order to avoid the degradation of fish culture or a given crop production caused by the excessive expansion, the information service about the demand in the market needs to be developed much more through different systems such as from the agricultural extension office or from local collectors. These agents should provide farmers with update demand trend in the market as well as search for new markets.

6.2 The emerging land issues and the need for a new policy on the agricultural land

6.2.1 Current issues of the agricultural land use system

In Hai Duong and other provinces in North Vietnam, the agricultural land use system is now in crisis that confronts the sustainable development of agriculture and rural society. The following emerging issues illustrate a high demand for setting up a new policy on the agricultural land in the forthcoming period.

6.2.1.1 Fragmentation of the agricultural land

The first and foremost problem is the small and fragmented land plots due to the egalitarian distribution of land in 1993. The situation of fragmentation of agricultural land differs from one region to another. At the whole country level, there were about 75 million plots of land and each household owned about 7-8 parcels on average (Lan 2001; Marsh & MacAulay 2002, cited in Hung et al. (2006). In the Red river delta and in Hai Duong province, the

average land parcels per farm holdings in 1998 was 7 and 10.3, respectively (Cat, 1998; Hung et al., 2006). Although the government has launched the land exchange program in many communes (about 700 communes in 20 provinces in the whole nation), this process is still at a low speed (Hung et al., 2006). In some regions like Hai Duong province, the project succeeded in some representative communes, which were selected and assisted by the province as the example, but failed in many others. The agricultural land in most regions are strongly fragmented and scattered. This is asserted by many authors that it is facing the development of agricultural production in Vietnam (Lan 2001; Ministry of Agriculture and Rural Development 2002; Research Institute of Agricultural Planning 2004, cited in (Hung et al., 2006). Although the small-fragmented land plot may be a significant factor for crop diversity, it clearly has a negative impact on crop productivity, family labour use and other financial expenses (Hung et al., 2006). Therefore, many farmers are in need of consolidation of agricultural land for a better use of natural resources. For example, in Hai Duong province, 2,300 households of total 2,500 samples demanded to reduce the number of small land parcels according to survey results in 1998 in 10 communes of 8 districts (Cat, 1998).

In this study, although the data about the number plots and their size were not collected, individual observations of the author and discussions with local people revealed that the fragmentation of agricultural land was really a serious problem for the development of a commercial agricultural production in all study sites. The land exchange program was implemented in some communes such as in Cam Hoang commune, Cam Giang district in 2003, but not succeeded in others, especially in the regions where vegetable and fruit cultivation are highly intensive and market-oriented like Gia Loc and Thanh Ha district. Besides that, the land exchange program is only a palliative solution to reduce the number of land plots and their size of each land holding. This solution does not enable producers to expand their total agricultural land areas. Many of vegetable and fruit growers acquire more land areas through short-term renting or buying the land use rights from other households. This is a big investment and risky to the fluctuation of the price of agricultural products, especially if they decrease in future like litchi. The scattering of land plots rented-in hinders producers in their efforts to consolidate land parcels. Thus, dissemination of unofficial land transaction activity impedes the development of a commercial agricultural production.

6.2.1.2 Different demands for the use of agricultural land among households and the growing abandonment of land

At present, the land use system seems to be inconsistent with the new situations of the industrialization and urbanization period. The demand and capacity of agricultural production is significantly different among groups of households. One group, mostly the young, is interested in engaging in non-farm works which potentially generate a higher income than that from farming jobs. The rest, especially the middle-age or the old people, continues working in agriculture. The direct agricultural labours have many difficulties in expanding their farm size because the non-farm group refuses to give their land plots to others. They still keep cultivating extensively on their land areas at low productivity or renting it out for a short-term period. The short-term renting contract does not allow land renters to invest in their production systems and does not care about the soil fertility improvement. Moreover, the highly scattered situation of land field due to the limit of land exchange among households, leading to the increasing land abandonment. It is likely that most of labours, especially the young, are now much less interested in investing in farming activities, whereas many active farmers are in great need of more agricultural land surfaces to mechanize and modernize their production systems. This contradiction causes the waste of natural resources and limits the development of agriculture.

Direct observations and discussions with local administrators and farmers reveal that the abandonment of agricultural land, especially rice land, is increasingly common in Hai Duong province and many others. A number of rice land plots are increasingly abandoned in Cam Giang district. In Thanh Ha district, the litchi orchards are non-harvested crops over large areas because of abundant rural migration to industrial zones and cities. It seriously threatens the national food security and the survival of farming holdings in the forthcoming years.

Besides that, after 20 years of land allocation under the 1993 land law, many emerging issues, especially the land ownership, are becoming inconsistent with the current reality of rural areas. A high proportion of old and dead people are still identified as the owner over their land areas allocated in 1993, meanwhile the young who were born after 1993 has not allocated land yet. Furthermore, the people who were born before 1993 and allocated agricultural land are still certificated as the land owner even though they are now engaging constantly in non-farm jobs in the governmental offices or organizations such as soldiers, polices, teachers, etc. These may lead to the conflicts among rural households over land regime. Thus, revision of the agricultural land policy is in high demand. Now, in 2013, a new land law is writing by the national parliament.

6.2.1.3 The imperfection of land market and the increase of land price

According to the Land Law in 1993 and the revised version in 2003, the land owners had basic rights over their land. The Article 106 of this law expresses that "land users may exercise the right to exchange, assign, lease, sub-lease, bequeath and donate land use rights; to mortgage, guarantee and contribute capital using land use rights"(Vietnamese National Assembly, 2004). These main rights have enhanced the transaction activity in many regions over the last few years. The inheritance and transfer rights may ensure the security and help improve productivity, but also add more tensions around land acquisition under the poorly codified land market (French Embassy in Socialist Republic of Vietnam, 2003). In the active land market in some regions, especially in the Red river delta, the better-off households are the ones who acquired more land areas than that of others, leading to the increase of poverty and equity concerns when the off-farm job opportunities remain low (Marsh et al., 2006). In fact, the land price in Hai Duong and many other provinces has increased rapidly in recent years because of the speculation of some land users, especially in the context of rapidly accelerated industrialization and urbanization around Hanoi and other big cities. In the vegetable and fruit land areas, the price of land is much higher than that in other regions and increasing rapidly. The actual price of land in the market is much higher than the price level assessed by the state. This kind of land transaction market cannot encourage the farm holdings, especially the young who lack financial capital, to expand their farm size and mechanize the agricultural production.

6.2.1.4 The complication of agricultural land tenure system in the industrialization and urbanization period

At the moment, when the process of industrialization and urbanization is enhanced, the revision of the land law seems to be much more difficult because of the competition function in land use and the rising property value of land. A high demand of land for installation of industrial parks and urban buildings in recent years has resulted in the significant reduction of agricultural land areas, especially in suburb of Hanoi and other metropolitan cities. The increase of land property value in this region induces the land speculation of some owners and makes it difficult to consolidate and redistribute the agricultural land. In many cases, the logic of keeping agricultural land areas is not for producing a high yield of crops. Land is becoming

a kind of capital of many farm households due to the rising price of land in the industrialization and urbanization period. Therefore, it is very difficult for policy makers to set up an appropriate policy on agricultural land towards sustainable development of agricultural production

6.2.2 Policy implications of consolidation of agricultural land

6.2.2.1 Principal requirements of agricultural land consolidation program

Based on the literature on the experiences of land consolidation programs at some communes in Hai Duong (Cat, 1998; Cam Hoang's People Committee, 2005), and the discussions with the local informants, the following principles and requirements should be fulfilled when implementing the program of land consolidation.

- Land needs to be offered to the right agents who actually have sufficient assets and capacity for the agricultural production. This means that the land will be given to workers who are currently working full-time or part-time on farms. The farmers who are temporarily engaging in unstable off-farm activities should be involved in this consolidation program.
- The land consolidation program has to facilitate the development of a commercial and modernized agricultural production. The land plots cannot be small size and fragmented.
- The land consolidation program needs to ensure the social equity of the rural society. It is of great importance for the project to avoid the social conflicts and disorders. For such objectives, the legitimate aspirations and demands of the most farming families should be taken into account in designing and implementing the land consolidation.
- When carrying out the consolidation of agricultural land, it is important to place great emphasis on the participation of rural communities in all steps from designing, conducting and inspecting stages. The program should be highly opened-up and encourage the participation of all villagers.
- Another requirement is that the land consolidation program has to be consistent with the long-term land use planning of the region. Without considerating the future land use planning, the project will be soon out of date.

6.2.2.2 Propositions of practical methods of land consolidation program

The need of institutionalization of land renting agreement among farm households

As illustrated in the previous part of this report, land renting is becoming more popular in Hai Duong and other regions of the Red river delta during the process of accelerated industrialization and urbanization around Hanoi and other metropolitan cities. The land renting is often conducted between farm households and their neighbours or relatives for an instable period, normally a short-term agreement. However, this kind of land transaction is often unofficial because they do not sign any types of contract. It is a simple verbal agreement between the land owners and the land renters about the duration and the payment of renting. The land renter often pays the land owner with the paddy rice or in conversion into cash at the market price after harvesting the crop.

However, the unofficial land renting has many disadvantages that hinder producers to invest in their agricultural production system. Firstly, the fragmented and scattered of land plots hinder land renters to consolidate and expand their farm land areas. Thus, they cannot

mechanize and modernize their agricultural production. Secondly, the renting duration is often instable, depending strongly on the demand for land use of the owners. In many regions, for example in the vegetable cultivation zone, when the price of agricultural commodities is in increasing trend, the land owners break the term of the contract and take back their land plots. Thirdly, the renting fee that the land renters have to pay increases rapidly, especially the land for growing vegetables and fruits. Many households have difficulties in renting more land from surrounding regions because of the high charge. Hence, it is important to institutionalize the agricultural land renting.

Institutionalization of the agricultural land renting contract for land consolidation

Institutionalization of the agricultural land renting contract is implemented by the legalization of the land renting agreement between the land renters and the land owners. This kind of legal renting contract has to indicate clearly the renting duration and the renting fee that are appropriate for both land owners and land renters.

To meet the above requirements and to have a good achievement of the land consolidation, the policy of institutionalization of renting land should consider the following aspects:

- Political persuasion and propaganda exercise

The political persuasion and propaganda exercise play an important role in explaining the goals and necessaries for land consolidation to people. It is clearly that the land renting contract will encourage some farmers to consolidate the land plots for mechanization and modernization of agricultural production. The abandoned land areas will be utilized effectively for the agricultural production purpose. The crop productivity and yield will increase and the production cost will be reduced significantly. Thus, the agricultural production will generate more income for farmers. Meanwhile, the land owners still keep their land ownership and get profit from leasing.

Historical experiences show that the change in land policy will only be successful if most of citizens give support to it. Their support will help not only to avoid the extreme argument, but also to motivate their new ideas that renovate the policy. Therefore, much attention needs to be paid to these exercises in the first step of the program to receive a high degree of unanimity of the local people. Therefore, it is in great need of participation of the commune staff in the political persuasion and propaganda exercise of institutionalization of land renting contract.

- Establishment of the program steering committee

The establishment of the program steering committee should be carried out at the local level. At the commune and village level, the steering committee members may include the authority staff and other representative people, for example, the head of the local social organizations such as chief of the village, head of farmer union, head of agricultural cooperatives, head of woman union, head of communist party unit, etc. The tasks of this steering committee are to practise the political persuasion, project design, management, and inspection.

- Inventory of all agricultural land resources of the local region

This step includes the inventory of the current agricultural land resources of each village and the whole commune. It also comprises the assessment of value of each zone of the land field in term of soil fertility, territory, advantages and disadvantages of production activities (the road, distance to the central village, irrigation facilities), and so on. This evaluation is useful for the planning on long-term land use as well as for the determination of the renting fee of each production zone.

- Reorganization of land parcels of all owners within the local region

In order to reorganize the land field, all land parcels of every owner will be regrouped to form a larger cultivation area. The consolidation of land plots varies from one village to another, depending on the specific agro-ecological environments of each field and the land use planning of the region. In each village, the land plots in a certain zone which have a relatively uniform production condition can be consolidated in one large field identified for one specific usage purpose of agricultural production such as rice zone, vegetable zone, converted animal-fish farm zone, etc. The local authority should consider carefully about the reorganization of agricultural land to be consistent with the future evolution of agricultural systems in the coming years.

- Institutionalization of land renting contract

The institutionalization of the land renting agreement should be firstly implemented between close neighbors or relatives. It is because these households often have the nearby land plots in the same location. Moreover, because of the close relationship, it seems to be easily for them to sign the agreement and obey the term of the contract. Year after year, when the farmers identify the benefit of official land renting transaction, they can enter into the contract with others from surrounding regions.

The land renting program should consider the appropriate renting duration and charge that are acceptable to both land owners and renters. The leasing duration should not too short or too long because of the rapid evolution of the agrarian systems in the urbanization and industrialization. It may be five or ten years, depending on the discussions between them. The renting charge should be appropriate for the fluctuation of the market and the change of the inflation rate.

The participation of the communal authority is of great important to legalize the renting contract and to protect the interests and to inspect the responsibility of both land owners and renters. Under this official renting contract, the land renters will not worry about breaking contract terms and invest more in their production systems to get a high crop productivity and income.

6.2.2.3 Propositions of auxiliary policies for the land consolidation program

In order to have a better result of the land consolidation program, the following policies should be involved:

- The government should implement some supportive policies to compensate the households who gave back their land plots to others and to help them to find stable jobs in the industry and service sectors. The role of improvement of rural small industry factories and traditional handicraft villages in absorbing the rural employments is well demonstrated in many regions. In some coming years, there is a growing need for supportive programs for the enhancement of these sectors.
- The rural infrastructure system, especially the road and irrigation system, needs to be improved by the public investment of the state. This intervention helps to reduce the heterogeneity of production conditions among land plots in different fields. If the facility of the land plots in the unfavourable locations is improved, farmers will readily agree with the land consolidation program.
- The land consolidation program should be accompanied by the policy of flexibility of land use. It means that the government should encourage and allow land users to

transform their land plots from one type of land use to another similar agricultural production activity under the control of the local government.

- To avoid the abandonment of agricultural land and the illegal land conversion into non-agricultural purposes, the state may consider some specific regulations of land withdrawal in some cases.

6.3 Implications of reorganization of agricultural production and marketing activities of households

6.3.1 Reinforcement of social farmers' associations for the improvement of cooperation between farmers and other development agents

In Vietnam, the cooperation among four main agents, including farming workers, agricultural scientists, agricultural businessmen, and the government, plays an important role in the development of agriculture and rural areas. The agricultural extension organization and other farmers' associations are known as the intermediate actor for the connections between producers and other supporters. It is an interactive relation in terms of the agricultural technology transfer, supplying agricultural inputs, marketing agricultural products, and agricultural policy orientation. In this development model, farmers are the central agent who needs great supports and protection from other organizations. If these relationships are strengthened, the agricultural production of households will be improved significantly.

In Hai Duong province and other regions of Vietnam, the existence of many organizations of civil society is advantageous for the development of agriculture and rural society in term of political manipulation and other social assistances. In rural areas, there is a high diversity of the socio-economic organizations and associations to which farmers are admitted as the official members. These organizations and associations such as agricultural extension services, agricultural cooperatives, communist party units, farmer union, woman union, youth union, ex-soldier association, etc., have a strong influence on the behaviour of rural communities. Therefore, strengthening the role and activities of these organizations is essential for the assistance of farm holdings.

However, due to the agrarian reform, the farm holdings have become the independent production unit, the activities of some organizations of civil society are then limited and less effective in helping agricultural production and protecting the rights of farmers than those before. The extension services are of great importance to farmers, but its working efficiency is still low because of many reasons (Ministry of Agriculture and Rural Development and United Nations of Development Programs, 2003). The liberalization of the agricultural market failed to create a fair marketing and trading system of agricultural communities in rural regions. The strong power of buyers and collectors results in the gross imposition of very low prices of agricultural products. Producers, especially the smallholders, are dispossessed of their market power on the price making decision of agricultural products. This undue phenomenon is widely observed in most regions in Hai Duong province and others. An investigation of farmers' need indicated that most farmers perceive that there is not any organization helping them to market their products (Ministry of Agriculture and Rural Development and United Nations of Development Programs, 2003). Thus, together with the legal system of the government, there is a great need to enhance the intervention of the social civil organizations in the agricultural production and marketing activities of farm holdings.

The discussions with local farmers and authority staff in Hai Duong demonstrate that it is necessary to improve the efficiency and the role of the agricultural public services in the agricultural production and marketing activities of farm households. Most farmers are often the members of several public service organizations such as farmer union, or agricultural cooperative. Therefore, they are often involved in all activities, from planning to managing and inspecting stage. Some agricultural cooperatives work effectively in providing farmers with some services such as irrigation and drainage services, seed and breed supply, pest management, etc. However, many agricultural cooperatives face huge difficulties of financial capital and work ineffectively because of shortage of motivation, management skills and assistance. In Hai Duong, several new kinds of farmer associations, for example the association of Thieu Thanh Ha litchi growers, have been established recently. Although great attempts have been made to help producers to develop their production systems and marketing activities, their working efficiency is still limited. They fail to encourage smallholders to joint in the association and do not succeed in helping smallholders in marketing agricultural products. Improving these agricultural organizations is of great demand.

It may be in need of establishment of new types of agricultural cooperatives and farmer associations. However, it had better improve the organization, management and working methods of the current agricultural cooperatives, extension stations and farmer associations in rural areas. The state may consider transforming from profit services into non-profit-making organizations working under the supports and instructions of the state. These organizations have to play an important role in assisting farmers' production activities and in protecting them from the monopoly of private enterprises in the market. They also work as an intermediate party between farmers and the agricultural scientists and government staff in terms of technology transfer and national policy extension. In order to improve the working efficiency and the political ascendancy, they should collaborate with other social civil organizations in rural areas such as the communist party unit, the ex-soldier association, the youth and the women union, etc. Furthermore, the activities of these organizations should be explicit and fulfil the demand of producers. They should give priority to the smallholders who often face difficulties in developing their production systems and have less power in the market.

In some cases, the social civil organizations can work more effectively than that of agricultural service organizations in solving some certain problems of the agricultural production development. The case of women union of Tan Truong commune (Cam Giang district) is a typical example as presented in detail in box 6.1. This union succeeds in mobilizing the cooperative action of all members to continuously cultivate rice crops over the abandoned areas. This union was chosen to take responsibility for developing rice cultivation because of their political and social credibility and ascendancy. Besides that, women are now the major agricultural labour force in this region since men engage in off-farm jobs. This typical example may be useful for other regions.

Box 6.1 The role of woman union in solving the problem of rice land abandonment in Tan Truong commune

Rice land abandonment is now an emerging issue in Tan Truong commune due to the rapid development of industrial and urban zones and its consequences such as environmental pollution and pest (mostly mouse) damage. The low profit of rice cultivation in comparison with that from off-farm activities results in the abandonment of large rice land areas. The communal government and communist party unit have to adopt a resolution to call for

participation of social civil organizations in solving this problem. The women union is the appropriate choice because they are the major labour force in rural areas at the moment. This union is organized by different units according to different hamlets. Each unit has to take responsibility to propagandize and mobilize its members to develop rice cultivation over their own land areas. The abandoned surfaces, mostly the communal areas or "Dat cong dien" (5% of total agricultural land areas of the commune), were collectively cultivated by all members of the union unit. Someone who cannot participate in these farming activities has to pay a fee that is equivalent to the current waged salary (about 100 thousand VND per day) to the fund of the union, or she can work on another day. All profit will be added to the union fund. This fund is then used for all activities of the union such as giving gifts to families of union member in case of sickness, marriage, organizing festival parties, or tourist trips, etc. At the moment (2012), a total of 30 sao (about 1ha) of rice land are cultivated by women union members of the commune.

(Source: Interview with Mr Chung, head of Farmer's Union and Mrs Vuong Thi Ngat, head of Women's Union of Tan Truong commune, 13/12/2012)

Apart from the supports from the government and social organizations, farmers also have to dynamically collaborate with each other and with other development agents in order to promote their production systems towards sustainable development. They can joint actively in the farmers' association that helps them to bulk buy inputs with a cheaper price, to share information about the market price, improved techniques, new animal breeds or plant varieties, and so on. As an official member of these associations, each farmer has to strictly comply with the specific regulations and the common goals of the group such as the standard quality of the products, the adequate disease prevention program, etc. The compliance and contribution of each producer are necessary for the sustainable development of farmer's associations as well as agricultural production system.

6.3.2 Support for the development of agricultural business and food processing as the driving force for the commercialization of production of farm households

The agricultural business often plays a vital role in promoting the commercialization of agricultural production of farm holdings. Our observations of the vegetable and fruit marketing system in Gia Loc and Thanh Ha district show that the development of marketing system in the regions around the central district encourages farm households to intensify their agricultural production much more than that in the remote regions. The agricultural businessmen are very active in the market expansion to the centre and the south of Vietnam as well as other neighbouring countries such as Lao PDR, Cambodia, and China. It is important to support for farmers who want to start the business of agricultural products.

Based on discussions with several agricultural businessmen in Gia Loc and Thanh Ha district, they place emphasis on the development of contract farming. In recent years, some agricultural businessmen have attempted to develop the contract farming with vegetable and fruit growers. For example, Mr. Tang Xuan Truong, director of the Thuy Truong Limited Company, signed a contract with vegetable growers in some communes in Gia Loc district to cultivate cauliflower and other vegetable crops. The company will provide producers with vegetable seeds, transfer the technology of vegetable growing and pest management. All vegetables will be purchased at the market price. The number of households who signed the contract with company increases from 96 households in 2006 to 290 ones in 2009. The total vegetable cultivation areas signed in the contract increase from about 5ha to 10.5ha in the

same period. This kind of farming contract is of great importance for the economic activity of both producers and buyers. All agricultural products of the farmers will be bought at a relatively stable price. It also enables the private enterprise to make a good business planning in term of commodity supply.

However, the lack of appropriate market institutions makes the contract farming difficult to be developed. According to the term of the contract, all agricultural products of farm holdings will be sold to the company at the average price in the market. In fact, many producers break it when the small and medium middlemen come to buy the products at a little higher price than that of the company. The case of vegetable growers in Gia Loc is a typical example. The local middlemen, who supply vegetables to the niche market in the urban regions such as Hai Duong city, Hai Phong, Hanoi, etc., often purchase the high-quality vegetable at a higher price than the average level in the market. In this case, vegetable growers break the term of the contract through selling a large proportion of their vegetables to the local middleman. The bad-quality products will be supplied to the company. There are no organizations and the legal constitution to protect the enterprise against the producers who often break the contract. Therefore, it is impossible for the company to continue the farming contract with the farmers anymore. Then, the company has to depend mostly on the intermediate collectors at the villages in buying vegetables and other agricultural commodities.

The solutions to this problem are not only to develop the market institutions that protect both producers and the enterprises in the marketplace, but also to improve the role and intervention of the local authority and social civil organizations. The market institutions should create a fair trade environment for agricultural commodities to protect the legitimate rights and to control the obligations of both producers and enterprises. To do so, there is a need of the intervention of both local authority and social civil organizations. Sometimes, the intervention of the organizations of civil society through political propaganda exercise and manipulation to improve the consciousness and responsibility of both farming households and the businessmen is much more important than the legal actions or remedies. Moreover, these social civil organizations should inspect the activities of both producers and buyers and appeal the interactive inspection among them. Thanks to the credibility and ascendancy of the social organizations of civil society in rural areas, it requires their participation and intervention in developing the contract farming towards a sustainable development of agriculture. In order to achieve this goal, the state should execute supportive policies to improve these organizations.

The lessons from the agricultural marketing system development in the central region clearly illustrate the need of helping the agricultural businessmen to develop the marketing system in the remote regions through direct and indirect ways. The farmers, who want and have ability to develop a business or the small-scale enterprises in the rural areas, are often in need of help of starting and working capital. It is essential to set up supportive policies to encourage them through different manners, not only accessing to the favourable financial capital, but also developing necessary infrastructure systems such as transport system, electricity system, rural stores and markets, etc. In several first years after establishment, the state may consider to reduce sale tax for these agricultural businessmen to stimulate them to expand their business. It is also important for the government to help the agricultural businessmen to find the potential market in both domestic and international marketplace. The development of agricultural marketing system will be one of the most important driving forces of agricultural production development.

On the other side, the agro-food processing plants need to be continuously developed in the forthcoming years. In Hai Duong province, most of fresh agricultural products are directly

supplied to the market. Some of them, for example litchi, are processed by traditional methods without quality control. In fact, the processed products, for instance dried litchi, are often sold at a higher price than that of the fresh ones. However, the traditional processing methods implemented by smallholders cannot fulfil the quality requirements of the customers, especially the high income groups. In this case, the big processing plants, which have sufficient modern equipments, often control the quality better than the small farms. In Hai Duong and other neighbouring provinces, there are several fruit processing companies. However, they have many difficulties in developing the manufacture of processed food because of limitation of financial capital, marketing expansion, as well as the supply of agro-food. The fluctuation of fruit yields and the short duration of fruit supply are the two big problems for their manufacture activities. This is the case of litchi because of the yield variation from year to year and short duration of harvesting (half of a month). The support for these processing plants to enhance the manufacture capacity can be considered as a good solution to the improvement of the agro-food processed industry.

VII. Development policies of agrarian systems in different zones of Hai Duong province

7.1 Development policies of livestock-fish based agrarian systems in the upper zone

7.1.1 Improvement of the technical knowledge and skills of producers through diversified assistance activities

In some recent years, one of the biggest challenges that most of livestock-fish farms have faced is the threats of the animal infectious epidemics. Among the reasons for this problem, the insufficient knowledge and skills of animal production and veterinary medicine of many farmers, especially the smallholders, are considered as the main causes. The technical assistance through diversified activities is of great importance on solving this problem.

In Cam Giang district, the technical assistance has been provided to farmers through short training programs and some other activities since many years ago. These programs are often carried out by staff of both the governmental organizations and the private companies. Over the last few years, thanks to theses actions, the technical knowledge and skills of farmers have improved considerably. Many of them, especially the big-scale farms, are fairly good at animal husbandry and disease treatment.

However, many farm holders, mostly the small-scale ones, have a limited access to these technical assistance services. Even though they are invited to the training courses, they have difficulties in applying advanced technologies to their production systems. It is because the advanced technologies, which are often transferred through training programs, are not appropriate for the small scale production. The small-scale livestock flocks are also not well-protected by vaccination. Moreover, the complexity and diversity of animal epidemics, which always threaten the animal flocks, hinder the untrained producers in their efforts to protect the animal population. That is the reason why the infectious epidemics have damaged significantly the animal herds during the recent years.

Diversification and improvement of technical training programs, especially about veterinary medicine, are now in great demand of most animal keepers in Hai Duong province. The discussions with producers reveal that the technical assistance activities should be diversified

through regular training programs and direct guidelines on animal disease prevention and treatment. The supportive policies should give priority to improve the knowledge and skills of the local veterinarian who take responsibility to guide farmers and to diagnose the occurrence of epidemics in the local areas.

Moreover, the development of the veterinary medicine supply chain is also in need of support. The effective supports of the common veterinary medicine cabinet in Cam Hoang commune will be a good example as the lesson for others. This association helps to provide local farmers with medicine and consultants about disease prevention and treatment. The members of this association have more chances to discuss and exchange each other about knowledge and experiences of animal production and veterinary practices. The local government should support for the development of this kind of association to increase the awareness and the ability of animal keepers in animal husbandry and disease control (see more details in box 6.2).

Box 6.2 The role of the common medicine cabinet in the animal disease prevention and treatment in Cam Hoang commune

The Cam Hoang's common veterinary medicine cabinet was established in 2007 upon the technical and financial supports of Centre of Interdisciplinary Research on Rural Development, Hanoi University of Agriculture. The centre played a vital role in consulting the working mechanism and supporting basic working capital to buy a fridge for vaccine conservation. A total of 25 members paid 200 thousand VND once time for the working capital to buy some kinds of veterinary medicine. The aim of the association is to provide members and other animal keepers in the commune with necessary vaccine and veterinary medicine at reasonable prices in comparison with those in the market. The association also works as the intermediate actor in technical training programs which are regularly implemented by the province and the university. The common veterinary medicine cabinet is managed by the head of veterinarian of the commune. Since 2007, the association has provided farmers with a lot of hygiene medicines, vaccines and many other kinds of veterinary medicines. To increase the working efficiency of the association, each year, the final meeting is organized to summarize all activities and point out the aspects needed to be improved in the future. This is a meaningful organization in which producers, especially the smallholders, have more opportunities to help each other. Furthermore, the awareness and skills of animal keepers are significantly improved through diversified assistance manners.

(Source: Interview with Mrs. Lan, head of veterinary station of Cam Hoang commune, 12/12/2012)

7.1.2 Improvement of use of local natural resources as feed for animals

Surveys of the feed ingredients used in the animal diet show that most animal farms in Hai Duong depend strongly on the purchased industrial feed because of degradation of the on-farm feed production. In the previous decades, a wide range of animal feed was produced on farm such as maize, soybean, sweet potatoes, etc. At the moment, animal farms, including small and medium scale ones, increasingly used the industrially manufactured feed for their animal herds. Meanwhile, records of price fluctuation of most industrial feed purchased by farmers illustrate the rapid increase in recent years. The shortage of local raw materials supplied to the feed manufacture industry results in an increasing proportion of import from foreign countries, leading to the high production cost and selling prices. Therefore, in the next

few years, the local government should make an effort to encourage farmers, especially the smallholders, to develop the cultivation of some cereal crops such as maize, soybean, etc. as the animal feed resources.

Statistical data of Hai Duong province and other regions indicate that the cultivation areas of several cereal crops such as maize, soybean, sweet potatoes, etc. have reduced significantly over the last few years, especially since the early year 2000s. The main reasons for this decline are the movement of active agricultural labours to off-farm jobs and the increasing attacks of pests and diseases. Some households, mostly in the livestock-fish-crop production system, want to develop maize cultivation in the winter crop. However, as they explained, their crops cannot be cultivated solely, without other households' crops. The scattered land plots of maize crops are highly vulnerable to attacks of mouse populations, pests and diseases. Furthermore, in this case, it is also not very convenient for the irrigating and draining activities. Consequently, all the surfaces of the rice fields are abandoned in the winter season. The solely rice-based production system is increasingly dominant in not only in Cam Giang district but also in other rice cultivation regions of Hai Duong province and the Red river delta.

The local government should make an attempt to encourage farm holders, especially the small and medium animal farms, to develop the cereal crops in the winter season, as that in the previous decades, to supplement animal diet with on-farm produced feed. Firstly, the revision of agricultural land policy is necessary for producers to have enough land surfaces to cultivate maize and other winter crops. The large areas of agricultural land are also the principal conditions for farmers to mechanize their crop cultivation. Secondly, the propaganda and manipulation campaigns will be a useful method like many local authorities did in the past. The participation of the social organizations of civil society is also so meaningful that should be increased like the way implemented by the woman union of Tan Truong commune (see box 6.1). Thirdly, the agricultural cooperatives of the commune have to improve the quality of their services of irrigation and drainage activities and pest management, especially the prevention method of mouse attacks. Fourthly, the agricultural extension station of each commune and district should enhance the efficiency of training programs and the supply of the hybrid seed corn to farm households. To motivate producers, the local government may consider to subsidy partly to crop growers through the seed price like the case of some hybrid rice seeds. With all the above attempts, the diversification of cropping systems through expanding the cultivation areas of maize and other cereal crops in the winter crop is expected to be implemented by many households to reduce the cost of animal feed.

7.2 Development policies of vegetable-based agrarian systems in the middle zone

Among the current constraints facing most vegetable growers in the middle zone, the degradation of agro-ecological environments and the inconvenient irrigation and drainage activities in some locations are the two principal ones. The intensive use of chemical fertilizers in vegetable cultivation of most producers over a long period has extremely impoverished the soil. Vegetable growers have abused pesticides and herbicides in pest management, causing the degradation of both ecological environments and the disease resistance of the vegetable crops. Besides that, the vegetable crops are also increasingly vulnerable to the flood in the rainy season because of the change of agrarian landscape. The enlargement of industrial and urban zones and other fish pond areas hinders the irrigation and drainage activities. The development policies should be given priority to solve these difficulties.

7.2.1 Enhancement of the application of good agricultural practices in the vegetable cultivation

The good agricultural practices are well-known as all practices to produce safe agro-food. These practices are now standardized according to specific agricultural production activities and widely disseminated by the Vietnamese Ministry of Agriculture and Rural Development. These practices, which are named as VietGAP, are very essential for the agricultural production of farm households towards sustainable development.

In the vegetable cultivation areas of Hai Duong province, the application of the good agricultural practices (such as VietGAP procedure) is still limited. Therefore, in order to encourage vegetable growers to apply the good agricultural practices, the agricultural cooperatives and extension stations should focus on the following activities

- Increasing the crop rotation and succession through new crop varieties

At present, three to four crops are rotated during the year in the vegetable-based production systems. However, several crop varieties in Gia Loc district are becoming degenerative due to the repeated rotation over a long period. Many farmers in the cabbage-melon production system in Gia Xuyen commune noted that the water melon crop, which has grown in Gia Xuyen for a long time, is now difficult to cultivate because of its degeneration and low capacity of disease resistance. The fruits are much smaller than those in the past. The musk melon crop is increasingly grown by many farm households to replace for watermelon. Similarly, the cultivation areas of cabbage in the main crops tend to decrease because of both low profit and the disease transmission from the early cabbage crop. In the coming years, another vegetable variety may be used to substitute for cabbage according to the estimation of many farm holdings. Thus, the agricultural cooperatives and extension stations should introduce farmers with different improved crop varieties for their selection. The new crop varieties have to adapt well to the specific agro-ecological environments of each region and meet the consumption demand in the market.

- Improving the efficiency of the use of chemical fertilizers and organic materials

The application of both chemical fertilizers and organic materials to the vegetable crops in Gia Loc district is not appropriate as the standard doses guided by the manufacturing companies and scientists. The investigation of the use of some main types of fertilizers reveals that most vegetable growers apply an overdose of chemical fertilizers to their crops, leading to the soil degeneration, water pollution, and high cost of production. Thus, improvement of fertilizer use efficiency is crucial.

The local agricultural cooperative and extension station should collaborate with staff of the fertilizer companies to train producers the appropriate method and dose of fertilizer application. They should disseminate information to producers about the choice of types of fertilizers, the period and the dose of applying fertilizers to different growth stages of crops. To enrich the soil fertility, farmers need to apply regularly the organic materials, especially the composted animal manure, to the land plots. Some types of fertilizers produced by bacterial technology can be a good choice to replace partly the chemical fertilizers. Moreover, the increase of crop rotation and succession by different crop varieties is also a good factor influencing the efficiency of fertilizer use through effective absorption of residual minerals in the soil.

- Applying the integrated pest management towards safe production.

The pest damage is now a big problem facing most vegetable farm holdings. The abuse of application of pesticides and insecticides is not only harmful to the agro-ecological

environments, but also the less disease resistance of vegetable crops. Vegetable crops are increasingly vulnerable to different types of pests and diseases. To control these attacks, farmers have to increase the dose and combine different types of pesticides and insecticides, leading to the extreme pollution.

In the coming years, due to the increasing concerns about human health, applying the safe production by integrated pest management is of great importance to the vegetable growers. The vegetable producers need to be trained how to manage effectively and safely the pest and insect attacks. The staff of the local agricultural cooperative and extension station should persuade vegetable growers to apply the biological pesticides and insecticides in pest control. Furthermore, the method of natural enemies in pest management needs to be studied and transferred to vegetable farmers. Besides that, based on the discussions with both farmers and pesticide retailers, the technical and financial assistance policies should be given priority to the local pesticide retailers because they play an important role in consulting and supplying the chemical synthesis to producers. The local government has to inspect these pesticide stores more regularly to forbid them to trade toxic chemicals and other harmful substances. All efforts of both local government and farmers need to be made in order to develop a safe organic agricultural production.

7.2.2 Improvement of the irrigation and drainage management and other rural infrastructure system

In the middle zone of Hai Duong province, although the irrigation and drainage systems have been improved significantly over the last few years, the change of agrarian landscape sometimes has an adverse impact on irrigation and drainage activities. The vegetable growers explain that their crops are highly vulnerable to the flood in the rainy season. They have to buy the mini water pumping machines to save their crops. However, it is only the palliative solution because of the inconvenient canal systems. Hence, improvement of the irrigation and drainage management should be a prior development policy.

- Construction of the irrigation and drainage systems

The construction of the irrigation and drainage systems has been often carried out by both the government state and the local people. This collaboration should be enhanced in the future. The state has to place the importance on the long-term planning of the water conservation projects that are consistent with the general space management and the regional planning. The state needs to invest more in the upgrade and construction of the pumping stations, irrigation and drainage canal systems, especially in the disadvantageous locations. The local organizations should encourage the producers to take part in the dredge and expansion of the irrigation and drainage canals.

- Improvement of the irrigation and drainage management

Increasing the management of irrigation and drainage activities plays a vital role in the success of the vegetable cultivation. This is also a difficult practice because many agents are related to these activities. The experiences of the participatory irrigation management in Gia Xuyen commune will be a useful lesson for other regions to promote the irrigation and drainage activities. The participatory irrigation management emphasizes on the involvement of the related agents in the irrigation and drainage activities, including the irrigation companies, the local agricultural cooperative and farmers. These agents are invited in all stages of the irrigation and drainage activities, including the planning and management. Thanks to the participation of these agents, the irrigation and drainage activities are well

managed, facilitating the development of the intensive vegetable production system in this commune.

The management of the irrigation and drainage activities in many vegetable cultivation areas is very complicated and difficult due to the diversified vegetable crops which have different demand for water supply. Thus, in order to improve the efficiency of these activities, the following issues should be solved.

- Increase the salary of the staff who takes responsibility to regulate the water flows. This salary is paid by farmers as a service. However, the low salary does not encourage the staff to work hard. Farmers should pay more for this service in order to increase the responsibility and working efficiency of these staff.
- The local agricultural cooperative should collaborate with the irrigation companies to set up a suitable irrigation schedule so that farmers can irrigate the vegetable crops on their own initiative.
- The schedule of irrigation activities is required to disseminate rapidly and widely to all producers of the commune. Thus, the development of means of communication such as broadcasting radio system is of great importance. The local government needs to invest more in this system to facilitate the dissemination of information.

7.3 Development policies of fruit-based agrarian systems in the lower zone

In the lower zone, as described in the previous parts, there is a diversification process of the fruit crops from litchi orchard into different varieties of fruits such as guava, kumquat, banana, etc. This trend is in progress in the locations which are favourable for diversification, but still limited in the disadvantageous areas. The local government gives priority to keep the cultivation areas of litchi stable, meanwhile farmers continue cutting down partly their litchi gardens. Therefore, the development polices should consider promoting the cultivation of litchi in the given areas while enabling farmers to convert partly their litchi gardens, especially the old trees and low productivity orchards, into other higher profitable fruit crops. To achieve this goal, the development policies should support more for producers and other agents in the fruit chain.

7.3.1 Development of litchi orchards through a wide range of supports

As illustrated in the previous chapter, litchi orchards in Thanh Ha district have been degraded significantly since the last decade. The low price of litchi, especially the main crops, results in the low profit and farmers stop investing in the litchi cultivation. Large areas of litchi orchards are becoming abandoned and non-harvested crops. Farmers start to cut down their litchi gardens while the province and district government are making great efforts to keep litchi cultivation areas stable. In this case, a wide range of supports should be given in order to sustain and develop this special fruit.

First and foremost, the local agricultural cooperative should encourage farmers to improve the productivity and quality of litchi fruits. Most of litchi orchards were grown in the period 1993-1995, and are about 20 years old now. Their reproduction ability has decreased gradually. Thus, farmers should prune or replant their fruit trees to facilitate the pesticide application and harvesting works. They also need to pay much attention to litchi crops by applying fertilizers, herbicides and pesticides appropriately. At the moment, the province and district are launching the project on application of good agricultural practices (VietGAP) in the litchi cultivation in several representative communes (Thanh Son, Thanh Khe, and Thanh

Thuy commune). Half of this financial capital will be funded by the provincial budget, and the rest will be called from the contribution of farmers involved in the project. The district government firstly identifies the specific litchi zone, which has a minimum area of 10ha of Thieu litchi. A total litchi cultivation area of 100ha will be selected for this project. Litchi growers, who will participate in this program, will be trained with the good cultivation practices. During the cultivation practices of litchi, they will be strictly inspected and controlled to follow the standard procedure. Their litchi fruits will be sampled to check the quality. If the quality of fruits is equivalent to the standard quality, the litchi orchards will be issued a quality certification (Thanh Ha' Department of Agriculture and Rural Development, 2011). This is a necessary program to improve the productivity and quality of Thieu Thanh Ha litchi.

Secondly, the local government should give supports for the processing plants of litchi. Litchi is often dried by the traditional method using the fossil fuel (mostly coal). This method cannot ensure the quality standard of the fruits. Several electric drying machines were created and introduced to producers. However, the low profit from litchi and the instability of electricity system in rural areas, especially in the summer, hinder the application of these machines. In order to increase the quality of dried fruit products, some farmers designed a new heating system using the fossil fuel. This system will blow the heating air to the cabin of litchi to prevent the fruits from the coals. This is only a palliative solution because the quality of dried fruits still does not meet the standard requirements. The government had better support for the fruit processing plants which can have enough capacity to dry a big amount of fruits with good quality.

Thirdly, the local government and the Thieu Thanh Ha litchi association should assist the promotion of the marketing and trading activities of the fruits. Over the last year, although great attempts have been made by both the local government and the litchi association, the marketing and trading activities of the fruits are still limited. In the forthcoming years, they should make more efforts to assist producers in these activities by diversified manners. They should organize the consumer meetings more regularly, especially right before the harvesting season. In this meeting, different target customers such as small businessmen, association of customers, supermarkets, processing plants, etc. should be invited. They also need to place importance on the dissemination of information about the brand name of Thieu Thanh Ha litchi through participating in national and international trade fair. Besides that, the Thieu Thanh Ha litchi needs to be well-packaged with specific logo or label to develop its brand name in the market. Developing the trading and marketing activities is a crucial factor in the success of the litchi cultivation.

7.3.2 Enhancement of diversification of fruit production systems

Diversification of the fruit-based production system is very meaningful for household economy in the lower zone of Hai Duong province. The single litchi production system is really vulnerable to the changes in the environments, especially the fluctuation of the market. The litchi growers' income is far lower than the living standard and not sufficient for the daily life of many households. Thus, diversification from litchi into other fruit crops is an indispensable process of farm holdings to adapt better to the changes in the socio-economic and agro-ecological environments.

The diversification of the fruit production system needs to be oriented by the local government to prevent the excessive development of one specific variety of fruit. The lesson from excessive expansion of litchi gardens in the last decade shows that local government has to make great attempts to plan the appropriate regional agricultural development scheme.

These efforts should limit the trading activities of fruit cuttings in the market, while promoting the supply of the fruit cuttings from the fruit institutes and companies. The local agricultural cooperative and extension station should introduce new fruit varieties, which are highly suitable for each region, to the farmers. In each region, fruit growers should select and develop one or several fruit varieties to take the most advantages of competitiveness like the case of guava cultivation in Lien Mac commune.

The provision of improved fruit varieties is also of great importance to the diversification of fruit crops. At the moment, most of farm holdings multiply their fruit crops by themselves and provide to others in the local market. This process will result in the degeneration of fruit crops that badly impact on their productivity and quality like guava in Lien Mac commune. Hence, the agricultural cooperative and extension station should work more effectively as the intermediate party to link farmers with the fruit institutes and companies in the development of new fruit varieties.

One of the most important conditions for the fruit diversification is the water supply through irrigation system. The survey results indicate that farmers in the favourable locations, where the water supply is sufficient, diversify their crops more early and rapidly than those in inconvenient areas of water intake. For example, in Thanh Son commune, where the irrigation system was definitely broken down in 1993 due to the complete conversion of all rice field areas into litchi orchards, farmers are now facing with difficulties in diversifying their litchi gardens into other fruit crops. In the region like Thanh Son commune, the reconstruction of irrigation system is in great demand for the fruit diversification. The improvement of the irrigation system can be achieved if the local government and social organizations call for the contribution of both the state and communities in term of financial supports and human power resources. The local government should give priority to these kinds of intervention when setting up the development policy of this region.

GENERAL CONCLUSIONS

1. The importance and objectives of the study

Vietnam is considered as an agriculture-based country, but now in progress to become an industrial country by the year 2020. On the way of industrialization and urbanization, the contribution of the agro-sector to the national economy will be less than that of the industry and service sectors. Under the context of the decrease of agricultural land areas and labours, it is of great demand for promoting a mechanized and modernized agricultural production to fulfil the increasing consumption of the population. This study was carried out in order to provide the policymakers with some theoretical and practical principles of agricultural development policies of Vietnam in the next periods, especially in the economic structure transition period.

By employing the systematic approach, which places the importance on the evolution of agrarian systems over a long historical period, we expect that the diagnosis and analysis of agrarian system dynamics in the economic transformation period would help to figure out the evolution stages and their driving forces, providing the evident lessons for the future interventions. Furthermore, the analysis of the problems of farming management and other constraints facing households when implementing different production systems will be the basics of setting up appropriate policies towards a sustainable development of agricultural production.

This research was conducted at several communes and districts of Hai Duong province as a representative case of the Red river delta, North Vietnam. Hai Duong is well-known as a big agricultural region, which is famous for a wide variety of agricultural products such as Thieu litchi in Thanh Ha district, vegetables in Gia Loc district, livestock and fish in Cam Giang district, etc. However, like many other provinces in the Red river delta, under the circumstances of acceleration of industrialization and urbanization, the agro-sector of Hai Duong is faced with a lot of difficulties and challenges to balance the development of both agriculture and industry. By investigating the dynamics of agrarian systems in different agro-ecological and socio-economic zones of the province that is linked with the process of rice land conversion into other agricultural land use purposes, this study aims to find appropriate solutions to the land issues and the organization and management of production activities of farm households.

2. The main research results and findings

The surveys at 96 farm households and numerous discussions with local people in three agro-ecological and socio-economic zones of Hai Duong province indicated the significant evolution of agrarian systems from a subsistence farming to a market-oriented agricultural production under the socio-economic and institutional changes in Vietnam during the economic transition period. However, the evolution of agrarian systems differs remarkably among different zones due to their specific environmental changes.

In the upper territorial zone, which has large water surfaces due to the uneven terrace and density of natural streams, farm holdings took the most advantages of the favourable water flows and borders to develop the fish culture and livestock production system. This process included not only the upgrade of natural pools to be fish ponds, but also the transformation from rice fields to fish ponds and animal buildings during 1990s. The lowland areas that were

difficult for the rice cultivation was converted gradually into fish ponds and animal houses for a better utilization of the natural resources and the generation of employment and income of farm holdings. During this period, the development of two rice crops and a winter crop (maize and other cereal crops) provided fish and livestock flocks with a significant proportion of feed. The integration of livestock, fish and crop cultivation into the production system of most farm households is highly effective in term of reduction of production cost, reuse of agricultural by-products, mitigation of environmental pollution and generation of employment and income for farm holders.

However, according to the acceleration of industrialization and urbanization process during the year 2000s, the agrarian systems in the upper zone have changed significantly. On one side, the availability of off-farm jobs around the industrial parks induced the huge movements of agricultural labours to migrate to cities, leading to the reduction of number of families keeping livestock flocks at the small scale. This disappearance of family's animal production was also caused by the extreme damage and threats of many infectious epidemics in pigs, chickens, cattle herds and the rapid increase of animal feed price. During this period, the cultivation of winter crops, especially maize crop, declined remarkably due to the switch of agricultural workers to off-farm jobs, the increasing attacks of pests, and unfavourable irrigation activities. The replacement of industrial animal feed for the on-farm produced feed resulted in the rapid increase of price of animal feed in the market, having a huge impact on economic efficiency of animal farm holdings. These problems are still facing the livestock-fish production systems in the forthcoming years. On the other side, the big farms, which had sufficient production resources (land, labour, capital), continued intensifying their production system by not only expanding their farm areas and livestock flocks but also developing closed animal buildings with modern equipments. In the next few years, the two production systems, including the semi-intensive livestock-fish-crop production system and the intensive livestock-fish production system will be continuously developed in this region. The intensive animal farms will invest more in improving animal performance, product quality and modernizing their production system. Meanwhile, households applying the semi-intensive livestock-fish-crop production system will focus on the local animal breed and adjust the livestock flocks to the fluctuation of the marketplace.

Rice is well-known as the staple crop in the Red river delta to ensure the national food security. However, the rice land cultivation areas have reduced since the last few years and the rice cropping system in some regions, especially around the industrial zones, is becoming extensified or even abandoned like the case of Tan Truong commune. The abandoned rice land areas have gradually increased because of the high production cost, extreme attacks of pests and insects, and the impact of waste from industrial factories. The fragmentation and scattering situations of rice land plots hinder farm households in their efforts to expand their rice land areas. The revision of the agricultural land policy is thus in great demand for the development of not only rice cultivation but also other agricultural production activities.

In the middle territorial zone, where there is a fairly plain territory, fertile soil, favourable irrigation and transportation system, farm holdings have conducted a gradual transformation from a rice-based production system into a vegetable-based production system over the last decades. This conversion was observed by the reduction of rice cultivation land areas and the replacement of vegetable crops during the year 1990s and 2000s. In the period of 1990-2000, because most households integrated the livestock into their production system, maize and several cereal crops were cultivated together with vegetables. Since the beginning of the year 2000s, according to the decrease of family's animal production, farm holders have specialized in vegetable cultivation. However, this process differs between the central locations and the remote regions due to their specific agro-ecological and socio-economic environments. In the

central location (like Gia Xuyen commune), which is situated near the Hai Duong city, industrial zones, and the big agricultural market, the specialized cabbage-melon production system has been employed widely by most farms. The development of the trading and marketing system through collecting and transporting large amounts of vegetables to the centre and the south of Vietnam has notably encouraged vegetable growers to intensify and specialize in cabbage-melon production system. On the contrary, in the remote region (like Thong Kenh commune), which is away from the central town and market and lower than others, farmers still develop a diversified vegetable production system. There is a wide range of vegetable varieties cultivated here in order to reduce the fluctuation of the vegetable prices in the market. The small-scale livestock production is sometimes employed by some farm holdings in this system. In the future, the specialized cabbage-melon production system will be continuously developed in the central region, while in the remote areas, farm households tend to focus on several varieties of vegetables, which have higher profitability than others. The diversification of the vegetable-based production system will be enhanced in the coming years.

However, the intensification of the vegetable production system over a long time through an abuse of chemical fertilizers, pesticides, and insecticides, has extremely spoilt the agro-ecological environments, leading to the impoverishment of the soil and the low resistant capacity to pests and disease pathogens of vegetable crops. The overuse of these kinds of chemical synthesis also causes the residue in agricultural products that is harmful to human health. The application of good agricultural practices in the cultivation of vegetables is thus in great demand for a sustainable agricultural production. Besides that, the improvement of irrigation and drainage management is also required because of the extreme damage of flood that sometimes occurs due to the changes in the territory in accordance with industrialization and urbanization in surrounding regions. Degradation of the environment and inconvenient drainage system are the two biggest constraints facing most vegetable growers in the middle zone at the moment.

The low territorial zone, which has disadvantages of territory and rural infrastructure, is known as a fruit-based region due to the conversion from rice fields into fruit gardens. In 1993, when the food security was basically ensured at the regional level, thanks to the policy of the state and the province on rice land conversion into other agricultural land use purposes, many households carried out a gradual transformation from rice fields into litchi orchards. In some communes (such as Thanh Son), all rice land areas were completely switched to litchi plantations. Since then, the rapid expansion of litchi cultivation areas not only in Thanh Ha district but also in other provinces, especially the mountainous regions like Quang Ninh, Bac Giang province, etc., has resulted in a significant decrease of litchi price in the market during the year 2000s. In this decade, farmers have different adaptive strategies to the decline of litchi price by converting into other fruit crops such as guava and kumquat or building animal houses to start raising animals, mostly pigs. These changes lead to the existence of three main production systems at the moment, including the litchi-livestock production system in Thanh Son, the litchi-kumquat-guava production system in Thanh Son commune, and the guava production system in Lien Mac commune.

Although the fruit crop diversification process is in progress in many places, the litchi orchards are still grown in other areas. In fact, large cultivation areas of litchi plantations are now becoming abandoned and non-producing fruit crops because the litchi growers moved to off-farm works in surrounding industrial parks. It seems to be difficult for the province to achieve the goal of keeping about 4,000ha of litchi in Thanh Ha because of the conversion into other fruit crops and the abandonment of the rest. These abandoned litchi orchards are difficult to be diversified into other fruit crops because of the collapse of the irrigation system

during the period of rice land conversion into litchi. Although the province and district have made great efforts in supporting litchi growers through technical training programs, establishment of litchi grower association, brand name development, etc., the income from litchi is still at low level. Farmers are now not interested in litchi cultivation any more. Similarly, households who keep the pig production under the litchi gardens are now becoming exhausted because of threats of infectious epidemics, the increase of animal feed price and the extreme environmental pollution from pigs' waste. The local government should approve the policies to keep the litchi cultivation areas stable while allowing farmers to diversify the old and non-harvested litchi orchards into other fruits in order to reduce market risks and generate more income.

In conclusion, over the last few decades, farmers have adapted well to the socio-economic and institutional changes by different adaptation and stabilization mechanisms. Firstly, the stabilization through keeping a certain land area for rice cultivation (except in the litchi areas in Thanh Son commune) is often the most important strategies of the majority of households for the food autonomy. Although the benefit from some other animal and crop productions is potentially higher than that from rice, farmers continue growing rice to ensure the food security and to avoid the negative impact of the increasing price of rice in the market. Secondly, diversification of the production systems by employing an integrated animal-crop production system or a diversified vegetable or fruit cropping system is an important resilience strategy of farmers to maximize the efficiency of household resource utilization and to reduce risks from physical and economic environments such as the extreme attack of pests and diseases, the highly vulnerability of the climate, and the strong instability of the input and output price in the market. The combination between agriculture and non-farm jobs also helps farm households to diversify their income sources and better survive under the context of economic crisis and the degradation of some kinds of agricultural production (litchi, for instance). Thirdly, taking the most advantages of the market development and the increasing food demand of the consumers through the intensification and specialization of the production systems is of great importance for farm households to increase the resource use efficiency (land, labour, capital) and to generate more income. To limit the negative impacts of the physical and economic environments, most farmers implement efficiently both the operational and strategic flexibility of production systems by adjusting the production scale of the animal species or plant varieties to be more appropriate with the changes in agro-ecological environments and the fluctuation of price in the market. Besides that, they not only improve their technical knowledge and skills by different ways such as participating in training courses, sharing experience, etc., but also connect strongly to the input suppliers and output collectors as a best way to access better to the market and enhance the sustainability of the agrarian systems.

3. Discussions of the policy implications

Based on the above findings, the report gives some implications of development policies on agricultural land use and organization and management of agricultural production. Besides that, the development priorities for each agro-ecological and socio-economic zone of the study sites are also recommended.

The land use policy is a great topic which is currently being discussed by the national parliament with different ideas about carrying out the redistribution or not. The agricultural land was allocated equally to farm households in 1993, leading to the fragmentation and scattered situations of land plots which hinder the mechanization and modernization of agricultural production. Although the long-term land distribution (20 years for land cultivated

by annual crops and 50 years for land cultivated by perennial crops) encouraged farmers to invest in their production systems, it is now likely inconsistent with the new context of industrialization and modernization era. Rice land areas are becoming abandoned because the households who moved to off-farm jobs still keep the land as their own property. Many households face difficulties in expanding their land areas because of the increase of land price in the market and the short-term duration of land renting contracts. In some regions, including several communes in Hai Duong province, the local government implemented the program of land consolidation through exchanging and regrouping land parcels among households. However, it was only the palliative solution to reduce number plots per household. The program did not help to increase the total land areas of each household. Professor Dao The Tuan (Tuan, 2009) reported that there is a need of having an organization and institutional mechanism to withdraw the land areas from households who stopped working in the agricultural industry.

Based on the current circumstances of land use in Hai Duong province and other regions of the Red river delta, we realize that the government may consider reorganizing and consolidating the agricultural land to the "direct" farm households who are engaged steadily in agricultural production as the famous slogan of Vietnamese people: "ruong dat cho nguoi cay" (land plots belong to ploughman). This policy enables to solve the fragmentation and scattered situations of land plots and to allow direct farmers to consolidate land areas, paving the way for the mechanization and modernization of the agricultural production in Vietnam in the forthcoming years. In order to achieve this goal, it is necessary to institutionalize the land renting agreement among farmers by legalizing the terms of renting duration and renting charge. The involvement of the communal authority is of great importance to protect the interests and to inspect the liability of both land owners and land renters under the contract. Furthermore, the participation of the commune is also effective in the political persuasion and propaganda exercise of farmers to participate in this program.

In the context of deeply international integration of Vietnamese economy, the reorganization of households' agricultural production through promoting the cooperatives among farmers and between farmers and other development agencies, including governmental state, scientists, and agricultural businessmen is of great importance. Farm holdings need to be highly supported by the local authority and other social organization of civil society to enhance these cooperatives. Besides the administration by law of local authority, there is a great demand for the enhancement of the role and participation of the social organization of civil society such as units of communist party, woman union, youth union, farmer union, etc. in the political propaganda exercises and dissemination of policies and laws on agriculture and rural development of the state. Moreover, these organizations have to help and protect the legitimate rights of farmers when they enter into the market-oriented economy. The combination of different social civil organizations will help to increase their ascendancy and working efficiency of assistance activities.

For each agro-ecological and socio-economic zone, the development policies should give priority to the major constraints facing most farm households in the region. In the context of upper zone of Hai Duong province, where the livestock-fish production system is the dominant model, the development agencies should place the importance on the development of a highly biological safety and effective production of animal husbandry. The biological safety animal husbandry, in which the animal epidemics are well-controlled, can be achieved by promoting farmers' awareness and consciousness of improvement of hygiene conditions and vaccination programs. The veterinary offices and agricultural extension stations need to improve the efficiency of technical training activities and to promote the collaboration between smallholders and big farms and between farmers with local veterinarian so that they

can learn from each other and share experiences of disease prevention and treatment. Besides that, in order to reduce the cost of animal production through utilizing local feed resources, the agricultural cooperative and other social organization should encourage farmers, especially the smallholders, who employ the livestock-fish-crop production system, to develop the winter crops, especially maize and other cereal crops. Different activities such as propaganda exercise, supply of improved varieties, pest control and irrigation management, etc. should be done by local organizations to support farmers to cultivate maize crops.

In the vegetable zone, in order to develop a safe and clean vegetable production, the local government and other social organizations should help and encourage farmers to apply the good agricultural practices and improve the efficiency of irrigation management as the prior development policies. Vegetable growers need to be trained and assisted with the safe and friendly-environmental production through the increase in crop rotation, the appropriate and effective use of fertilizers (including chemical and organic products), and the integrated pest management. The public investment should focus on the improvement of the irrigation and drainage system through participatory management of local people. The participation of different agents such as farmers, irrigation companies, the local agricultural cooperative, etc. will help to improve not only the canal systems and pumping stations, but also the irrigation and drainage activities in order to facilitate the vegetable cultivation and limit the impact of bad weather conditions.

In the lower zone of the province, the Thieu litchi is a special fruit and needs to be supported to develop better. The development policy should be comprehensive solutions, including the improvement of litchi productivity and quality and the promotion of processing and marketing system. The introduction and application of the good agricultural practices are of great importance to increase the productivity and quality of the fruit. Furthermore, it is essential to promote the role and participation of the local agricultural cooperative and social organizations, especially the litchi grower association, in assisting farmers to market their fruits because this is one of the most important solutions to the degradation of litchi cultivation. Besides that, the diversification of the fruit gardens from old litchi trees into other fruit crops to minimize the risks of market fluctuation and pest attacks is a good adaptive strategy of farm households. This process should be supported by restoring the irrigation and drainage systems and providing farmers with improved fruit varieties. To prevent producers from the risks of degradation of fruit cultivation in the future, the local government has to make an appropriate plan of fruit cultivation to increase the competitive advantages of each specific region and to stop the excessive expansion of one variety of fruit.

4. The relevance of the methodology in the scope of diagnosis of agrarian system dynamics

Research for sustainable development of agriculture and rural society often faces a number of difficulties related to the complexity, diversity and instability of agrarian systems. The agrarian systems are known as the mode of environmental exploitation of farm households in a given physical and socio-economic and institutional circumstance. Therefore, the agrarian systems often differ from one agro-ecological and socio-economic region to another one. Even within a region, the production systems employed by farm households are also different due to a wide diversity of production resources (land, labour, and capital), agricultural knowledge and skills, and the interests in production among groups of farmers. Furthermore, these agrarian systems are not a constant mode due to the extreme variation of the physical and economic environments. Most of the agrarian systems are influenced strongly by the environmental changes, leading to the evolutionary series or dynamics over time. Therefore,

the choice of research methodology of dynamics of agrarian systems needs to take these factors into account so that it can be more relevant to the objectives of sustainable development of agriculture and rural society.

This study has well illustrated that the systematic, adaptive, and historical approaches are highly efficient and relevant to the research objectives of sustainable development of agriculture and rural society in the context of Vietnam. Firstly, this methodology identifies the differentiation and adaptation strategies of farm households in different regions over a long time by analysing the evolution of agrarian systems during the socio-economic and institutional transformation period. By this way, the author can adequately classify the production systems into different categories based on their own developmental trends rather than the statistical typology. Therefore, it enables us to make several recommendations that are more appropriate for each kind of production systems in each region. Secondly, the analysis of agrarian system dynamics always takes account of the changes of physical and socio-economic environments in conjunction with the adjustment of production systems at the farm level. Hence, it helps to better understand the adaptive strategy and the stabilization mechanism of farm households to the changing environments. These understandings are very useful for us to formulate the adequate policy to favour the agricultural production and to enhance the adaptive capacity of farmers through some kinds of governmental supports and assistance beside the efforts of farmers. Thirdly, the diagnosis of long-term evolution of agrarian systems enables us to clarify and grade the constraints facing different groups of farmers in different zones. Thus, this provides an important background of the priority topics or areas of intervention to the policymakers to promote the growth and sustainable development of agriculture in the future. Moreover, the understanding of transformation of agrarian systems over the time, in step with their current situations, is of great importance to estimate their evolutionary perspectives that orientate the policy-making of agriculture and rural development to be more feasible and appropriate to each region. Last but not least, the hierarchical approach from the regional level to the local and farm level in the analysis and diagnosis of agrarian system dynamics is not only to increase the correction of the system typology and household investigation, but also to rapidly identify the common constraints of the whole region as well as the specific difficulties of different farmer groups. By this method, the suggested solutions for the development of different agrarian systems seem to be more efficient and accurate. These abovementioned demonstrations about the French-style methodology used in this thesis shows its strong relevance to the sustainable development objectives of research on agrarian system dynamics.

5. Some main limitations of the study

Although we have made the great attempts to reduce the factors that may influence on the results of the study, it cannot avoid some limitations as indicated in the followings.

Due to the limitation of time and financial capital, the household surveys were carried out once (in 2010 and 2011), without repeated observations over a long period. The description of evolution of agrarian systems was mostly based on the memory of respondents. Therefore, their ability to remember what exactly happened in the past may influence the research results. By choosing the specific dates related to significant changes in household economy (land reallocation in 1993, the industrial installation in 2003, and the current time of the survey in 2010), we ensured to collect the correct information. The combination of different information sources (historical documents, discussions with local people, and direct observations, etc.) helped to check the information collected.

The sample size of this study is also limited due to several difficulties during the research period. Firstly, travelling among six communes of three districts took great time and fund. Secondly, the researcher sometimes had difficulty in accessing and collecting data at some households due to their unwilling participation. It was because at the time of the survey (2010), there was an extreme attack of infectious epidemics in pig populations (the PRRS epidemic) in Cam Giang district and a non-harvest year of litchi orchards in Thanh Ha district. Thirdly, this is a case study that needs to place the importance on several representative households to have a deep understanding of their production systems rather than to increase the number of households. Moreover, the sample size also depends on the diversity of each type of production systems. We expected that the number of households surveyed is sufficient to generalize the results to the whole study sites.

6. Discussions of the insightful directions or opportunities for future research

The research in the future may focus on the two major emerging issues of agriculture and rural development in Vietnam, including the agricultural land use issues and farmers' production reorganization and management. Researchers should examine the need of households, the constraints and appropriate methods of the revision and institutionalization of agricultural land in different regions. They also need to conduct experiments on the establishment of new modes of farmers' associations or the improvement of the role and participation of social organizations in the agricultural production and marketing. The improved methods of agricultural extensions, which promote the development of the safe and sustainable agricultural production systems, should also be studied more.

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