A STUDY ON EVALUATING THE EFFECTIVENESS OF CULTIVATION ON UPLAND IN NORTHWEST OF VIETNAM

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KYUSHU UNIVERSITY

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A STUDY ON EVALUATING THE EFFECTIVENESS OF CULTIVATION ON UPLAND IN NORTHWEST OF VIET NAM

By

TRUONG TUAN LINH

A Dissertation
Submitted to Kyushu University in Partial Fulfillment of
the Requirements for the Degree of
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ABSTRACT

Although the political and economic reforms have launched 28 years, Viet Nam is still a developing country with low-income and agriculture is also still remained as the most important sector in GDP of Vietnam. Rice and maize are the two most important annual crops in Viet Nam. Rice production is sufficient for self-consumption and exportation, whereas maize production is insufficient and must be imported because of the growing feed industry. Three quarters of Vietnam's territory is made up of mountainous and hilly regions where famers have to cultivate in upland because lack of arable land for agricultural activities. Nearly 70% of population and 90% of poor people are living in rural areas. Therefore, one of the most important orientations of Vietnamese government is developed agriculture and rural economy. And ICT application has been enhancing to narrow the gap between different regions, poverty reduction and promote sustainable growth.

There are very few studies which have emphasized on productive efficiencies of farms and factors influencing them in upland areas. In addition, none of researches have been found relating with effectiveness of using ICT tools or factors affecting farmers' use ICT sources in Vietnam. Hence, this study aims to monitor the status of cultivation on uplands and provides insight for adopting appropriate technical applications for improving farm productivity, adding the value and having sustainable livelihood for farmers in the Northwest upland of Vietnam. In order to clarify the aims, it needs to address the specific objective as following: 1) To identity important factors and their influence on productive efficiencies among farms; 2) To examine the role of information sources and their impact on farm's.

With the aim to present overall about Northwest upland and investigate its policies that influence on agricultural production system and information source, the secondary data had been used. The result has revealed that northwest is the poorest region in Vietnam with the highest ethnic, low educated, economic and environmental diversity. Rice and maize are the most important crops in this region. Many problems in

agriculture of northwest upland was issued, for example soil erosion, overused fertilize on sloping land, low applying innovation technologies, poor productivity, low price and constrained market access for rural products, pollution of waterways with sewage, manure effluent and agrochemicals, and poor implementation of the policy. The information system in northwest region has been upgraded along with the developing of information system in Vietnam and the world, however, it is still backward. Along with many challenges, northwest region also has many opportunities based on its comparative advantages.

In order to analyze the influence of social- economic factors affecting on the average individual income from maize, a total of 352 maize farmers in 12 villages were conducted by face-to-face interviews. The data were analyzed by using 2SLS regression model. Unexpected as our hypothesis, the results investigated that education of household head were positively significant, membership of agricultural group were significant but negative. Likewise, credit access and extension service were not significantly effective on individual income of farm's members from maize production. On the other hand, results also demonstrated that the age of farm's head, household size and group membership were the factors which can reduce individual income volume from maize production.

The result of estimate the technical and scale efficiencies of both rice and maize crops using a smooth bootstrapping method to analyze the variability of DEA technical efficiency estimates and to correct for the inherent bias in the DEA method had revealed that the opportunity for both technical and scale inefficiencies of maize and rice crops is significant. The result of using a Tobit regression to explain variations in efficiencies among farms showed that national electricity source is an important factor to improve the technical efficiency of both rice and maize farms. And, large families are likely to be more technically efficient on maize farms.

With the purpose to estimate technical efficiency (TE) levels and identify the information factors that influence the technical inefficiency of crop farmers in the northwest, the stochastic frontier production function and the inefficiency model were estimated simultaneously using 358 respondents' data. The results show that there is

significant room for technical inefficiency and no farm is fully technically efficient. We also found some interesting results regard to information sources that have impacted on technical inefficiency. Agricultural information from printed materials and frequent watching of television were two negatively significant factors for technical inefficiency. This indicates that if farmers read more agricultural information from printed materials and watched television related to social life at appropriate times, the TE of crop farms would increase.

To examine the factors that influence the probability of participation in the CCPO program, as well as the impact of participation on household income per capita, the endogenous switching regression was used to analyze random sample of 336 farm households in Son La Province. The results indicated a positive and significant influence of household head education and owning livestock on participation, as well as an impact on household income per capita. These results also suggest that knowledge is a very important factor to increase the social-economic life of farmers, especially with mountainous areas and ethnic groups. Our estimates suggest positive self-selection in both the participant and non-participant groups, and significance only for the participant equation. This implies that farmers in both groups are better off participating in the CCPO as it could lead to a higher per capita income. However, the different effects between the expected outcome for participants and what non-participants would have achieved had they participated is not meaningful and not sufficiently high.

The result of identifying factors that may effect on other information sources using household-level data of 360 farm households found that household income, farm size, household size, educational attainment and off-farm jobs were the most important influences on whether the respondents used the media and personal information sources.

According to the results of finding some important factors and their influence on individual income from maize, technical and scale efficiency, there are some recommendations to respect government, organizations. More investment on public education is an important role for not only government but also farms in this area.

Government and group leaders should more emphasize on finding the way of credit providing, extension services, adjusting customs, and group supporting. In addition, expanding a national electricity source is an important strategy for the government in the near future to increase social welfare. There are also some suggestions for farmers, such as make new models for value chain development, using resources more sustainable, increasing technology adoption and implement of governmental and provincial policies. And, co-operation in cultivation, crop diversity and the optimal use of rice plots are several suggestions for optimal farm production.

Based on the finding of examine the role of information sources and their impact on farms', some implications are suggested. It should be checked and strengthened the effectiveness of the Commune Cultural Post Office, extension services, and group support. And, there should be more funds available for farmers to visit advanced agricultural models to help them develop agricultural information and business networks. This finding also recommend that off-farm employment for farmers should be provided and encouraged. Local government and extension agent should work more effectiveness to enhance and help farmers diversifying crops, applying technologies. It is also important to make efforts to close the gap among districts by increasing investments, expanding road infrastructure, and wireless towers to farmers in remote areas.

In closing, limitations of this study were explained in details. We hope to solve all these limitations in the future research.

ACKNOWLEDGEMENTS

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I am grateful to the Thai Nguyen University of Information and Communication Technology (ICTU) and my colleagues in my office in Vietnam, who always support and encourage me during my study in Japan.

I wish to extend my appreciation to the households/farmers from Mai Son, Moc Chau, and Phu Yen districts in Son La province, Vietnam on their hospitality and kind collaboration helped me my field survey successfully. Without their help and cooperation in providing precious information, this study would not have been possible.

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- TRUONG TUAN LINH-

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LIST OF ABBREVIATIONS

2SLS	Two- stage Least Square
AFTA	ASEAN Free Trade Area
APEC	Asia-Pacific Economic Community
ATT	Average Treatment effect on the Treated
BMGF	Bill and Melinda Gates Foundation
CCPO	Commune Cultural Post Office
CIs	Confidence Intervals
CRS	Constant Return to Scale
DEA	Data Envelopment Analysis
ECI	Economic Complexity Index
FIML	Full Information Maximum Likelihood
GAP	Good Agricultural Practices
GDP	Gross Domestic Product
GNI	Gross National Income
GSO	General Statistical Office of Vietnam
ICT	Information and Communication Technologies
ILRI	International Livestock Research Institute
IPM	Integrated Pest Control
IRS	Increasing Return to Scale
IT	Information Technology
LPM	Linear Probability Model
MARD	The Ministry of Agriculture and Rural Development of Vietnam
MIC	Ministry of Information and Communications of Vietnam
MLE	Maximum Likelihood Estimates
NGO	Non-Governmental Organization
NIRS	Non-Increasing Return to Scale
OLS	Ordinary Least Square
SE	Scale Efficiency
SFA	Stochastic Frontier Analysis
TE	Technical Efficiency
TPP	Trans-Pacific Partnership
TV	Television
US	United States

VCD	Video Compact Disc
VHLSS	Vietnam Household Living Standard Survey
VND	Viet Nam Dong
VNPost	Viet Nam Post
VNPT	Vietnam Posts and Telecommunication Group
VRS	Variable Return to Scale
WTO	World Trade Organization

CHAPTER 1: INTRODUCTION

1.1 Country Background

Vietnam is the easternmost country on the Indochina Peninsula in Southeast Asia. It covers a total area of approximately 330,966.9 km^2, with mountains accounting for 40% and tropical forests covering around 42%. Vietnam shares borders with China, Laos, and Cambodia. In 2014, the population of Vietnam was 90,728.9 thousand with density at 274 persons per km^2. The country had the crude birth rate at 17.2% and labor force at 15 years of age and above was 53,748 thousand persons (GSO, 2015).

After the political and economic reforms (Doi Moi) launched in 1986, Vietnam's society and politics have gradually progressed towards greater openness and tolerance for civil participation. The Viet Nam government has a strategy to make the country a more modern, industrialized society by 2020. Vietnam's growth rate in 2012, 2013 and 2014 was 5.2%, 5.4% and 6.0%, respectively; the poverty headcount ratio at the national poverty line was 17.2% of the population in 2012 (World Bank, 2015b). In 2014 the GDP of Vietnam was $186.2 billion with the inflation rate at 4.1% (World Bank, 2015b). Vietnam now is a member of many economic organizations such as AFTA (ASEAN Free Trade Area), APEC (Asia-Pacific Economic Community), WTO (World Trade Organization), TPP (Trans-Pacific Partnership). Vietnam is the 33rd largest export economy in the world and the 73rd most complex economy according to the Economic Complexity Index (ECI). In 2014, Vietnam imported $148.04 billion and exported $150.19 billion with the change of 12.1% and 13.7%, respectively (GSO, 2015).

1.2 Agricultural Sector

Agriculture's share of economic output has decreased in recent years, falling as the share of GDP from 22.7% in 2000 to 18.1% in 2014 (World Bank, 2015b). Although agricultural sector contributing to Vietnam's economy has been declining, it is still is one of the vital components of GDP and rural livelihoods. The share of

employment in the agricultural sector is still high at over 47% of the labor force in 2012 (World Bank, 2015b). Agricultural exports have increased continuously. Vietnam is now one of top world exporters in rice, rubber, coffee, pepper, cashew nuts, wood products and fisheries. In 2014, agricultural products are the second most major export items, around $30.86 billion.

However, agricultural development in Vietnam is mostly based on using the natural resources (land surface etc.) and numerous of input materials but low technology. On the other hand, the low development quality is gotten by unsafe food sanitation and low capability in creating new added values, uneven quality of products, and the high loss level after harvest. Moreover, the agricultural products structure has been changed slowly, which is not appropriated with the competitive advantages or the demand in reality. Cropping still accounts more than 50% of the agricultural sector and rice is the most important major crop.

Agricultural land accounted for 81.04% total land of Vietnam as of January 2014. The agricultural production land is mainly in the flat area of Vietnam and was about 38.14% while forestry land covered for 59.07% (Table 1.1).

Table 1.1. Land use as of January 2014

Land use types	**Area (1000ha)**	**%**
Agricultural production land	10,231.7	38.14
Forestry land	15,845.2	59.07
Water surface land for fishing	707.9	2.64
Land for salt production	17.9	0.07
Others	20.2	0.08

Source: General Statistical Office of Vietnam, 2015

1.3 Major Agricultural Crops

In Vietnam, the major agricultural production is rice, which accounted for 39.86% of agricultural production land in 2014. Figure 1.1 shows the planted area of main annual crops in Vietnam from 2000 to 2014. The paddy land is far ahead from

other crops following by maize and soybean land. Rice is measured in hundred-thousand ha.

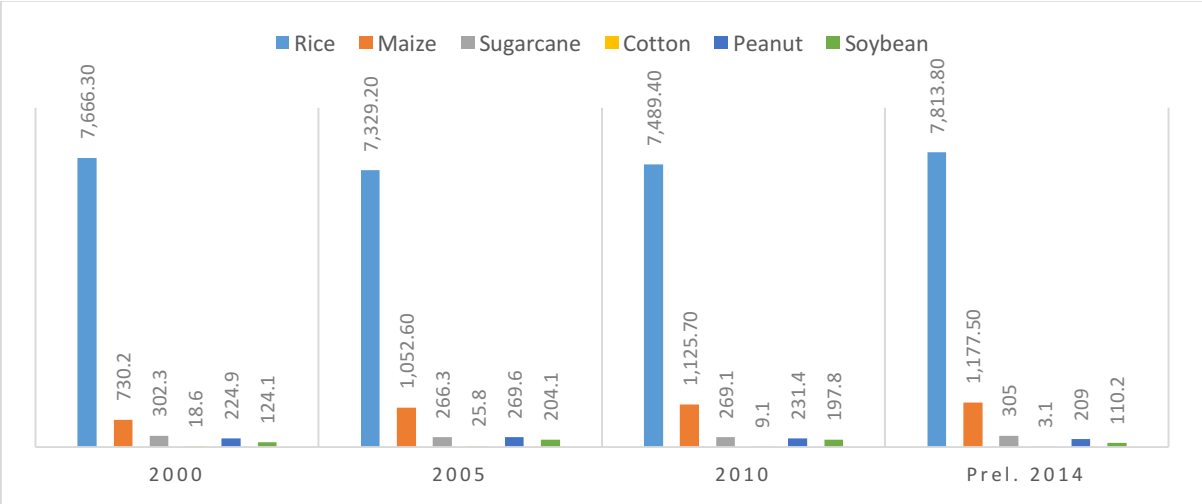

Figure 1.1 Planted area of main annual crops (1,000 ha)

Source: General Statistical Office of Vietnam, 2015

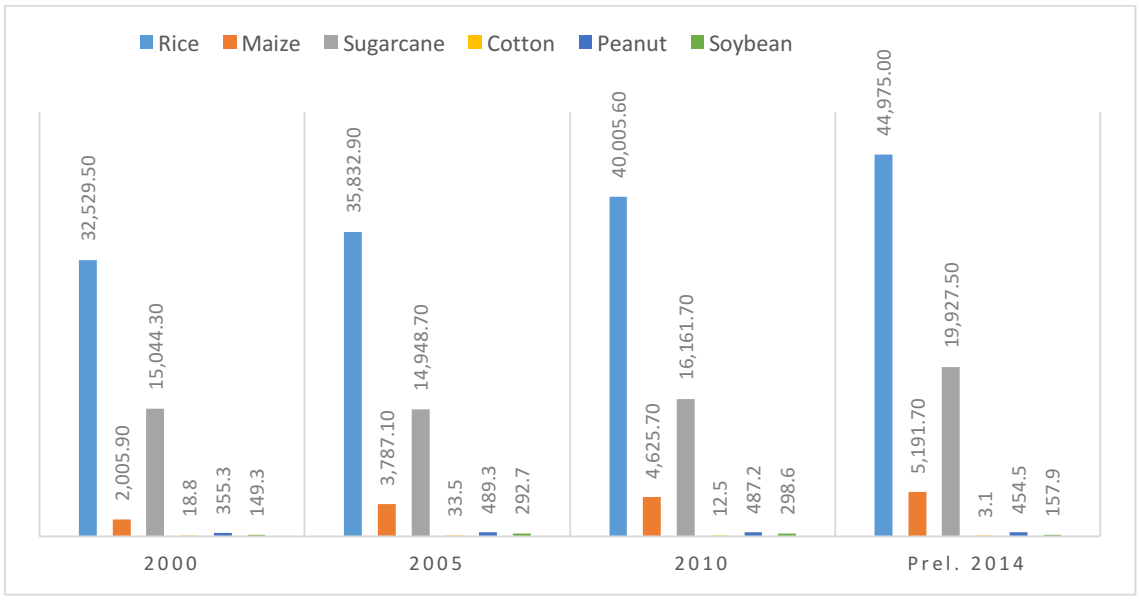

Figure 1.2 Production of main annual crops (1,000 tons)

Source: General Statistical Office of Vietnam, 2015

Rice is also had the biggest production, followed by sugarcane and maize. Figure 1.2 shows the production of main annual crops in thousand tons between 2000 and 2014. Although sugarcane has smaller area than maize and soybean, its weight is bigger. Therefore, sugarcane is the second annual crop production.

1.4 Rice Production

Figure 1.3 shows the data of total planted area of paddy rice in Vietnam from 1997 to 2014. It is obviously that the planted area of paddy was fluctuated in all the time. It went down from 2000 and had a dip at 2007 due to the policy of government to cut down agricultural sector and increase the role of industry and service, and natural disaster also. However, after that year the planted area of paddy rice has been increased significantly till now.

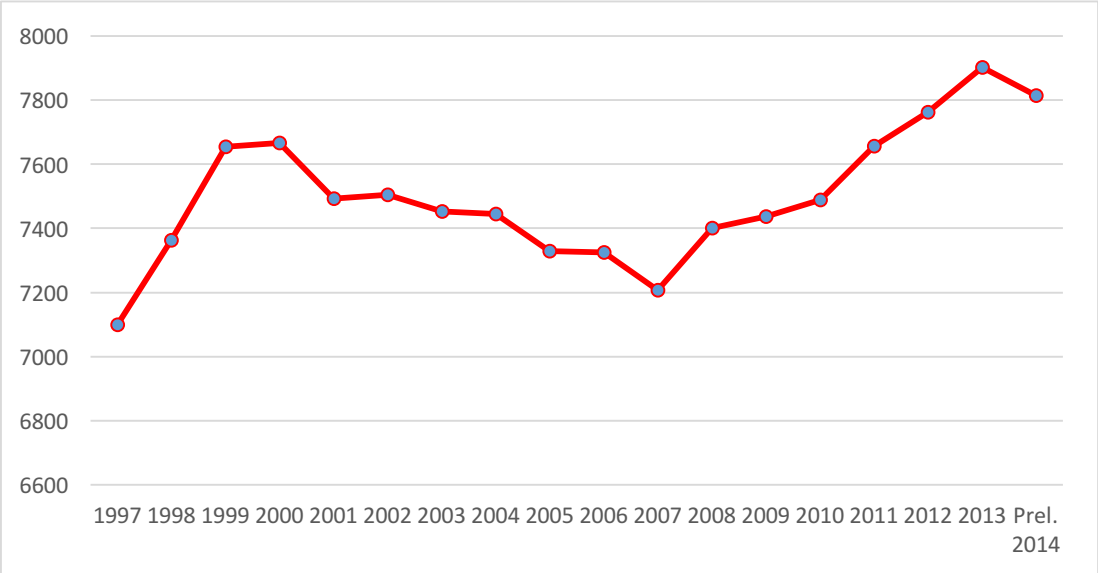

Figure 1.3 Total planted area of paddy (1,000 ha)
Source: General Statistical Office of Vietnam, 2015

Figure 1.4 shows that although the total planed area of paddy rice was fluctuated, there was graduate increase in the total production of paddy between 1997 and 2014. It was about 27,524,000 tons in 1997 and reach the number of 44,975,000 tons in 2014.

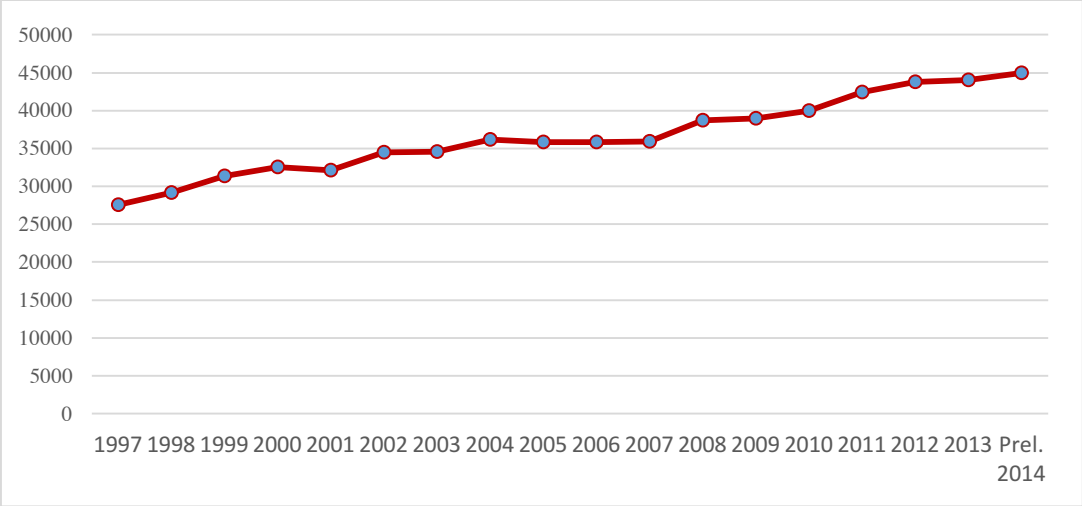

Figure 1.4 Total production of paddy (1,000 tons)

Source: General Statistical Office of Vietnam, 2015

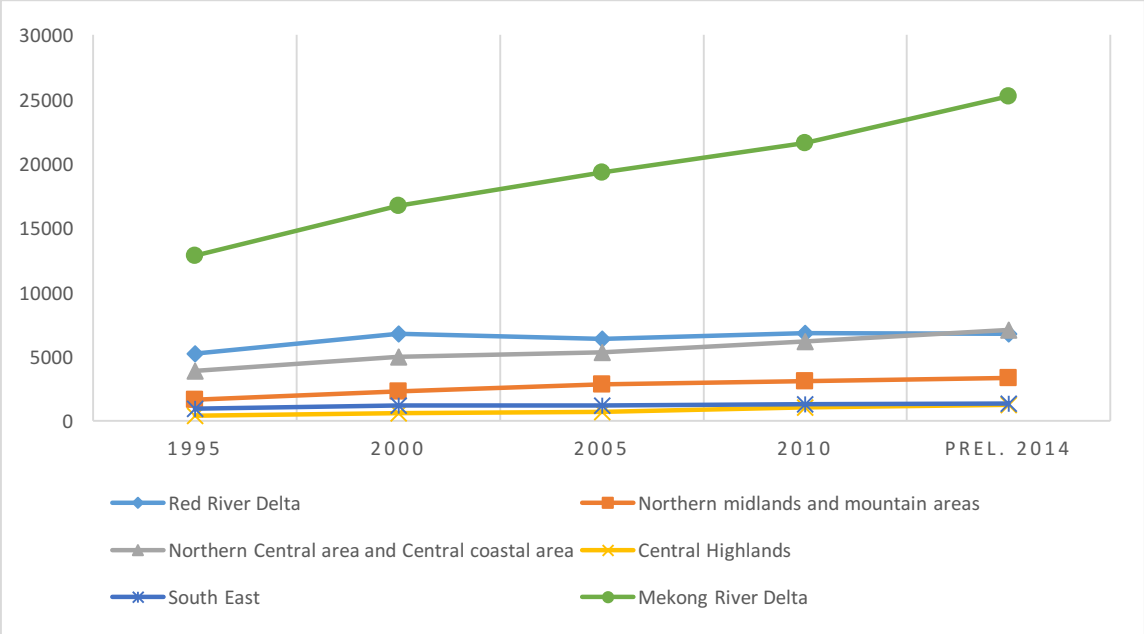

Figure 1.5 Production of paddy by region (1,000 tons)

Source: General Statistical Office of Vietnam, 2015

The production of paddy by region is shown in figure 1.5. Among six regions, Mekong river delta was the leading region, followed by Red river delta. They were the two largest area and highest production because of their two largest delta in Vietnam. However, in overall it is clear that the number of production in all regions had been increasing from 1995.

1.5 Maize Production

Maize is the second most annual crops in Vietnam right after rice. The area and production of maize has increased strongly over the last years. It is proved in figure 1.6 which shows the number of planted area and production of maize increase over years. In 1995, about 557,000 ha was used to cultivated maize and the production was 1,177,000 tons but it got the number of 1,178,000ha and 5,192,000 tons in 2014, respectively.

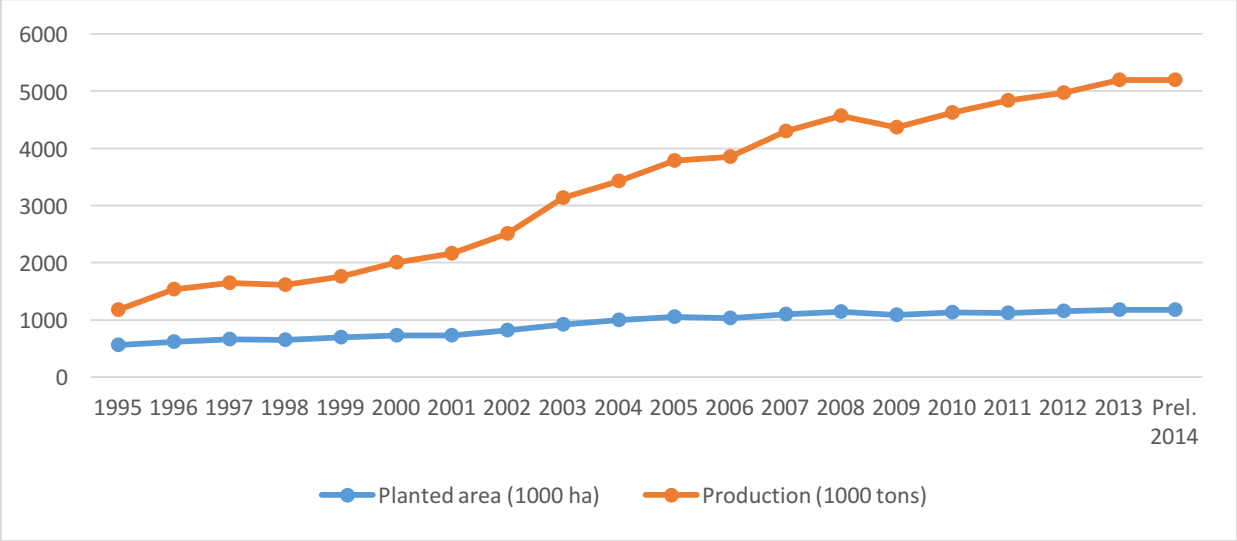

Figure 1.6 Planted area and production of maize

Source: General Statistical Office of Vietnam, 2015

There was a comparison of maize production among six regions in Vietnam in figure 1.7. Because rice is often well cultivated in flat area and maize is mostly cultivated in high lands, the production of maize in northern midlands and mountain areas, central highlands and northern central area and central coastal area was always

higher than others. Northern midlands and mountain areas, including northwest and northeast area, harvested 334,000 tons in 1995 and got the number 1,891,000 tons in 2014.

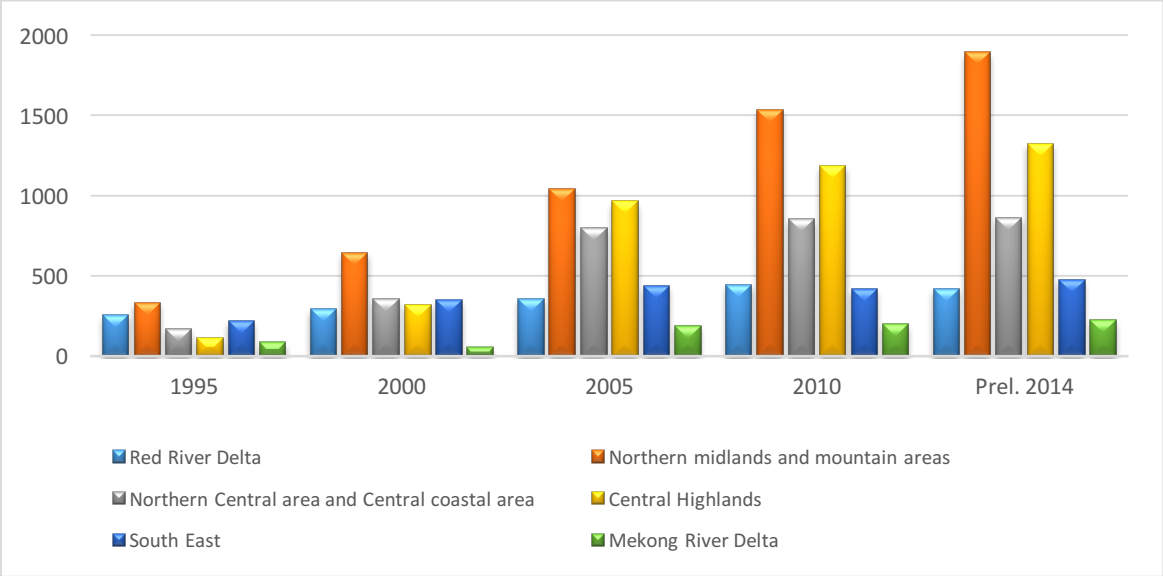

Figure 1.7 Production of maize by region (1,000 tons)

Source: General Statistical Office of Vietnam, 2015

1.6 Agricultural Technology Application

Continuing the implement, the Resolution of the 5th Conference of Central Party Committee (Section IX) (February 2002), the Resolution of Congress X of the Party (2006) stated that one of the most important task of industrialization and modernization country in the future was industrialized rural agriculture and rural areas. Agricultural industrialization can make a great changes in agriculture production, the economy of rural area and increase welfare (GSO, 2012b).

Vietnam's agriculture has faced many challenges. There are many factors which have impacted on agricultural products such as weather effects, outbreaks of diseases, over used chemical and fertilizers. Therefore, applying hi-tech agriculture will make the agricultural products meet the consumers' diverse demands in quality and quantity. Applying hi-tech agriculture is the important role in restructuring the

agricultural sector to become more sustainable. A hi-tech agriculture means using not only various types of technology, like new mechanisms, biology, automation, smart management systems, but also take advantage of the country's natural resources and weather conditions.

Applying hi-tech in agriculture widely has gotten many effectiveness, contributed to increase yield and quality of agricultural products in recent years. Over 90% area of rice, 80% of maize, and 60% area of sugar cane, cotton, fruit are using new varieties. Nearly 80% variety of crop, animal was selected and bred and the proportion of variety which applied hi-technology was increased to 35%. Some programs are applying such as application of advanced farming process, program "3 down, 3 up", sustainable farming, integrated pest control IPM, producing under GAP standard (VinaCert, 2014). Ministry of Agriculture and Rural Development of Vietnam has established the development strategies of science and technology for agriculture and rural development from 2011 to 2020 with the targets that the achievements of science and technology will contribute 40% in 2015 and 50% in 2020 GDP in the agricultural sector, respectively. High technology's agricultural productions will account for 30% major production value in 2015 and 50% in 2020 (VinaCert, 2014).

1.7 ICT in Agriculture

Now a day, we cannot deny the important role of information in life activities. But what exactly are ICTs (Information and Communication Technologies)? And can they really be useful and cost effective for poor farmers with restricted access to capital, electricity, and infrastructure? "First, ICT is any device, tool, or application that permits the exchange or collection of data through interaction or transmission. ICT is a term that includes anything ranging from radio to satellite imagery to mobile phones or electronic money transfers. Second, these ICTs and others have gained traction even in impoverished regions. The increases in their affordability, accessibility, and adaptability have resulted in their use even within rural homesteads relying on agriculture. New, small devices (such as multifunctional mobile phones and nano- technology for food safety), infrastructure (such as mobile

telecommunications networks and cloud computing facilities), and especially applications (for example, that transfer money or track an item moving through a global supply chain) have proliferated. Many of the questions asked by farmers (including questions on how to increase yields, access markets, and adapt to weather conditions) can now be answered faster, with greater ease, and increased accuracy. Many of the questions can also be answered with a dialogue—where farmers, experts, and government can select best solutions based on a diverse set of expertise and experience. The types of ICT-enabled services that are useful to improving the capacity and livelihoods of poor smallholders are growing quickly" (World Bank, 2011).

Information and communication have always mattered in agriculture. Ever since people have grown crops, raised live-stock, and caught fish, they have sought information from one another. Farmers in a village may have planted the "same" crop for centuries, but over time, weather patterns and soil conditions change and epidemics of pests and diseases come and go. Updated information allows the farmers to cope with and even benefit from these changes. Providing such knowledge can be challenging, however, because the highly localized nature of agriculture means that information must be tailored specifically to distinct conditions. Farmers can make better decisions and realize greater profits when they have good data, analysis of marketing strategies, and details information on costs (Milovanović, 2014).

"Five main trends have been the key drivers of the use of ICT in agriculture, particularly for poor producers: (1) low-cost and pervasive connectivity, (2) adaptable and more affordable tools, (3) advances in data storage and exchange, (4) innovative business models and partnerships, and (5) the democratization of information, including the open access movement and social media. These drivers are expected to continue shaping the prospects for using ICT effectively in developing country agriculture" (World Bank, 2011)

In Vietnam, ICT application and development helps to increase the material, intellectual and spiritual growth. ICT encourages the reform process, quicken the development and modernization of economic sectors. ICT supports an active process of close the gap between urban and rural areas. It creates possibilities to overleap successfully serving the need of industrialization, modernization in rural areas.

As the Vietnamese government has become aware of the importance of information and communication technology (ICT), it has put in place policies to promote ICT. These include Decision No. 1755/QD-TTg of September 22, 2010, which approved a national strategy for "Transforming Vietnam into an advanced ICT country"; Decision No. 698/QD-TTg of June 1, 2009, which approved general plan on information technology (IT) human resources development up to 2020; and Decision No. 1605/QĐ-TTg of August 27, 2010, which approved a national program of IT usage for government bodies for 2011—2015. In particular, on July 12, 2011, the Prime Minister of Vietnam wrote an official letter No. 1138/TTg-QHQT allowing the Ministry of Information and Communications to establish and deploy the expanded project "Improved computer usage and public internet access ability in Vietnam" in 2011—2016 period. With a total value of 50.5 million USD, of which more than 33.6 million USD is funded by the Bill and Melinda Gates Foundation (BMGF) and Microsoft Corporation, this project aims to plug the digital gap between rural and urban areas, improve the livelihoods of people through the use of modern technology, and provide opportunities for people in rural areas to benefit from ICT services. The project has been deployed only in three provinces of Vietnam, namely, Thai Nguyen, Nghe An, and Tra Vinh.

1.8 Problem Statement

Agriculture is facing new and severe challenges in its own right. With rising food prices that have pushed over 40 million people into poverty since 2010, more effective interventions are essential in agriculture (World Bank 2011). The growing global population, expected to hit 9 billion by 2050, has heightened the demand for food and placed pressure on already-fragile resources. Feeding that population will require a 70 percent increase in food production (FAO 2009).

Although economics was reformed 28 years, Viet Nam is still a developing country with low-income (OECD, 2013). Agriculture is still remained as the most important sector in GDP of Vietnam. After rice, maize is the second most important food crop in Viet Nam. It is a substitute stable food for people in the rural areas and especially mountainous region. It also is the main source for livestock industry and

poultry in Viet Nam. The demand for maize has increased promptly and is expected to be more accreted in the future. Only about 10 % of the maize produced is used for home consumption (Thanh Ha et al., 2004).

In Vietnam, nearly 75 % of the population is living in rural areas. Ninety percent of the poor or three quarters of the population, live in the rural areas which is why rural development and agriculture are critical to Vietnam's development. Developing agriculture and rural economy is one of the most important orientations of the Vietnamese Government.

ICT has been creating not only opportunities but also many challenges to business in rural areas to shrink the gap between different regions, make gender equality and the role of women to enhance sustainable growth and poverty reduction. Promoting step by step the development of the rural areas is one of the major problems of the Vietnamese Government to improve the legal framework, mechanisms and policies with purpose to create appropriate conditions and offering high preferences for ICT application and development in rural areas. However, the status of information and communication use in Vietnam remain backward, especially in the agricultural sector and rural areas. Most ICT programs and projects are focused on urban areas and local officers. Compared to other regions and countries, progress has been very slow and there are many difficulties and challenges, especially for farmers in the highland area.

So far, there are few researches had been done in northwest area, especially for upland and ICT field.

1.9 Research Objectives

Based on the statements above, this study aims to evaluate the efficiencies of cultivation methods on upland, and find some factors that effect on those efficiencies. From those factors, for more specific, we try to find the impacting evidences of information sources on farm's efficiencies and its determinants. In order to clarify the aims, it needs to address the specific objectives as following:

1) To identity important factors and their influence on productive efficiencies among farms.

2) To examine the role of information sources and their impact on farm's.

1.10 Conceptual and Framework

Figure 1.8 shows the aspects of effectiveness of our study. The idea that influenced us to conduct this research is effectiveness had many aspects and one of them is economic efficiency. Effectiveness is the ability to produce a desired result and may not concern about how much inputs spent. And, economic efficiency means that farm try to get a number of results but also consider how much resources expended in archiving them (Frøkjær, Hertzum, & Hornbæk, 2000; Nábrádi et al., 2015; Šebo, Maleg, Mihok, & Šebo, 2006). Economic efficiency usually defines as the ratio of the output(s) and input(s). Economic efficiencies usually are measured in term of production output or money, such as technical efficiency, scale efficiency, allocative or income (T. J. Coelli, Rao, O'Donnell, & Battese, 2005; Nábrádi et al., 2015).

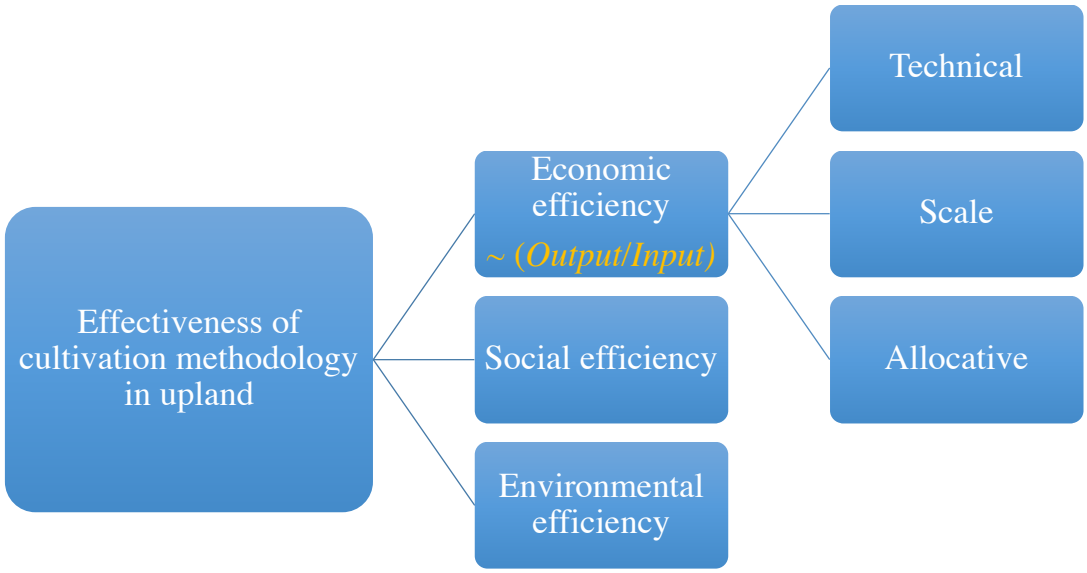

Figure 1.8 Aspects of effectiveness

Figure 1.9 shows the framework of this study. There are many inputs that farm has to manage in appropriated quality and quantity to produce a desired output. In our study, two main outputs have been selected to research are rice and maize. In addition, the management of farm is impacted by many factors, such as social-economic factors of farm, objective factors and ICT factors also. In our study, some of productive

efficiencies firstly are estimated, then the factors may effect on them will be tried to identify. Chapter 3 will try to identify socio-economic factors effect on individual income from maize- the main cultivation methodology in northwest. In chapter 4, the technical and scale efficiencies of rice and maize crops firstly are estimated, then we try to find the factors influenced on those efficiencies. Chapter 5 firstly technical efficiency of farm is estimated, then we try to find the evidence of information sources that may impact on this efficiency. In chapter 6, the role of CCPO- one of important information sources for farmer is examine through its impact on gross income of farm and the benefit if farm join or not in CCPO program. In addition, chapter 7 try to find the factors which may influence on farm's decision to use which type of information sources.

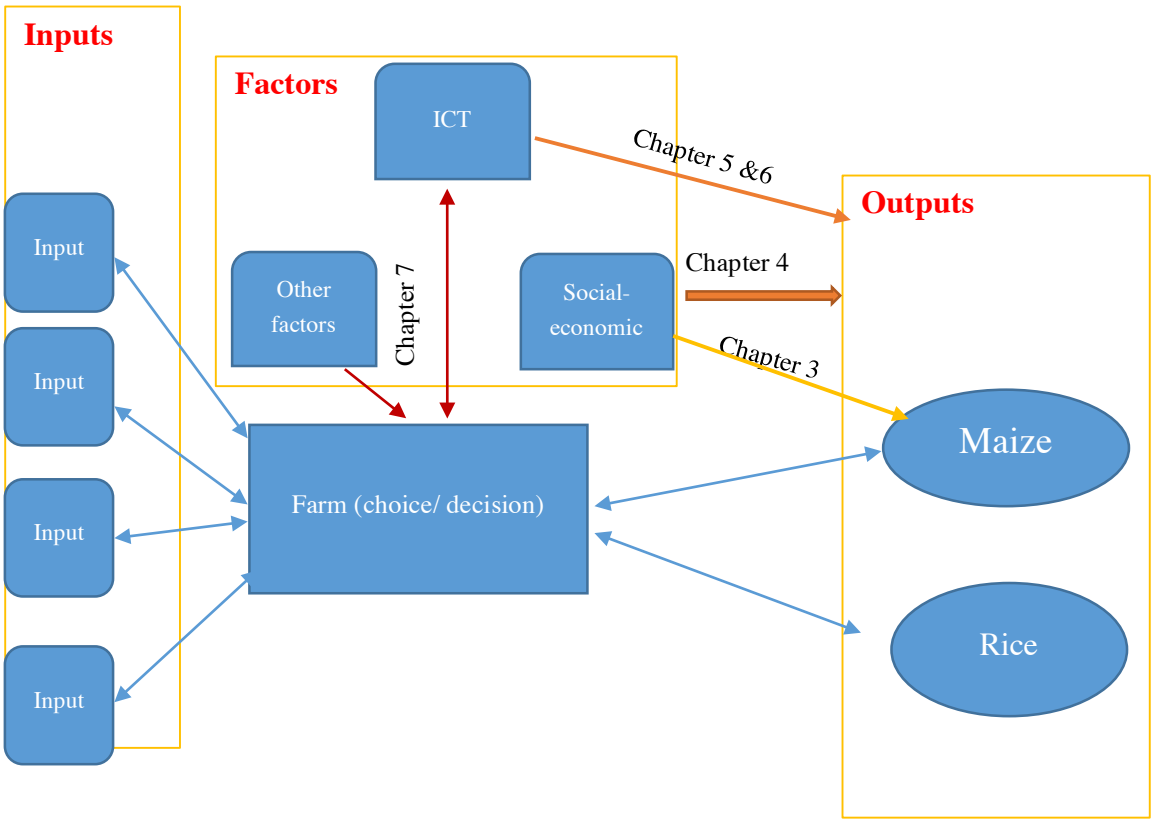

Figure 1.9 Study Framework

1.11 Structure of Dissertation

This dissertation includes eight chapters and their relationship is presented in figure 1.10. Chapter 2, 3, and 4 were employed under the objective 1 and chapters 5,

6, and 7 were taken under the objective 2. The detail of each chapter are following: The chapter 2 presented overall about Northwest upland and its policies that influence on agricultural production system and information sources. This chapter was using secondary data to show the status and conditions of agriculture in northwest upland. It was also included some policies of government that effect to farming system and the usefulness of using information sources.

Chapter 3 was to analyze the influence of social- economic factors affecting on the average individual income from maize- the main cultivation methodology in Son La Province of Viet Nam. A two stage least square was applied to estimate factors influencing on the average personal income from maize for total 352 respondent farmers. Unexpected as our hypothesis, the results investigated that education of household head were positively significant, membership of agricultural group were significant but negative. Likewise, credit access and extension service were not significantly effective on individual income of farm's members from maize production.

Chapter 4 was the first study to estimate farm-level technical and scale efficiencies and to identify the factors influencing them based on the data of 292 households in Son La province. This study first applied a standard and smooth bootstrap DEA method to estimate the technical and scale efficiencies, then used a Tobit regression method to identify factors influencing these efficiencies among farms. The results showed that the opportunity for both technical and scale inefficiencies of maize and rice crops is insignificant. Findings from the second stage indicated that the age of the head of household, the numbers of family, the national electricity source, the distance to the nearest market, and the access to credit, extension services and milling machines are the main factors affecting the technical and scale efficiencies of rice and maize crops. The findings suggest continuing improvement of management, co-operation in cultivation, crop diversity and optimal use rice plots. The results also recommend expanding the national electricity source, emphasizing policies for adjusting customs and knowledge, using credit in appropriate ways and continuing to enhance extension services.

Chapter 5 estimated the technical efficiency levels and identified the information factors that influence the technical inefficiency of crop farmers in the

northwest highland of Vietnam using farm-level data of 358 crop-farm households. The results show that there are significant opportunities to increase technical inefficiency and no farm has full technical efficiency. Agricultural information from printed materials and frequent watching of television were significantly and negatively related to technical inefficiency. This indicates that if farmers read more agricultural information from printed materials and watch television related to social life at appropriate times, the technical efficiency of crop farms would increase. Based on the results, some suggestion is proposed to optimize crop-farm technical efficiency and increase the effectiveness of using information sources.

Because the commune cultural post office (CCPO) is an important program in Viet Nam. Its duty is to contribute to the development of the social and economic aspects of the country, allowing people to easily gain knowledge about the policies of the government. However, after 16 years, there are some disadvantages, and it has become unsuccessful and not effective. There is no research that uses an econometric approach to estimate the implications of the CCPO and to suggest certain policies based on the results that enhance or cut off the program. Chapter 6 aimed to identify factors that influence the probability of participation in the CCPO, to estimate the factors affecting economic outcome indicators and to quantify the benefit of the participant decision for both groups. Endogenous switching regression analysis was used for the farm level data in Son La province, Viet Nam for the first time. The results indicate a positive and significant influence of the head of household's education, and owning livestock on participation, as well as the impact of extension services on household income per capita. With regard to the main hypothesis, it also unexpectedly suggests that differences in participation in the CCPO are not really meaningful.

Every information source has its advantages and disadvantages for delivering certain types of information. However, in general, information sources have been recognized as tools that improve the efficiency and effectiveness of agriculture. Gathering and distributing agricultural information is difficult, time-consuming, and expensive. The purpose of chapter 7 is to identify the factors that explain the variation among farmers in their uses of information sources based on household (farm)-level data. The results found that household income, farm size, household size, educational

attainment and off-farm jobs are the most important factors influencing the use of media and personal information sources. The results suggest introducing and encouraging more off-farm jobs for farmers. Provincial government and extension agents are recommended to work more effectiveness to enhance and help farmers diversifying crops, applying technologies. It is also important to improve the quantity and quality of extension services. The results also suggest that adjusting the policies that influence conditions to lessen the gap among districts and increasing farmers' education should focus training for agricultural knowledge, social activities, and governmental policies as well as properly educating them on using informational, such as the Internet, computer.

Finally, chapter 8 presents the overall conclusions and recommendations for farmers, policy makers and further research.

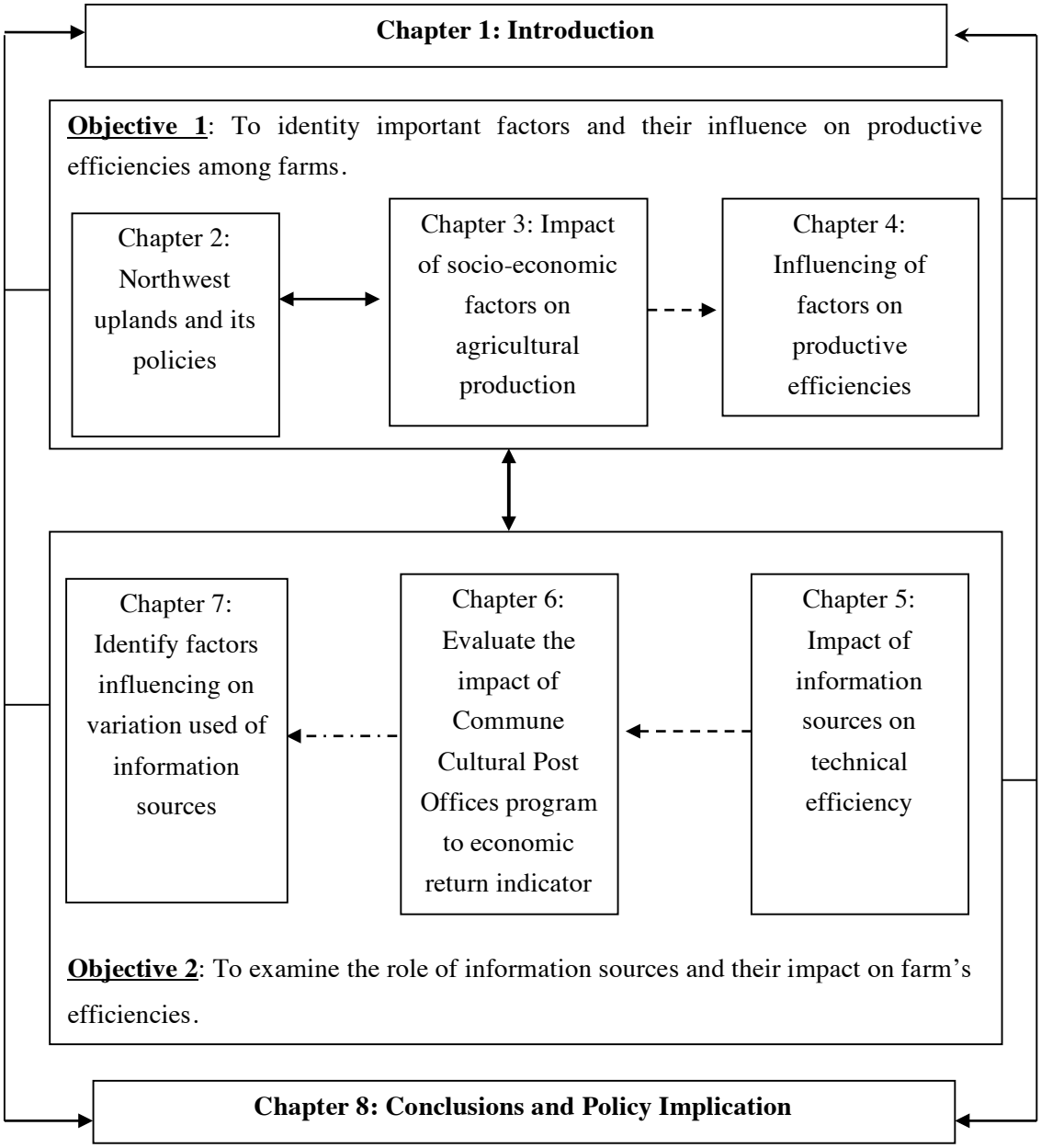

Figure 1.10 Overall structures of dissertation

CHAPTER 2: NORTHWEST UPLAND AND ITS POLICY

2.1 Introduction

Northwest region located in the mountainous northwestern part of Vietnam. It contains six provinces, namely Hoa Binh, Son La, Lai Chau, Dien Bien, Yen Bai, and Lao Cai. The Northwest's topography is hilly and mountainous (80% total land area), the infrastructure is very difficult, and the density of population is low. In 2014, the total area was 50,685 km^2 with the total population around 4,385,000 persons and density at 97 persons per km^2.This area is more dependent and less urbanized on agriculture than any other regions in Vietnam. Almost the population is belong to ethnic minorities (Minot et al., 2006). Poverty realty is the major problem in this region. The poverty head count in Northwest area is 58.7%, far higher than the national average of 17.2% in 2012 (GSO, 2012a).

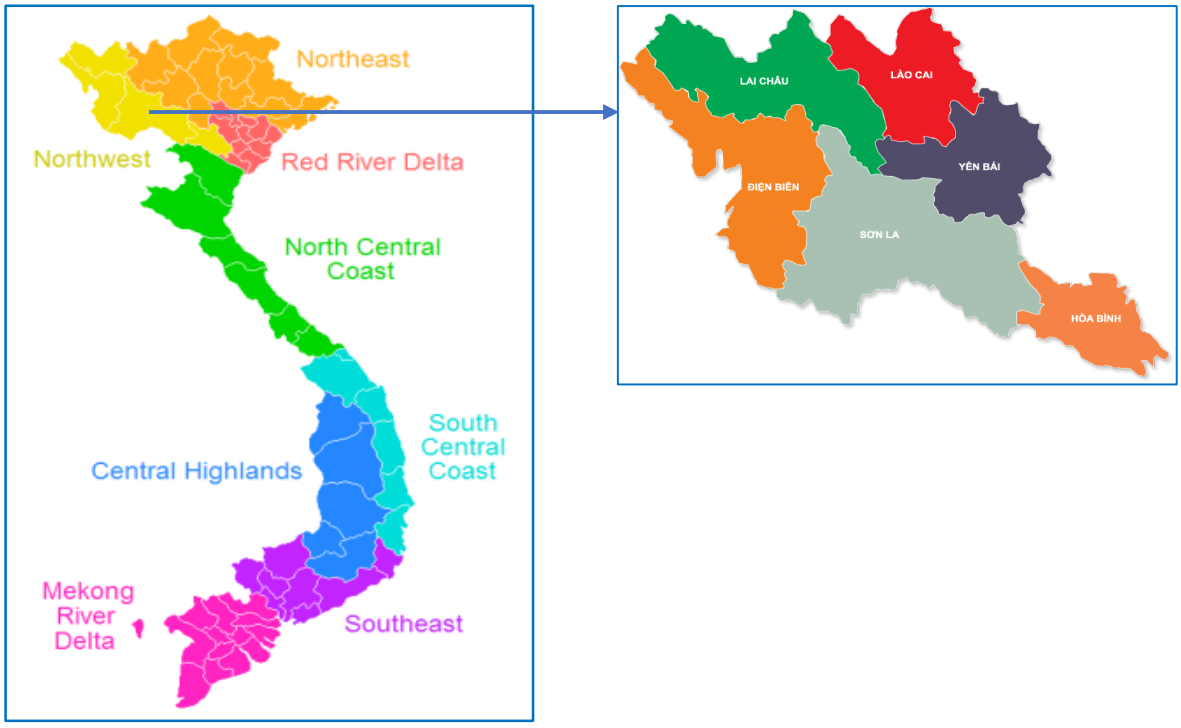

Figure 2.1 Map of study site

2.2 Northwest Upland Agricultural System

The Northwest is the poorest among the seven regions in Vietnam. Because the topography is high and mountainous, paddy rice production is insufficient, and maize production has been increasing rapidly in recent years. Rice is mostly cultivated in lowland valley and maize mono-cropping on sloping land. Maize has become the main income source for farmers (Luckmann, Ihle, & Grethe, 2011). Maize is the top annual crop in the Northwest.

Figure 2.2 shows the land use in northwest area as of the January 1st 2014. It is clearly that forestry land was the main land use, accounted for 62% followed by agricultural production land and other. It proves that the arable land for agricultural production is limited, due to the topography of this region.

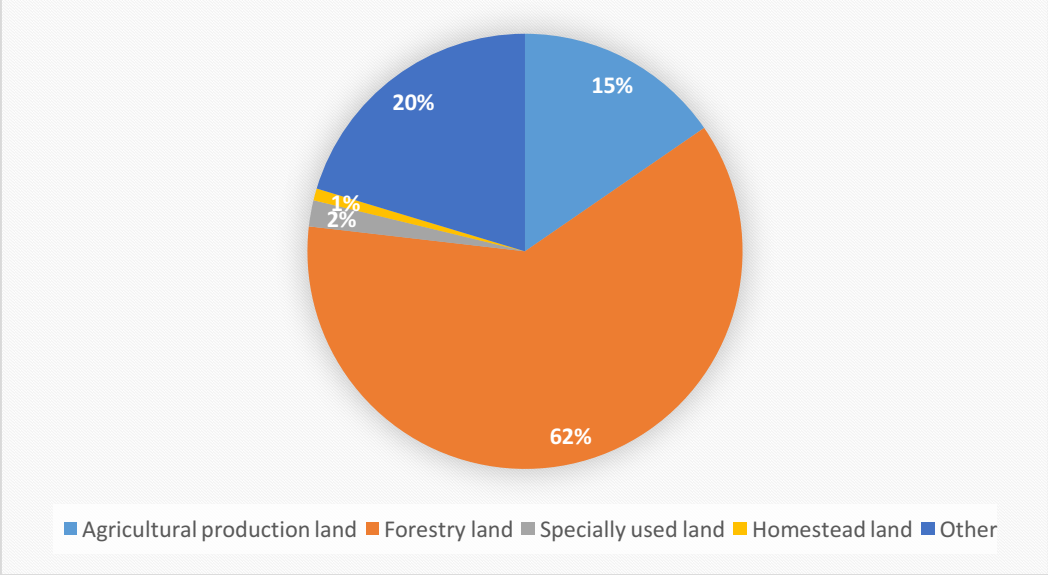

Figure 2.2 Land use in Northwest (%)

Source: General Statistical Office of Vietnam, 2015

In northwest region, the major annual crops are rice, maize, cassava, and yam. The others annual crops, such as peanut, soya-bean are also cultivated but not covering in all region. Farmers might cultivate them but server only for their consumption and not large enough to involve in data of statistic agent. For example,

peanut in only cultivated in Hoa Binh province while soya-bean has data for all provinces in northwest region except Yen Bai. Figure 2.3 shows the information of planted area of some major crops in northwest region. The data was reported by General Statistic Office of Vietnam as of the January 1st 2014. It is evidence that the planted area of maize was increased significantly. In 1995, the area of rice and maize was 206,100 ha and 92,500 ha but the proportion was changed when that number increased to 246,300 ha and 319,100 ha in 2014, respectively. On the other hand, the planted area of cassava and yam had also increased slightly over 20 years from 1995 to 2014.

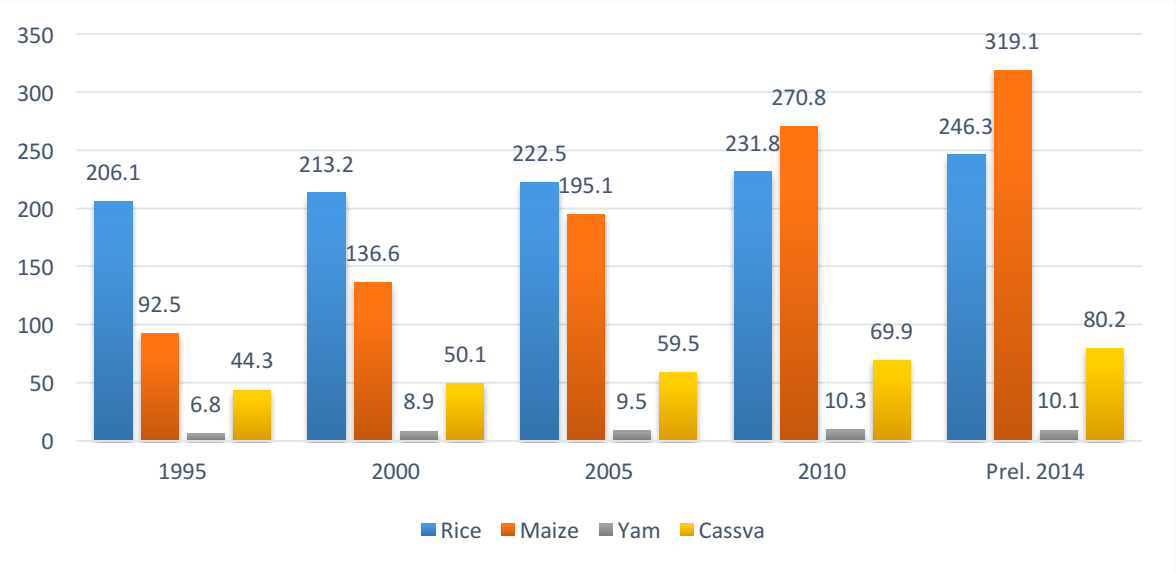

Figure 2.3 Planted area of major annual crops in Northwest (1,000ha)
Source: General Statistical Office of Vietnam, 2015

Figure 2.4 shows the data of production of some major annual crops in northwest region as of January 1st 2014. It is obvious that along with planted area, the production of all crops had increased. The production of maize and rice in 1995 was at 134,400 tons and rice 532,100 tons, respectively. However, in 2014 the production of maize (1,151,000 tons) was higher than the production of rice (1,047,000 tons) about 104,000 tons. Maize turns to the main annual crop and income source of

farmers in northwest region. The production of cassava was also increased dramatically and a little higher than rice production in 2014.

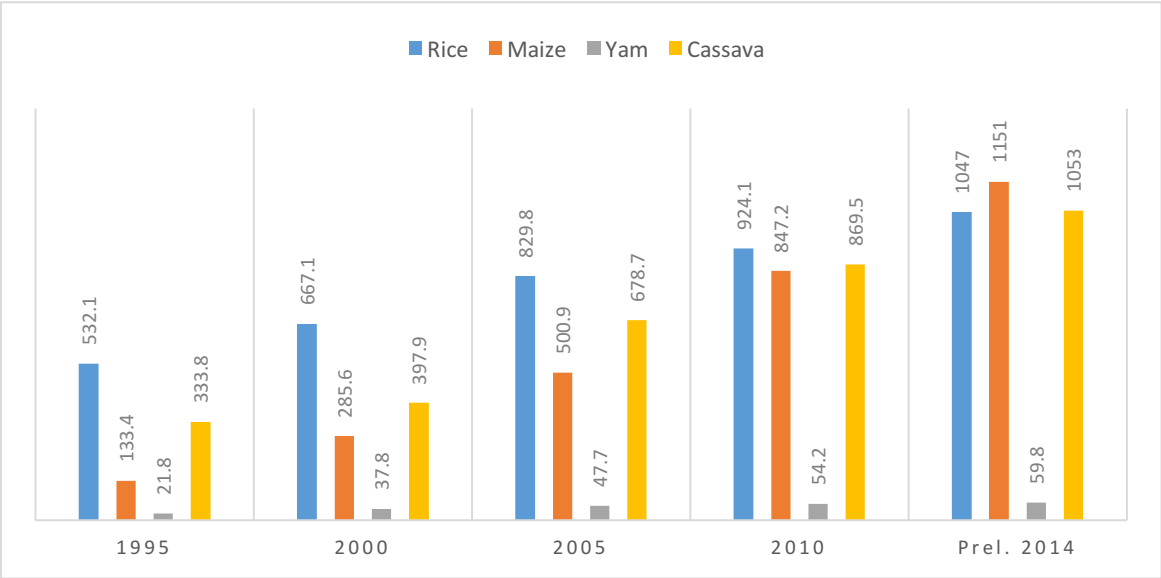

Figure 2.4 Production of major annual crops in northwest (1,000 tons)

Source: General Statistical Office of Vietnam, 2015

2.3 Northwest Agricultural Policies

A number of policies crafted at the national level support agricultural development in northwest Vietnam. On July 8th 2013, the Prime Minister of Vietnam signed the decision No. 1064/QD-TTg on approving the overall plan to develop social-economic for midland and northern mountain until 2020. This decision has emphasized the development direction for agriculture, forestry, and fisheries. It stated that developing sustainable agriculture production in associated with forestry and ecology protection; increasing agriculture, forestry, and fisheries products with an average growth rate by 3-4.5%/year for 2011-2015 and from 3.5 to 4%/year for period 2016-2020 (Prime Minister of Vietnam, 2013). Three main direction are:

- Based on the comparative advantages of each region and market demand, trying to focus on developing specialized crop areas, such as tea, rubber, flowers, coffee. Increasing the number of livestock and poultry. Making the zone formation

of the grazing livestock and big pig farm size associated with food processing industry in order to increase the proportion of livestock sector in agriculture.

- Caring and protecting the existing forest area, promoting the upstream reforestation, planting the protective forest of lakes, dams, and erosion hazard area. To complete the land and forest allocation associated with the sedentary, ending the deforestation for cultivation. Protecting strictly the national park systems, natural reserves and genetic resources of rare animal and plants.

- Developing the freshwater aquaculture in great lakes under the advances technique, efficiency, sustainability, and ensuring the ecological environment.

The Ministry of Agriculture and Rural Development (MARD) of Vietnam also approved "The agricultural and rural development strategy in period 2011-2020" (MARD, 2009). This development strategy stated the strategic orientation to develop agro-ecological regions in Vietnam including northwest areas. The agriculture in northwest is oriented to produce some main agricultural products, like tea, maize, soy-bean, vegetable and flowers at advantage area. It is also focused to increase the number of livestock, cattle, and pig following farm and industry orientation.

Decision No. 2331/QD-TTg gives farmers partial government subsidies through provision of hybrid seeds, fertilizers and machinery (tractors, threshing machines). These policies, however, do not benefit some members of the poor community; a case in point is the lack of incentive or knowledge of the H'Mong people to take advantage of the subsidy. Decision No. 800/QD-TTg aims to enhance the role of agricultural extension agents, improve technology transfer through training and increase investment in postharvest technology to reduce losses. Organizing smallholder producers into collective groups, cooperatives or companies is encouraged to improve the standard of living of farmers. Recently, the Ministry of Science and Technology issued Decision No. 1847/QĐ-BKHCN and Decision No.1746/QĐ-BKHCN to launch the program 'Science and technology for sustainable development of northwest Vietnam'. These created the legal framework and established funding for agricultural research and development.

In the provincial level, supporting policies cover two aspects: strengthening local commercial production through training and input provision and supporting subsistence crops through advisory services.

Table 2.1 Products having provincial policy support

	Lao Cai	Son La	Dien Bien	Lai Chau
Grains	Rice, maize, soybean, sweetpotato, potato	Local and hybrid rice, potato, cassava, maize	Rice, maize, potato	Local and hybrid rice, maize, soybean
Industrial plants	Tea	Rubber	Rubber	Rubber, tea
Vegetables and fruits	Tropical vegetables and fruits (plum, pear)	Tropical vegetables and fruits	All types of vegetables, banana	Fruit trees (orange, tangerine, peach)
Livestock	Cattle	Buffalo	Buffalo, cow, pig	Big cattle
Aquaculture	Hybrid carp, tilapia	Green crayfish, carp, tilapia	–	Fish living in cold-water environment
Non-timber products	Cardamom	Son tra	Cardamom	Cardamom

Source: ILRI, 2014.

These policies have the target that bring excellent results in the beginning because of the scale of application. However, it is hard for farmers, especially those from poor households, to comply fully with technical requirements as they involve significant investments and management. Consequently, the number of producers who benefit from these support policies remain limited. (ILRI, 2014)

2.4 Agricultural Problem Issues

Wezel, Luibrand, & Thanh, 2002 had concluded that rice production is decreasing or disappearing because of overused fertilize on sloping land. Cassava and maize are now dominated in most of area, especially maize because the new varieties were introduced. This positive development for individual household is existing in short duration because almost all arable land is cultivated with increasing intensities. However, farmers were not aware with the decline in soil fertility and soil conservation management. These became a crucial topic in this region nowadays.

The Northwest Vietnam has been transformed to huge area of maize mono-cropping system from what once believed to be the forest area. Some of scientists said “amazing, surprising and depressing” when seeing the landscape in northwest. Most of the area is covered by maize and not many trees left, including hilltops and

steep slopes. Therefore, natural resources degradation is the most crucial one. The major problems in many research so far in this area are soil erosion and degradation. The heavy soil erosion made the stream extremely polluted with brownish color. The farmers also revealed that too much fertilizer and pesticide was applied for maize cultivation. Another challenging issue is that farmers do not have sufficient information to access to market. They all sell in low price for collectors (Yasmi, 2013)

International Livestock Research Institute (ILRI) has conducted a project in northwest Vietnam in 2014 (ILRI, 2014). This research reported some main constrain in some field:

- In production system, soil erosion and degradation, increased labor requirements to work on sloping land and relative low percentage of cultivated land are greater risks in northwest region. Besides that, the terrain and temperature are also constrained to develop agriculture. Mechanization is limited. Low use of improved genetics and other inputs and adherence to traditional practices.

- In markets and institutions, smallholders have significant role on private traders who pay in cash at the farm gate rather than collector or company, even it may lead to lower prices and unreliability but really convenient as farmers' desire. Most rice and livestock are consumed locally, although beef and certain rice is also marketed in other provinces. Vegetable and fruits is low consumption. Aquaculture is significant undersupply locally and may be a potential area for investment. Ethnic groups are observed to participate mostly in the initial farm to market stages of agricultural supply chains and they mostly focused only on agricultural production. The efforts of provincial governments to directly support farms may be inadequate.

- In natural resource management and the environment, the utilization of natural resources is currently limited and uncertain. Information on natural resources and their utilization in agriculture is inadequate. The functional of forest is being reduced and degradation. The sources of water are pollution increasingly because of waste management, processing practices, and apparently few incentives for changing those. The reliable data on changes in water availability are very little.

2.5 Status of Information Sources

In overall, the information system in northwest has been upgraded, completed to better serve the need of management, business and life activities. However, the gap between flat area and mountainous area is still huge due to both natural and human conditions like topography, transportation, residential education, and their perception, behavior.

Figure 2.5 shows the proportion of major information sources which available in northwest region. There are total 850 communes in six provinces of northwest Vietnam. The statistic of General Statistical Office of Vietnam (GSO) in 2015 shows that the post office and CCPO are having in 115 and 742 communes, respectively. In rural area, post office and CCPO are the place where people can come to send and receive mails, packages; read books or newspapers; make phone calls; use computer or access internet. However, number of post office and CCPO is limited do not work effectively (T. T. Linh, Nanseki, & Chomei, 2014).

Library is also a place where farmer can come and look for needed information, but there are only 20 communes have library. It takes only 2.35 % of total communes.

Internet has been spreading so far, and become familiar with people in urban region, however it has not popular with citizen in rural and mountainous area yet. There were only 8.59% communes which have private internet service point. In addition, in total 742 CCPO there were only 3.91% of them has internet and 33 computers which can access internet. It indicates the difficult of people in northwest region to access new information technology.

Loud speaker system is managed and developed by government. The system is linked to villages and used to disseminate information at least twice a day. Therefore, it is also a good channel for inhabitant to receive variety information. However, this system has just been covered 31.65% communes and need to increase in the future.

Extension services reach out to villages from the central government. Extension is regulated and implemented by the Ministry of Agriculture and Rural Development. Extension agents have their own schedules and ways to contact farmers. Each commune has at least one extension officer to help famers. But the

report of GSO shows that about 86% of communes in northwest has extension officer. In addition, there are 10.284 villages in 850 communes of northwest and the number of villages which has extension collaborators is 813 people. Therefore, farmer will have less chance to meet and receive extension advices for their farm activities.

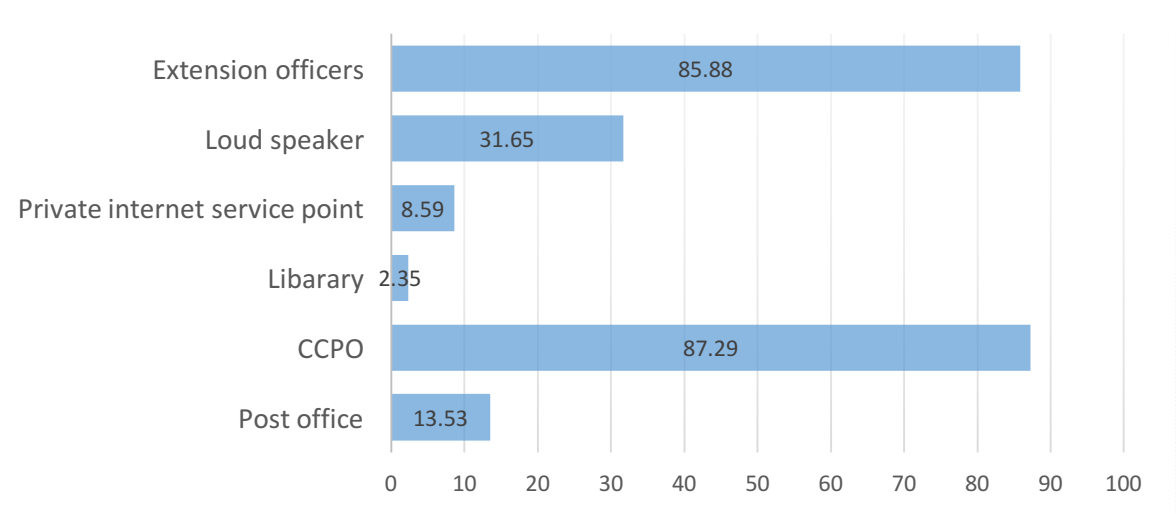

Figure 2.5 Proportion of some information sources in Northwest's communes (%)
Source: General Statistical Office of Vietnam, 2015

Figure 2.6 shows the comparison of some information sources by using proportion between whole country and northwest region. It is obvious that about 44% and 9% of citizen who live in northwest are using color and black-white television compare with the proportion of whole country is 71% and 7.5% respectively. In fact, using color television is better than black-white television. Therefore, people can easier to watch and receive information. This figure also indicates that proportion of using radio cassette in northwest is higher than the proportion of whole country because color television is more expensive with citizen in northwest, especially in remote area and also television signal not available in all northwest area, radio cassette is a good choice for them.

The proportion of people using fixed -phone and mobile-phone in northwest area is lesser than the average proportion of whole country. Only 5.5% and 1.92% of

citizen in northwest are using fixed-phone and mobile-phone. It indicates a very low rate of population can use those devices even mobile-phone now is very popular, easy to access and using.

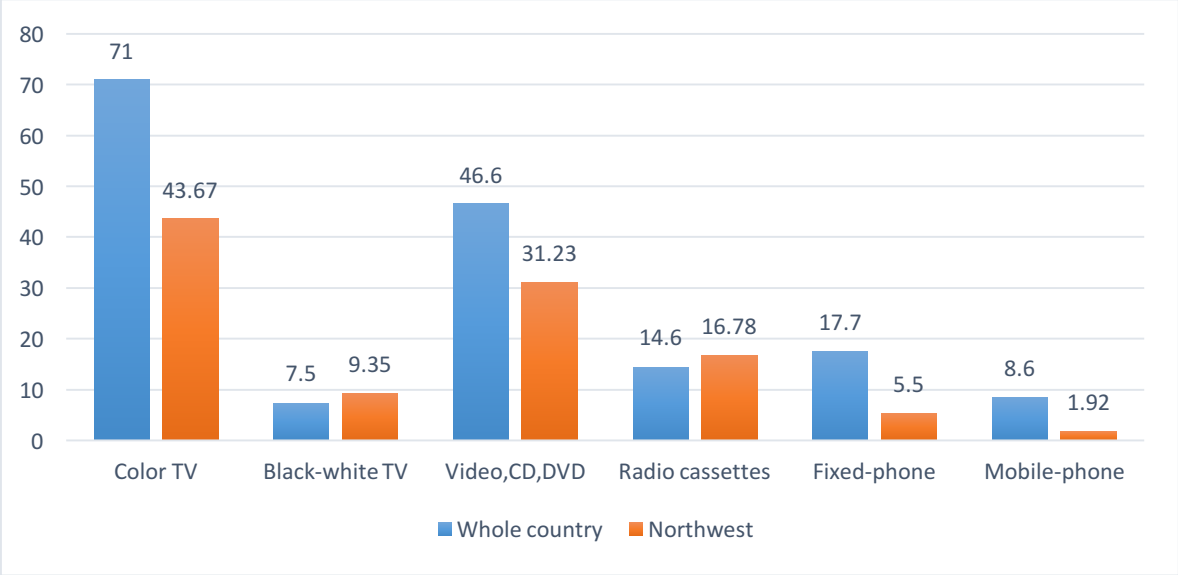

Figure 2.6 Comparing proportion of some information sources (%)
Source: General Statistical Office of Vietnam, 2015

The more details of using some information sources by province in northwest region are shows in table 2.2. Overall, it is evidence that the proportion of those sources in Son La province is quite high compare with five other provinces in northwest. However, none of those proportion can be over than 50%, it means that population who are using those information sources are low and need to be increased especially color TV and mobile-phone which are now very popular.

Table 2.2 Proportion of some information sources by province (%)

	Color TV	Black-white TV	VCD, CD, DVD	Radio cassettes	Fixed-phone	Mobile-phone
Son La Province	48.4	9.4	38.7	21	4.2	1.6
Dien Bien Province	34.5	6.3	25.7	13.9	6.1	1.4
Lai Chau Province	22.9	5.1	18.4	16.3	2.2	0.5
Hoa Binh Province	58.4	13.5	40.6	17.9	8	4.1
Lao Cai Province	43	7.5	28.3	16.9	5.1	2
Yen Bai Province	54.8	14.3	35.7	14.7	7.4	1.9

Source: General Statistical Office of Vietnam, 2015

2.6 Conclusion

Northwest is the poorest region in Vietnam with the highest ethnic, low educated, economic and environmental diversity. Rice and maize are the most important crops in this region. However, the proportion of maize is increased grammatically and become the top agricultural income sources for farmers because of the increasing of poultry and food industry in Vietnam recently.

Although, many policies from national level to provincial governments have generated to develop social-economic for this region, especially for remote area and agricultural sector, poverty is the major problem and this region has not developed as expectation.

Many problems in agricultural were issued, for example soil erosion, overused fertilize on sloping land, low applying innovation technologies, poor productivity, low price and constrained market access for rural products, pollution of waterways with sewage, manure effluent and agrochemicals, and poor implementation of the policy.

There is no doubt to deny the important of information to our life activities and also agricultural sector. The information system in northwest region has been upgraded along with the developing of information system in Vietnam and the world.

However, the information system in northwest is still backward due to the low educated, traditional custom, perception of farmers, low income, high topography, difficulty in transportation, low technology. This chapter presents some indicators of information sources which are available and popular with people who live in northwest region. The comparison of those proportion shows that the using status of them is still lower comparing with the average use of whole country or other regions.

Along with many challenges, northwest region also has many opportunities based on its comparative advantages. The plentiful rainfall and elevated terrain allow northwest farmers to increase production and specialization in a number of high-value crops, tree and livestock products. The indigenous knowledge was provided by the rich ethnic diversity among people who maintain sustainable agricultural practices will be helpful for managing and utilizing the challenging terrain and resources. The diversification of homestead production will increase the possibility of improved dietary diversity and income for farmers. Therefore, diversifying farm's income by diversify crops, livestock; make new models for value chain development; more educated for citizen; using resources more sustainable; increasing technology adoption and implement of governmental and provincial policies are some suggestions.

CHAPTER 3: IMPACT OF SOCIO-ECONOMIC FACTORS ON AGRICULTURAL PRODUCTION

3.1 Introduction

Although economics was reformed 28 years, Vietnam is still a developing country with low-income (OECD, 2013). Agriculture is still remained as the most important sector in GDP of Vietnam. After rice, maize is the second most important food crop in Vietnam. It is a substitute stable food for people in the rural areas and especially mountainous region. It also is the main source for livestock industry and poultry in Vietnam. The demand for maize has increased promptly and is expected to be more accreted in the future. Only about 10 % of the maize produced is used for home consumption (Thanh Ha et al., 2004).

The Northwest is considered as the poorest region in Vietnam. It consists of six provinces, such as Hoa Binh, Son La, Lai Chau, Dien Bien, Yen Bai, and Lao Cai. The Northwest's topography is hilly and mountainous, the infrastructure is very difficult, and the density of population is low. This area is more dependent and less urbanized on agriculture than any other regions in Vietnam. Almost the population is belong to ethnic minorities (Minot et al., 2006). In Northwest, farmers still cultivate on slopping land because they lack of arable land. It causes to erode land strictly and reduce yields gradually. Therefore, the life of households is very difficult. In reality, poverty is the major problem in this region. The poverty head count in Northwest area is 58.7%, far higher than the national average of 17.2% in 2012 (GSO, 2012a).

The largest area and production of maize in Vietnam is located in northwest upland areas. Maize in Son La has the largest cultivation area and also the greatest production in northwest upland area. Recently, in Son La, maize has been increased promptly and strongly to supply for the feed industry. It comes from the urban demand for poultry and pork (Minot et al., 2006).

Although maize has an important role in socio-economic structure of famers' life, there have been no study regarding the impact of socio-economic factors to the income from maize in this area. Therefore, the aim of this study was to analyze the

influence of social- economic factors affecting on the average individual income from maize- the main cultivation methodology in Son La Province of Vietnam. The importance of analyzing the socio-economic characteristic of household is not only for knowing the relationship between maize production and socio-economic factors but also suggesting better strategies and suitable policies for maize farms.

3.2 Data

The data used in this study were collected in a stratified, random sample of farm households in Son La province, Vietnam. Three districts chosen based on three types of altitude: Mai Son< 1000m, Moc Chau 1000- 2000m and Phu Yen> 2000m. Four villages were then randomly selected from each district, with twelve villages in total. These villages are far from each other and there are many households cultivating maize. Before conducting the research, pre-test interview was taken to ensure the adequacy and reliability of the tools to be used to collect the relevant information.

A total of 352 maize farmers in 12 villages were conducted by face-to-face interviews. The farmers were responded to the structured questionnaire that the interviewer asked them. Interviews were taken place in February and March 2014. This is the winter season when farm work is at a lower time. We gave them our phone number and email for contacting if they want to modify their answers.

3.3 Methodology

Recently, instrumental variables methods are widely used in many fields of social, especially economics and finance to deal with endogeneity and measurement error problems. Angrist & Krueger (2001) showed that good instrument variables gave a consistent estimate and passed the measurement error problem in explanatory variables. Instrument variables methods also eliminated the omitted variables bias. They also suggested that using two- stage least square (2SLS), the second- stage estimates was consistent if the first- stage used linear regression even with a binary endogenous variable.

Tipraqsa & Schreinemachers (2009) found that multicollinearity did not have problem in 2SLS method. R^2 results of OLS was little higher than 2SLS (0.678 and 0.672) and showed that the model was an overall good fit. They indicated that the results of OLS and 2SLS were the same.

Yorobe & Smale (2012) used OLS and 2SLS to analyze the impact of Bt maize adoption on net farm income, off farm income and household income per month. The coefficient and P-value of variables in their results showed mostly similar between OLS and 2SLS estimate. Lastly, they concluded that self-selection and endogeneity problems were controlled and solved but placement bias was not.

Individual income from maize absolutely bases on maize production. However, in this study we studied on analyzing the influence of social- economic factors to know how they affected on personal income from the main cultivation method in this area. Maize production should not be accounted directly and is an endogenous variable. A two stage least square was applied to estimate factors influencing on the average personal income from maize for total 352 respondent farmers.

Structural equations:

$$LnAIM = a_0 + a_1Gender + a_2 Age + a_3Edu + a4HHsize + a_5Credit + a_6Extents + a_7Member + a_8LnProduct \quad (1)$$

Here, average individual income from maize (AIM) is the dependent variable. Some independent social-economic variables of each household are gender head of household (Gender), age (Age) and the education of household head (Edu), credit access of household (Credit), agricultural extension that household had received (Extents), household is an agricultural group membership (Member) and production from maize (Product). Some socio-economic characteristics such as extension contacts, education, farming system and credit use influenced on the farmer's perception of sustainable agriculture but age, income, farm size, membership of cooperative were not (Tatlıdil, F., Boz, & Tatlidil, 2008). Production function of the Cobb-Douglas form is used in many researches so far. When using Cobb-Douglas form to estimate technical efficiency of rice production in Northern upland of Vietnam, Bac et al. (2013) suggested that seed, nitrogen, potassium and hired machine were the positive significant factors affecting technical efficiency of household. Besides that, pesticides were not affective but also negatively significant.

In this study, instrument variables of endogenous production variable were maize farm size (Msize), maize's seed (Seed), nitrogenous and NPK fertilizer (Nifer and NPK respectively), pesticide (Pesti) and Herbicide (Herbi) and Hired labor (Hired).

The empirical equation of Cobb-Douglas production function specified as:

$$LnProduct = b_1 LnMsize + b_2 LnSeed + b_3 LnNifer + b_4 LnNPK + b_5 LnPesti + b_6 LnHerbi + b_7 LnHired \quad (2)$$

Socio-economic factors had an important role in a farmer's activities (Higuchi, Moritaka, & Fukuda, 2012) so it is important to study them in the personal income of farmer. Previous study about policies and socio-economics influencing on agricultural production found that experience in maize cultivation, group membership, market access and credit access were the positive significant factors that affected on maize production (Boundeth, Nanseki, & Takeuchi, 2013). Nonetheless, the age of household head, the size of household and years in school of household head did not have the relationship with production from maize (Boundeth et al., 2013). Safa (2005) using OLS and WLS to determine five socio-economic factor affecting the income of agro forestry farms found that farm size and number of livestock affected on farm income, while education was positively significant on farm in lowland and age of respondent, family size was not significant affecting. Parvin & Akteruzzaman (2012) used Cobb-Douglas production function form to estimate the effect of five socioeconomic variables on farm and non-farm income. The results found that family size and farm size were positively affected on farm income, non-farm income negatively significant at 1% level whereas the age of respondent and the level of education was not significant at any level (Parvin & Akteruzzaman, 2012). In our research, we hypothesize that education of household head, credit access of household, agricultural extension that household had received, membership of an agricultural group variables will improve average individual income from maize of household members. It means that these social-economic coefficients are expected to be significant and positive.

Table 3.1 displays the descriptive statistics of all variables which were used to analyze the influence of factors on personal income from maize of households.

Table 3.1 Summary statistics of variables in the model

Variable	Description	Mean	SD	Min	Max
AIM	Average individual Income from Maize (1000VND)	21,964.90	18,918.74	840	180,000
Gender	Gender of household head which take 1= male, 0= female	0.87	-	0	1
Age	Age of head household (years)	44.85	11.72	21	87
Edu	Schooling of household head (years)	1.47	0.82	0	12
HHsize	Household members (Person)	4.87	1.58	2	13
Credit	Taking value 1 if famer access to credit; 0= not	0.63	-	0	1
Extens	Taking value 1 if the farmers got the information from extension services; 0= none	0.22	-	0	1
Member	Taking value 1 if the farmers is group membership; 0= not	0.77	-	0	1
Product	Production of maize (Kg)	13,841	10,801.88	300	90,000
Msize	Maize farm size (Ha)	1.41	1.08	0.05	6
Seed	Total amount of maize's seed (1000VND)	4,249.53	3,299.59	260	21,000
Nfer	Total amount of Nitrogenous fertilizer for maize (1000VND)	3,487.83	3,959.62	0	20,000
NPK	Total amount of NPK fertilizer for maize (1000VND)	5,410.14	3,999.55	235	24,000
Pesti	Total amount of Pesticides for maize (1000VND)	30.91	194.21	0	2,500
Herbi	Total amount of Herbicides for maize (1000VND)	1,170.76	903.99	80	5,000
Hired	Total amount of Hired labor for maize (1000VND)	284.79	1581.10	0	20,000

Source: Own survey, 2014

3.4 Results and Discussions

Before conducting the 2SLS method to analyze factors that may influence on individual income from maize, we should have some test for endogeneity, validity and the weakness of instrument variables. If there is any problem in each test, we need to stop and concern again about the model or variables used.

According to Wooldridge (2013), the endogeneity of maize production on the average personal income from maize is tested by getting the residual from the reduced equation that run by ordinary least square method (where, dependent variable is Lnproduction and explanation variables are all exogenous and instrument variables), then adding the predicted residual value to structural model (1) including endogenous explanation variable product and run by ordinary least square method again. Lnproduction is the endogenous variable when only the residual variable that got from reduced form must correlate with the dependent variable in the structural equation. The result gave that the significance of the residual variable was $p< 0.001$. It means that Lnproduction is an endogenous variable, therefore it could not estimate in the model directly and suggest that OLS method is not suitable for this case.

There are seven instruments and one endogenous variable in our model so we need to check the overidentification restrictions (Wooldridge, 2013). The overidentifying restrictions' testing is going to check the validity of all instruments. We can do by obtaining the residual when estimate structural equation using 2SLS. Then regress that residual with all exogenous variables in our model. Our null hypothesis here is that all instrument variables are uncorrelated with this residual. A comparison between $N.R^2$ and chi-square distribution showed that $N.R^2 (14.89) > \chi_6^2$ (12.59) and the null hypothesis could not be rejected ($p \leq 0.05$). However, the endogenous variable is Lnproduct and seven instrument variables are the factors that using for Cobb-Douglas production function (Bac, Nanseki, & Takeuchi, 2013). Thus, if we take out one of them, such as Lnseed, the rest is absolutely valid but the Cobb-Douglas function in this case will not make sense. Hence, we still use all instrument variables here and go to check the suitability of them by testing the weak instruments.

Table 3.2 Estimates of the socio-economic factors on individual income from maize: 2SLS approach

Independent variables	2SLS					
	1st stage: LnProduct level			2nd stage: LnAIM		
	Coefficient	SE	P	Coefficient	SE	P
Cons	4.2539***	0.5321	0.000	2.0912***	0.2804	0.000
Gender	-0.0656	0.0707	0.355	0.0499	0.0783	0.524
Age	0.0005	0.0020	0.806	-0.0056**	0.0022	0.012
Edu	0.0288***	0.0075	0.000	0.0151*	0.0084	0.072
HHsize	0.0124	0.0160	0.440	-0.0933***	0.0176	0.000
Credit	-0.0941	0.0488	0.054	-0.0189	0.0532	0.733
Extens	0.1610***	0.0565	0.005	0.0073	0.0637	0.909
Member	-0.0590	0.0559	0.292	-0.1920***	0.0617	0.002
Lnproduct	-	-	-	0.9012***	0.0324	0.000
LnMsize	0.4047***	0.0573	0.000	-	-	-
LnSeed	0.2122***	0.0572	0.000	-	-	-
LnNifer	0.0275***	0.0069	0.000	-	-	-
LnNPK	0.2219***	0.0488	0.000	-	-	-
LnPesti	-0.0460**	0.0181	0.012	-	-	-
LnHerbi	0.1543***	0.0491	0.002	-	-	-
LnHired	0.0479***	0.0112	0.000	-	-	-
R-sq			0.822			0.756
Adj R-sq			0.814			
F-value			110.820			989.380
Prob > F			0.000			0.000

Note: *, **, *** significant at the 10%, 5% and 1% confidence, respectively.

Number of observation = 352

Source: Own survey, 2014

The test for weak instrument is an additional test. It helps us to avoid the unreliable statistic inference (Greene, 2012). Checking the weak instrument is to test the partial and sufficient correlation between endogenous and its instrument variables strongly or not. We get the F-statistics on the estimators of the instrument variables after regressing endogenous variable with all the exogenous and instrument variables. The result showed that F-statistic value was 168.49 ($p<0.001$). According to Staiger& Stock (1997), we can conclude that no weak problem with our instrument variables and 2SLS will have consistent estimators.

Table 3.2 shows the result of 2SLS regression model to estimate the socio-economic determinants that effect on the average personal income from maize, the main cultivation method on Northwest upland of Vietnam.

The first stage of the 2SLS showed the determinant factors of maize production. All instrument variables were significant. Maize farm size, seed, herbicide and hired labor were found positively significant. It means that the production of maize will increase if farmer also increases these elements. The positive sign of nitrogenous and NPK fertilizer coefficient showed that although nitrogenous included in NPK fertilizer, farmers still added it more independently. The reason is that farmers grow maize on upland from bottom to top of all hills and mountain. They do not follow the advice of government and extension officers to keep the trees or build the contour lines. Therefore, land erosion is a very serious problem in this area. Hence, farmers cannot increase maize production but also need to use much more fertilizers. Farms use a lot of pesticide and it becomes ineffective with maize production. The negative sign of pesticide further confirmed this. It suggests that farmer should decrease using pesticide as much as possible.

The predicted values for maize production are used in the second stage. The R^2 - value of 0.756 indicated an overall good fit of 2SLS regression model. It can be said that 75.6% of the variation in mean individual income from maize production is explained by using 7 exogenous and 7 instrument variables (Table 3.1). The result of 2SLS regression showed that two variables had a positive significance and three variables had negatively significant effect on dependent variable. It indicates that these socio-economic factors have an important relationship with individual income from maize of farms.

Absolutely, maize production is the main and highest factors that affects on individual income from maize of farm. The result indicated that maize production was found to be statistically significant at 1% level and had a positive sign. This implies that if the maize product increases 1% or10%, holding other factors fixed, the average personal income from maize may also raise 0.9012% or 9.012%. This is a natural problem because personal income from maize is mainly based on maize production. Thus this study concentrates on finding other socio-economic factors that may influent in individual income from maize.

The coefficient of education was positive effect on individual income from maize and significant at 10% level. It means that the more education of head household, the more income that they can be received from maize for every member of family. The farmers will have more production from maize if they can improve their perception, knowledge and experience by training and studying as much as possible. The average age of household head in this study site is 45 years old. Household head is usually the main employee and the person who make the decision in farm life. When the household heads are being older, they do not want to study or apply new methods, new technologies of maize cultivation. They only follow the stable cultivation method and scare to adopt a new one. The variable of household size had significant but negative effect on individual income from maize production at 1% level. It means that household with more people tends to be less received income from maize. It indicates that when other factors are not change, such as maize size, other income, education and etc… the average personal income from maize production will decrease if the members of family increase.

As unexpected, the coefficient of group membership was significant at 1% level but had negative effect on individual income from maize production. It explains that becoming a membership of one farm group does not help that farmer anymore. There are some farm groups for farmer to join, such as farmer group, women group, credit group, veteran group… The goal of these groups is helping farmer on agricultural activities. However, they do not act as expected desires. According to field survey 276 (78.4%) households are member of groups but 255 (92.4%) said group is not effective and should improve more appropriate with farmer's life.

The coefficients of household head gender, credit access and extension services were not significant. The variable of household head gender implies that gender is not an important factor affecting on farm decision and cultivated activities. In reality, women are the main employees in maize cultivation. Men usually work on tilling and harvesting activities only. Likewise, extension services were estimated not effective. Moreover, only 77 (21.9%) households said that they received information about maize cultivation from extension services, while 275 (78.1%) did not. It mean that the ratio of households who can receive extension services is very few. The variable of credit access had negative sign affected on average personal income from maize. One possible explanation for this is that farmers used credit for another purpose than investing for maize production. In the sample size, 227 (64.5%) households received credit from Agricultural bank, Viet Nam bank for socio policies, Local credit funds, Woman group, Private... Although 152 (70%) households used credit for cultivation, most of them invested for rice and vegetable crops and 75 (30%) for other goals. In addition, 224 (63.7%) farmers said that the interest rate is too high and not suitable for borrowing.

3.5 Conclusion

This research studied only about the influence of socio-economic factors affecting individual income from maize crops of farm's members. Unexpected as our hypothesis, the results investigated that education of household head were positively significant, membership of agricultural group were significant but negative. Likewise, credit access and extension service were not significantly effective on individual income of farm's members from maize production.

Maize production and education of household head were found significant and positive effectiveness. This implies that except maize production which directly effects on maize income, year in school is the factor that can be influent to increase farm's member income from maize production. Thus, more investment on public education is an important role for not only government but also farms in this area. Most household heads are adults, therefore short training programs, workshops, visit the good farms are some suggestion to improve farmers' knowledge.

On the other hand, results also demonstrated that the age of farm's head, household size and group membership were the factors which can reduce individual income volume from maize production. Being older means that less tending on adopting new technology and different cultivation methods. While maize land is fixed and cannot expand, if number people of household increase, it will make family more difficulties. The results also showed that the extension services is not appropriate and do not reach the demand of farmers. Although government has many policies to develop farm's groups which can support and assist farmers in farm activities, especially in maize cultivation in Northwest area, the results is not similar as expectancy. Therefore, government and group leaders should more emphasize on this situation, especially by finding the way of credit providing, extension services and group supporting. As farmers note "Do not give us what you have, let's give us what we need". Farmers really "need the fishing rods but not the fishes".

Despite the income of household is received from off-farm income, livestock and other crops, this study focused only on income from maize- the main cultivation method not only on this area but also in most of northern uplands of Vietnam. The primary information was based on farmer's memories because they did not have any record. In addition, even though we visited household several times, the respondent sometimes was not household head, therefore, there was some missing information. This study has been focus on quantitative analysis of socio-economic factor, whereas their condition was not mention. It may be used to analyze in a future research.

CHAPTER 4: INFLUENCING OF FACTORS ON PRODUCTIVE EFFICIENCIES

4.1 Introduction

Although the role of agriculture in the economy of Viet Nam has recently declined, it is still the most important economic sector. Agriculture contributed 20% of the GDP and comprised 47% of the total employment in Viet Nam in 2012 (World Bank, 2015b). Decision No. 432/QD-TTg on approving the Viet Nam Sustainable Development Strategy for 2011-2020 emphasizes that "To shift the structure of agriculture and rural areas towards industrialization, promote regional advantages; develop quality agricultural products; combine production with local and foreign market in order to lift the efficiency of using natural resources…" (Prime Minister of Vietnam, 2012). This strategy extends the application of scientific and technological advances to increase the quantity and quality of agricultural production.

Rice and maize are the two most important annual crops. Their planted area and production are the highest compared with all types of annual crops, such as sugar cane, soya bean, and peanut. By 2012, the planted area of rice and maize was 7761.2 and 1172.5 thousand ha, respectively; production was 43737.8 and 5193.5 thousand tons, respectively (GSO, 2013). Rice is mostly used for food consumption and export, whereas maize production is insufficient and must be imported for the feed industry (USDA, 2014).

The Northwest is the poorest among the seven regions in Viet Nam. Because the topography is high and mountainous, paddy rice production is insufficient, and maize production has been increasing rapidly in recent years. Maize has become the main income source for farmers (Luckmann et al., 2011). Maize is the top annual crop in the Northwest. The area and production in 2011 were 28.74% and 14.92%, respectively (GSO, 2012b).

Son La, one of the six provinces in the Northwest, has the largest area and greatest production of maize. The planted area and production of maize in 2012 was 168.7 thousand ha and 667.4 thousand tons, respectively. However, the planted area and production of paddy rice had only 48.2 thousand ha and 162.9 thousand tons,

respectively (GSO, 2013). Maize is cultivated continuously all year, whereas paddy rice is cultivated mostly in the spring.

Son La Province and the Northwest are also facing many problems. The transportation system is poorly developed. Many ethnic groups live together with low education and traditional customs. The ratio of poverty in the Northwest in 2013 was 58.7%, which is high compared with the ratio for the entire country: 17.2% (GSO, 2012a). The annual crop plots are highly fragmented and very small. Farmers work as individuals and do not want to join co-operatives. Therefore, applying scientific and advance technologies here is a significant challenge for farmers and the government.

Although rice and maize have an important role in the Northwest social-economic structure, there are few studies regarding the efficiency of rice and maize crop production. To our knowledge, this article is the first study to estimate farm-level technical and scale efficiencies and identify the factors influencing them. This study estimated farm efficiency using a nonparametric method with a smooth bootstrap procedure to avoid measurement errors and data noise. After obtaining the technical and scale efficiencies, a Tobit regression method was used to determine the factors influencing these efficiencies.

There have been several studies regarding the efficiency of agriculture in Viet Nam. Khai and Yabe (2011) used stochastic production frontier analysis (SFA) with the Cobb-Douglas production function to measure the technical efficiency (TE) of rice production. Rios and Shively (2005) used a standard DEA method to first estimate technical and cost efficiencies and then a standard Tobit regression to identify the factor effect on these efficiencies of coffee farms in Dak Lak Province, Viet Nam. Linh (2012) is the first author to use a smooth bootstrapped DEA method to estimate technical and scale efficiencies of rice farms in the first step. Linh (2012) then used a standard and weight Tobit to determine the factors influencing technical efficiency. However, Linh (2012) used the Vietnam Household Living Standard Survey 2003-2004 (VHLSS 2004) for 8,813 households in all of Vietnam and only for rice farms. Dao and Lewis (2013) estimated the technical and scale efficiencies of annual crop farms in northern Vietnam using a DEA smooth bootstrap approach. However, Dao and Lewis (2013) have only used a DEA smooth bootstrap approach

in the first step because the second step to identify factors was not completed. Dao and Lewis (2013) also did not focus on analyzing maize and rice farms in the Northwest.

This chapter has two objectives. First, we estimate the technical and scale efficiencies of both rice and maize crops in Son La Province, Vietnam using a standard and smooth bootstrap DEA method. Second, we use a Tobit regression method to identify the factors influencing these efficiencies among farms.

The next section describes a short review of the methodology. Section 3 describes the main characteristics of the data. The results and discussion are presented in section 4. Finally, conclusions and several recommendations are provided.

4.2 Methodology

Efficiency can be estimated by two methods, namely, parametric and non-parametric. In the literature, most parametric approaches use the Stochastic Frontier Analysis (SFA) method, whereas the non-parametric approach uses Data Envelopment Analysis (DEA). The main difference between these two methods is based on the way that the production possibility frontier can be estimated. An advantage of the DEA method is that it does not require a functional form, whereas SFA requires a functional form.

DEA requires detailed information regarding all inputs and output data. Following the work of Coelli, Rahman, and Thirtle (2002); Farell (1957) and others, the four efficiencies often measured are technical, scale, allocative and cost. However, the allocative and cost efficiencies are strengthened by the availability of all inputs and output prices, which were difficult to collect when we conducted the field survey. Because the survey was conducted based on farmers' memories, sometimes they could not remember details. Therefore, this article focuses on measuring technical efficiency (TE) and scale efficiency (SE).

DEA has input orientations and output orientations. This study employed DEA to measure farm efficiency using an input orientation. We first used the smooth bootstrap procedure proposed by Simar and Wilson (2000) to estimate bias and the confident interval for technical efficiency (TE). We then used Tobit analysis to

identify the exogenous factors affecting the estimated efficiency. We used the package FEAR developed by Wilson (2008) in the R platform and Stata software in the process.

4.2.1 Technical and Scale Efficiencies

The DEA production frontier is constructed and solved using linear programing techniques. Considering an i[th] farm out of a total of n farms, the input-based technical efficiency (TE) under variable return to scale (VRS) is calculated as:

$$TE_i = min_{\theta,\lambda}\theta_i, \text{ Subject to } Y_i \leq Y\lambda;\ \theta_i X_i \geq X_i;\ \lambda \geq 0;\ \sum_{i=1}^{n}\lambda_i = 1 \quad (1)$$

Where,

Y and X are the output and input vectors, respectively. The value of θ_i is the technical efficiency score for the i = th farm under VRS. In general, $0 \leq \theta_i \leq 1$, when $\theta_i = 1$, indicating that the farm is producing on the production frontier and is therefore technically efficient, whereas $\theta_i < 1$ shows that the farm is technically inefficient.

In case of a constant return to scale (CRS), we can easily impose it by deleting the convexity constraint $\sum_{i=1}^{n}\lambda_i = 1$ in Equation (1). Therefore, we can easily calculate scale efficiency (SE) by Coelli et al. (2002):

$$SE = TE_{CRS}/TE_{VRS} \quad (2)$$

We can also calculate the non-increasing to scale (NIRS) by replacing the convexity restriction $\sum_{i=1}^{n}\lambda_i = 1$ in Equation (1) to $\sum_{i=1}^{n}\lambda_i \leq 1$. In general, $0 \leq \theta_i \leq 1$ if SE = 1, and farms are considered to be scale efficient. If TEVRS = TENIRS and SE < 1, the farm is operating under a decreasing return to scale (DRS), or is "too large". If TEVRS ≠ TENIRS and SE < 1, the farm is operating under an increasing return to scale (IRS) or is "too small". Finally, if TEVRS = TECRS, the farm is operating under a CRS (T. Coelli et al., 2002).

4.2.2 Bootstrapping in DEA

DEA is a deterministic method, and one of its disadvantages is that no statistical noise is assumed in the analysis. Although DEA methods have been widely applied to date, many researchers have completely ignored the statistical noise in the estimators. This oversight can cause bias in the DEA estimates and mistaken results (Dao & Lewis, 2013). Simar and Wilson (1998, 2000) proved that bootstrapping is the best method to construct the statistical properties of DEA. In the bootstrap method, the data are simulated by resampling. Therefore, the data generating process (DGP) can be mimicked to the correct data generation. In the literature, several studies have applied the bootstrap method of Simar and Wilson (2000), such as Brummer (2001); Dao and Lewis (2013); Gocht and Balcombe (2006); Latruffe, Balcombe, Davidova, and Zawalinska (2005).

After using a smooth bootstrap procedure, we can check the biased DEA estimators and locate their confidence interval. The confidence interval is an important index to determine the exact results. The larger the variance, the more incorrect the efficiency results may be. Efron and Tibshinari (1993) have suggested that the number of iterations should be less than 1000 if researchers only want to estimate bias and standard deviation. Because we are more interested in confidence interval estimation, in our study, 2,000 bootstrap iterations were performed.

4.2.3 Variables Explaining the Efficiency Estimates

This article used Tobit analysis in the second stage to evaluate the factors influencing efficiency similar to most authors. Crop production is affected by many exogenous factors, such as household characteristics, household assets, extensions, and weather. Moreover, farms operating at optimal scale are assumed in constant return to scale (CRS) technical efficiency (Karimov, 2013). Therefore, this study selected the technical efficiency under variable return to scale (VRS) to become dependent variables in the Tobit model.

However, which index is suitable to use for analysis: the bias-corrected estimator or original technical efficiency? Simar & Wilson (2000) have suggested that using only bias-corrected estimates in the second step when,

$$\hat{\sigma}^2 < \frac{1}{3}(bias[\hat{\theta}])^2 \quad (3)$$

Where $\hat{\sigma}^2$ is the sample variance of the bootstrap values, and $\hat{\theta}$ is the uncorrected estimated score. In our study, using only bias-corrected estimates could not occur. Thus, we used the original technical efficiency score (TEVRS) in the second stage.

The estimated coefficients in the Tobit regression models can not directly be used to interpret the results as the true marginal effect. This coefficient will affect the mean value of the dependent variable (Yi), given that it is observed and also affects the probability of the dependent variable being observed (Y*i) (Gujarati, 2011). Therefore, similar to other studies, this study uses the marginal effects of all independent variables that are reported and calculated at the sample mean.

4.3 Data and Variables Used

The data used for this study originate from a survey conducted in six communes located in three districts of Son La Province, in northwest Vietnam. The survey was conducted from February to March 2014. The respondents were selected through a multi-stage sampling procedure. Three districts in the survey were based on three types of altitude: Mai Son < 1,000 m, Moc Chau 1,000 – 2,000 m and Phu Yen > 2,000 m. A total of 360 farm households from 12 villages were interviewed. Of this total, 292 households cultivate both rice and maize, 60 households cultivate only maize, six households cultivate only rice, and four conduct business. Therefore, we used the data of 292 household farms to compare the efficiency between the two main crops.

Table 4.1 Descriptive variable used

Variable	Definition	Rice		Maize	
		Mean	SD	Mean	SD
Output and Inputs					
Output	Gross income (1,000vnd)	13,072.21	11,915.02	58,934.96	44,17566
Land	Cultivated land (ha)	0.32	0.44	1.48	1.10
Labor	Including family labor and hired labor (Man-days)	18.32	25.99	126.65	96.16
Seed	Total amount of seed (1,000vnd)	2,604.42	2,110.01	4,474.06	3,265.96
Fertilize	Total amount of fertilizer (1,000vnd)	2,638.31	2,356.90	9,146.38	6,485.98
Chemical	Total amount of chemicals (1,000vnd)	927.08	965.46	1,276.69	927.32
Others	Other expenses (1,000vnd)	190.34	819.79	117.89	766.24
Farm specific variables					
Age	Age of household head (years)	44.32	11.59	44.32	11.59
Edu	Schooling of household head (years)	6.62	3.22	6.62	3.22
Hhsize	Household members (person)	4.92	1.59	4.92	1.59
Sourele	Source of electricity of household, which takes 1 = use national source, 0 = otherwise	0.88	0.33	0.88	0.33
Dismark	Distance from household to nearest market (km)	9.20	7.11	9.20	7.11
Credit	Takes 1 if farmer has access to credit, 0 = not	0.67	0.47	0.67	0.47
Extent	Takes 1 if farmers received the information from extension services, 0 = none	0.41	0.49	0.94	0.24
Motor	Motorcycle of household, which takes 1 = have milling, 0 = otherwise	0.30	0.46	0.30	0.46
Tractor	Tractor machine of household, which takes 1 = have tractor, 0 = otherwise	0.22	0.41	0.22	0.41
Milling	Milling machine of household, which takes 1 = have milling, 0 = otherwise	0.28	0.48	0.28	0.48
Offic	Off-farm income of household (Million vnd)	1.99	10.39	1.99	10.39

Source: Own survey, 2014.

Output is measured as the gross income of rice and maize. Rice product is mostly used for self-consumption; maize product is used for both selling and self-consumption. Therefore, using profit or income from the rice and maize product index

does not precisely show the technical and scale efficiencies. The inputs are planted land, family and hired labor, seed, fertilizer (including organic, NPK, nitrogenous and phosphate fertilizer), chemicals (including herbicide and pesticide) and other expenses (such as irrigation and transportation fees, etc.).

We also explain efficiency differences among farms using farm-specific variables. The selected variables are those most often used in the literature, such as the age and education of the household head, distance to the nearest market, access to credit, extension services, off-farm income and household assets (Binam, Tonyè, Wandji, Nyambi, & Akoa, 2004; T. Coelli et al., 2002; V. H. Linh, 2012).

Table 4.1 presents summary information regarding the variables used for rice and maize crops separately. The table shows that gross income from maize production is higher than rice production by 46,000 thousand vnd. The simple reason for this result is that all of the inputs of maize except other expenses are higher than rice. The planted rice crops are small by 0.32 ha, similar to the rice farm size in Bangladesh (T. Coelli et al., 2002), with an average size of only one-third of a hectare. The average size of a rice crop is equal to one-fifth the size of a maize crop. Most rice farms have only one or two plots. Because maize is cultivated on sloping land, it requires much more labor, seed, and fertilizer.

The farm-specific variables provide an overview of the farms' characteristics. The average age of the head of household is 44; the average education of the head of household is at the secondary level. The average family size is 5. Nearly 90% of farms use a national electricity source, and approximately 67% of farms have access to credit. The average distance to the nearest market is 9 km. Farmers have had contact with maize extensions more than rice. Few households have tractors and milling machines, and off-farm income is small: approximately 2 million Vietnamese dong per year.

4.4 Results and Discussion

4.4.1 Technical and Scale Efficiencies

The standard DEA technical estimates under VRS and CRS are reported in Table 4.2. The results show that the majority of farms are inefficient in both the technical and scale efficiencies of rice and maize production.

The average technical efficiency score under VRS is 0.63 for rice crops and 0.54 for maize, with 34 rice and 19 maize crops fully efficient. These results suggest that, on average, farms can still maintain the same output performance with a decrease in the inputs by 37% for rice crops and 46% for maize crops. The results also indicate that technical efficiency under CRS and VRS in rice production is higher than in maize production, which may be partly because of the insufficiency and sloping of maize
crop lands.

The mean scores of scale efficiency for rice and maize production are the same: 0.89. This conclusion indicates that farm size is much less important in changing technical efficiency. The last three rows of Table 4.2 show the percentages of farms that have constant return to scale (CRS), decreasing return to scale (DRS) and increasing return to scale (IRS). Overall, farms are mostly under increasing return to scale in both rice and maize crops, with scores of 84.25% and 77.40%, respectively. These results mean that farms are "too small" and may need to increase their scales. Only 11 rice crops and 10 maize crops are producing at optimal scale.

The technical efficiency score for both crops under VRS is lower than the scale efficiency score. This conclusion indicates that the technical inefficiency of maize and rice farms is mainly affected by management rather than the operating scale. This finding is similar to the result of Karimov (2013), which estimated the efficiency of potato and H-W melon crops on Uzbekistan farms. This result implies that farmers must focus more on improving the management of crop production, and rice farms must also increase their scale efficiency.

Table 4.2 Frequency distribution of technical and scale efficiency estimates in a pooled sample

	Rice crop			Maize crop		
	TE_{CRS}	TE_{VRS}	SE	TE_{CRS}	TE_{VRS}	SE
Mean	0.56	0.63	0.89	0.48	0.54	0.89
Std.dev	0.20	0.22	0.14	0.21	0.21	0.15
Minimum	0.15	0.16	0.21	0.07	0.14	0.28
Maximum	1.00	1.00	1.00	1.00	1.00	1.00
<60 %	60.96	51.72	4.45	73.97	67.10	6.85
60-69 %	12.67	9.93	6.51	11.30	12.00	4.79
70-79 %	13.01	12.33	6.51	6.51	8.20	6.16
80-89 %	7.19	8.90	17.81	2.40	3.80	14.05
90-100 %	6.17	17.12	64.73	5.82	8.90	68.15
IRS %			84.25			77.40
DRS %			11.99			19.18
CRS %			3.76			3.42

Source: Own survey, 2014.

4.4.2 Smooth Bootstrap Results

To improve the robustness of the results and realizing that the standard DEA method may have biases in estimating efficiency scores, we used a smooth bootstrapping method. The results of bias-corrected TE_{VRS} are reported in the sixth column of Table 4.3. The confidence intervals (CIs) of bias-corrected TE_{VRS} are also shown in the seventh and eighth columns.

Table 4.3 Technical efficiency estimates using smooth bootstrap method

Variables	Sample	Initial TE_{CRS}	Initial TE_{VRS}	% of farm with TE_{VRS} = 1	Bias-Corrected TE_{VRS}	Lower bound	Upper bound
Rice crop							
Pooled sample	292	0.56	0.63	11.64	0.55	0.50	0.62
Mai Son	93	0.61	0.68	16.10	0.58	0.52	0.66
Moc Chau	87	0.69	0.76	26.40	0.66	0.59	0.75
Phu Yen	112	0.62	0.69	19.60	0.59	0.53	0.68
Maize crop							
Pooled sample	292	0.48	0.54	6.50	0.46	0.42	0.52
Mai Son	93	0.65	0.75	26.90	0.66	0.59	0.74
Moc Chau	87	0.50	0.60	9.20	0.51	0.45	0.58
Phu Yen	112	0.51	0.58	8.04	0.49	0.44	0.56

Source: Own survey, 2014.

The results show that the mean of bias-corrected TE results are lower than the initial scores, and no farms have a full technical efficiency score. Similar results are found in Linh (2012) for a single bootstrap and Olson and Vu (2009) for a double bootstrap. Comparing efficiency scores in the location category of rice crops, farmers in the Moc Chau district have a higher TE score (0.66 compared with 0.58 and 0.59). The difference between the initial and bias-corrected efficiency scores is also highest in this group (0.76 compared with 0.66). However, with maize crops, farmers in the Mai Son district have the highest initial and bias-corrected TE scores compared with the Moc Chau and Phu Yen districts. These results indicate that rice crops in Moc Chau and maize crops in Mai Son have much more efficient farmers in the sample.

Karimov (2013) has suggested that authors must use bias-corrected efficiency scores to recommend policy. This suggestion is based on the distance between the initial and bias-corrected TE. For detail, the initial TE_{VRS} for the pooled sample suggests that rice and maize farms could decrease their inputs by 37% and 46%,

respectively. If full efficiency was achieved, the bias-corrected TE_{VRS} suggests decreasing inputs for rice and maize production approximately 45% and 54%, respectively.

Using the smooth bootstrap method, the width of the 95% confidence intervals is 0.12 for rice production and 0.10 for maize production. This finding is similar to Karimov (2013) and Latruffe et al. (2005) for the single bootstrap procedure. This result indicates that farms could be more inefficient if we used a confidence interval index rather than the single estimated point. For example, in the location category, the mean TE_{VRS} of maize crops in the Moc Chau district shows that, on average, farms could obtain the same level of output by reducing 40% of their inputs. However, the confidence interval explains that inputs could be reduced from 42% to 55%. If we do not use the DEA bootstrap method, farms that were originally identified as lying on the production frontier may, in fact, lie below it.

4.4.3 Factors Explaining Efficiencies

To explain the variation of technical and scale efficiencies, these scores were regressed concerning the farm characteristics using a Tobit regression model. The results of the Tobit model are presented in Table 4.4, and the partial effect of each factor is listed in Table 4.5.

The age of the household head has a significant and negative effect on the technical efficiency of rice crops and the technical and scale efficiencies of maize crops. If household heads are older, they do not want to change their cultivation methods, apply new technologies or expand scales of production. Younger heads of household are considered to be more flexible by adopting new knowledge and technology and increasing investment.

Source electricity has positive effects on the technical efficiency of both rice and maize crops. The results indicate that farms using a national electricity source have a higher technical efficiency than those that do not. Because a national electricity

source is stable and powerful, farms can use it for crop activities, such as using pumps for irrigation.

Table 4.4 Results of Tobit regression

Variable	Rice		Maize	
	TEVRS	SE	TEVRS	SE
Constant	0.6507***	0.8009***	0.4402***	1.1088 ***
	(0.0951)	(0.0520)	(0.0861)	(0.0581)
Age	-0.0022*	0.0009	-0.0020*	-0.0015*
	(0.0013)	(0.0007)	(0.0012)	(0.0008)
Edu	0.0029	-0.0002	-0.0029	-0.0032
	(0.0049)	(0.0027)	(0.0045)	(0.0029)
Hhsize	0.0029	-0.0051	0.0215**	-0.0088
	(0.0096)	(0.0052)	(0.0088)	(0.0059)
Sourele	0.1146**	0.0444	0.0764	-0.0137
	(0.0507)	(0.0277)	(0.0463)	(0.0311)
Dismark	-0.0013	-0.0039***	0.0018	-0.0028**
	(0.0021)	(0.0011)	(0.0019)	(0.0013)
Credit	-0.0245	0.0106	-0.0647**	-0.0048
	(0.0314)	(0.0171)	(0.0281)	(0.0189)
Extent	0.0158	0.0330**	0.1018 *	-0.0480
	(0.0293)	(0.0160)	(0.0565)	(0.0381)
Motor	-0.0111	0.0469	-0.0474	0.0144
	(0.0628)	(0.0349)	(0.0307)	(0.0206)
Tractor	-0.0062	0.0055	-0.0152	0.0072
	(0.0344)	(0.0187)	(0.0343)	(0.0230)
Milling	-0.0391	0.0512**	-0.0356	-0.0020
	(0.0379)	(0.0207)	(0.0286)	(0.0192)
Offic	0.0006	0.0003	0.0005	-0.0005
	(0.0014)	(0.0008)	(0.0013)	(0.0009)
Log likelihood	-39.42	161.33	4.01	134.68

Note. ***, **, * => Significance at the 1%, 5%, and 10% level, respectively.

Source: Own survey, 2014.

Table 4.5 Partial effects of the Tobit regression

Variable	Rice		Maize	
	TEVRS	SE	TEVRS	SE
Age	-0.0022*	0.0009	-0.0020*	-0.0015*
Edu	0.0029	-0.0002	-0.0029	-0.0032
Hhsize	0.0030	-0.0051	0.0215**	-0.0088
Sourele	0.1146**	0.0444	0.0764*	-0.0137
Dismark	-0.0013	-0.0039***	0.0018	-0.0028**
Credit	-0.0245	0.01062	-0.0647**	-0.0048
Extent	0.0158	0.0330**	0.1018*	-0.0480
Motor	-0.0111	0.0469	-0.0474	0.0144
Tractor	-0.0062	0.0055	-0.0152	0.0072
Milling	-0.0391	0.0512**	-0.0356	-0.0020
Offic	0.0006	0.0003	0.0005	-0.0005

Note. ***, **, * ==> Significance at the 1%, 5%, and 10% levels, respectively.
Source: Own survey, 2014.

Unexpectedly, the distance to market has a significant and negative impact on the scale efficiency of rice and maize crops. This finding shows that if the distance to market is nearer, the scale inefficiency of rice and maize crops will increase. Arable land for rice and maize crops is small and limited. Although natural conditions allow cultivation in two seasons per year, most farmers cultivate rice in one season. In addition, the custom of people upland is to relax after the harvest. Therefore, these farms will consume more if they are near the market and if they do not keep money to invest in increasing the scale of rice and maize production.

Family members have a positive effect on the technical efficiency of maize crops. This effect can come from the fact that maize plots are mainly located on upland, with a slope more than 15°; thus, it costs time and money to use modern technology, such as a tractor for land preparation and a motor for transportation. In fact, farmers prepare land with animals or their hands. Thus, maize crops require more labor than rice crops. Family laborers will help farms save money and initiate

production. This finding is inconsistent with Coelli et al. (2002) who found that larger families have a negative effect on the technical, allocative and cost efficiencies of modern Boro rice.

The insignificant effects of education, motors, tractors and off-farm income indicate that these factors have a low impact on different efficiencies. Experience may be a more important factor than the education of the household head, especially with the people in the highlands. Moreover, the average education of the household head is at the secondary level. Motors are mostly used for daily life rather than for cultivating activities. Rice plots are also small and fragmented; maize plots are located on sloping lands. Thus, tractors have no effect on either rice or maize efficiencies.

Finally, milling machines have a positive effect on the scale efficiency of rice crops. Farmers who have their own milling machine could improve the scale of their rice crop. Using milling machines should save time and costs for farmers and allow them to be proactive in their farm activities.

4.5 Conclusion

This study uses a smooth bootstrapping method to analyze the variability of DEA technical efficiency estimates and to correct for the inherent bias in the DEA method. This study uses detailed survey data for 292 farms that cultivate both rice and maize crops in 12 villages in three districts in Son La Province, Vietnam. The study shows that the opportunity for both technical and scale inefficiencies of maize and rice crops is significant. The results indicate that the TE_{VRS} among farmers differs across districts. The bias-corrected point estimate of TE_{VRS} in rice and maize crops is 0.55 and 0.46, respectively. These numbers indicate that input levels could decrease 45% for rice and 54% for maize with the present levels of output. This result suggests continuing to improve the management of annual crop production and cultivation methods for farmers. In terms of the scale efficiency score, most rice and maize crops are producing under increasing return to scale. This score indicates that farm scales

are mostly “too small”. Therefore, co-operation in cultivation, crop diversity and the optimal use of rice plots are several suggestions for optimal farm production.

In the second step, a Tobit regression is used to explain variations in efficiencies among farms. The results indicate that a national electricity source is an important factor to improve the technical efficiency of both rice and maize farms. Thus, expanding a national electricity source is an important strategy for the government in the near future to increase social welfare.

Large families are likely to be more technically efficient on maize farms. Because maize farms are mostly cultivated through human power, more people will be helpful. Therefore, motors and tractors are insignificant in both efficiencies of both types of farms. An undesirable credit factor is found to have a negative impact on the technical efficiency of maize farms; the distance to the nearest market has a negative effect on the scale efficiency of both rice and maize crops. These factors may come from outdated customs, low education and farmers’ life behavior. Therefore, policies for adjusting customs, knowledge and credit in appropriate ways should be emphasized. Extension services are considered to continue enhancement because they have a positive effect on the scale efficiency of rice crops and the technical efficiency of maize crops.

CHAPTER 5: IMPACT OF INFORMATION SOURCES ON TECHNICAL EFFICIENCY

5.1 Introduction

Over the past years, although Vietnam's economic and labor structure has changed, its rural population still accounts for 67.81% of the total and the main livelihood of rural dwellers is agricultural production. Rice and maize are the largest crops by planted area and comprise the biggest cereal crop production proportion (GSO, 2013).

The National Assembly of Vietnam approved plans to grow gross domestic product (GDP) for the 2011—2015 period by on averages approximately 6.5—7% a year (National Assembly of Vietnam, 2011). In addition, poor households will be reduced in a fast and sustainable manner, by 2% a year on average and by 4% a year in districts and communities stricken by poverty and extreme difficulties. Furthermore, the proportion of high-tech products will account for around 30% of total industrial production by value with a technological innovation rate of 13% per year. However, GDP in 2011, 2012, and 2013 was 6.2%, 5.2%, and 5.4%, respectively; the poverty headcount ratio at the national poverty line was 17.2% of the population in 2012 (World Bank, 2015a); and technology application remains low, especially in the agricultural field (Vietnam Trade Promotion Agency, 2014). One of the reasons for the low adoption technology is that farmers lack skill, experience, and knowledge to receive and generate information sources.

Now a day, we cannot deny the important role of information in life activities. Information sources are needed for agriculture because of agriculture's importance for socio-economic development, especially in developing countries; food security and welfare issues; improving the quality and quantity of agricultural products; and reducing agricultural product costs (Kaaya, 1999). Adequate quality of information is the required condition to improve all areas of agriculture, especially in countries with increasingly larger markets (Milovanović, 2014).

As the Vietnamese government has become aware of the importance of information and communication technology (ICT), it has put in place policies to

promote ICT. These include Decision No. 1755/QD-TTg of September 22, 2010, which approved a national strategy for "Transforming Vietnam into an advanced ICT country"; Decision No. 698/QD-TTg of June 1, 2009, which approved general plan on information technology (IT) human resources development up to 2020; and Decision No. 1605/QĐ-TTg of August 27, 2010, which approved a national program of IT usage for government bodies for 2011—2015. In particular, on July 12, 2011, the Prime Minister of Vietnam wrote an official letter No. 1138/TTg-QHQT allowing the Ministry of Information and Communications to establish and deploy the expanded project "Improved computer usage and public internet access ability in Vietnam" in 2011—2016 period. With a total value of 50.5 million USD, of which more than 33.6 million USD is funded by the Bill and Melinda Gates Foundation (BMGF) and Microsoft Corporation, this project aims to plug the digital gap between rural and urban areas, improve the livelihoods of people through the use of modern technology, and provide opportunities for people in rural areas to benefit from ICT services. The project has been deployed only in three provinces of Vietnam, namely, Thai Nguyen, Nghe An, and Tra Vinh.

However, the status of information and communication use in Vietnam remain backward, especially in the agricultural sector and rural areas. Most ICT programs and projects are focused on urban areas and local officers. Compared to other regions and countries, progress has been very slow and there are many difficulties and challenges, especially for farmers in the highland area.

In the literature, some researches have studied technical efficiency (TE) and the factors that influence the TE of rice and coffee products in Vietnam, such as Rios & Shively (2005); Khai & Yabe (2011); Linh (2012); Bac et al. (2013). Nevertheless, none of them have studied both main cereal crops (rice and maize) and the impact of information sources on TE. Therefore, this study has two objectives. First, it estimates the TE of crop farmers in Son La province, Vietnam using stochastic frontier analysis (SFA). Second, we determine the information sources that influence technical inefficiency using farm-level data.

5.2 Methodology

TE is the indicator reflecting the capacity of a farmer to achieve maximal output with a given set of inputs (Farell, 1957; Coelli et al., 2005). Stochastic frontier analysis (SFA) and Data envelopment analysis (DEA) are the two methods that are applied widely by many researches so far. Each method has different strengths and weaknesses. DEA is a deterministic and non-parametric method while SFA is a parametric method and can separate the effects of noise from technical inefficiency. This study is more interested in the SFA method.

Following the work of Farell (1957), the stochastic production frontier was proposed by Aigner et al. (1977); Meeusen, W. and Van den Broeck (1977). It can be written as

$$Y_i = X_i\beta + \varepsilon_{i,} \qquad i = 1, \ldots., N \tag{1}$$

where Y_i is the scalar output of the *i*-th farm;

X_i is the vector of input quantities of the *i*-th farm;

β is a vector of parameters to be estimated; and

ε_i is a "composed" error term and can be represented as

$$\varepsilon_i = V_i - U_{i,} \tag{2}$$

where V_i is a two-sided random error ($V \sim N[0, \sigma_v^2]$) that captures the stochastic effects beyond farmers' control (e.g., measurement errors, disease outbreaks and weather). The term U_i is a non-negative random variable that represents the technical inefficiency of production (Coelli et al., 2005). The one-sided term U_i can follow some distribution as half-normal, truncated-normal, exponential, or gamma (Aigner et al., 1977; Meeusen, W. and Van den Broeck, 1977). This study assumes that U_i follows truncated-normal distribution with mean μ and variance($U \sim N[\mu, \sigma_u^2]$), which is used widely in many research. It also assumes that U_i and V_i are independent of each other.

The different frontier models are based on the different specification of technical inefficiency effects U_i. Some authors, like Bravo-Ureta, B & Pinheiro, A

(1997); Khai & Yabe (2011), estimated stochastic frontiers to obtain farm-level efficiencies, then regressed these predicted efficiencies upon firm-specific factors, such as farmer characteristics, farm conditions, and production conditions, in an attempt to explain the different output between firms. However, Battese & Coelli (1995) revealed that these firm-specific factors might impact on efficiency if they were used directly in the estimation of the production frontier. This is inconsistent with the assumption of independence between inefficiency effects and noise in this two-stage estimation procedure. To overcome this problem, Battese & Coelli (1995) proposed a one-stage simultaneous estimation approach in which the technical inefficiency effects are stochastic and expressed as an explicit function of a vector of farm-specific variables. The technical inefficiency effects can be written as

$$\mu_i = Z_i\delta + \omega_i \tag{3}$$

where μ_i is the mean of technical inefficiency that can be estimated by one-stage simultaneous estimation. Z_i is a vector of variables that can influence the inefficiency of a farm. δ is a vector of unknown parameter to be estimated. ω_i is an error term (unobservable random variable).

The stochastic frontier production (1) and technical inefficiency model (3) are estimated simultaneously using maximum likelihood method. We choose the widely applied computer program FRONTIER 4.1c (T. J. Coelli, 1996) for estimation. This program allows us to present the coefficients of variance parameters

$$\sigma^2 = \sigma_v^2 + \sigma_u^2 \tag{4}$$

$$\gamma = \sigma_u^2/(\sigma_v^2 + \sigma_u^2), \quad 0 \le \gamma \le 1 \tag{5}$$

where gamma parameter (γ) indicates the share of inefficiency in the overall residual variance and must lie between zero and one. If $\gamma = 0$, the deviations from the frontier are due to noise, and if $\gamma = 1$, all deviations are due to technical inefficiencies (Battese & Corra, 1977; Battese & Coelli, 1995).

5.3 Data and Empirical Model

5.3.1 Data

The data used in this study are based on a direct interview survey of 358 randomly selected crop-farm households in 12 villages of three districts in Son La province in the northwest highland of Vietnam. The data cover 2014.

All the output and input variables are summaries of rice and maize crops. In the study area, maize products are used for both selling and self-consumption while rice products are mostly for self-consumption, therefore, using profit or income from the rice and maize product index does not display technical efficiency accurately. Therefore, the total gross income of rice and maize production is measured as output. The inputs chosen for the stochastic production frontier function are planted land, family and hired labor, seed, fertilizer (including organic, nitrogen-phosphorus-potassium, nitrogenous, and phosphate fertilizer), chemicals (including herbicide and pesticide) and other expenses (such as irrigation and transportation fees) (Hasnah et al., 2004; Khai & Yabe, 2011; Bac et al., 2013; Linh et al., 2015).

Information is a vital resource for farmers. The information on generated technologies from research systems are important for farmer to apply to agricultural activities. Moreover, farmers need marketing information to make suitable decisions on how, when, and where to buy inputs or sell their products (Kaaya, 1999). In the literature, several studies have researched the importance and effects of information technology sources on agriculture, such as Ford & Babb (1989); Ortmann et al. (1993); Patrick et al. (1993); Foltz & Makus (1996); Kaaya (1999); Gloy et al. (2000); Gloy & Akridge (2000); Milovanović (2014). However, most of this research has taken place in the United States, as well as in such countries as Tanzania, and Serbia; none has occurred in Vietnam. Therefore, to our knowledge, this is the first study that evaluates the influence of information sources on technical inefficiency in Vietnam. Based on the literature and survey conditions, some information source variables are chosen and presented in Table 5.1 (Gloy et al., 2000; Boz & Akbay, 2005; Füsun Tatlıdil et al., 2008).

Table 5.1 Descriptive statistics of variables in the empirical model

Variable	Description	Mean	Min	Max
Y	Gross income (1,000 VND[a])	67,400.99 (50,358.66)	840	238,500
X1	Cultivated land (ha)	1.65 (1.27)	0.05	10.00
X2	Total amount of seed (1,000 VND)	10,953.42 (7,750.732)	192	40,220
X3	Total amount of fertilizer (1,000 VND)	1,947.28 (1,481.87)	80	9,630
X4	Total amount of chemicals (1,000 VND)	132.80 (104.70)	2.8	750
X5	Total labor, including family labor and hired labor (Man-days)	6,320.94 (4,522.813)	300	27,900
X6	Other expenses (1,000 VND)	319.01 (1,129.62)	0	10,400
Z1	Extension services. Takes 1 if farmers received information about extension services, 0= otherwise	0.22 (0.41)	0	1
Z2	CCPO. Takes 1 if farmers usually visit CCPO, 0= otherwise	0.29 (0.46)	0	1
Z3	Reading printed materials. Takes 1 if farmers read several times a month, 0= otherwise	0.25 (0.43)	0	1
Z4	Reading information. Take 1 if farmers read the agricultural information, 0= otherwise	0.24 (0.43)	0	1
Z5	Listening to the radio. Takes 1 if farmers listen at least 5 times per week, 0= otherwise	0.13 (0.33)	0	1
Z6	Listening information. Takes 1 if farmers usually listen the agricultural information, 0= otherwise	0.14 (0.35)	0	1
Z7	Watching TV. Takes 1 if farmers watch at least 5 times per week, 0= otherwise	0.89 (0 .30)	0	1
Z8	Watching information. Takes 1 if farmers usually watch agricultural programs, 0= otherwise	0.59 (0.49)	0	1
Z9	Takes 1 if farmers' cell-phones can access the internet, 0= otherwise	0.01 (0.11)	0	1
Z10	Takes 1 if the farmer has visited a good agricultural model, 0= otherwise	0.16 (0.36)	0	1
Z11	Takes 1 if the farmer has agricultural group membership, 0= otherwise	0.77 (0.42)	0	1

Note: 1 USD = 21,125.00 VND (March 2014)

Source: Own survey, 2014

Table 5.1 shows that total gross income of rice and maize products in 2013 was 67.4 million VND. Total rice and maize cultivated land was 1.65 ha of which most is maize. Because maize and rice are cultivated mostly on highland and sloping land, these crops demand much more seed, labor, and fertilizer. All cultivation is based strongly on human power, and thus, the total amount of chemicals and other expenses are less than other inputs. In the survey, 22% of farmers received extension services. Farmers may not have the time or inclination to read printed materials and listen to the radio. Only 25% and 13% of respondents read printed materials every month and listen to the radio at least five times per week, respectively. Of this total, only one fourth and one sixth were interested in reading and listening to agricultural information, respectively. On the other hand, 89% of respondents said they usually watched television at least five times per week and 60% of them usually watched agricultural programs. Most farmers owned cell-phones but only 1% had tried to access the internet through their smart-phones. In addition, 77% respondents were members of at least one farm group and only a small proportion of farmers had visited good agricultural models.

5.3.2 Empirical Model

There are several production functions in econometric estimation, such as the Cobb-Douglas function, translog function, and constant elasticity of substitution (CES).

Based on Hanley & Spash (1993), Khai & Yabe (2011) proposed that the Cobb-Douglas functional form is suitable if the model has three or more independent variables. Our study has six independent variables, and therefore, the Cobb-Douglas production function is chosen; it can be written as

$$lnY_i = \beta_0 + \sum_{j=1}^{6} \beta_{ji} lnX_{ji} + V_i - U_i \quad (6)$$

where Y_i is the output of i farmer, X_{ji} are the j input variables presented in Table 5.1, and β_{ji} are parameters to be estimated. The inefficiency model is estimated from

$$\mu_i = \delta_0 + \sum_{k=1}^{11} \delta_{ki} Z_{ki} + \omega_i \quad (7)$$

where μ_i represents the mean technical inefficiency effects. Z represents various information source variables presented in Table 5.1.

5.3.3 Hypotheses Tests

It is noted that several tests are needed to test the presence of inefficiency in the model and whether the efficiency parameters are significantly different from zero (Coelli & Battese, 1996). Therefore, the following hypotheses tests are of interest:

1) $H_{01}: \mu = 0$, the null hypothesis specifies that the inefficiency effects are half-normal distribution;

2) $H_{02}: \gamma = \delta_0 = \cdots \delta_{11} = 0$, the null hypothesis specifies that the inefficiency effects are not present;

3) $H_{03}: \gamma = 0$, the null hypothesis specifies that the inefficiency effects are not stochastic; and

4) $H_{04}: \delta_1 = \cdots \delta_{11} = 0$, the null hypothesis specifies that the coefficients of the variables in the model for the inefficiency effects are zero.

Since the model is estimated using maximum likelihood, these null hypotheses can be tested using the general likelihood-ratio statistic, λ, given by

$$\lambda = -2[L(H_0) - L(H_1)] \quad (8)$$

where $L(H_0)$ and $L(H_1)$ present the value of the likelihood function under the null (H_0) and alternative (H_1), respectively. The critical values for each of these tests are derived from Kodde & Palm (1986), as they are adjusted Chi-square (χ_J^2) values to take into account the mixed nature of the likelihood ratio test (Coelli & Battese, 1996), where *J* is the number of restrictions under H_0 .

5.4 Results and Discussion

5.4.1 Parameter Estimates

Table 5.2 Parameter estimates of stochastic production frontier and technical inefficiency models

Variables	Parameter	Coefficient	SD
Stochastic production frontier			
Constant	β_0	2.53***	0.96
Log(land)	β_1	-0.45**	0.22
Log (seed)	β_2	0.35***	0.05
Log (fertilizer)	β_3	0.21***	0.04
Log (chemical)	β_4	-0.03	0.04
Log (labor)	β_5	0.87***	0.20
Log (other)	β_6	5.48E-06	0.01
Technical inefficiency model			
Constant	δ_0	0.37*	0.20
Extension services	δ_1	-0.04	0.11
CCPO	δ_2	0.02	0.11
Reading printed material	δ_3	0.23	0.16
Reading information	δ_4	-0.32*	0.19
Listening to the radio	δ_5	-0.39	0.27
Listening information	δ_6	0.39	0.26
Watching television	δ_7	-0.29*	0.16
Watching information	δ_8	-0.18	0.11
Cell phone can access internet	δ_9	-2.82	3.43
Visited a good agricultural model	δ_{10}	0.09	0.14
Agricultural group membership	δ_{11}	0.05	0.12
Variance parameters			
Sigma squared	σ^2	0.21***	0.05
Gama	γ	0.64***	0.12
Log-Likelihood		-137.701	

Note*:* ***, **, and * => Significance at the 1%, 5%, and 10% levels, respectively.

The maximum likelihood estimates (MLE) of the parameters of the stochastic frontier production function and the inefficiency model are estimated simultaneously and reported in Table 5.2. The signs of the coefficients of the stochastic frontier are

as expected, except the negative of land for cultivation and chemical variables. The negative sign of land for cultivation, which is significant at 5% level, may be due to the fact that most cultivated land is fragmented and located in the highland. Thus, the more cultivated land is, the lower is productivity efficiency. Hung et al. (2007) indicated that land fragmentation is very common in the north of Vietnam. In addition, they found that land fragmentation increased family labor use and other expenses and had negative influence on crop productivity (Hung et al., 2007). This also explains our results when the coefficients of seed, fertilizer, and labor are positive and highly significant at the 1% level. The insignificance of the coefficients of chemicals and other expenses indicate that they are not important factors and rarely used by farmers. Chemical prices are quite high and famers know that chemicals are very harmful. Farmers use mostly human power; transportation is mostly by human and animal and lower levels of technology are applied. Thus, other expenses are very small and do not effect crop productivity.

5.4.2 Hypothesis Testing

Generalized likelihood tests are conducted to test the null hypothesis that the technical inefficiency effects are absent or that they have simpler normal distribution. The results are shown in Table 5.3.

The first null hypothesis (H_{01}) that the inefficiency effects are half-normal distribution is rejected at the 10% level of significance, indicating that our assumption of truncated-normal distribution is adequate. The second null hypothesis (H_{02}), which specifies that the inefficiency effects are absent from the model, is rejected. The third null hypothesis (H_{03}), which specifies that the inefficiency effects are not stochastic, is strongly rejected at the 1% level. Thus, it can be said that the inefficiency effects are both stochastic and present. The γ- parameter associated with the variance in the stochastic frontier is 0.64 and significant at the 1% level. This can explained as 64% of the variation of gross income from maize and rice being due to technical inefficiency. The last null hypothesis (H_{04}), in which the coefficients of the variables

in the model for the inefficiency effects are zero or have no effect, is rejected. This suggests that even the individual effects of 1 or more of 11 explanatory variables of the inefficiencies of production may not be statically significant but, in general, the joint effects of all variables are significant.

Table 5.3 Results of hypothesis tests

Null hypothesis	Test statistic	d.f.	Critical value (χ^2)	Decision
$H_{01}: \mu = 0$	2.126	1	1.642	Reject H_0
$H_{02}: \gamma = \delta_0 = \cdots \delta_{11} = 0$	21.598	13	19.216	Reject H_0
$H_{03}: \gamma = 0$	25.448	1	6.635	Reject H_0
$H_{04}: \delta_1 = \cdots \delta_{11} = 0$	18.932	11	16.67	Reject H_0

Sources: Own survey, 2014.

5.4.3 Technical Efficiency Estimates

The distribution of technical efficiency (TE) is shown in Figure 5.1. We can see that most crop farms have TE of higher than 0.7 but no farm is fully technically efficient. The mean TE of crop farmers is estimated to be 0.751 with the range from 0.332 to 0.967. This indicates that farmers could improve TE by 24.9% with a given set of inputs and technology at that time. This mean value is smaller than the finding of Khai & Yabe (2011) and Bac et al. (2013). However, Khai & Yabe (2011) estimated TE for rice production of farmers in all Vietnam using The Vietnam Household Living Standard Survey 2005-2006 and Bac et al. (2013) estimated TE for two rice seasons in the northern highland of Vietnam while our study calculates crop production, including rice and maize throughout the year.

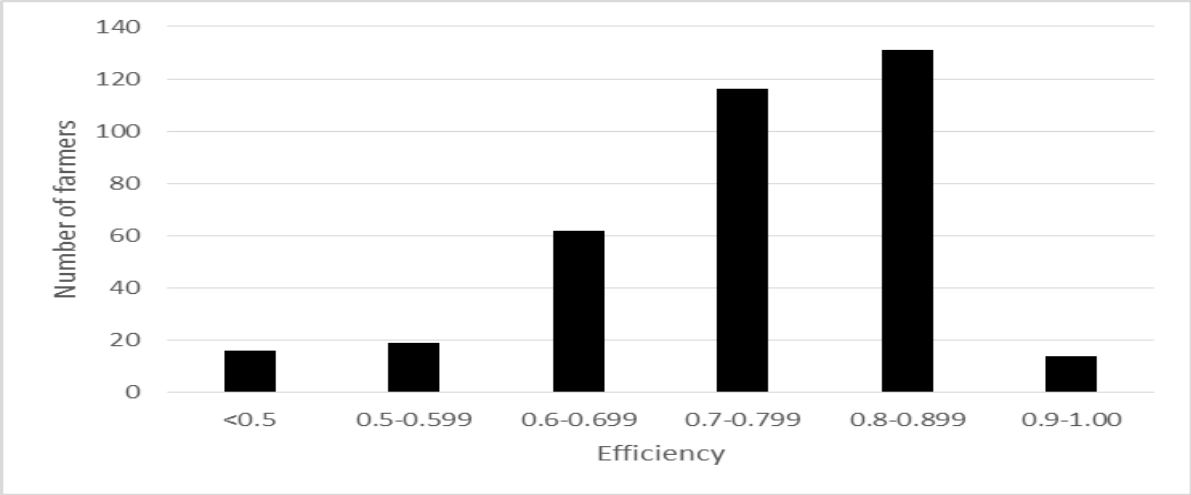

Figure 5.1 Distribution of technical efficiency

5.4.4 Factors Influencing Technical Inefficiency

The most interesting finding of this study is the determination of information technology sources that affect the technical inefficiency of crop farmers. The estimation of an inefficiency model was performed simultaneously with the stochastic frontier model and the results are also presented in Table5.2. The results show that the estimated coefficients of reading agricultural information through printed material and frequent watching of television are negatively significant with technical inefficiency. In other words, they had positive relationships with TE of crop farms. This indicates the importance of information from printed materials and television for improving farmers' perceptions, knowledge, and increasing crop efficiency.

Agricultural extension services in Vietnam are run by the Ministry of Agriculture and Rural Development. These services extend from the government to villages. They are expected to have a significantly negative impact on decreasing technical inefficiency, but the results indicate that they do not significantly influence even the negative sign with technical inefficiency. This is inconsistent with the finding of Linh et al. (2015). They found that extension services were positively

significant with the TE of maize crops but not rice crops. However, this research uses the sum of both rice and maize crops.

The Commune Cultural Post Office (CCPO) is an important and significant program of the Vietnamese government to support information and improve knowledge for citizens, especially in difficult and remote areas. Another study used it to evaluate the economic returns to farmers of participating in the CCPO (Linh et al., 2014). The results indicated that despite its many investments so far, the CCPO has many disadvantages and it does not affect the economic return of farmers (Linh et al., 2014). This is confirmed by our result that the CCPO is not statically significant on TE.

Even the coefficient of frequent reading of printed materials by farmers was not significant, although the agricultural information that farmers read is negatively significant with technical inefficiency. This proves the importance of the information that influences TE. Printed materials can be read by own buying, borrowing, or going to the CCPO. However, the extent of reading printed materials was found to be far less in the study area. These printed materials are quite out of date and are not sufficient. This is in line with the results of Boz & Akbay (2005), who studied factors influencing the adoption of maize in Turkey.

Radio and television are extensively used in the study area, but the main purpose of utilizing these mass media is for news and entertainment, and the programs on television or radio lack agricultural information. Out of 9,071 communes in the whole country, there were 7,380 communes with loudspeaker systems linked to villages in 2011 (GSO, 2012b). This system is built to spread information and knowledge for residents. Thus, the number of radios that farmers owned in the research area is 0.06%. However, the loudspeaker system was used mostly twice per day (morning and evening), and each time was for only around 30 minutes. In addition, the information is used to spread government policy and is not related entirely to agriculture and farm life. The results show that 91.1% of households in the study area have their own television and some families have more than one television. In this area, the television program is transmitted using analog signals. Most

television programs are for entertainment and a few programs or channels are for farmers, like VTV1, VTV2, and VTV5. Most respondent stated that television programs did not supply sufficient agricultural information, and this may explain why the coefficient of agricultural information watching is not statistically significant.

When cell-phones are used widely in Vietnam, the numbers of people who used fixed phones decreases gradually. In the study area, 99% farmers have cell-phones but all of them stated that they use it only to communicate with each other for social life and not for agriculture. Now a day, the power of computers and the internet for information transmission and daily life is known widely. However, in the study area, no respondents used or owned computers, although some accessed the internet through their cell-phones. However, smart-phones, which can access the internet, are priced highly. Farmers do not have experience in and are not trained to use the internet. The two carriers that have good networks for remote areas are Viettel and Vinaphone. However, 3G is expensive and its speed is slow. The survey results indicate that 1% of respondents can use the internet though their cell-phones but do so for entertainment and not for agricultural purposes.

A good way for farmers to obtain information and improve farm efficiency is to visit a good farm model. Of the 358 respondents, only 16% had visited good agricultural models and all of them stated that this was very helpful; in addition, 298 farmers stated they wanted to visit good agricultural models for free at least once. While there are some agricultural groups to help farmers with agricultural activities, such as farmers' groups, women's groups, credit groups, and veteran groups, they do not perform as expected. According to the field survey, 275 households (77%) are members of groups but 264 (96%) said their group was ineffective and should improve to become more appropriate to farmers' lives. This explains why membership of a farm group does not necessarily help farmers.

5.5 Conclusion and Recommendations

The purpose of this research was to estimate technical efficiency (TE) levels and identify the information factors that influence the technical inefficiency of crop farmers in the northwest highland of Vietnam. We chose 358 respondents randomly based on a multi-stage procedure. The stochastic frontier production function and the inefficiency model were estimated simultaneously using maximum likelihood estimates (MLE). Several tests were undertaken to test the null hypothesis that technical inefficiency effects are absent or that they have simpler normal distribution. The results show that there is significant room for technical inefficiency and no farm is fully technically efficient. Because of land fragmentation and highland location, labor, seed, and fertilizer are the most important factors for enhancing TE of these crop farms.

This study found some interesting results with regard to information sources that have impacted on technical inefficiency. Agricultural information from printed materials and frequent watching of television were two negatively significant factors for technical inefficiency. This indicates that if farmers read more agricultural information from printed materials and watched television related to social life at appropriate times, the TE of crop farms would increase. Some factors were found to be statistically insignificant but as they are important information sources, we need to find good reasons and explanations.

Based on this research finding, some implications are suggested. First, management of annual crop production and cultivation methods for farmers needs to continue. Second, improving co-operation in cultivation, crop diversity, and optimal land use would optimize farm production. Third, the effectiveness of the Commune Cultural Post Office (CCPO), extension services, and group support should be checked and strengthened. Fourth, the quantity and quality of printed materials for farmers through the CCPO, extension service system, farm group system, or local

government should be increased. Fifth, the number of programs and appropriate information for farmers through radio and television should be increased; there should be a focus on teaching and spreading information about agricultural activities, such as livestock, cultivation, and fishing. Sixth, training programs should be developed and extended for farmers in remote area to improve their experience and knowledge to access and use computers and the internet. Lastly, there should be more funds available for farmers to visit good agricultural models to help them develop agricultural information and business networks.

CHAPTER 6: EVALUATE THE IMPACT OF COMMUNE CULTURAL POST OFFICES PROGRAM TO ECONOMIC RETURN INDICATOR

6.1 Introduction

After the political and economic reforms (Doi Moi) launched in 1986, Vietnam's society and politics have gradually progressed towards greater openness and tolerance for civil participation. The Viet Nam government has a strategy to make the country a more modern, industrialized society by 2020. Although the Gross National Income (GNI) per capita for Viet Nam rose from 590$ in 2004 to 1.730$ in 2013, poverty in the country is still widespread and intense (World Bank, 2015a). Vietnam's economic development and social and political stability are heavily dependent on agriculture. Nearly 70% of the population live in the rural areas, 50% of the labor force is agricultural and agriculture accounts for nearly 75% of the total land in the year 2011 (GSO, 2012b).

Recently, the information and culture network has been promptly upgraded, supporting the enhancement of the people's spiritual life. The communication systems in rural areas have been improved to better serve the needs of business and management activities in all sectors and in rural households. The number of households with a phone has increased from 5.3% in 2001 to 86.6% in 2011. The proportion of communes with a local loudspeaker system linked to the villages is 81.4% in 2011 (56.8% in 2006). The proportion of communes in rural areas with private Internet service points is developing very fast, from 32.5% in 2006 to 53.7% in 2011. The system of the CCPO continues to develop providing destinations for people to read papers, make phone calls, access internet, receive postal packages and meet and engage in cultural activities. By the year 2011, there were 7467 CCPOs in a total of 9071 communes in the whole country (GSO, 2012b). This suggests the importance of the CCPOs in the social life of Vietnamese, especially in rural household life.

In this study, we apply the endogenous switching regression approach to the farm-level data for the first time. This method accounts for selection bias and

quantifies the economic outcome indicators for discussion group membership by controlling both the observed and unobserved factors that affect participant decisions and income per capita of household. Many researchers have used the endogenous switching regression method to evaluate the impact of social programs in both group adoption and non-adoption on different economic indicators such as Alene and Manyong (2006); Läpple, Hennessy, and Newman (2013); (Fuglie & Bosch, 1995). In all cases, selection bias and the endogeneity of technology adoption was accounted for.

The CCPO is an important program in Viet Nam. There have been many meetings, and conferences have discussed and evaluated the impact of the CCPO on rural social life. However, to our knowledge, there is no study that uses the econometric approach to estimate the implications of the CCPO and that, based on the results, suggests policy to enhance or cut off the program. Therefore, this study provides an additional literature review for policy makers or those who are interested in the topic. This chapter aims to (a) identify the factors that influence the probability of participation in the CCPO; (b) to estimate factors affecting the economic outcome indicators as to whether farmers participate in the CCPO program; and (c) to quantify the benefit of the decision to participate for both groups.

6.2 Background of CCPO

Started in 1998, the CCPO is a large program of the Ministry of Information and Communications (MIC) of the Socialist Republic of Viet Nam, which includes business and social service activities. Basically, the CCPO is a combined model that provides postal and basic telecommunications services (including Internet access). It supplies information and free books and magazines for people in rural areas, especially in difficult communes. Its duty is to contribute to the development of the social and economic aspects of Vietnamese life, allowing people to acquire knowledge and understand the policies of the government. The average land area granted per point is 185 m^2. However, after 16 years of establishing and developing the program, some advantages and many disadvantages have become apparent.

The national conference of the CCPO held by the Ministry of Information and Communications on 8th January, 2011 concluded that the CCPO is a familiar destination for farmers where they are able to read newspapers, send and receive letters, make phone calls, and access the internet for a low price. Therefore, it has helped to develop the rural economy, increase people's expectations in life and improve the conditions for people to have access to information technology, knowledge, and the policies of the party and the laws of the government. Nevertheless, after 13 years and the division of the Vietnam Posts and Telecommunication Group (VNPT) into the VNPT and VNPost (Viet Nam Post), the development of the rural economy, mobile phones, the internet, and postal services as well as the decrease in CCPO infrastructure, the volume of books and magazines, and the CCPO staff salaries, have made the program unsuccessful and in supportable (Viet Thang, 2012). According to the VNPost statistics, total income in quarter II, 2009 is 32.5 billion VND (1.823 million USD), averaging 1.347 million VND (75 USD) per CCPO per month, and the CCPO of the Hoang Van Thu ward (located in the Ha Noi capital) is only 5.000 VND per month (Minh Quyen, 2009). The number of CCPO decreased by 3.18% from 2006 to 2011 (GSO, 2012b). The number of staff and visitors has also fallen over time.

Despite inefficient operation, the CCPO still maintains a very important policy in developing the social-economic life, reducing the gap between rural and urban and supporting the availability of information technology for farmers. Therefore, the Minister of the Ministry of Information and Communications called for a review of all CCPOs; the objectives were to maintain points in remote areas; to diversify and integrate services to maintain not only the social objectives but also the economic objectives; and to develop a comprehensive system of radio, television and telecommunications services, including broadband internet (Viet Thang, 2012). Hence, this article contributes to the literature by investigating the economic impact of participation in the CCPO using an endogenous regression model.

6.3 Methodology

The important issue in the evaluation of any social program is how to account for endogeneity and sample selection bias problems. Because of the hampering effect caused by the fact that the before and after activities of the farm are not observed, researchers usually have to change their approach to a comparison of the adopter and non-adopter (Fulie K.O, 1995). A suitable estimation method accounts for both endogeneity and sample selection bias, and participants and non-participants are not directly comparable; the endogenous switching regression model allows complete interaction between the participation and non-participation inputs in the income function (Alene & Manyong, 2006; Maddala, 1983). The self-selection bias corrected estimate of the impact of the program was addressed by using the comparison between expected outcome and the actual case (Läpple et al., 2013).

The literature suggests numerous econometric techniques in analyzing the impact of technology adoption on agricultural productivity and income. Yorobe & Smale (2012) estimated the impacts of Bt maize on smallholder income using two methods of instrumental variables estimation. The results indicated that the placement bias was not examined, while selection and endogeneity was examined (Yorobe & Smale, 2012). However, this method generates residuals that are heteroskedastic, and the result cannot be used to obtain the consistent standard errors without potentially cumbersome adjustments (Lokshin & Sajaia, 2004). An additional method that is commonly used in the quasi-experimental approach is propensity score matching (Dehejia & Wahba, 2002). However, this method does not account for unobserved variables. It is only used if the assumption is that selection is on the observable characteristics only (Heckman, 1998)

The endogenous switching regression model uses a probit model in the first stage to determine the relationship between participation in the CCPO program and a number of household, farm, and wealth characteristics. In the second stage, separate regression equations are used to model the household income per capita indicator on a specified criterion function for both groups conditional on selection.

Theoretically, the participation in the CCPO program is a dichotomous choice, for which the farmer decides to participate in discussion groups when there is a

positive difference in the expected utility received between participation (D_1^*) and non-participation (D_0^*). Nevertheless, the participation in discussion groups (D) is observed, while the expected utility is not observed. Thus, using the underlying latent variable model, the participation decision is a probit model that can be expressed as:

$$D^* = \alpha Z + u \quad (1)$$

$$D = 1 \; if \; D_1^* > D_0^*$$

$$D = 0 \; if \; D_0^* \geq D_1^*$$

where Z is a vector of explanatory variables, α is a vector of parameters to be estimated, and u is a vector representing a normally distributed error term with mean zero and variance σ_u^2. The error term includes measurement error and factors known by the farmer but not observed by the researcher.

It assumes that the choice of the farmer to participate in the CCPO program affects household welfare, such as household income per capita. In the endogenous switching regression model, separate outcome equations are specified for participants and non-participants.

$$Y_1 = \beta_1 X_1 + v_1 \quad (2)$$

$$Y_0 = \beta_0 X_0 + v_0 \quad (3)$$

Here, Y_1 is a dependent variable representing household income per capita under the participation in the CCPO, and Y_0 represents household income per capita under the non-participating CCPO program. β is a parameter to be estimated, X represents the explanatory variables, and v is an error term. That is, only Y_1 and Y_0 are observed for any given household, depending on the criterion function (1). This indicates that ordinary least squares regression (OLS) estimates of β_j will be biased if some unobserved farmer characteristics, such as farmer ability and skills, influence both the decision to participate and household income per capita.

Assume that the error term u, v_1 and v_0 have a trivariate normal distribution with mean vector zero and covariance matrix:

$$Cov(u, v_1, v_0) = \begin{bmatrix} \sigma_u^2 & \sigma_{u0} & \sigma_{u1} \\ \sigma_{u0} & \sigma_0^2 & . \\ \sigma_{u1} & . & \sigma_1^2 \end{bmatrix} \quad (4)$$

where σ_u^2 is a variance of error term u in the selection equation; σ_0^2 is the variance of v_0; σ_1^2 is the variance of v_1; and σ_{u0} and σ_{u1} are the covariance between u and v_0 and v_1, respectively. The covariance σ_{01} is not defined, as Y_{0i} and Y_{1i} are never observed simultaneously. It can be assumed that $\sigma_u^2 = 1$, because α is estimable only up to the scalar factor. Under these assumptions, in the presence of selection bias, the expected values of the truncated error term $(v_1|D = 1)$ and $(v_0|D = 0)$ are:

$$E(v_1|D = 1) = E(v_1|u > -\alpha Z) = \sigma_{uv_1} \frac{\varphi(\alpha Z)}{\emptyset(\alpha Z)} = \sigma_{uv_1}\lambda_1, \quad (5)$$

$$E(v_0|D = 0) = E(v_0|u \leq -\alpha Z) = \sigma_{uv_0} \frac{-\varphi(\alpha Z)}{1-\emptyset(\alpha Z)} = \sigma_{uv_0}\lambda_0, \quad (6)$$

where $\emptyset$ and φ are the cumulative distribution functions and the probability density of the standard normal distribution, respectively. The ratio of φ and $\emptyset$ evaluated at αZ, using the probit estimation in equation (1), is the inverse Mills ratio [λ_1 and λ_0 in equations (5) and (6), respectively]. The terms λ_1 and λ_0 can be used as missing variables in equations (5) and (6). Substituting λ_1 and λ_0, the household income per capita equation can be written as (Maddala, 1983):

$$Y_1 = \beta_1 X_1 + \sigma_{uv_1}\lambda_1 + u_1 \ \ if\ D = 1 \quad (7)$$

$$Y_0 = \beta_0 X_1 + \sigma_{uv_0}\lambda_0 + u_0 \ \ if\ D = 0 \quad (8)$$

where u_1 and u_0 have zero conditional means and are heteroscedastic (Maddala, 1983). In reality, if we use OLS to estimate equation (2) and (3), it will lead the parameters β_j to be biased and inconsistent, as the term $\sigma_{uv_j}\lambda_j$ is omitted. Recently, full information maximum likelihood (FIML), an efficient method to fit the endogenous switching regression model, has been widely used (Abdulai & Huffman, 2014; Lokshin & Sajaia, 2004). The FIML method is the simultaneous estimation of the selection and outcome equations to yield consistent standard errors. However, the FIML method has an identification problem in that it requires at least one variable in selection equation (1) that is not included in outcome equations (7) and (8). This means that we must choose at least one variable as a selection instrument that directly affects the decision to participate in the CCPO program but not the household income per capita.

We used the *movestay* command in STATA (Lokshin & Sajaia, 2004) to obtain the parameters of the endogenous switching regression model.

The signs of the estimated covariance $\rho_1(\sigma_{uv_1})$ and $\rho_2(\sigma_{uv_0})$ not only provide statistical evidence of sample selection bias but also have economic interpretations. The statistically significant estimates of ρ_1 and ρ_2 suggest that there is sample selection. It proves that using the endogenous switching regression model in this case is suitable. Moreover, if $\rho_1 > 0$ and $\rho_2 < 0$, this indicates that both groups have positive selection. This indicates that farmers who participate in the CCPO program have above-average returns from the participation and that those who choose not to participate have above-average returns from non-participation, while the opposite case is not to have the definition of the covariance terms. The same positive sign ($\rho_1 > 0$ and $\rho_2 > 0$) implies a positive selection for a group who choose participation and a negative selection for a group who choose non-participation. In this case, it suggests that participants have above-average returns whether they participate or not but that they are better off participating. If $\rho_1 < 0$ and $\rho_2 < 0$, this mirrors the explanation in the previous case (Läpple et al., 2013; Maddala, 1983)

The greater interest in this study is the effect of participation in the CCPO program on household income per capita. This can be examined by comparing the expected household income per capita of the participating members with the conditional expectations case that non-participant members will be participating in that program. They can be derived as follows (Maddala, 1983):

$$E(Y_1|D = 1) = \beta_1 X_1 + \sigma_{uv_1}\lambda_1. \quad (9)$$

$$E(Y_0|D = 1) = \beta_0 X_1 + \sigma_{uv_0}\lambda_1. \quad (10)$$

The interest parameter is the difference between expected outcome with and without participation in the CCPO program. This estimate is referred to as the average treatment effect on the treated (ATT) and is calculated as follows (Abdulai & Huffman, 2014; Heckman, J.J., Tobias, J.L., Vytlacil, 2001; Läpple et al., 2013):

$$ATT = E(Y_1|D = 1) - E(Y_0|D = 1) = X_1(\beta_1 - \beta_0) + \lambda_1(\sigma_{uv_1} - \sigma_{uv_0}) \quad (11)$$

6.4 Data and Empirical Models

6.4.1 Data

The data used for this study originates from a survey conducted in six communes located in three districts of Son La Province. The survey was carried out from February to March 2014. A multi-stage sampling procedure was used to select the respondents. In the first stage, three districts, namely, Mai Son, Moc Chau and Phu Yen, were purposively selected based on three categories of altitude, under 1000 m, from 1000 to 2000 m and higher than 2000 m, respectively. In the second stage, we randomly selected two communes in each district. These communes have a large area, but the density is very low. According to GSO (2014), while the density of the whole country is 268 people/km^2, the figure for Son La Province is 80 people/km^2 and approximately 40 people/km^2 per commune. Because one commune has at least one CCPO, we chose one village in which the CCPO is centrally located in and another village that has a CCPO located a great distance from it in the third stage. In the last stage, a total of 336 farmers was then randomly selected from the list of farm families in the 12 villages. Before conducting the research, a pre-test interview was administered to ensure the adequacy and reliability of the tools used to collect the relevant information.

The survey collected valuable information on several factors including household composition and characteristics, farm characteristics, crop production and cropping systems, household membership in different rural institutions and other information on the households.

The literature suggests that many factors influence adoption of or participation in social program. In this study, we included various proxies for household characteristics such as gender, age, schooling of household head, number of children in family, and off-farm labor; proxies for farm characteristics such as total farm size, livestock of farm, electricity cost, and total cost for cultivation; proxies for household assets such as motorcycles, televisions, VCD players, milling machines, and tractors;

and proxies for institutional factors such as access to credit, access to extension services, membership in a rural group, distance from household to nearest market, the source of electricity for farm use, distance to the nearest CCPO, and the answer of respondent for the material of CCPO question (Alene & Manyong, 2006; Amare, Asfaw, & Shiferaw, 2012; Asfaw, Shiferaw, Simtowe, & Lipper, 2012).

Table 6.1 represents the definition and the mean values used in this study; 103 (30.7%) respondents in the survey answered that there is at least one family member that usually visit the CCPO, which is the dependent variable for the selection equation. The dependent variable for the outcome equation is defined as the total household income per capita. Previous studies usually used household income for household welfare indicators. However, per capita income is better because it automatically controls for household size, giving a measure of individual welfare, notwithstanding that this measure does not account for the economic scale in larger households (Paweenawat & McNown, 2014). The mean family size is a decreasing function of family income per capita that mirrors household income. It can be very defective if the policy decisions based on household income rather than household per capita income (G. Datta& J. Meerman, 1977). In this survey area, the mean household income per capita is 20 million Viet Nam Dong per year (≈944$/year).

Three regional dummy variables account for the three districts that took the survey. Mai Son is located near the Son La Province capital, where the transportation and economy are more developed. This region has also had good natural conditions to develop cultivation and livestock. In this study, to avoid the dummy variable trap and perfect multicollinearity, we chose this region for the basic group, which is used for comparison with other regions.

Table 6.1 Definitions and summary statistic of the variables used

Variables	Definition	Mean	Std.Dev
Income_hh	Total household per capita(1000vnd/person)	20473.81	13132.56
Participants	Takes the value 1 if farmer answered usually visit CCPO; 0= otherwise	0.31	0.46
D_gender	Gender of household head , 1= male, 0= female	0.89	0.31
Age	Age of household head (years)	44.93	11.51
Edu	Schooling of household head (years)	6.86	3.18
Child	Number of children in household (Person)	1.36	0.89
D_off_farm	Off-farm labor, 1= have off-farm labor, 0=otherwise	0.12	0.33
Farm_size	Total farm size (ha)	1.93	1.45
D_livestock	Livestock of household, 1= have livestock, 0= otherwise	0.49	0.50
Cost_elect	Electric cost per month (1000vnd)	106.46	96.32
Total _cost	Total cost of household for cultivation (1000vnd)	20090.5	12381.82
D_motor	Motorcycle in household, 1= have motorcycle, 0= otherwise	0.95	0.22
D_TV	Television in household, 1= have TV, 0= otherwise	0.93	0.25
D_vcd	VCD player in household, 1= have VCD, 0= otherwise	0.67	0.47
D-milling	Milling machine in household, 1= have milling, 0=otherwise	0.22	0.41
D_tractor	Tractor for household, 1= have tractor, 0-otherwise	0.27	0.44
D_credit	Takes the value 1 if farmer has accessed to credit; 0= not	0.65	0.48
D_extens	Takes the value 1 if the farmers obtained the information from extension services; 0= none	0.21	0.41
D_member	Takes the value 1 if the farmer has group membership; 0= not a member	0.79	0.41
Dis_market	Distance from household to nearest market (m)	8592.26	6769.3
D_ source_elect	Source of electricity of household, 1= use national source, 0= otherwise	0.92	0.28
Dis_post	Distance from household to nearest CCPO (m)	3095.29	3880.35
D_material	Materials in the CCPO, which take the value 1 if farmer answered sufficient material; 0- Need to add more	0.13	0.34
D_pyen	Takes the value 1 if farmer lives in Phu Yen district, 0= otherwise	0.32	0.46
D_mchau	Takes the value 1 if farmer lives in Moc Chau district, 0= otherwise	0.34	0.47
D_Mson	Takes the value 1 if farmer lives in Mai Son district, 0= otherwise	0.34	0.48

Source: Own survey, 2014

Table 6.2 Comparison of the characteristics of participation and non- participation

Variables	Non-participation (N= 233)	Participation (N=103)	Difference
Income_hh	19926.01	21712.98	t = -1.0504
D_gender	0.89	0.88	χ^2 = 0.24
Age	45.52	43.62	t = 1.47
Edu	6.64	7.36	t = -1.87*
Child	1.39	1.30	t = 0.90
D_off_farm	0.08	0.20	χ^2 = -2.68***
Farm_size	1.81	2.19	t = -1.94*
D_livestock	0.45	0.55	t = -1.67*
Cost_elect	102.90	114.52	t = -0.89
Total _cost	19657.59	21069.81	t = -0.88
D_motor	0.95	0.95	χ^2 = -0.11
D_TV	0.94	0.92	χ^2 = 0.43
D_vcd	0.66	0.69	χ^2 = -0.51
D-milling	0.19	0.28	χ^2 = -1.80*
D_tractor	0.26	0.30	χ^2 = -0.81
D_credit	0.61	0.73	χ^2 = -2.18**
D_extens	0.21	0.19	χ^2 = 0.43
D_member	0.77	0.827	χ^2 = -1.22
Dis_market	8309.01	9233.01	t = -1.17
D_ source_elect	0.93	0.89	χ^2 = 0.97
Dis_post	3658.79	1820.39	t = 5.08***
D_material	0.03	0.37	χ^2 = -7.02***
D_pyen	0.30	0.34	χ^2 = -0.63
D_mchau	0.36	0.28	χ^2 = 1.52
D_mson	0.33	0.38	χ^2 = -0.84

Note: ***, **,* indicate significance at 1%, 5% and 10% respectively.

Source: Own survey, 2014

It can be observed from the table that the majority of household heads of family are male (89%), who is typically the main source of labor and decision making for the family. Household heads in the sample have an average age of 45 years and graduated at grade 6, with the total number of grades being 12. We believe that household heads with more education will more likely visit the CCPO. The average farm size is 1.96 ha; however, if farmers have a large area, it means that they own large areas of forest mountain land where it is very difficult to produce. In these areas,

many households can use a national electricity source, but 8% still do not have electricity for family activities. Distance to the CCPO and the material in the CCPO are believed to affect the frequency of visits of the farmer. When farmers say that the material at the CCPO is sufficient, it means that they are more interested in participating in the CCPO, while the distance to the CCPO is an inhibiting factor for visits to the CCPO.

Table 6.2 outlines the differences in the characteristics of participation and non-participation. The results indicate some notable differences between the two groups, which are confirmed using statistical tests (a *t*-test for the continuous variables and a chi-square test for the category variables). No significant difference is observable in the age, gender of household head and the number of children. The level of education of the household head and the off-farm labor of the household is significantly higher for those who participate in the CCPO program. This suggests that education and off-farm labor may be correlated with the decision to participate. In term of proxies for farm characteristics, there is significant difference between two groups in farm size and livestock activities variables. All of the proxies for household assets are not significantly different except the milling variable. This indicates that the participating group had more milling than the non-participating groups, and they are more likely to visit the CCPO to obtain more information for better milling.

CCPO participation is also distinct in terms of the access to credit, as indicated by the percentage of farmers who borrow from the government banks, local banks or private credit funds. Participants might have more information and are also more likely to access credit to invest in their farm or off-farm activities to increase income and also household welfare. Moreover, both the distance to the CCPO and the quantity and quality of materials in the CCPO are significantly higher for participants. The results also indicate that no significant difference is observed in the access to extension services, membership in a community or farmer group, the distance to the nearest market and the source of electricity used.

6.4.2 Empirical Model

The literature indicates that the model is identified only if the second-stage regression does not include at least one explanatory variable in the first-stage probit regression (Maddala, 1983). In this research, the selection probit function included four identification restrictions such as use of Television and VCD in the household, distance to the nearest CCPO and the status of the material in the CCPO based on the respondent answers. It is hypothesized that these variables are influenced through the decision to participate decision. Our hypothesis is based on the fact that the majority of families use TV and VCD for entertainment so that it might not affect the income of the household directly.

The probit model of participation in the CCPO was specified and estimated as:

Participation = *f*
d_gender,age,edu,child,d_off_farm,d_livestock,farm_size,cost_elect,total_cost,d_tractor,d_milling,d_motor,d_source_elect,dis_market,d_credit,d_extens,d_member,d_pyen,d_mchau,d_tv,d_vcd,dis_post,d_material)

The separate household incomes per capita function for participation and non-participation, jointly with the probit selection equation,were specified as:

$Ln(Y_j)$= *f*(d_gender, age, edu, child, d_off_farm, d_livestock, farm_size, cost_elect, total_cost, d_tractor, d_milling, d_motor, d_source_elect, dis_market, d_credit, d_extens, d_member, d_pyen, d_mchau)

where: Y, the dependent variable, is household incomes per capita; j= 1 if household participation in the CCPO and 0 for non-participation.

The main hypothesis of this study is that participation in the CCPO has significantly different effects on total household income per capita.

6.5 Results and Discussion

The estimates of the probit model of the discussion group participation decision are presented in Table 6.3. This result is based on estimation from the endogenous switching regression model.

Table 6.3 Discussion group participation

Variables	Coefficient	Std. err	z-statistic
d_gender	-0.1112	0.2905	-0.38
Age	-0.0125	0.0090	-1.39
Edu	0.0609*	0.0316	1.93
Child	-0.1812	0.1138	-1.59
d_off_farm	0.1005	0.2841	0.35
farm_size	0.0656	0.0841	0.78
d_livestock	0.3677*	0.1967	1.87
cost_elect	0.0008	0.0009	0.93
total_cost	7.96e-06	9.43e-06	0.84
d_motor	-0.2144	0.4177	-0.51
d_tv	0.2222	0.5594	0.40
d_vcd	-0.0016	0.2098	-0.01
d_milling	-0.1614	0.2336	-0.69
d_tractor	0.0034	0.2649	0.01
d_credit	0.2239	0.1983	1.13
d_extens	-0.2924	0.2247	-1.30
d_member	0.2664	0.2361	1.13
d_source_elect	-2.5326***	0.5985	-4.23
dis_market	-0.00002	0.00002	-0.81
dis_post	-0.0002***	0.00004	-4.24
d_material	2.2952***	0.3707	6.19
d_pyen	-0.9934***	0.3237	-3.07
d_mchau	-0.8511***	0.2999	-2.84
Constant	2.3051	0.8684	2.65

Note: ***, **, * indicate significance at 1%, 5% and 10% levels, respectively.

Source: Own survey, 2014.

The results indicate that the coefficient of education of household head is positive and significant, suggesting that the more educated household heads are more likely to participate in the CCPO. This finding is similar with the notion that

education is an important factor in helping farmers to adopt new innovations and to make technology decisions (Huffman, 2001). The variable livestock of farm is also positive and statistically significant, indicating that farms with livestock are more likely to visit the CCPO to read and have access to information that is related to livestock. This result confirms the importance of livestock activities in the farm's economic well-being.

The source of electricity has a negative effect on the frequency of visits to the CCPO. If the household has a national electric source, the best source, they are more likely to use it for farming as well as at home for the Television and VCD to access information or entertainment rather than to take the time to go to the CCPO.

In terms of regional effects, the results indicate that farmers who are living in the Phu Yen district and Moc Chau district have a lower probability of participating in discussion groups, other things being equal, compared with farmers in the Mai Son district. The Phu Yen and Moc Chau districts have higher altitudes, difficulties in transportation, more ethnic groups, and a lower level of education; therefore, farmers are less likely to participate in the CCPO. The coefficients of household head age, number of children in family, farm size and total farm cost do not have a significant effect on participation. The non-significance of age is similar to the finding in Läpple et al.(2013), which implies that the age of the household head does not affect the decision to participate.

In terms of the four identified restriction variables, distance to nearest CCPO has a positive significance, although material in the CCPO has a negative and statistically significant effect on the CCPO participation decision. These results prove the hypotheses, indicating that households that are far from the CCPO have less desire to visit, while if the material at the CCPO decreases, the number of visitors will also decrease. However, owning a Television and VCD do not have significant effects, suggesting that farmers are likely to use the TV and VCD for entertainment purposes rather than obtaining agricultural knowledge from information sources. If they have a TV and VCD, they might stay at home rather than go to the CCPO.

The FIML estimates of the endogenous switching regression model of household income per capita are reported in Table 6.4. The last two rows of the table present the estimates of the correlation coefficient between the random errors in the system equations. The correlation coefficients ρ_1 and ρ_2 are both positive (case 2) but are significant only for the correlation between the participant equation and total household income per capita equation. Because ρ_1 is positive and there is significant difference from zero, this indicates that the observed and unobserved factors influence the participation decision to frequently visit the CCPO, which confirms that an endogenous switching regression model is the appropriate model. That ρ_1 and ρ_2 are positive implies that participation in the CCPO had a significant impact on total household income per capita and that the participants would have obtained above-average income from participation regardless of participation, but they are better off choosing to participate; however non-participants have below-average income in either case, and they are better off participating.

Overall, the results indicate that age of household head, off-farm labor, livestock of family, electric cost and total cultivation cost are statistically significant in both groups. The negatively significant age of household head suggests that the older the household head, the less family member income is because the household head is the main source of labor that controls and earns profit for the family. The positive significance of off-farm labor and livestock activities indicates that these are important factors that can increase household income in addition to the cultivation activities, implying that the more off-farm labor and number of livestock, the more income the household is able to obtain. The increase in the electricity and total cultivation cost will make the income of the farm also increase, in fact indicating successful investment. This indicates that households invested in modern technologies for cultivating such as pumps, mills, tractors, hybrid seed, etc.

Table 6.4 Endogenous switching regression results for impact of participation on household income per capita

Variables	Participants		Non-participants	
	Coefficient	Std. err	Coefficient	Std. err
d_gender	0.0936	0.1262	-0.0105	0.0968
age	-0.0089**	0.0043	-0.0102***	0.0028
edu	0.0315**	0.0136	-0.0042	0.0105
child	-0.0407	0.0515	-0.1329***	0.0359
d_off_farm	0.2929**	0.1171	0.4051***	0.1127
farm_size	0.0387	0.2805	0.1874 ***	0.0296
d_livestock	0.2634***	0.0924	0.1304**	0.0640
cost_elect	0.0007*	0.0004	0.0013***	0.0004
total_cost	0.00002***	3.73e-06	0.00002***	3.18e-06
d_motor	0.1319	0.1922	-0.2013	0.1357
d_milling	0.2089**	0.1014	-0.0386	0.0819
d_tractor	0.1344	0.1093	0.0793	0.0858
d_credit	0.0589	0.0909	-0.0327	0.0626
d_extens	0.2914***	0.1022	0.0209	0.0710
d_member	0.0011	0.1104	-0.0330	0.0733
d_source_elect	-0.1113	0.1676	0.4889***	0.1490
dis_market	0.00003***	9.19e-06	-5.77e-06	5.81e-06
d_pyen	-0.2213*	0.1171	0.0252	0.0932
d_mchau	0.1171***	0.1525	-0.0144	0.0870
Constant	8.3971	0.3426	9.3267	0.2794
σ_1	0.3874***	0.0305		
σ_2			0.4271***	0.0202
ρ_1	0.4231**	0.1878		
ρ_2			0.0995	0.2901

Note: ***, **,* Significant at 1%, 5% and 10%, respectively.

Source: Own survey, 2014.

While education of the household head, ownership of milling of household, the access to extension services and the distance to nearest market have a significant and positive effect for participants, they have no significant effect for non-participants on the household income per capita. The education of the household head and the access to extension services raised participant income per capita by 3.15% and 29.14%, respectively, but they were not significant for non-participants. This is inconsistent with the Abdulai and Huffman (2014) findings and could be because the experience of the farmer is a more important factor than education or information from extension agents in terms of the non-participating members. The significance of

distance to nearest market variable of the participant group is similar with the Tipraqsa and Schreinemachers (2009) results, implying that households farther away from the market experience more market integration and may have greater income. Farmers in the participant group with higher education and more information from extension services realize that with the same price as selling agricultural products to the middleman, they are better off not wasting time, and costs to go to the market.

The number of children is statistically significant but has a negative effect on the non-participant group only, suggesting that the non-participant group with lower income per capita will experience difficulty if the number of children increases but this will not happen with the participant group. Therefore, the Vietnamese government introduced the family planning program, suggesting that families must have one or two children to lessen the difficulties for the family and also for social reasons (Ministers Council of Viet Nam, 1988). The results indicate that electric source is positive and significant with the non-participant group but has no significant effect for the participant group, indicating that perhaps non-participant members depended more on electricity in farm activities. The effects of owning motor, tractor, access to credit and membership in rural or farmer group is not significant for either group.

Finally, region variables have different significant effects on income per capita for the participant group but no significance for the non-participant group. While farmers in the Phu Yen district achieve significantly lower income, farmers in the Moc Chau district achieve significantly higher income per capita than the farmers in the Mai Son district. This difference is based partly on the natural and transport conditions in these regions. The Moc Chau district is a wide and beautiful plateau in the northern uplands with many national roads, green hills, and cool weather all year round. This district has a variety of agricultural products such as maize, lush tea, cow milk and is also an attractive place for tourists from all over the world. Therefore, this region can achieve more income per capita than other regions in the Son La Province and also in the northwest area.

As mentioned above, the greater interest in this study is to determine the effect of participation group membership by comparing the expected income per capita for participants $E(Y_1|D = 1)$ with the conditional expectation that non-participants will participate in the CCPO program $E(Y_0|D = 1) = \beta_0$. This different effect is calculated following equation (11) and is presented in Table 6.5.

Table 6.5 Estimated Average Treated for Treatment (ATT) of the impact of participation on household income per capita

Items	ATT	Treated	Control	Difference	Std. Err
Per capita household income	$E(Y_1-Y_0)\|D=1$	9.771	9.717	0.054	0.066

Source: Own survey, 2014.

The overall estimates indicate that participation in the CCPO program has positive but non-significant effects on total household income per capita. The result shows that farmers who participated in the CCPO program have approximately 5.4% higher total household income. As an unexpected contrast with the main hypothesis that participation in the CCPO has statistically significant different effects, this result suggests that the difference is not really meaningful for non-participating members.

6.6 Conclusion

Based on a random sample of 336 farm households in Son La Province, Viet Nam, this chapter examines the factors that influence the probability of participation in the CCPO program, as well as the impact of participation on household income per capita. Comparisons of average per capita income between participation and non-participation in the CCPO program revealed no significant difference. We used the endogenous switching regression approach to control for unobserved factors and to capture the differential impact of participation on participants and non-participants in

the CCPO program. Related to the diffusion, it is important to note that sample selection bias would result if the outcome equation (income per capita) was used to estimate without considering the participant decision.

The results indicate a positive and significant influence of household head education and owning livestock on participation, as well as an impact on household income per capita. These results suggest that knowledge is a very important factor to increase the social-economic life of farmers, especially with mountainous areas and ethnic groups, thus supporting the decisions of the Vietnamese Government regarding the goals of the national program of education and training for the period 2012-2015. The goals of this program are maintaining universal education, helping children in difficulty areas and encouraging ethnic groups to go to school (Viet Nam Government, 2012). The life of farmers is very difficult if they only work on cultivation; therefore, they are better off adding to agricultural activities by raising livestock, engaging eco-tourism, and varying crops and products.

The negative significance of distance to the CCPO and the positive significance of material variables are consistent with our hypotheses, suggesting that if households are far from the CCPO and the material at the CCPO is not sufficient, farmers will not want to go to the CCPO. Hence, the question is how to improve the quantity and quality of CCPOs to attract famers? This question has been the concern of many meetings and conferences of the Vietnamese government, the local government and the VNPT. Recently, there have been an increasing number of books, magazines, and papers, and computers have been equipped with the internet. These policies are believed to increase the availability of information and technology for farmers, especially in difficult regions, in an adequate and timely fashion.

Our estimates suggest positive self-selection in both the participant and non-participant groups, and significance only for the participant equation. This implies that farmers in both groups are better off participating in the CCPO as it could lead to a higher per capita income. However, the different effects between the expected outcome for participants and what non-participants would have achieved had they participated is not meaningful and not sufficiently high. This is based on the reality

that 47.4% of the participant respondents visit the CCPO to read papers and magazines, while the rest go to make phone calls, receive post parcels or join meetings. In addition, 87% of respondents answered that the material at the CCPO is not updated and not sufficient for their desires and requirements.

CHAPTER 7: IDENTIFY FACTORS INFLUENCING ON VARIATION USED OF INFORMATION SOURCES

7.1 Introduction

An information source is an originator of facts or knowledge that can inform individuals. There are many types of information sources because there are numerous types of questions. Consequently, information sources can be primary, secondary, or tertiary sources, and they can be classified as observations, people, documents, etc.

Information sources are very important in agricultural activities because agriculture strongly relates to socio-economic development, food and securities issues, increasing yields, improving product quality, and reducing costs. As such, information is necessary to both the inputs and outputs of agricultural activities (Kaaya, 1999). Farmers can better decide and realize greater profits when they have good data, analysis of marketing strategies, and detailed information on costs (Milovanović, 2014).

Numerous studies have investigated the use and adoption of information and communication technologies (ICT) in agriculture (Foltz & Makus, 1996; Ford & Babb, 1989; Gloy et al., 2000; Kaaya, 1999; Milovanović, 2014; Ortmann et al., 1993; Patrick et al., 1993). Some of these studies cover mostly rural and remote areas (Adamides, Stylianou, Kosmas, & Apostolopoulos, 2013; Madden & Coble-Neal, 2003; Michailidis, Partalidou, Nastis, Papadaki-Klavdianou, & Charatsari, 2011; Ramirez, 2001). However, most of them are conducted in developed countries, such as the US, Australia, and Canada or in countries such as Cyprus, Tanzania, Serbia, and Greece. Furthermore, they focus on analyzing factors that influence the adoption and use of personal computers and the Internet by farmers unfamiliar with farming in Vietnam, particularly in rural and remote areas.

This study employs data from surveys conducted in Son La Province in northwest Vietnam. Son La is considered the largest cultivated area and biggest

producer of maize in Vietnam. However, it is distant from the capital and more rural than any other region in Vietnam (Minot et al., 2006)

The Son La geography consists mostly of hills and mountains, the transportation system is poorly developed, and poverty is relatively high (58.7%), compared to the 2012 national average of 17.2% (GSO, 2012a). The inhabitants are mostly members of ethnic groups that tend to have a low educational attainment and that lack access to modern technologies (T. T. Linh et al., 2015c).

As previously mentioned, information sources have an important role in all socio-economic activities, including agriculture, and are recognized as a tools to improve efficiency and effectiveness in agricultural production. However, studies have not been conducted place in Vietnam on the importance of information sources in agriculture or the determinants of information source use by Vietnamese farmers. Consequently, this study identifies the factors that explain variation among farmers in their use of information sources. The results are helpful for farmers, policy makers, extension agents, and researchers. The following section briefly explains the study's methodology. Subsequently, the data and variables are described, the results are presented and discussed. Finally, the implications and conclusions are drawn.

7.2 Methodology

Farmers at the study site were asked whether and how often they use information sources. A respondent's decision to use an information source was provided by an indicator, where 1 would mean "yes" and 0, "no". Since the indicator is the outcome variable, a binary regression model was used to examine the farms' and farmers' characteristics that influenced their use of information sources (Adamides et al., 2013; Gloy & Akridge, 2000; Hoag, Ascough, & Frasier, 1999).

The binary model is written as follows:

$$D = I(\beta X_i + \varepsilon \geq 0) \quad (1)$$

where D is an observed binary variable, the dependent variable to be explained, $\beta_{i\prime s}$ are the parameters to be estimated, X_i is the vector of the independent variable, and ε

is the unexplained random component (error term). This type of specification is known as a threshold crossing model, and special cases of the threshold crossing model are logit and probit models, with logistic or normal error term, respectively.

However, binary choice models often deal with estimation problems when one or more regressors are endogenous or mis-measured. For example, if treatment is not randomly assigned and outcomes are binary, the endogeneity of treatment effects will be occurred. Literature suggests certain approaches to solve this problem, such as the linear probability model (LPM) with instruments, maximum likelihood estimation (MLE), control function based estimation, and special regressor methods. Each of these estimators have advantages and disadvantages, but of these drawbacks are rarely acknowledged or recognized. However, all of this estimators requires a set of strong instrument variables (Lewbel, Dong, & Yang, 2012). For our study, we chose MLE using the ivprobit model (probit model with continuous endogenous regressors) to solve the endogeneity problem if it appears after trying to compare with other methods.

Assume that some elements of X_i in the binary model (1) are endogenous or mismeasured, and they may correlate with the error term (ε). Let X_i^e and X_i^0 denote the vectors of endogenous and exogenous regressors. Let Z be a vector of instrument variables. Generally, Z can include all of the elements of X_i^0. Let G(X_i^e,Z,ϵ) = 0 show the relationship between X_i^e and Z, where G is a function containing many elements of the vector X_i^e and ϵ is a vector of errors.

Hence, the threshold model is

$$D = I(\beta^e X_i^e + \beta^0 X_i^0 + \varepsilon \geq 0) \quad (2)$$

$$X^e = G(X_i^e, Z, \epsilon)$$

This model can be implemented using MLE. Maximum likelihood allows endogenous regressors in X^e only to be continuous only, and can not be used with discrete endogenous regressors (Lewbel et al., 2012; StataCorp, 2013).

7.3 Data and Variables

The data were derived from face-to-face interviews with 360 randomly sampled respondents from 12 villages in three districts in Son La province, Vietnam. The survey was conducted between February and March 2014, and collected valuable information on various aspects of respondents' lives, such as household composition and characteristics, farm characteristics, crop production and cropping systems, information sources used, etc.

7.3.1 Information Sources Used by the Respondents

Previous studies suggest that farmers use many information sources (Ford & Babb, 1989; Füsun Tatlıdil, Boz, and Tatlidil, 2008; Gloy et al., 2000; Ortmann et al., 1993; Patrick et al., 1993). However, this survey received limited responses on the information sources use because of the methodology and status of the respondents. Following Gloy et al. (2000) and Füsun Tatlıdil, Boz, and Tatlidil, (2008), and considering the reality of information sources farmers use, and the difficulty in collecting data, we define all dependent variables. Five information sources (i.e., print materials, radio, television, mobile phones, and the Internet) were categorized as media sources and three others (i.e., extension services, visited an agricultural model, and agricultural group membership) were categorized as personal sources.

Table 7.1 summarizes the eight measures of information source use in the study. Most of these dependent variables were collected by asking the frequency of accessing information sources. Printed materials include books, magazines, news, brochures, which can be read by buying, borrowing or going to the Commune Cultural Post Office (CCPO). Most household in the study area owns television, some families having more than one. The number of radios that famers own is small because most of the commune has a linked loudspeaker system. However, famers use

these mass media for entertainment, and news, and programs on television or radio lack agricultural information. Around 99% of respondents have their own mobile phone but they only use them to communicate with each other for social activities.

Table 7.1. Descriptive statistics of the dependent variables on the use of information sources

Variable	Description of variables	Proportion	Standard deviation
Media sources			
Print material	Reads print materials several times a month	0.247	0.432
Radio	Listens to the radio at least 5 times per week	0.125	0.331
Television	Watches television at least 5 times per week	0.900	0.300
Mobile phone	Has at least one cell (mobile) telephone	0.986	0.117
Internet access	Mobile phone can access the Internet	0.011	0.105
Personal sources			
Extension services	Receives information from extension services	0.214	0.411
Visited agricultural model	Has visited an advanced agricultural model	0.158	0.366
Membership	Is a member of an agricultural group	0.767	0.424

Note: All variables are coded 1= yes and 0 = no
Source: Own survey, 2014.

Although most of the respondents have mobile phones, only around 1% of them have Internet connectivity. This lack of access is because smart-phones and Internet services that use 3G technologies are too expensive for the respondents. Moreover, the Internet signal in the studied area is limited. Only around 24.7% and 12.5% of respondents read print materials several times per month or listened to the

radio at least five times per week, respectively. On the other hand, around 90% of the respondents reported that they watched television at least five times per week. There are various types of agricultural information that farmers can get from printed materials, television, radio, the Internet, such as weather, agricultural technologies, price of agricultural input and output, advanced or new agricultural models, policies, etc. Farmers can use mobile phones to directly connect with friends, local government staffs, and extension agents to ask or access the internet to get information related to their agricultural activities.

Regarding personal sources, about 76.7% of the sample are members of at least one agricultural group, but only a small proportion had visited an advanced agricultural model (15.8%). There are some agricultural groups whose purpose is to help and advice famers in farm activities such as women, farmer, and credit groups. Advanced agricultural models are any kind of agricultural operations on a farm, such as breeding, cultivation, forestry, or fishery activities, which use little input but can get high profits and higher income. In this respect, the extension agent may be a good information source, because only 21.4% of the respondents reported that they could receive support from extension services. In Son La province and the entire Vietnam, the current extension activities are focused on setting up models and transferring new advanced techniques to farmers, such as organizing training for farmers by forum in the fields, face-to-face, via TV, radio, brochures, VCD, and websites, and creating opportunities for some advanced farmers to utilize advanced agricultural technologies. Additionally, the extension system takes the responsibility to transfer new policies and market information. There are many actors participating in agricultural extension activities, such as government extension system, universities, research institutions, enterprises, NGOs, and volunteer extension organizations (associations, local common interest groups). However, the government extension plays as the key role, and top down or the supply-driven extesion approach is the main orperation method (Bo, 2012). Please see Linh, Nanseki, & Chomei (2015b) for details on these information sources.

7.3.2 Determinants of Information Source Use

Previous studies have identified numerous factors expected to influence the adoption of certain information sources. Table 7.2 describes the variables in this study, expected to influence use of the eight information sources. Household heads are most likely to be males with a mean age of around 45 years and between six and seven years of education. The average number of household members is five, although the largest household has 13 people. The largest farm size is 12.6 ha, with a mean size of 1.84 ha. However, the geography of the study site dictates that large area farms have hilly and sloping lands. The mean gross household income was VND 91 million per year (USD 4,323 as of March 2014). The household incomes at the top of the distribution were obtained from off-farm economic activities. Vietnamese labor laws indicate that the minimum working age is 15 and the statutory retirement age 60 for men and 55 for women. Therefore, in our research, we calculate the number of labor force in that range. Table 7.2 shows that the average laborers in each household are around three with a minimum of one and a maximum of 11.

The three districts, based on the three types of altitudes in the study area, are indicated in the analysis as dummy variables. Phu Yen is at the highest attitude, 2000 m, where transportation and engaging the economy are difficult and less developed. This region serves as the reference group in the statistical analysis and is, thus, used for comparison to the other regions in the logistic regression models.

In our study, we assumed that household income is an endogenous regressor, and the number of household members of working age and livestock activity were used as the instrument variables.

Considering multicollinearity, we also examined the correlation matrix, and the results show that the multicollinearity does not exist among all variables.

Table 7.2. Descriptive statistics of the variables influencing information sources

Variable	Description of variables	Mean (SD)	Min	Max
Gender	Gender of household head, 1= male, 0 = female	0.872 (0.334)	0	1
Age	Age of household head (years)	44.781 (11.662)	21	87
Education	Education attainment of household head (years)	6.669 (3.270)	0	12
Household size	Number of household members (persons)	4.856 (1.594)	2	13
Farm size	Total farm size (ha)	1.836 (1.444)	0.09	12.6
Income	Total household income (VND millions) per year	91.328 (62.749)	2.55	355
Off-farm	Takes 1 if the farm has off-farm job, 0 = otherwise	0.139 (0.346)	0	1
Labor	Number of household members in working age (person)	2.942 (1.251)	1	11
livestock	Takes 1 if the farm has livestock activities, 0 = otherwise	0.461 (0.499)	0	1
Moc Chau	Takes the value 1 if farmer lives in Moc Chau district, 0 = otherwise	0.342 (0.475)	0	1
Mai Son	Takes the value 1 if farmer lives in Mai Son district, 0 = otherwise	0.328 (0.470)	0	1
Phu Yen	Takes the value 1 if farmer lives in Phu Yen district, 0 = otherwise	0.330 (0.471)	0	1

Source: Own survey, 2014

7.4 Results and Discussion

Before conducting the ivprobit model to analyze the factors that may influence each type of information source, we check the strength of instrument variables, which shows the partial and sufficient correlation between endogenous and instruments

variables and its strength. This was archived by regressing the endogenous regressor (household income) with all exogenous and instrument variables and then calculating the F-statistic on the estimators of the instrument variables. The results indicate an F-statistic of 11.09 ($p < 0.001$). Hence, our instrument variables are strong enough and ivprobit will lead to consistent estimators (Staiger& Stock, 1997; StataCorp, 2013).

The output of the ivprobit model gives us the Wald test of exogeneity for instrument variables. If the test is significant, we reject the null hypothesis that assumes no endogeneity. Otherwise, we cannot reject the null hypothesis because of insufficient sample information, a regular probit model being more appropriate (Wooldridge, 2013, 2010). Literature suggests that the point estimates are likely to have smaller standard errors and those from ivprobit are still consistent (StataCorp, 2013). The Wald test is explained along with its theory in Wooldridge (2010). For the MLE with a single endogenous variable, the Wald test simply tests the correlation between the reduced-form equation for the endogenous variable and the error terms in the structural equation. However, in the two-step estimator, in the second stage, the residuals from the first-stage OLS regression are used as regressors. Therefore, the Wald test, in this case, is a test of significance on those residuals` coefficient. Additionally, they will be presented directly in the output of the ivprobit regression model, using Stata. In our results, the Wald tests of the exogeneity of the instruments are reported in the penultimate row of Tables 7.3 and 7.4 for media information sources and personal information sources, respectively. The results show that all information source models are deal with endogeneity and ivprobit regression should be used, except for models for mobile phone, internet, and extension services, which use regular probit regression. To verify our result, we also perform the procedure suggested by Wooldridge (2010) to check the endogeneity problem. The results shown the same statistical report if using "Wald test of exogeneity" indicator in Stata.

The first step of the models which used ivprobit regression method is reported in Tables 7.3 and 7.4. It shows the relationship between endogenous and instrument variables. For the MLE, these parameters are estimated jointly with the parameters of the probit equation. The results report that livestock is positively significant with total

household income in all models while labor is only significant in the model of membership. This indicates that livestock is a very important source to increase income, and labor is not as important. In fact, labor is easy to solve in the rural area of Vietnam because if households do not have enough labor, they can ask their relatives and neighbors to help or exchange labor force in busy times such as tilling, transplanting or harvesting.

7.4.1 Media Sources

Table 7.3 reports the results of each parameter for each of the media source models. The penultimate reports that mobile phone and internet models do not have an endogeneity problem, so we applied probit regression for these two models. Additionally, while running the mobile phone model, the off-farm variable is omitted because of perfect multicollinearity. The literature implies that dropping variables and perfectly predicted observations will not affect the result of remaining coefficients and increase the stability of regression (StataCorp, 2013). The last row of the table shows the results of the likelihood ratio test of the combined significance of all the parameter estimates. All of the models were statistically significant at the 1% or 5% level. This indicates that the variables used are appropriate.

Household income was positively significant with all media information sources except mobile phones, which indicates that farmers with higher income are likely to get more information about social, agriculture, economics, etc. through all types of media sources. Households with high income can easily buy many types of printed materials, radio, television, and expensive mobile phone, which can access the internet easily. Additionally, many of the households with relatively high incomes owned more than one television, and household members spent their evenings watching television.

Table 7.3. Results of the media information sources

	Probit with continuous endogenous regressor (ivprobit)						Probit	
Variables	Print material		Radio		Television		Mobile	Internet
	1st stage	*2nd stage*	*1st stage*	*2nd stage*	*1st stage*	*2nd stage*		
Gender	10.725	-0.125	10.326	0.080	10.605	-0.142	0.245	-1.553*
	(7.747)	(0.226)	(7.759)	(0.263)	(7.748)	(0.245)	(0.591)	(0.825)
Age	0.084	-0.003	0.127	0.002	0.096	-0.001	-0.024	-0.036
	(0.237)	(0.007)	(0.238)	(0.007)	(0.237)	(0.007)	(0.017)	(0.036)
Education	1.586*	0.044	1.553*	0.005	1.574*	-0.009	0.166**	0.162
	(0.829)	(0.029)	(0.831)	(0.027)	(0.829)	(0.028)	(0.081)	(0.140)
Household size	4.490**	-0.091	5.597***	-0.112**	4.836**	-0.165***	0.268	0.063
	(2.093)	(0.056)	(2.104)	(0.055)	(2.064)	(0.055)	(0.252)	(0.246)
Farm size	21.408***	-0.207*	21.579***	-0.239**	21.461***	-0.391***	-0.016	-0.349
	(1.873)	(0.104)	(1.186)	(0.104)	(1.872)	(0.079)	(0.259)	(0.317)
Income	-	0.013***	-	0.014***	-	0.022***	0.009	0.009*
		(0.004)		(0.003)		(0.002)	(0.008)	(0.005)
Off-farm	15.278**	0.316	15.767**	-0.063	15.423**	0.266	-	1.168
	(7.441)	(0.242)	(7.454)	(0.228)	(7.441)	(0.384)		(0.741)
Moc Chau	6.274	-0.264	5.657	-0.292	6.040	0.554*	0.291	- 0.670
	(6.464)	(0.181)	(6.629)	(0.193)	(6.457)	(0.300)	(0.690)	(0.871)
Mai Son	21.349***	-0.099	20.967***	-0.098	21.236***	0.282	-0.607	0.136
	(6.284)	(0.198)	(6.295)	(0.207)	(6.285)	(0.291)	(0.578)	(0.744)
Labor	3.719	-	1.269	-	2.941	-	-	-
	(2.455)		(2.443)		(2.309)			
Livestock	22.753***	-	23.614***	-	23.227***	-	-	-
	(5.058)		(5.059)		(4.993)			
Constant	-26.159*	-0.918*	-26.119*	-1.217**	-26.157*	0.454	0.879	-2.202
	(13.906)	(-0.491)	(13.926)	(0.597)	(13.909)	(0.412)	(1.224)	(1.957)
Log likelihood	-	-2079.519	-	-2020.018	-	-1975.032	-17.672	-11.847
Wald test of exogeneity (/athrho = 0)	-	**	-	***	-	***	-	-
Model significance[a]	-	***	-	***	-	***	**	**

Note: a) Likelihood ratio test result for combined significance of parameters.
***, **, and * => Significance at the 1%, 5%, and 10% levels, respectively.
Number in parentheses is standard deviation.
Number of observation: 360

Source: Own survey, 2014

Farm size was negatively significant regarding the use of printed material, radio, and television as a sources of information at the10%, 5%, and 1% levels, respectively. This means that respondents with larger farms were less likely to read printed materials, listen to radio, and watch television. Farmers who have large farms are too busy with farm activities so they do not waste time or need to get information from media sources.

Household size was negatively significant related to the frequent listening of radio and watching television, suggesting that households with more members are less likely to listen to radio and watch television programs. In fact, in rural and remote areas in Vietnam, households with many family members are having low income because most members are dependent, such as children or elderly. Therefore, households with more member will take more time to work and have less time to listen to radio or watch television.

Education has a statistically significant influence on ownership of mobile phones, but is not significant with the use of printed materials, suggesting that farmers with more education might be more interested in using mobile phones rather than reading books, magazine, leaflets, etc. This finding is not in line with Gloy et al. (2000), which found that education influences with crop/livestock- specific farm publication in the United States.

Farm location mattered to the use of television as a source of information. The coefficient of Moc Chau was positively related to the use of television ($p < 0.1$), meaning that respondents who live in the Moc Chau district were watching television more often than were respondents in Mai Son and Phu Yen districts. This area has a relatively good television signal, and some respondents can watch television programs using a digital rather than analog signal. Moreover, this area has relatively stable sources of electricity, a relatively flatter topography, and higher incomes than Mai Son and Phu Yen districts. Therefore, farmers might need less time to do farm activities and have more time to relax. In addition, The Moc Chau district has better environmental and transportation conditions conductive to information exchange. Moreover, this district is an attractive tourist destination throughout the year because of its wide and beautiful plateaus in the northern highlands, where there are many national roads, green hills, and cool weather.

In the sample, none of respondents had computers, so the Internet was necessarily accessed via smartphones. Female household heads were more likely than their male counterparts to access the Internet, even through smartphones. However, the price of smartphones with Internet access capability and Internet provider fees were relatively high, and the Internet speed slow. Moreover, those respondents who did use the Internet via smartphones did so for entertainment and not agricultural purposes. This finding is contrary to Adamides et al. (2013), who found that Internet use of farmers in Cyprus was not influenced by the gender of the household head, but by the age and educational level of the household head, farm income, and agricultural activity. In large US farms, age and educational attainment are the most influential factors of Internet use (Gloy & Akridge, 2000)

7.4.2 Personal Sources

The results of the analyses of the three personal information sources are shown in Table 7.4. The Wald test of exogeneity of instrument variables is not significant only in the case of the model of extension services, where regular probit regression was applied. The likelihood ratio test results of the combined significance of the independent variables of two of the sources were statistically significant, the exception being the analysis of extension services as an information source. Extension services are objective information sources that reach out to villages, originating from the government, research institutions, universities, companies, NGOs, and volunteers, all extension activities being controlled and managed by the government extension service with top-down, supply driven operation methods. Extension is regulated and implemented by the Ministry of Agriculture and Rural Development. BO (2012) found some limitation of current extension services, such as most of extension workers being specialized only in livestock and crops, lack of professional extension workers, the extension methods have not satisfied the demand for agricultural activities, the extension programs and policies are only followed government extension system and extension without payment, and improper monitoring and evaluation systems. Therefore, this does not depend on farmers or farm characteristics.

Similarly to media information sources, household income is the most important factor influencing the use of personal information sources. The coefficients are positively influenced by visiting advanced agricultural models and agricultural memberships as information sources at $p < 0.01$. Households with higher incomes may be more likely to have visited an advanced agricultural model and become members of agricultural groups because they may want to get more experience, extend their business networks, exchange ideas, or find more suitable (or profitable) agricultural activities.

Farm size is strongly and negatively related to having visited advanced agricultural model and becoming member of an agricultural group at the 1% level. In the studies area, if farms are larger, they have larger sloping land where they could only cultivate by monocropping. In fact, maize is the main crop and main income from cultivation activities (T. T. Linh, Nanseki, & Chomei, 2015a). Additionally, maize crops require much more labor and are time consuming because farmers mainly use human power for cultivating it. Therefore, households with larger farm size spend more time on their farm activities all year round. As such, they are not interested or have time to visit other advanced agricultural models or join agricultural groups.

The coefficients of off-farm jobs were negatively related to extension services and membership in the agricultural group at the 10% and 1% levels, respectively. Respondents with off-farm jobs are less likely to receive information from agricultural extension services because they may want to get more information related to their job and social activities. Additionally, respondents with off-farm jobs may not want to join nearby agricultural groups because, despite the variety of farmer groups, women's groups, credit groups, and veterans' groups, these groups might not have provided the expected benefits or were not effective (T. T. Linh et al., 2015a, 2015b).

Table 7.4. Results of the personal information sources

Variables	Probit	Probit with continuous endogenous regressor (ivprobit)			
	Extension services	Visited advanced agricultural model		Membership	
		1st stage	*2nd stage*	*1st stage*	*2nd stage*
Gender	-0.311	10.542	-0.312	10.827	-0.255
	(0.227)	(7.748)	(0.205)	(7.745)	(0.201)
Age	-0.010	0.103	0.003	0.073	0.005
	(0.007)	(0.236)	(0.007)	(0.236)	(0.006)
Education	-0.005	1.569*	-0.005	1.599*	0.001
	(0.025)	(0.829)	(0.024)	(0.829)	(0.023)
Household size	0.052	5.011**	-0.082	4.192**	-0.117**
	(0.055)	(2.021)	(0.052)	(2.016)	(0.047)
Farm size	-0.119	21.488***	-0.365***	21.362***	-0.297***
	(0.081)	(1.871)	(0.069)	(1.871)	(0.081)
Income	0.002	-	0.0176***	-	0.017***
	(0.001)		(0.002)		(0.002)
Off-farm	-0.442*	15.499**	0.083	15.159**	-0.633***
	(0.258)	(7.441)	(0.215)	(7.437)	(0.189)
Moc Chau	-0.007	5.936	-0.052	6.511	0.144
	(0.201)	(6.453)	(0.175)	(6.452)	(0.182)
Mai Son	0.157	21.177***	-0.336*	21.441***	-0.252
	(0.191)	(6.285)	(0.178)	(6.282)	(0.166)
Labor	-	2.551	-	4.399**	-
		(2.106)		(2.099)	
Livestock	-	23.392***	-	22.171***	-
		(4.981)		(4.993)	
Constant	-0.266	-26.152*	-0.916*	-26.152*	0.241
	(0.415)	(13.912)	(0.497)	(13.907)	(0.359)
Log likelihood	-180.599	-	-2035.852	-	-2070.489
Wald test of exogeneity (/athrho = 0)	-	-	***	-	***
Model significance[a]	-	-	***	-	***

Note: a) Likelihood ratio test result for combined significance of parameters.
***, **, and * => Significance at the 1%, 5%, and 10% levels, respectively.
Number in parentheses is standard deviation.
Number of observation: 360

Source: Own survey, 2014

Household size negatively influences agricultural membership as information source at $p < 0.05$. A larger family size was less likely to have joined a group because they need to work harder for income, food, and facilities of their own. Consequently, they could not join or consider joining agricultural groups. Moreover, farmers know that agricultural groups are not effective and might not want to join.

Respondents with farms in the Mai Son district were less likely to have visited an advanced agricultural model than those in Phu Yen or Moc Chau districts. One reason for this finding may be that Mai Son is the district nearest to the provincial city, the center of economics, culture, social, and entertainment of Son La province. Therefore, farmers in this district find it easier to obtain information from other sources and they may have more chances to get off-farm jobs.

7.5 Conclusion

Using household-level data for 360 farm households in three districts of Son La province, Vietnam, this study analyzes the influence of farmer and farm characteristics and factors on the use of eight types of information sources. Each information source has unique benefits to farmers. Certain information sources, such as television, mobile phones, and group memberships, were more popular than others. Others sources, such as the Internet and having visited an advanced agricultural model, were less common among the respondents.

The statistical results of the probit model with continuous endogenous regressor (ivprobit) and regular probit regression analysis show that household income, farm size, household size, educational attainment, and off-farm jobs were the most important influences on whether the respondents use the media and personal information sources. The coefficient of household income was positively significant regarding six information sources, except mobile phone and extension services. This finding implies that households with higher income may be more encouragement, have more time, and be more interested in using information sources to seek knowledge, information, or entertainment. In the studied area, the main income of

households comes from off-farm activities. This is the reason why households with larger farm size have to spend more time on farm activities and could not get higher incomes. Hence, households with larger farms less likely to spend time reading printed materials, listening to radio, watching television programs frequently, and also having visited advanced agricultural model or becoming members of agricultural groups.

The coefficient of household size was negatively significant related to the frequency of listening to the radio, watching television, and being a member of an agricultural group. In the survey area, larger household size means that the number of dependent people is higher, dependence being defined when a person under 15 and over 60. The dependency rate in the studies area is 60%, roughly meaning that one person of working age has to work for one more person. This is the main reason why in rural and remote areas larger families always have many children and low income. Therefore, they have to work harder and are less likely to get information by listening to the radio, watching television, or becoming group members.

Having an off-farm job was negatively significant regarding extension services and group membership. This result suggests that respondents that have off-farm income were less likely to get information from extension agents or to become members of a group because of irrelevancy with off-farm jobs and ineffectiveness of group activities, respectively. The coefficient of education was positively significant regarding mobile phones. This finding implies that knowledge is an important factor to the use of information sources.

These results offer some broad implications. First, off-farm employment for farmers should be provided and encouraged. The respondents in the studies area found it difficult to improve their households' well-being and incomes with agricultural activities alone. Additionally, if dependents have suitable off-farm job, the family can get more income and depend less on working age individuals. Hence, those farms with higher incomes and more off-farm jobs would likely use information sources more often. Second, local government and extension agents should work more effectively to enhance and help farmers diversify crops, by applying new

technologies. Consequently, farmers can get more income from farming activities and are more likely desire to get information through all sources. Third, it is recommended to increase the farmers' education attainment through short training seminars and workshops and offer no-cost education to their school-aged children. This education should not only focus on agricultural knowledge/skills, social activities, and governmental policies, but should train farmers to use information sources, such as the Internet, to their fullest. Fourth, agricultural extension should change the method from one-way and top-down to a two-way and farmer-led, demand-driven method. Moreover, it could socialize the extension system, improve the link between research and extension, and increase the number of professional extension workers. Finally, efforts should be made to close the gap among districts by increasing investments, expanding road infrastructure, and spreading national electricity and wireless towers to farmers in remote areas.

There are other important variables, such as quality of information and experience of using information sources. However, we do not have data on those variables and, as such, they are scope for future research.

CHAPTER 8: CONCLUSION AND RECOMMENDATIONS

The main purpose of this study is to evaluate the effectiveness of cultivation on upland Vietnam. To access this purpose, we firstly tried to identify important factors and analyze their influence on productive efficiencies among farms. We then focus on information sources, one of main important factors, by examining the role of information sources and their impact on farms.

This study is mainly based on primary data derived from field survey in Son La province, Vietnam in 2014. Several econometric methods were used, such as Two Stage Least Square (2SLS), Data Envelope Analysis (DEA), Cobb-Douglass stochastic frontier, Endogenous switching regression model, ivprobit and so on in order to estimate and examine the effectiveness of cultivation on upland Vietnam through some aspects.

8.1 Main Conclusions

The original point of this study is to evaluate the efficiency of cultivation methods on upland focusing on two main crops rice and maize, and try to find the evident of the role of information sources and their impact on farm's. These are the major different between this study and previous studies. The new findings of this study is that all of farms are not fully technical and scale efficient and they are influenced by some social- economic factors. We also found some interesting results regard to information sources that have impacted on technical inefficiency, farm income and its determinants.

The main result is summarized from each chapter as follows: Chapter 2 presents overall northwest upland and its policies that influence on agricultural production system and information sources. This chapter were using secondary data to show the status and conditions of agriculture in northwest upland. It was also included some policies of government that effect to farming system and the usefulness of using information sources. This chapter has revealed that northwest is the poorest region in Vietnam with the highest ethnic, low educated, economic and

environmental diversity. Rice and maize are the most important crops in this region. However, the proportion of maize is increased grammatically and become the top agricultural income sources for farmers because of the increasing of poultry and food industry in Vietnam recently. Although, many policies from national level to provincial governments have generated to develop social-economic for this region, especially for remote area and agricultural sector, poverty is the major problem and this region has not developed as expectation. Many problems in agriculture of northwest upland were issued, for example soil erosion, overused fertilize on sloping land, low applying innovation technologies, poor productivity, low price and constrained market access for rural products, pollution of waterways with sewage, manure effluent and agrochemicals, and poor implementation of the policy. In addition, there is no doubt to deny the important of information to our life activities and also agricultural sector. The information system in northwest region has been upgraded along with the developing of information system in Vietnam and the world. However, the information system in northwest is still backward due to the low educated, traditional custom, perception of farmers, low income, high topography, difficulty in transportation, low technology. This chapter presents some indicators of information sources which are available and popular with people who live in northwest region. The comparison of those proportion shows that the using status of them is still lower comparing with the average use of whole country or other regions. Along with many challenges, northwest region also has many opportunities based on its comparative advantages. The plentiful rainfall and elevated terrain allow northwest farmers to increase production and specialization in a number of high-value crops, tree and livestock products. The indigenous knowledge was provided by the rich ethnic diversity among people who maintain sustainable agricultural practices will be helpful for managing and utilizing the challenging terrain and resources. The diversification of homestead production will increase the possibility of improved dietary diversity and income for farmers.

Chapter 3 studies about the influence of socio-economic factors affecting individual income from maize crops of farm's members using 352 maize farms' data.

Despite the income of household is received from off-farm income, livestock and other crops, this study focused only on income from maize- the main cultivation method not only on this area but also in most of northern uplands of Viet Nam. Unexpected as our hypothesis, the results investigated that education of household head were positively significant, membership of agricultural group were significant but negative. Likewise, credit access and extension service were not significantly effective on individual income of farm's members from maize production. Maize production and education of household head were found significant and positive effectiveness. This implies that except maize production which directly effects on maize income, year in school is the factor that can be influent to increase farm's member income from maize production. On the other hand, results also demonstrated that the age of farm's head, household size and group membership were the factors which can reduce individual income volume from maize production. Being older means that less tending on adopting new technology and different cultivation methods. While maize land is fixed and cannot expand, if number people of household increase, it will make family more difficulties. The results also showed that the extension services are not appropriate and do not reach the demand of farmers. Although government has many policies to develop farm's groups which can support and assist farmers in farm activities, especially in maize cultivation in Northwest area, the results are not similar as expectancy.

Chapter 4 uses a smooth bootstrapping method to analyze the variability of DEA technical efficiency estimates and to correct for the inherent bias in the DEA method. This study uses detailed survey data for 292 farms that cultivate both rice and maize crops in 12 villages in three districts in Son La Province, Vietnam. The study shows that the opportunity for both technical and scale inefficiencies of maize and rice crops is significant. The results indicate that the TE_{VRS} among farmers differs across districts. The bias-corrected point estimate of TE_{VRS} in rice and maize crops is 0.55 and 0.46, respectively. These numbers indicate that input levels could decrease 45% for rice and 54% for maize with the present levels of output. In terms of the scale efficiency score, most rice and maize crops are producing under increasing return to

scale. This score indicates that farm scales are mostly "too small". In the second step, a Tobit regression is used to explain variations in efficiencies among farms. The results indicate that a national electricity source is an important factor to improve the technical efficiency of both rice and maize farms. Large families are likely to be more technically efficient on maize farms. Because maize farms are mostly cultivated through human power, more people will be helpful. Therefore, motors and tractors are insignificant in both efficiencies of both types of farms. An undesirable credit factor is found to have a negative impact on the technical efficiency of maize farms; the distance to the nearest market has a negative effect on the scale efficiency of both rice and maize crops. These factors may come from outdated customs, low education and farmers' life behavior.

The purpose of chapter 5 was to estimate technical efficiency (TE) levels and identify the information factors that influence the technical inefficiency of crop farmers in the northwest highland of Vietnam. We chose 358 respondents randomly based on a multi-stage procedure. The stochastic frontier production function and the inefficiency model were estimated simultaneously using maximum likelihood estimates (MLE). Several tests were undertaken to test the null hypothesis that technical inefficiency effects are absent or that they have simpler normal distribution. The results show that there is significant room for technical inefficiency and no farm is fully technically efficient. Because of land fragmentation and highland location, labor, seed, and fertilizer are the most important factors for enhancing TE of these crop farms. This chapter found some interesting results with regard to information sources that have impacted on technical inefficiency. Agricultural information from printed materials and frequent watching of television were two negatively significant factors for technical inefficiency. This indicates that if farmers read more agricultural information from printed materials and watched television related to social life at appropriate times, the TE of crop farms would increase. Some factors were found to be statistically insignificant but as they are important information sources, we need to find good reasons and explanations.

Chapter 5 has showed that CCPO is an important information source for farmers and need to be checked and strengthened, hence chapter 6 is conducted to examine the factors that influence the probability of participation in the CCPO program, as well as the impact of participation on household income per capita using random sample of 336 farm households in Son La Province, Viet Nam. Comparisons of average per capita income between participation and non-participation in the CCPO program revealed no significant difference. We used the endogenous switching regression approach to control for unobserved factors and to capture the differential impact of participation on participants and non-participants in the CCPO program. Related to the diffusion, it is important to note that sample selection bias would result if the outcome equation (income per capita) was used to estimate without considering the participant decision. The results indicate a positive and significant influence of household head education and owning livestock on participation, as well as an impact on household income per capita. These results suggest that knowledge is a very important factor to increase the social-economic life of farmers, especially with mountainous areas and ethnic groups, thus supporting the decisions of the Vietnamese Government regarding the goals of the national program of education and training for the period 2012-2015. The life of farmers is very difficult if they only work on cultivation; therefore, they are better off adding to agricultural activities by raising livestock, engaging eco-tourism, and varying crops and products.

The negative significance of distance to the CCPO and the positive significance of material variables are consistent with our hypotheses, suggesting that if households are far from the CCPO and the material at the CCPO is not sufficient, farmers will not want to go to the CCPO. Hence, the question is how to improve the quantity and quality of CCPOs to attract famers? This question has been the concern of many meetings and conferences of the Vietnamese government, the local government and the VNPT. Recently, there have been an increasing number of books, magazines, and papers, and computers have been equipped with the internet. These policies are believed to increase the availability of information and technology for farmers, especially in difficult regions, in an adequate and timely fashion. Our

estimates suggest positive self-selection in both the participant and non-participant groups, and significance only for the participant equation. This implies that farmers in both groups are better off participating in the CCPO as it could lead to a higher per capita income. However, the different effects between the expected outcome for participants and what non-participants would have achieved had they participated is not meaningful and not sufficiently high.

Previous chapters have analyzed the information sources that influence technical efficiency of crop farms and factors affected on the probability of participation in the CCPO, one of information sources. Hence, it is a good idea if we can identify factors that may effect on other information sources. Using household-level data of 360 farm households in three districts of Son La province, Vietnam, chapter 7 analyzes the influence of farmer characteristics and farm factors on the use of eight types of information sources. Each information source has unique benefits to some farmers. Some information sources, such as television, mobile phones, and group membership, were more popular than others. Others sources, such as the Internet and having visited an advanced agricultural model, were less common among the respondents. The statistical results of the probit model with continuous endogenous regressor (ivprobit) and regular probit regression analysis show that household income, farm size, household size, educational attainment, and off-farm jobs were the most important influences on whether the respondents use the media and personal information sources. The coefficient of household income was positively significant regarding six information sources, except mobile phone and extension services. This finding implies that households with higher income may be more encouragement, have more time, and be more interested in using information sources to seek knowledge, information, or entertainment. In the studied area, the main income of households comes from off-farm activities. This is the reason why households with larger farm size have to spend more time on farm activities and could not get higher incomes. Hence, households with larger farms less likely to spend time reading printed materials, listening to radio, watching television programs frequently, and also having visited advanced agricultural model or becoming members of

agricultural groups. The coefficient of household size was negatively significant related to the frequency of listening to the radio, watching television, and being a member of an agricultural group. In the survey area, larger household size means that the number of dependent people is higher, dependence being defined when a person under 15 and over 60. The dependency rate in the studies area is 60%, roughly meaning that one person of working age has to work for one more person. This is the main reason why in rural and remote areas larger families always have many children and low income. Therefore, they have to work harder and are less likely to get information by listening to the radio, watching television, or becoming group members. Having an off-farm job was negatively significant regarding extension services and group membership. This result suggests that respondents that have off-farm income were less likely to get information from extension agents or to become members of a group because of irrelevancy with off-farm jobs and ineffectiveness of group activities, respectively. The coefficient of education was positively significant regarding mobile phones. This finding implies that knowledge is an important factor to the use of information sources.

8.2 Recommendations

Based on results of finding some important factors and their influence on individual income from maize, technical and scale efficiency, there are some recommendations to respect government, organizations. More investment on public education is an important role for not only government but also farms in this area. Most household heads are adults, therefore short training programs, workshops, visit the good farms are some suggestion to improve farmers' knowledge. Government and group leaders should more emphasize on finding the way of credit providing, extension services, adjusting customs, and group supporting. In addition, expanding a national electricity source is an important strategy for the government in the near future to increase social welfare. There are also some suggestions for farmers, such as make new models for value chain development, using resources more sustainable,

increasing technology adoption and implement of governmental and provincial policies. This finding also suggests farmers to continue improving the management of annual crop production and cultivation methods for farmers. And, co-operation in cultivation, crop diversity and the optimal use of rice plots are several suggestions for optimal farm production.

From the finding of examine the role of information sources and their impact on farms', some implications are suggested. It should be checked and strengthened the effectiveness of the Commune Cultural Post Office, extension services, and group support. The quantity and quality of printed materials for farmers through the CCPO, extension service system, farm group system, or local government should be increased. The number of programs and appropriate information for farmers through radio and television should be increased; there should be a focus on teaching and spreading information about agricultural activities, such as livestock, cultivation, and fishing. Training programs should be developed and extended for farmers in remote area to improve their experience and knowledge to access and use computers and the internet. And, there should be more funds available for farmers to visit advanced agricultural models to help them develop agricultural information and business networks. It is also very important role for government to improve the quantity and quality of CCPOs to attract famers more.

This finding also recommend that off-farm employment for farmers should be provided and encouraged. The respondents in the studies area found it difficult to improve their households' well-being and incomes with agricultural activities alone. Additionally, if dependents have suitable off-farm job, the family can get more income and depend less on working age individuals. Hence, those farms with higher incomes and more off-farm jobs would likely use information sources more often. Second, local government and extension agents should work more effectively to enhance and help farmers diversify crops, by applying new technologies. Consequently, farmers can get more income from farming activities and are more likely desire to get information through all sources. Third, it is recommended to

increase the farmers' education attainment through short training seminars and workshops and offer no-cost education to their school-aged children. This education should not only focus on agricultural knowledge/skills, social activities, and governmental policies, but should train farmers to use information sources, such as the Internet, to their fullest. Fourth, agricultural extension should change the method from one-way and top-down to a two-way and farmer-led, demand-driven method. Moreover, it could socialize the extension system, improve the link between research and extension, and increase the number of professional extension workers. Finally, efforts should be made to close the gap among districts by increasing investments, expanding road infrastructure, and spreading national electricity and wireless towers to farmers in remote areas.

8.3 Study Limitation and Future Research

Although this dissertation is aimed to evaluate the effectiveness of cultivation on upland, Vietnam by finding important factors and their influencing on productive efficiency, and examining the role of information sources and their impact on farm's, there are also some limitations.

- Northwest of Vietnam includes six provinces but, due to time limitation, this study is mainly taken from the survey in three district of Son La province.

- The primary information was based on farmer's memories because they did not have any record. In addition, even though we visited household several times, the respondent sometimes was not household head, therefore, there was some missing information. The secondary data are always not enough and difficult to collect. This is the common problem with secondary data in Vietnam.

- This study is mainly focus on two main crops, like maize and rice. Other crops, like soybean, yam, and vegetable have not concerned yet.

- Other economic efficiencies have not analyzed, such as price efficiency, allocative efficiency

- In study area, many types of media information sources, like computer, software are not being used. Therefore, they did not able to involve in this research. In addition, the choice models for using information sources were not enough information to analyze.

- Most of researches in this study is the first research in northwest region so it is extremely difficult to find references and make the comparison with our researches.

Therefore, we hope to concern and involve those limitations in future research.

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LIST OF RELATED PRESENTATIONS

Linh, T. T., Nanseki, T., & Chomei, Y. (2014, Sep). Determinants Influencing on Individual Income from Maize in Northwest Vietnam- Paper presented at 14th Study Conference of Farm Management Society of Japan.

Linh, T. T., Nanseki, T., & Chomei, Y. (2016, Jan). Factors affecting information sources by farmers in Vietnam- Presented at International Forum on Global Food and Agricultural Resource Economics, Japan

*: Interviewer should change by himself

Main code:……..
(Write in sequence code: interviewer, district, commune, village

Appendix A. QUESTIONAIRES FOR HOUSEHOLD SURVEY

Interviewer:..... (Code.....). Date: .....

District: …….(Code.....) Commune :…….(Code.....) Village:…… …...…(Code …….) No…….

I. HOUSEHOLD'S (HH) INFORMATION

1**. Household head's name**:..... Gender ☐ (Male: 1; Felmale:0) – Age :… Ethnic: ……(1-Kinh, 2-Thái,3- others:…..)

Education ☐ (1-Illiterate; 2-Primary; 3-Middle; 4-High, 5- Vocational; 6- College/University) Marital status☐ (1=Married, 0=Single)

2. Household's member:

HH size:…… ….persons	Male……Female……	Number of people in working age: ..... person	Labors in off farm job :…..persons
Children..... persons	Children in school: ..... persons	Children joining farm work:..... persons	

3. HH Occupation: ☐ (1-Farming 0- Others:.....)

4. HH income in 2013

Sources	*Cultivation*						*Livestock*						*Wage*	*Trade*	**Others**	**Sum**
	Rice	Maize	Tea	Fruit	Others	**Sum**	Buffalo	Cow	Pig	Chicken	Others	**Sum**				
Income (Million VND/Year)																

5. HH main properties

5.1. House? ☐ (1- Brick ; 2- Wooden; 3- Otherss)

5.2. Some Assets

Asset	Unit	Car	Motor	Bycicle	Tractor	Pump	Milling	TV	Video	Radio	PC	Laptop	Fixed phone	Mobile phone
Time buying														
Number														
Price	MillionVND													
Amount	MillionVND													

6. HH Land

	Area		***Area of crop…….***		***Area of crop…….***		***Area of crop…….***		***Area of crop…***	
Land type	**(Sào)**	**Ha (*)**	**(Sào)**	**Ha (*)**	**(Sào)**	**Ha (*)**	**(Sào)**	**Ha (*)**	**(Sào)**	**Ha (*)**
Total Area										
1. Residential lands										
2. Gardens										
3. Annual Crop lands										
- Wet Rice										
- Terraced fields										
- *Maize*										
- Others annual crop lands										
4. Perennials land										
5. Forest										
- Planted forest										
- Protected forest										
- Natural forest										
6. Ponds, lake										
7. Other lands										

7. The quality of household life

7.1. Transport conditions

- Distant from your house to main road ? ☐(1. Below 300m;0- Over 300m)
- Material of road ? ☐ (1- Soil; 2- Macadamize; 3- Asphalt; 4- Concrete)
- Difficult months to go? ……. (Month); Specific months……

7.2. Electricity

- Source of electricity? ☐ (1- None; 2- National electricity; 3- Others……..……..)
- Goals of using electricity ? ☐ (1- Living; 2- Produce; 3- Both)
- Time to start using electricity? ……
- Quality of electricity ? ☐ (1- Good; 2- Normal; 3- Not good)
- Price:…… (1000đ)
- Cost of using electricity per month ? …… (1000đ)

7.3. Water of Household

- Source of water for living? ☐ (1- Well; 2- Springs; 3- Rain; 4- Others……..…..)
- Distant from your house to water source? …… (m)
- Quality of water? ☐ (1- Good; 2- Normal; 3- Not good)
- Can your family use water frequently?☐ (1- Frequent; 0- Erratic)
- Difficult months to use water? ……. (month)
- Main water source for cultivation?☐ (1- Spring; 2- Rain; 3- Others)
- Do you use pump for producing? …….(1- None; 2- Occasionally; 3- Sometime)

7.4. Market conditions

- Name of nearest market:……
- Distant from your house to nearest market: ……(m) Number of market meeting per month……
- Products often selling ……..……..……
- Agricultural products often buying:……

……..……..……..

7.5. HH Capital

7.1.1. Available capital of HH in 2013 (1000đ)

	Rice crop……	Rice crop …	Maize crop ……	Maize crop ……	Maize crop ……	Other crops
Amount (1000đ)						

7.1.2. Capital from borrowing

No.	Lending sources	Amount (1000đ)	Rate (%/ month)	Time to borrow	Time to pay	Have paid (1000đ)	Purpose of borrowing? 1- Cultivation; 2- Livestock; 3- Trading; 4-Others (write specific)
1							
2							
3							
4							
5							
6							

7.1.3. Donated capitals:

No.	Sources	Amount 1000đ)	Time of donation
1			
2			
3			

7.1.4. Additional information about credit

- Do you want to borrow more? ☐ (1- Yes; 0-No)
- Purpose of borrowing more? ☐ (1- Cultivation; 2- Livestock; 3- Trading; 4-Others……)
- Desired amount money to borrow? …….. (1000đ)
- How do you think about present rate? ☐ (1- Suitable; 0- None)
- Desired rate? …… (%/ month)

II. PRODUCTION COST IN 2013

Cost	**Quantity**						**Rice (1000đ)**		**Maize (1000đ)**			**Annual plants (1000đ)**	**Perennials (1000đ)**
	Rice 1	Rice 2	Maize 1	Maize 2	Maize 3	**Units**	***Crop 1***	***Crop 2***	***Crop 1***	***Crop 2***	***Crop 3***	***All***	***All***
Area						Ha							
1. Seed						Kg							
- Owner						Kg							
- Buying						Kg							
2. Fertilizer						Kg							
- Cattle manures						Kg							
- Green manures						Kg							
-NPK						Kg							
3. Pesticides						…..							
4. Herbicides						…..							
5. Labor						labor							
-Hired						labor							
6. Other						1000đ							
-Irrigation						1000đ							
- Tilling						1000đ							
- Weeding						1000đ							
-Threshing						1000đ							
-Harvesting						1000đ							
-Others						1000đ							
Total													

III. RESULTS OF CULTIVATION IN 2013

No.	Products	Harvests		Selling			Saving		Total amount (1000đ) *(*)*
		Product (Kg)	*Yield (Kg/ha)(*)*	Product (kg)	Price (1000đ/kg)	Amount (1000đ) *(*)*	Product (Kg) *(*)*	Amount (1000đ) *(*)*	
		(1)	(2)	(3)	(4)	(3)x (4)	(1) - (3)	(5)x (4)	(1)x (4)
1	Rice crop 1								
2	Rice crop 1								
3	Maize crop 1								
4	Maize crop 2								
5	Maize crop 3								
6	Bean								
7	Cabbage								
8	Yam								
9	Cassava								
10	Tea								
11	…….								
12	……..								
13	…….								
14	……..								

IV. STATUS OF HH'S CULTIVATION RICE AND MAIZE

A. MAIZE

1. Do you get information from extension services about Maize crops? ☐ (1- Yes, 0- No)

- If yes, how do you feel about extension services? ☐ (1- Good; 2- Normal; 3- Not good)
- Do you want extension services? ☐ (1-Yes, 0: No)
- What do you want about extension services:……

……..……..……..……..……

2. Do you have enough water for maize cultivation ☐ (1: Yes; 0: No). Difficult months……
3. How does the road to come cornfield? ☐ (1: Good; 0:Not good). Difficult months to go ……
4. Tilling by: ☐ (1-Machine; 2- Buffalo, Bull; 3- Man-labor; 4- Hired)
5. Main seed sources: ☐ (1. Long time ago; 2.Previous crop; 3. Buy new one)
6. Maize names and place of production:… ……

……..……..……..……..……

7. Characteristic of used maize: ☐ (1. Hybrids; 2. Sticky; 3. Sweet; 4. Others……..)
8. What do you usually do after harvesting?☐ (1. Fresh selling; 2 Dry and sell whole corn; 3. Dry and sell seed; 4. Keeping; 5. Others:……)
9. Who do you usually sell for? ☐ (1. Private; 2. Company; 3. Bring to market; 4. Other…..)
10. How do you feel about maize price? ☐ (1- Suitable, 0- Not suitable, specific:……)

B. RICE

1. Do you get information from extension services about Rice crops? ☐ (1- Yes, 0- No)
- If yes, how do you feel about extension services? ☐ (1- Good; 2- Normal; 3- Not good)
- Do you want extension services? ☐ (1-Yes, 0: No)
- What do you want about extension services:……

……..……..……..……..……

2. Do you have enough water for rice cultivation ☐ (1: Yes; 0: No). Difficult months……
3. How does the road to come rice field? ☐ (1: Good; 0: Not good). Difficult months to go ……
4. Tilling by: ☐ (1-Machine; 2- Buffalo, Bull; 3- Man-labor; 4- Hired)
5. Main seed sources: ☐ (1. Long time ago; 2.Previous crop; 3. Buy new one)
6. Maize names and place of production:… ……

……..……..……..……..……

7. Who do you usually sell for? ☐ (1. Private; 2. Company; 3. Bring to market; 4. Other…..)

8. How do you feel about rice price? ☐ (1- Suitable, 0- Not suitable, specific:…….)

V. OTHER QUESTONS

1. Commune Cultural Post Office (CCPO) information:

- Distant from your house to CCPO :…….km
- Do you usually visit CCPO? ☐ (1-Usually; 2- Sometimes; 3- Never).
- Who does usually visit CCPO?: ……..…...
- If you go there, what do you usually do? ☐ (1- Calling, 2- Reading book, magazine ; 3- Internet; 4- Others:…….)
- What do you looking for when you read?.....
- How do you think about material in CCPO?☐ (1- Enough; 0- Need to add more ;Others…….)
- How do you want to change?:……

……

2. Do you usually read book, paper or magazine? ☐ (1- Sometime per month; 0- Rarely)

- What information do you usually read ? ☐ (1- Agriculture.0- Others:……)

3. Do you usually hear radio ☐ (1- At least 5 times per week;0- less)

- What information do you usually hear ? ☐ (1- Agriculture.0- Others:……)

4. Do you usually watch TV? ☐ (1- At least 5 times per week;0- less)

- What information do you usually watch? ☐ (1- Agriculture.0- Others:……)

5. What do you usually do with your mobile phone: ☐ (1. Call; 2- Entertain ; 3-Others:……..)

- Can you access internet by your mobile phone? ☐ (1- Yes,0- No)
- If yes, what information do you usually looking for? ☐ (1- Agriculture.0-

Others:……)

6. Do you have computer which can access internet? ☐ (1- Yes,0- No)

- If yes, what information do you usually looking for? ☐ (1- Agriculture.0- Others:…… …….)

7. Have you ever visit other agricultural models? ☐ (1- Yes; 0- Never)

- If yes, how do you think about that trip? ☐ (1. Good,0-Others:……)

-Do you want to visit agricultural model from another village, province? ☐ (1-Yes;0- No, why:……)

- If you can, what model do you like to visit? .....

  Where……

8. Do you participate in some agricultural organization in your village? ☐ (1- Yes; 0-No)

- If yes, what its name and goals? .....

..... ……

- How do you think about agricultural organization? ☐(1. Good; 0-Need to improve, specific:.....)

- If no, do you want to join agricultural organization? ☐ (1- Yes; 0-No)

- What do you want when you join agricultural

organization? .....

9. How do you think about erosion in your upland? ☐ (1- Strong; 2- Normal,3- None)

- In your opinion, how to restrict erosion? .....

10. Your desires..... .....

....

....

....

.....

Thank you for your cooperation!

Sign of interviewer:……

Appendix B. SUMARY STATISTIC

Total respondents: 360

I. HOUSEHOLD'S (HH) INFORMATION

No.	Variables	Unit	Mean	Frequency
1	***District***	***Households***		
1.1	*Mai Son*		*118*	
1.2	*Moc Chau*		*123*	
1.3	*Phu Yen*		*119*	
2	***Gender of HH head***	***%***		
2.1	*Male*			*87.2*
2.2	*Female*			*12.8*
3	***Average age of HH head***	***Years***	***44.78***	
4	***Ethnic group***	***%***		
4.1	*Kinh*			*17.22*
4.2	*Thai*			*56.39*
4.3	*Others*			*26.39*
5	***Average education***	***Years***	***6.67***	
6	***Marital status***	***%***		***99***
7	***Household size***	***Person***	***4.86***	
8	***Average number of man in family***	***Person***	***2.38***	
9	***Average number of woman in family***	***Person***	***2.48***	
10	***Average number labors in family***	***Person***	***2.94***	
11	***Off farm job***	***%***		***13.06***
12	***Average number of children in family***	***Person***	***1.37***	
13	***Average number of children in school***	***Person***	***1.09***	
14	***Average number of children joining farm work***	***Person***	***0.23***	
15	***Farming occupation***	***%***		***98***
16	***Average gross income***	***1000 VND/year***	***82,927.94***	
16.1	*Cultivation*		*65,387.15*	
16.1.1	Rice		941.15	
16.1.2	Maize		54,157.39	
16.1.3	Tea		21.11	
16.1.3	Fruit		3,518.97	
16.1.5	Others		6,749.91	

16.2	*Livestock*	*1000 VND/year*	*10,878.19*	
16.2.1	Buffalo		1,539.25	
16.2.2	Cow		1,229.44	
16.2.3	Pig		7,368.61	
16.2.4	Chicken		565,59	
16.2.5	Others		690.48	
16.3	*Wage*		*6,080.39*	
16.4	*Trade*		*1,979.52*	
16.5	*Other*		*0*	
17	***Type of house***	***%***		
17.1	*Brick*			*23.06*
17.2	*Wooden*			*72.22*
17.3	*Others*			*4.72*
18	***Average number of asset in family***	***%***		
18.1	*Car*			*1.67*
18.2	*Moto cycle*			*93.06*
18.3	*Bicycle*			*18.61*
18.4	*Tractor*			*25.56*
18.5	*Milling*			*28*
18.6	*Pump*			*41*
18.7	*Television*			*91*
18.8	*VCD*			*65*
18.9	*Radio*			*2*
18.10	*Mobile phone*			*242.22*
19	***Average number of HH land***	***Ha***		
19.1	*Farm size*		*1.84*	
19.2	*Residential size*		*0.04*	
19.3	*Garden*		*0.08*	
19.4	*Rice size*		*0.2*	
19.4.1	Wet rice		0.16	
19.4.2	Terraced rice		0.01	
19.5	*Maize size*		*1.41*	
19.6	*Other annual crops*		*0.09*	
19.7	*Perennial land*		*0.13*	
19.7	*Forest*		*0.15*	
19.7.1	Planted forest		0.1	
19.7.2	Protected forest		0.04	
19.7.3	Natural forest		0.01	
19.8	*Ponds, lake*		*0.01*	
19.9	*Other*		*0*	
19.10	*Wet rice crop 1*		*0.16*	
19.11	*Terraced crop 1*		*0.01*	
19.12	*Maize crop 1*		*1.41*	
19.13	*Wet rice crop 2*		*0.02*	

19.14	*Terraced crop 2*		*0*	
19.15	*Maize crop 2*		*0.18*	
	Quality of life			
20	***Distant from your house to main road ?***	***%***		
20.1	*Below 300m*			*82*
20.2	*Over 300m*			*18*
21	***Material of road ?***	***%***		
21.1	*Soil*			*45.28*
21.2	*Macadamize*			*10*
21.3	*Asphalt*			*31.94*
21.4	*Concrete*			*12.78*
22	***Difficult months to go?***	***Months***	***2.4***	
23	***Source of electricity***	***%***		
23.1	*National electricity*			*89.72*
23.2	*Others*			*10.28*
24	***Goals of using electricity ?***	***%***		
24.1	*Living*			*82.5*
24.2	*Produce*			*2.5*
24.3	*Both*			*12.5*
25	***Quality of electricity ?***	***%***		
25.1	*Good*			*75.83*
25.2	*Normal*			*13.61*
25.3	*Not good*			*10.56*
26	***Cost of using electricity per month ?***	***1000VND***	***102.96***	
27	***Source of water for living***	***%***		
27.1	*Well*			*21.11*
27.2	*Springs*			*1.94*
27.3	*Rain*			*76.39*
27.4	*Others*			*0.56*
28	***Distant from your house to water source?***	***Meters***	***1,297.18***	
29	***Quality of water?***	***%***		
29.1	*Good*			*87.23*
29.2	*Normal*			*11.94*
29.3	*Not good*			*0.83*
30	***Can your family use water frequently***	***%***		
30.1	*Frequent*			*72*
30.2	*None*			*28*
31	***Difficult months to use water?***	***Months***	***1.51***	
32	***Main water source for cultivation***	***%***		
32.1	*Spring*			*8.06*
32.2	*Rain*			*61.67*

32.3	*Others*			*30.27*
33	***Do you use pump for producing***	***%***		
33.1	*None*			*71.67*
33.2	*Occasionally*			*15.28*
33.3	*Sometime*			*13.05*
34	***Distant from your house to nearest market***	***Meters***	***8,617.22***	
35	***Credit access***	***%***		***63.06***
36	***Average borrowing amount***	***1000 VND***	***28,926***	
37	***Average interest rate***	***%***		***1.05***
38	***Purpose of borrowing***	***%***		
38.1	*Cultivation*			*42.22*
38.2	*Livestock*			*7.5*
38.3	*Trading*			*3.06*
38.4	*Others*		*47.22*	
39	***Average donated capitals***	***1000 VND***	***28.81***	
40	***Do you want to borrow more***			
40.1	*Yes*	*%*		*74*
40.2	*No*	*%*		*26*
41	***Purpose of borrowing more?***			
41.1	*Cultivation*	*%*		*45.83*
41.2	*Livestock*	*%*		*17.5*
41.3	*Trading*	*%*		*4.72*
41.4	*Others*	*%*		*31.95*
42	***Average desired amount money to borrow***	***1000 VND***	***45,258.33***	
43	***How do you think about present rate?***			
43.1	*Suitable*	*%*		*38*
43.2	*None*	*%*		*62*
44	***Desired rate?***	***%***		***0.53***

II. PRODUCTION COST IN 2013

No.	Variables	Unit	Mean
45	***Rice crop 1***		
45.1	*Seed*	*1000 VND*	*1,303.72*
45.2	*Fertilize*	*1000 VND*	*1,379.32*
45.3	*Chemical*	*1000 VND*	*175.33*
45.4	*Labor (including hired labor)*	*Man-days*	*8.95*

45.5	*Others*	*1000 VND*	*107.47*
46	***Rice crop 2***		
46.1	*Seed*	*1000 VND*	*835.33*
46.2	*Fertilize*	*1000 VND*	*775.51*
46.3	*Chemical*	*1000 VND*	*586.18*
46.4	*Labor (including hired labor)*	*Man-days*	*6.3*
46.5	*Others*	*1000 VND*	*63.03*
47	***Maize crop 1***		
47.1	*Seed*	*1000 VND*	*3,627,85*
47.2	*Fertilize*	*1000 VND*	*7,956.44*
47.3	*Chemical*	*1000 VND*	*1,059.57*
47.4	*Labor (including hired labor)*	*Man-days*	*103.77*
47.5	*Others*	*1000 VND*	*142.85*
47	***Maize crop 2***		
47.1	*Seed*	*1000 VND*	*527.25*
47.2	*Fertilize*	*1000 VND*	*780.47*
47.3	*Chemical*	*1000 VND*	*115.39*
47.4	*Labor (including hired labor)*	*Man-days*	*13.04*
47.5	*Others*	*1000 VND*	*3.89*

III. RESULTS OF CULTIVATION IN 2013

No.	Variables	Unit	Mean
48	***Rice crop 1***		
48.1	*Product*	*Kg*	*923.25*
48.2	*Price*	*1000 VND*	*8.08*
48.3	*Total*	*1000 VND*	*7,227.53*
49	***Rice crop 2***		
49.1	*Product*	*Kg*	*504.21*
49.2	*Price*	*1000 VND*	*8.06*
49.3	*Total*	*1000 VND*	*3,469.51*
50	***Maize crop 1***		
50.1	*Product*	*Kg*	*12,467.04*
50.2	*Price*	*1000 VND*	*4.15*

50.3	*Total*	*1000 VND*	*52,593.16*
51	***Maize crop 2***		
51.1	*Product*	*Kg*	*1,066.39*
51.2	*Price*	*1000 VND*	*1.19*
51.3	*Total*	*1000 VND*	*3,736.33*
52	***Soy bean***		
52.1	*Product*	*Kg*	*52.89*
52.2	*Price*	*1000 VND*	*0.31*
52.3	*Total*	*1000 VND*	*324.72*
53	***Cabbage***		
53.1	*Product*	*Kg*	*105.94*
53.2	*Price*	*1000 VND*	*0.38*
53.3	*Total*	*1000 VND*	*370.69*
54	***Kohlrabi bulbs***		
54.1	*Product*	*Kg*	*108.46*
54.2	*Price*	*1000 VND*	*0.29*
54.3	*Total*	*1000 VND*	*628.89*
55	***Cassava***		
55.1	*Product*	*Kg*	*861.13*
55.2	*Price*	*1000 VND*	*0.38*
55.3	*Total*	*1000 VND*	*736.61*
56	***Sugar cane***		
56.1	*Product*	*Kg*	*3,634.73*
56.2	*Price*	*1000 VND*	*0.18*
56.3	*Total*	*1000 VND*	*2,392.14*
57	***Plum***		
57.1	*Product*	*Kg*	*1,280.2*
57.2	*Price*	*1000 VND*	*1.02*
57.3	*Total*	*1000 VND*	*3,986.94*
58	***Other crops***		
58.1	Product	Kg	7,377.78
58.2	Price	1000 VND	6.03
58.3	Total	1000 VND	1,463.61

IV. STATUS OF HH'S CULTIVATION RICE AND MAIZE

A. MAIZE

No.	Variables	Unit	Frequency
59	***Do you get information from extension services about Maize crops?***	***%***	***21.39***
60	***If yes, how do you feel about extension services***	***%***	
60.1	*Good*		*42.5*
60.2	*Normal*		*4.17*
60.3	*Not good*		*53.33*
61	***Do you want extension services***	***%***	***83.89***
62	***Do you have enough water for maize cultivation***	***%***	***49.72***
63	***How does the road to come cornfield***	***%***	
63.1	*Good*		*49.17*
63.2	*Not good*		*50.83*
64	***Tilling by***	***%***	
64.1	*Machine*		*1.39*
64.2	*Buffalo, Bull*		*27.78*
64.3	*Man-labor*		*66.94*
64.4	*Hired*		*3.89*
65	***Main seed sources***	***%***	
65.1	*Long time ago*		*0.56*
65.2	*Previous crop*		*2.78*
65.3	*Buy new one*		*96.67*
66	***Characteristic of used maize***	***%***	
66.1	*Hybrids*		*96.67*
66.2	*Sticky*		*0*
66.3	*Sweet*		*0.83*
66.4	*Others*		*2.5*
67	***What do you usually do after harvesting?***	***%***	
67.1	*Fresh selling*		*64.44*
67.2	*Dry and sell whole corn*		*12.22*
67.3	*Dry and sell seed*		*16.94*
67.4	*Keeping*		*3.06*
67.5	*Others*		*3.34*
68	***Who do you usually sell for?***	***%***	
68.1	*Private*		*91.94*

68.2	*Company*		*2.78*
68.3	*Bring to market*		*1.94*
68.4	*Other*		*3.34*
69	***How do you feel about maize price***	***%***	
69.1	*Suitable*		*53.89*
69.2	*Not suitable*		*46.11*

B. RICE

No.	Variables	Unit	Frequency
70	***Do you get information from extension services about Rice crops?***	***%***	***34***
71	***If yes, how do you feel about extension services***	***%***	
71.1	*Good*		*28.34*
71.2	*Normal*		*5.83*
71.3	*Not good*		*65.83*
72	***Do you want extension services***	***%***	***72.78***
73	***Do you have enough water for rice cultivation***	***%***	***54.72***
73	***How does the road to come rice field***	***%***	
73.1	*Good*		*68.89*
73.2	*Not good*		*31.11*
74	***Tilling by***	***%***	
74.1	*Machine*		*38.33*
74.2	*Buffalo, Bull*		*49.44*
74.3	*Man-labor*		*9.17*
74.4	*Hired*		*3.06*
75	***Main seed sources***	***%***	
75.1	*Long time ago*		*0.83*
75.2	*Previous crop*		*0.56*
75.3	*Buy new one*		*98.61*
76	***Who do you usually sell for?***	***%***	
76.1	*Private*		*6.67*
76.2	*Company*		*0*
76.3	*Bring to market*		*2.78*
76.4	*Other*		*90.55*
77	**How do you feel about maize price**	***%***	
77.1	*Suitable*		*45*
77.2	*Not suitable*		*55*

V. OTHER QUESTONS

No.	Variables	Unit	Mean	Frequency
78	***Distant from your house to Commune Cultural Post Office (CCPO)***	***Metter***	***3,145.83***	
79	***Do you usually visit CCPO?***	***%***		
79.1	*Usually*			*5.83*
79.2	*Sometimes*			*24.44*
79.3	*Never*			*69.73*
80	***If you go CCPO what do you usually do?***	***%***		
80.1	*Calling*			*0.28*
80.2	*Reading book, magazine*			*0.56*
80.3	*Internet*			*19.17*
80.4	*Others*			*80*
81	***How do you think about material in CCPO?***	***%***		
81.1	*Enough*			*13.33*
81.2	*Need to add more*			*86.67*
82	***Do you usually read book, paper or magazine?***	***%***		
82.1	*Sometime per month*			*75.28*
82.1	*Rarely*			*24.72*
83	***What information do you usually read***	***%***		
83.1	*Agriculture*			*24.17*
83.2	*Others*			*75.83*
84	***Do you usually hear radio***	***%***		
84.1	*At least 5 times per week*			*12.5*
84.2	*Less than 5 times per week*			*87.5*
85	***What information do you usually hear?***	***%***		
85.1	*Agriculture*			*15.28*
85.2	*Others*			*84.72*
86	***Do you usually watch TV***	***%***		
86.1	*At least 5 times per week*			*90*
86.2	*Less than 5 times per week*			*10*
87	***What information do you usually watch***	***%***		
87.1	*Agriculture*			*59.72*
87.2	*Others*			*40.28*
88	***What do you usually do with your mobile phone***	***%***		
88.1	*Call*			*0.28*
88.2	*Entertainment*			*99.44*
88.3	*Others*			*0.28*

89	***Can you access internet by your mobile phone?***	***%***	
89.1	*Yes*		*1.11*
89.2	*No*		*98.89*
90	***If yes, what information do you usually looking for?***	***%***	
90.1	*Agriculture*		*0.56*
90.2	*Others*		*99.44*
91	***Do you have computer which can access internet***		***0***
92	***Have you ever visit other agricultural models***	***%***	
92.1	*Yes*		*15.83*
92.2	*Never*		*84.17*
93	***If yes, how do you think about that trip?***	***%***	
93.1	*Good*		*16.67*
93.2	*Others*		*83.33*
94	***Do you want to visit agricultural model from another village, province***	***%***	
94.1	*Yes*		*83.33*
94.2	*No*		*16.67*
95	***Do you participate in some agricultural organization in your village***	***%***	
95.1	*Yes*		*76.67*
95.2	*No*		*23.33*
96	***How do you think about agricultural organization***	***%***	
96.1	*Good*		*26.39*
96.2	*Need to improve*		*73.61*
97	***If no, do you want to join agricultural organization***	***%***	
97.1	*Yes*		*23.33*
97.2	*No*		*76.67*
98	***How do you think about erosion in your upland?***	***%***	
98.1	*Strong*		*63.33*
98.2	*Normal*		*25.28*
98.3	*None*		*11.39*