Productivity and Efficiency of Rice Production: The Implication for Poverty Alleviation in Cambodia

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Abbreviations

ADB	Asian Development Bank
ASEAN	Association of Southeast Asian Nations
CE	Cost Efficiency
CSES	Cambodia Socio-Economic Survey
DEA	Data Envelopment Analysis
FAO	Food and Agriculture Organization of the United Nations
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GNI	Gross National Income
HDI	Human Development Index
IV	Instrumental Variable Regression
KHR	Cambodian Riel
MAFF	Ministry of Agriculture Fisheries and Forestry
MDGs	Millennium Development Goals
MOP	Ministry of Planning
MOWRAM	Ministry of Water Resources and Meteorology
NGO	Non-Governmental Organization
NIS	National Institute of Statistics
NSDP	National Strategic Development Plan
TE	Technical Efficiency
ODA	Official Development Assistant
OLS	Ordinary Least Square Regression
SAW	Strategy for Agriculture and Water
SFA	Stochastic Frontier Analysis
TE	Technical Efficiency
TFP	Total Factor Productivity
WDI	World Development Indicators

Chapter 1: Introduction

1.1 Background

After suffering from several decades of conflict and the atrocity that has shocked the world, Cambodia has strived to reconstruct and reinvigorate many aspects of the socio-economy to reintegrate and catch up with the rest of the countries in the world and in the Southeast Asian region as well as to reduce poverty, bring prosperity and improve welfare of the people. In this endeavor, Cambodia has achieved a remarkable economic growth which has sustained for more than 15 years[1] thanks to the gracious official development assistance (ODA)[2] from many donor countries and the inflow of the foreign direct investment (FDI)[3], which has brought needed capital and managerial know-how to support the process of growth. Cambodian people, in general, have benefited from the fruit of this episode of economic growth. Their income has increased, which enable them to enjoy higher standard of living, and to get better access to quality education, health care and other socio-economic infrastructures unlike in the old day, when the mere basic needs such as food, shelter and clothing, were hardly enough. For only the period of seven years, from 2004 to 2011, Cambodia has managed to achieve remarkable poverty reduction. The number of people living below national poverty line has been reduced approximately 32 percentage point from 53.2% to 20.5% (Sobrado et al., 2013: 106). The annual rate of poverty reduction in Cambodia from 2004 to 2010 is 1.55%, which is the highest among Southeast Asian countries (Menon, 2013: 40).

Despite this astonishing achievement, Cambodia remains one of the poorest countries in the world. In 2013, the country had the per capita gross national income (GNI) of only 950 US$[4], the lowest among the countries in the Association of the Southeast Asian Nations

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[1] From 1999 to 2013, the Cambodian economy has grown at an annual average of 8.2%. In 2009, the export of Cambodian garment and the tourism sector was adversely affected by the Lehman shock; the growth rate was only 0.1% (ADB Key Indicators, 2014).

[2] Cambodia's net ODA received as a percentage of GNI in 2012 is about 6%, among the highest in Asia. See: http://data.worldbank.org/indicator/DT.ODA.ODAT.GN.ZS. Last accessed January 19, 2015.

[3] FDI inflow is expected to be 9.3% of the GDP for 2012 (Sobrado et al., 2013)

[4] World Development Indicator: http://data.worldbank.org/country/cambodia. Last accessed December 20, 2014

(ASEAN) region and was classified as a low-income country[5], a term used by the World Bank to categorize a group of the world's poorest countries. In the ASEAN region, Cambodia and Myanmar are the only two countries in the low-income group. This fact implies that poverty reduction in Cambodia is far from over, and to improve the living standard of the people and to catch up with the rest of the world, the country needs to make greater effort. The problem of poverty and the endeavor to reduce poverty is not new as poverty has occurred in the world for ages but reducing it is quite a difficult task that even in the 21 century still there are large number of people living below the poverty line, not only in Cambodia but also in many other countries. With the support of the developed countries and the international organizations such as the World Bank, many developing countries have been working hard to fight against poverty and many different poverty reduction policies have been formulated. Some have achieved encouraging results, while other has performed not so well.

The poor are not homogeneous so reducing poverty needs policy prescriptions that are designed for a particular group of the poor in a particular region. In other words, it is difficult, if not impossible, to replicate successful policies from countries to countries and from regions to regions. In this regards, to reduce poverty, policy makers are required to be knowledgeable of the characteristics of the poor; who the poor are and what their endowment is are indispensible in formulating poverty reduction policies that are effective. For instance, reducing the rural poverty requires policy actions that are different from reducing urban poverty, and the policies to reduce poverty among the landless poor should be different from that to reduce poverty among landed farmers. In Cambodia, the latest statistics show that the Cambodian poor concentrated in rural areas. In fact, there is also urban poor, who live in dire condition in slums in big cities, but their number is much smaller than their rural fellows because the percentage of rural population is, in 2011, about 79% of the total population and the rural poverty rate is much higher. In the same year, that is 2011, the poverty headcount rate in rural areas is 23.7%, while in Phnom Penh, the capital city of Cambodia, the rate is

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[5] Low-income countries are those countries with 2012 GNI per capita of less than $1035. As of May 9, 2014, there are 36 low-income countries. More detailed information can be found at: http://data.worldbank.org/about/country-classifications/country-and-lending-groups

only 1.5% and in other urban areas, it is 16.1%. (Sobrado et al.,2013). Thus, it is undeniable that the rural poor are much greater in number and reducing rural poverty in Cambodia must contribute significantly to reducing overall poverty.

In addition to the knowledge of who are the poor, the knowledge of their endowment is indispensable as it gives guidance, in particular, to what needs to be done to raise the income[6] and consumption of the poor. In the context of this research, the knowledge of the endowment of the rural poor is crucial because the overwhelming majority of the poor are in rural areas. In general, the endowment of the rural Cambodian is their land and labor. In terms of labor, they are regarded as low-skilled if taking into consideration their low educational attainment and literacy rate[7]. For this reason, they have fewer choices for employment opportunity. For their livelihood, many of them engage mainly in agriculture and agriculture-related activities and employments in informal sectors. In Cambodia's undiversified agriculture, rice is the predominant food crop, which the majority of rural households cultivate for family consumption and cash income; rice is thus their lifeline. According to Sobrado et al. (2013) and Tong et al. (2013), income from agricultural crops, which is predominated by rice, is among the top contributor to rural households' income and because of the rice price hike in 2008 and in 2009, many rural households could escape poverty. But because many farming households own small plot of land, growing rice alone cannot sustain their family for the whole year. Some households can manage to produce surplus for cash income while other households cannot even fulfill the household consumption. Rice growing is a seasonal work; farmers may not necessarily be occupied in the rice field for the whole year. The usual practice is that during rice planting and harvesting season, farmers work in the field, while, in the off-season, mainly in the dry season, they migrate to other places to find additional employments and income. Many of them migrate to urban and semi-urban areas,

[6] There are more dimensions of poverty than just income such as capability and well-being. Income poverty provides the simplest way to measure poverty.

[7] Among ASEAN countries, the Cambodian literacy rate of people over 15 years old and over is only higher than in Laos (72.2%) but lower than in Myanmar (91.9%), Vietnam(93.9%), Thailand (96.4%), Indonesia (92.6%), and Malaysia (92.1%). See: http://www.phnompenhpost.com/analysis-and-op-ed/working-towards-literate-cambodia

where there is more opportunity for working in informal sectors or to other rural areas, where different crop than rice is planted. In short, the Cambodian poor is rural based and subsists on multiple income sources; income from rice is one of the important sources.

1.2 Problem Statement

Engvall et al. (2008) suggests two ways to reduce the rural poverty in Cambodia; one of which is improving agricultural productivity and the other is creating employment opportunity in the rural areas, where the rural poor is able to engage. Improving agricultural productivity has been found to reduce poverty in many different countries and different regions, from South Asia and East Asia to Latin America (De Janvry & Sadoulet, 2010; Irz et al., 2011; Datt & Ravallion, 1998). In East Asia, especially in Japan, the growth of the agricultural productivity was always regarded as the prerequisite for industrialization. In Cambodia, the agricultural sector, to certain extent, is synonymous with rice industry because rice is the predominant crop having been grown on about 80% of the total crop area (NIS, 2011) by most of the rural households who account for about 79% of the total population. The majority of them are employed and survived by growing rice. Even so, many studies and reports have revealed that the economic performance of the Cambodian rice industry is far from its full potential. When talking about economic performance, there are two keywords, productivity and efficiency. Therefore, in other words, we can say that the productivity and efficiency of the Cambodian rice industry and actors involved in the industry are low. Although the yield of Cambodian rice has been growing steadily from 2.1 tonnes per hectare in 2000 to 3.2 tonnes per hectare in 2013 (MAFF Agricultural Statistics, Various Volume), Yu & Fan (2011) found that it has a substantial potential to be further improved. There are many constraints to the growth of Cambodian rice production and the USDA (2010) stated some of the critical constraints such as the farmers' low level of schooling, the traditional cultivation practice, the shortage of infrastructure such as irrigation and water reservoir, the rainfall dependence, the insufficient availability of modern high yielding varieties, the inadequate government support and funding for agricultural researches and extensions, the low usage of modern input, and the insufficient investment to improve their cultivated plots due to limited access to less costly formal financing.

Improving the economic performance of the farmers and the rice industry are crucial in improving the income generated from rice growing as well as job creation. It is necessary to help farmers become more efficient and the productivity of the rice production higher. We can measure productivity by dividing the output of the production by its input, while efficiency is measured by comparing the value of the observed and the optimal output, and the input of the producer. Even though rice plays a big role in the Cambodian economy and has the potential to contribute to poverty reduction, the study on the issues pertinent to productivity and efficiency of Cambodian rice production is scant. There are several reports on the Cambodian rice productivity, which used rice yield as the indicator, but until recently, there has not been a study on efficiency of rice production yet. The study on rice productivity and efficiency is significant because it provides practical information for policy makers to formulate poverty reduction policies that are based on the improved productivity and efficiency of rice as it is the most important food crop, from which the poor farming households generate most of their income. Therefore, the significance of improving productivity and efficiency of the rice production should not be overlooked.

1.3 Research Objectives and Questions

Based on the aforementioned problem statement, this dissertation has two main objectives. The first objective is to examine the status of the productivity and efficiency of Cambodian rice and to explore factors that affect the level of the productivity and efficiency. More specifically, this dissertation attempts to shed light on whether the productivity of Cambodian rice is low or high, and whether or not the rice farming households are cost efficient. Then, in order to improve the productivity and efficiency, factors that affect these two key indicators of economic performances are to be explored. The second objective is to examine the relationship between the productivity and efficiency, and poverty status of rice farming households in different regions. The study will explore the impact of the improved productivity and efficiency on poverty in different regions in Cambodia to see if improving the rice productivity and efficiency can be beneficial to farming households in all regions. To achieve the stated objectives, the study seeks to answer the following questions:

1. What is the status of the productivity of Cambodian rice?

    1.1. Is the productivity high or is it low?

    1.2.What are factors affecting the productivity?

2. Are Cambodian rice farming households cost efficient?

    2.1.What are factors affecting the level of the cost efficiency?

3. What is the impact of the growth of the productivity and efficiency of rice production on poverty among farming households?

    3.1.Does the improved land productivity raise the household consumption?

    3.2.Does the improved labor productivity raise the household consumption?

    3.3. Does the improved cost efficiency level raise the household consumption?

1.4 Research Methodology

The study employs the method of literature survey, descriptive and quantitative analysis to address the three main questions. To answer the first main research question, that is, to examine the status of the Cambodian rice productivity, this study will compare different productivity indicators among different countries. In particularly, two productivity indicators, rice yield and gross rice value per hectare will be compiled and computed, and will be compared among other Asian rice producing countries. By so doing, it is possible to draw a conclusion on whether the productivity of Cambodian rice is low or high. The factors that affect the productivity are mainly drawn from the literature. In order to respond to the second main research question, the Stochastic Frontier Analysis (SFA) will be employed to test the hypothesis that the Cambodian rice farming households are cost efficient. If the hypothesis is rejected, meaning that the farming households are not cost efficient, or we can say they are inefficient[8]; then the factors that affect the cost inefficiency level will be explored. The last methodologies are the Ordinary Least Square (OLS) and Instrumental Variable (IV)

[8] In the whole dissertation and especially in the efficiency analysis part, Chapter 5, the term efficiency is frequently used. However, for ease of explanation, sometimes the term inefficiency also appears.

regression analysis. These two methods are used to answer the third main research question. The IV regression is used on top of the OLS regression because in the literature, the type of function to be regressed in this study has the endogeneity problem, which needs to be corrected by the IV regression.

1.5 Data Sources

Secondary data from various institutions such as the United Nation's Food and Agriculture Organization (FAO), World Bank's World Development Indicators (WDI), Cambodia's Ministry of Agriculture, Forestry and Fisheries (MAFF)'s Agricultural Statistics, the Asian Development Bank's Key Indicators for Asia and the Pacific and the Ministry of Planning (MOP)'s Cambodia Socio-Economic Survey (2009), hereafter referred to as CSES 2009 are used in the dissertation. The data utilized in the main analysis, specifically the analysis in Chapter 5 and Chapter 6, are the CSES 2009 data. MOP's National Institute of Statistics (NIS) is responsible for conducting the survey and publishing CSES data. CSES is a household survey with questions to the household head and their household members. The CSES 2009 survey was conducted from January to December, 2009. It is a nationwide survey covering the sample of 12,000 households within 720 villages, which are divided into 12 monthly samples of 1,000 households in 60 villages. NIS conducts the nationwide survey once every five years. The previous nationwide survey is the CSES 2004, whose sampling design is the same as that of the CSES 2009. The survey in this interval, for example, the CSES 2007 or CSES 2008, contains the sub-sample of only 3,600 households. CSES 2009 is a comprehensive survey covering rich data in many areas such as agriculture, education, health, housing condition, income and expenditure and so on. Households from various regional and occupational backgrounds were included in the survey but in this dissertation, only rice farming households were selected because its main focus is only on the rice farming households. In addition, diversified farmers, i.e. farmers producing rice and other crops, are not included in the analysis. By so doing, the effect of diversification on the efficiency and productivity can be avoided.

1.5 Organization of the Study

The dissertation is structured into seven chapters. Chapter 1, the introductory chapter, discusses the background and motivations of the study. The research objectives, methodology and data sources are also briefly explained. Chapter 2 reviews the literature on the relationship between of the growth of agricultural productivity and the growth of agricultural efficiency, and poverty reduction. This chapter intends to shed light on the role of the agricultural productivity and efficiency on poverty reduction. Chapter 3 reviews the recent situation of Cambodian poverty, focusing thoroughly on the characteristics of the rural poor, their endowment, sources of income and perceptions of future income. Chapter 4 illustrates the status of the Cambodian rice productivity by comparing the productivity of Cambodian rice with those of other rice producing countries using rice yield and gross rice value per hectare as indicators; in addition, this chapter also reviews the literature on factors that constraint the growth of Cambodian rice, which hopefully will be applicable for improving the productivity. This chapter helps us understand whether the productivity of Cambodian rice is low or high and understand factors that can improve the rice productivity.

Chapter 5, the first main chapter, uses the method of Stochastic Frontier Analysis to test the cost efficiency of Cambodian rice farming households. The null hypothesis is that the rice farming households are cost efficient; if it is rejected, that is, farming households are not cost efficient, factors affecting the cost inefficiency is examined in order to improve the level of cost efficiency. In this chapter, the data from the CSES 2009 is employed. This chapter answers the second research questions and its sub-questions: Are Cambodian farming households cost efficient? And what are factors affecting the level of the cost inefficiency?

Chapter 6, the second main chapter, examines the impact of land and labor productivity, and cost inefficiency on poverty among rice farming households. Like the Chapter 5, the analysis in this chapter also utilizes the data from CSES 2009. This chapter's analysis comprises of two steps. First, the formula of poverty indices proposed by Foster, Greener & Thorbecke (1984) is applied to construct the poverty profile of the rice farming households. Then, regressions of the consumption functions[9] are carried out using the methods of Ordinary Least Square (OLS) and Instrumental Variable (IV) to obtain the consumption elasticity of the main variables—the land and labor productivity, and the cost inefficiency. The computed elasticity is used to calculate the impact of the land and the labor productivity, and the cost inefficiency on poverty among farming households. This chapter will help us understand whether improving the productivity and efficiency of rice production have an impact on rural poverty. It also intends to illustrate that the improved productivity and efficiency have a different effect in different regions.

Chapter 7 concludes the dissertation. This chapter summarizes and synthesizes the findings from previous chapters and provides policy recommendations. It also provides direction for future research on the role of rice production in reducing poverty.

[9] There are two consumption functions to be estimated. In the first one, the per capita total consumption is the dependent variable and in the second regression, the per capita food consumption is the dependent variable. Sometimes, the term “the consumption” is used to refer to both the consumption types.

Chapter 2: The Role of Agricultural Productivity and Efficiency in Poverty Reduction: A Literature Survey

2.1 Introduction

Scholars hold different views on the role of agriculture in development and poverty reduction. Prominent scholars like Prebisch (1950) and Singer (1950) were not optimistic about the role of the agricultural sector. They viewed agriculture as the sector that developing countries should not depend on because the income elasticity of agricultural commodities is usually less than one, while that of industrial products manufactured by developed countries is always larger. In the long run, developing countries' term of trade will lag behind that of developed countries making them unable to catch up with developed countries if the primary sector is their specialization. In other words, if developing countries specialize in agriculture, they will stay poor but developed countries that specialize in manufacture will become richer, and the gap between the developed and developing countries will become widening. The government in developing countries, which adopted this school of thought, especially those in Africa and Latin America in the 1950s, formulated the so-called import substitution policies, which were bias against agriculture (Anriquez & Stamoulis, 2007) and brought disastrous result. The economic growth became stagnated, and the debt accumulated; finally these countries abandoned the import substitution policy. In the opposite camp, economists like Johnston & Meller (1961), Ahearn et al. (1998) and Ruttan (2002) viewed agriculture as prerequisite for industrial development and growth of the rest of the economy, and a key to a healthy economy. In the early stage of development, the role of agriculture is to supply raw material and food to other sectors. In many major countries in Asia like Japan, India, China, except for small island country and territory such as Singapore and Hong Kong, the successful industrialization has always been preceded by the strong growth of agricultural sector (Anrique & Stamoulis, 2007; Timmer, 2005; Rosegrant & Hazell, 2000). Thus, the role the agricultural sector plays should not be overlooked especially the experiences of the East Asian countries. In many today's developing countries including in Cambodia, agriculture is still a dominant sector in terms of its contribution to the GDP and employment. People in developing countries are generally low-skilled and thus subsist largely by engaging in agriculture-related activities. This suggests that agriculture also have a significant role in poverty reduction. In this regard, starting from the definition of key terms, this chapter reviews the previous studies on the role of agricultural productivity and efficiency in poverty reduction.

2.2 Definition of Key Concepts

Before discussing the role of agricultural productivity and efficiency on poverty reduction, it is necessary to define the concept of productivity, efficiency and poverty as these three terms may be defined differently depending on the academic discipline and objectives of the study.

2.2.1 Defining Productivity

Productivity is defined as a ratio of output(s) to input(s). The computation of this ratio becomes complicated in the real world because producers always apply more than one input to produce several outputs. If they use only one input to produce a single output, productivity is simply the ratio of the output and the input. In the multi-input and multi-output setting, productivity can be computed as partial and total factor productivity (TFP). Partial productivity is the amount of output per unit of a particular input. In agriculture, the commonly used partial productivity is yield, the output per unit of land and labor productivity, the output per economically active person or output per agricultural person-hour. These two partial productivities have different roles: yield is generally used to measure the performance of new production practices or technology while labor productivity is commonly used to compare productivities across sectors of the economy. However, Zepeda (2001) argued that partial productivity can be misleading because its change cannot be clearly measured. For example, the growth of yield or labor productivity may be resulted from the increased mechanization, i.e. the increased use of fertilizers, tractors, or output mix (move to higher value crop) not from labor or crop seed per se. To correct the limitation of partial productivity, TFP is introduced. TFP is computed as the ratio of the index of output(s) and inputs: different from partial productivity, which only one input is used in calculating productivity although in production, more than one input is used (Fried et al., 2008). In economic terms, the growth in TFP is also known as the Solow residual; usually, it is a measure of technological progress of the production that is resulted from the government's expenditure on research and development (R& D) in agriculture, the expenditure on agricultural extension services, the investment in farmers' education that facilitate the adoption of technology, the investment in infrastructure, and government programs such as policies on tax, regulation and intellectual property rights that support the production of agriculture (Ahearn et al., 1998). Besides factors that affect TFP, the change in TFP also can be resulted from the error of measurement of inputs.

Agricultural productivity has been defined differently by scholars in different fields. In agricultural geography or economics, for instance, agricultural productivity is defined as the output per unit of input, or output per unit of land area (Dharmasiri, 2012). Besides land, labor is one of the most important factors of production in agriculture, and its definition varies in empirical economics due to different objectives of the studies and data availability. Land or labor productivity is partial productivity, but they are widely used in empirical studies because it is simpler to compute as data required in calculating TFP is huge, and it is usually not available. Land productivity is defined as crop yield or gross crop value per acre by Datt & Ravallion (1998), Sarris et al. (2006), and De Janvary & Sadoulet (2009) while Irz et al. (2001) defined land productivity as the gross output net of the intermediate input cost. They argued that using this way of calculating productivity, the effect of input intensification during production can be reduced. Labor productivity was defined by Irz et al. (2001) and de Janvary & Sadoulet (2009) as per worker average value added.

2.2.2 Defining Efficiency

Efficiency refers to the comparison of observed and optimal values of outputs and inputs. The comparison can be output-oriented or input-oriented or the combination. The output-oriented efficiency compares the observed output to the maximum output obtainable from the input while the input-oriented efficiency compares the observed input to the minimum potential input required to produce the output. There are different types of efficiency[10] depending on the behavioral of a producer such as cost efficiency, revenue efficiency, profit efficiency, technical efficiency and allocative efficiency. Each type of efficiency follows the standard procedure, that is, the ratio of the observed to the optimal values.

2.2.3 Definition and Measurement of Poverty

People have diverse perception on poverty. What it means to be poor in Cambodia may be very much different from what people in other parts of the world perceive poverty. In the World Bank's well-known world development report published in the year 2000/2001 titled "Attacking Poverty", the poor were given chances to express what living in poverty means. As expected, different perceptions of poverty were gathered. Some people mentioned that living in poverty means that they do not have enough food to eat or decent accommodation while other stressed the important of freedom from being feared. From the opinion of different groups of the poor, poverty is multi-faceted. The report tried to incorporate the different aspects and defined poverty as the severe deprivation of well-being, but it was argued that the concept of well-being is too abstract and difficult to measure. Haughton & Khandker (2009) proposed several approaches to defining well-being. In one of the approaches, well-being is considered as the capability of the people to acquire commodities and resources. If people are at least able to meet their basic need, they are considered well-off. This is a conventional approach because poverty is measured by comparing the individual or household resources to the defined threshold. It is the starting point of an analysis of poverty. Another approach is to ask whether or not people are able to attain enough basic needs such as food, shelter, health care and education. Unlike the first approach that measure poverty in terms of monetary value, this approach incorporates non-monetary values such as nutrition and literacy status of the people. Amartya Sen (1999) provided another approach to defining well-being. He argued that well-being comes from the

[10] A more rigorous definition of efficiency is presented in Chapter 5.

capability to function in the society, which means that people are considered poor if they lack capability just as they have insufficient income or low education, or they are not able to properly access health care services, or they feel they are not well protected, or their self-confidence is low, or they feel that they are powerless, or they do not have of basic rights such as freedom of speech. In accordance with the above approach, poverty is viewed as a multidimensional phenomenon, and it becomes more difficult to resolve in a normal situation. For example, people with higher income may not necessary be better off if they are insecure or have insufficient access to education and health care. They may live in constant fear in a place where stability is not assured although they may have high income.

In a statement signed by all heads of its agencies, the United Nations defined poverty as a rejection of choices and chances that people should command, which is synonymous with an abuse of human dignity. In other words, being in poverty means that people cannot effectively participate in the society given their capacity, do not have enough food to eat and clothes to wear, do not have access to schooling and medical care, do not have access to capital and credit. Being poor also means being powerless and excluded from households and community, being vulnerable to violence and being living in marginal or fragile situation, that is to say, being poor simply means that basic utilities such as clean water and hygienic environment are denied (UN, 1998 as cited in Gordon, 2005).

Because poverty is multi-faceted, the measurement of poverty is complicated. Stewart et al. (2007) proposed four approaches to measuring poverty, that is to say, the monetary approach, the capability approach, the social exclusion approach, and the participatory approach. Each approach has its strength and weakness, and the monetary approach is the most straightforward and the easiest to compute due to the more accessible data; thus, it has been widely applied in many empirical economics. In the monetary approach, poverty line defined by the government or international institution such as the one-dollar or two-dollar a day or the Human Development Index (HDI) are used as a threshold to which the income or consumption of the poor is compared. In fact, there are problems of comparison of poverty among countries because an equal amount of money in a different country may command different commodity leading thus to different poverty situation. There more suitable monetary value for international comparison such as the purchasing poverty parity (PPP) can be better utilized if the comparison is the objective.

2.3 The Role of the Growth of Agricultural Productivity in Poverty Reduction

Rich empirical evidences prove that the growth of agriculture reduces poverty and the effect is not only confined to rural areas, that is not only poverty among farming households is alleviated; agricultural growth contributes to the reduction of poverty in urban areas as well as inducing the growth in other sectors. In a cross-country context, Irz et al. (2001) found that both the growth of agriculture's land and labor productivity significantly contributes to poverty reduction regardless of whether poverty headcount ratio or HDI were used as poverty indicator. The magnitude of poverty reduction depends on the structure of the economy; the more the economy depends on agriculture, the stronger the impact. The country like Cambodia, where the share of agriculture to the GDP is still high and large portion of the population still engages in agriculture for their livelihood, should gain higher benefit from the growth of the agricultural productivity. In another study, it was found that in the region where agriculture is smaller in scale and more labor intensive, the growth of agriculture contributes more to poverty reduction (De Janvry & Sadoulet, 2009).

In addition to the cross-country studies and the studies in different regions, there are sectoral studies, which disaggregate the growth of the economy into different sectors and compare the contribution to poverty reduction of each sector. In Southeast Asia, the study by Warr (2002) revealed that the growth of the agricultural sector contributes to poverty reduction even though the magnitude is smaller than that of the service sector. In Indonesia, Thorbecke & Jung (1996) found that the agricultural and service sector contributed more to poverty reduction than the industrial sector, and in South Africa, Khan (1999) found that agriculture, mining and services were the sectors which contributed most to the poverty reduction due to their high direct linkages to poor households. To sum up, agriculture plays an important role in poverty reduction although the magnitude may be large or small due to the structure of the country's agricultural sector and the stage of development of the country.

Besides the cross-sectional studies mentioned above, Ahluwalia (1978) traced the role of agriculture in poverty reduction in different Indian states in time series context and found that agricultural growth contributed to poverty reduction in aggregate (nationwide); nonetheless, when examining each state separately, the results showed that, in some states, the growth of the agriculture reduce poverty while, in other states, the results were reversed. The growth of agricultural productivity, surprisingly, was found to have a positive correlation with rural poverty. However, using the same data set as Ahluwalia (1978), Saith (1981) found that, actually, agricultural growth did not reduce rural poverty because the positive effect of poverty reduction was smaller than the negative effect of price rise. In other words, agricultural growth reduced poverty of the farmers but it raised the agricultural price, in particular the food price, which made the poor who were net consumers of food crops worse off. Therefore, inflationary pressure is one of the main causes of rural poverty. The inconsistency of the results of the studies by Ahluwalia (1978) and Saith (1981) encouraged Mathur (1985) to investigate the causes, and as a result, it was found that the main reason for the difference in conclusions of the above two studies was the use of different specification to estimate the equation. Ahuwalia (1978) used value added while Saith (1981) used gross output as an indicator of agricultural growth. In addition, Mathur (1985) supported the finding of both studies: agricultural growth reduced poverty, while price rise increased poverty, which was also supported by the study of Bell & Rich (1994), who used data set with longer time span. The effect of agricultural growth on poverty reduction in India was later confirmed by Datt & Ravallion (1998) whose research suggested that higher farm yield reduced absolute poverty, and the effect was not confined to the farmers living close to poverty line; those who were relatively poorer, i.e. the poorest of the poor were also benefited.

In Indonesia, Suryahaid et al. (2012) examined the role of sectoral growth on poverty reduction and found that agriculture contributed to the poverty reduction in both the pre and post Asian financial crisis. However, in the post-crisis Indonesia, the growth of agriculture reduced poverty only in the rural areas and the impact was lagged behind the contribution of the service sector. This indicated that agricultural growth contributed to poverty reduction differently in different time period and it the case of Indonesia due to the structural change after the crisis, the role of agriculture in poverty reduction shrank. More concretely, as the economy becomes more developed, the role of the agricultural sector seems to be diminishing.

Not all studies supported the hypothesis that agricultural growth reduces poverty. A study in Pakistan by Malik (2005), for example, found that in the period when agricultural grew, the Pakistani rural poverty actually got worse. This was a very much unexpected result. The author then investigated the causes of this bizarre outcome and found that generally large farmers were the initial group to benefit from agricultural subsidies and the newly invented technology. The new technology innovation that is more capital intensive allowed large-scale farmers to reap more benefit from the agricultural growth than the small-scale farmers. The author did not oppose the previous findings that agricultural growth reduces poverty but argued that the use of aggregate agricultural data to examine its poverty-reducing effect was unreliable, and that because poverty is a complicated problem, differences in agro-climatic condition, regional endowment and socio-economic status of farmers need to be incorporated into the analysis in order that the entirety of the effect of agricultural growth on poverty can be measured. In short, the role of agriculture in poverty reduction varies from country to country, from region to region and from time to time. Countries where agriculture is more labor intensive and smaller in scale tend to fare better in reducing poverty, while in countries with large-scale estate plantation, only those estate farmers are able to reap the benefit of agricultural growth; thus, the gap between the rich and the poor farmer become wider as the rich farmers stand to gain more from the growth of the agricultural productivity. In addition, agricultural growth that is resulted from capital intensive technology appears to perform poorly in reducing poverty than the labor intensive technology as poor farmers in general have limited access to capital intensive machinery due to its prohibitive cost.

2.4 Agricultural Productivity and Poverty Reduction: Pathways

The majority of empirical works supported the hypothesis that agricultural growth contribute to large or small extent to poverty reduction, but the channel through which the growth benefit the poor is not clearly mentioned in most empirical works. It is important to know how the poor can benefit from the growth of agricultural productivity; otherwise, it is difficult to direct the agricultural sector toward lifting the poor out of poverty. This section describes the path that the growth of agriculture affects poverty. Irz et al. (2001) categorized the level of the economy into the farm level, the rural level, and the country level and intelligently described the impact of agricultural growth on each level of the economy. The impact is different on different level of the economy and thus worth studying in detail. The effects of agricultural growth in different level of the economy are presented in Table 2.1 and are summarized as follows. In the farm level, agricultural growth directly increases farm income because farmers are able to produce more, thus are able to sell more output than before. If they can produce more, farmers who produced insufficient for household consumption become self-sufficient farmers. Farmers who produced small surplus to sell for cash income can bring larger surplus to the market to generate higher income, while farmers who produced large surplus can produce even larger surplus and are able to increase income substantially. There are conditions that influence this effect. Unless large portion of the rural poor engages in agricultural production, and unless the growth of agriculture does not considerably reduce prices, the poor cannot benefit much. In the law of demand and supply, if farmers supply more farm output, it is likely that the price of those farm products will fall and the magnitude of the price drop depends on the elasticity of the said products. In order to gain optimal benefit from agricultural growth, policies to stabilize the price and increase demand such as diversifying from the domestic market to the international market and increase processing need to be implemented. In other words, if the growth in output reduces the price significantly, although farmers are able to sell more, the profit may not be larger than before. Moreover, if agricultural growth is driven by technical innovation, the benefit reaped by the poor may be limited because they are less likely to adopt new technical knowledge (Hazell & Haddad, 2001). In general, only the better off farmers can access to the high tech machinery and gain benefit from the technology imbedded in that physical capital.

The other contribution of agricultural growth within the farm level economy is through the employment creation. When the agricultural productivity grows, more farm laborers are needed to work in the same cultivated land. For example, before the productivity improves, farmers may be able to produce rice only two tonnes per hectare and need to employ only two farm laborers to harvest; after the improvement of productivity, they are able to produce three tonnes per hectare and may need to employ three or more farm laborers to harvest the output in the same one hectare of farmland. If the source of income generation of the poor, especially the landless or land poor is farm laboring, improving agricultural productivity means improve employment opportunity of them. In many developing countries including Cambodia, many of the poor are either landless or land poor. In South Asia, for example, around one-third to one-half of the poor are landless, thus depend on farm laboring for income. Even in rural Africa, where it is uncommon to find landless households, farm employment is still important, especially for households having small plots or having inadequate working capital (Irz et al., 2001). In Cambodia, farm employment is one of the main sources of rural households' waged employment (Sobrado et al., 2013).

In the rural economy, the important effect of agricultural growth is the production linkages. Agricultural production is linked upstream and downstream from the farm. Farmers need inputs such as fertilizers, seeds, and insecticides and services such as processing, storage, and transportation in the production of agricultural commodities and supply the products as a raw material to other sectors or as consumption goods to consumers. When farm production grows, the demand for those products and services also grow. And the growth of production from farm increases the supply of raw materials that are demanded by other sectors. The growth of rice production, for instance, increases the supply of rice to the food processing industry. The linkage in production creates trust and builds social capital among farmers and other rural dwellers since they have to communicate more often; this can facilitate investment in other non-farm industry in the rural areas. In addition, there are consumption linkages as farmers and farm laborers spend their incremental income on goods and services in the rural economy. The first stage of the growth of agricultural productivity enhances and induces the second stage growth because the increased income and jobs allow farmers and farm laborers to spend more on nutritious foods, education, and health care. These kinds of consumption, in particular education and health care, are regarded as investment in human capital rather than normal consumption because more educated and healthy farmers tend to be able to work more productively.

The increased agricultural productivity is likely to drive down the price of the commodity. In the case of food production, the prices of food become cheaper allowing the poor net consumers of food to increase nutritious intake regardless of whether or not their income increases. Thus, improved agricultural productivity increases the purchasing power of the poor. The magnitude of the price drop depends on the structure of supply and demand of the product. The reduced prices benefit the poor who are net consumers of food, but may hurt the other group of the poor, who are net producers of food. Therefore, in the context that the majority of the poor is the net producer of food, if the prices drop too much, it is not good for poverty reduction. The sensible policy makers have to be vigilant in balancing the cost that is borne by one group and the benefit gained by the other group.

Not only do farmers and farm laborers gain benefit from the increased agricultural production, the local government is also one of the beneficiary. Increased production permits the local government to generate more tax revenue, which they can mobilize to fund more investment in their locality such as building and renovating needed rural infrastructure such as road and irrigation system. These two types of physical infrastructure are basic needs for agricultural production. Without reliable water supply, farmers cannot grow crops, and without all-weather road, farmer cannot transport their products to the market or the middleman cannot get access to the village; thus, trade is difficult to conduct. For both the farmers, and the local government, investment in physical infrastructure is a win-win policy because it benefits farmer in improving production, which then befit the local government themselves in tax collection. Moreover, in a more favorable situation, the improved agricultural production may induce farmers or other rural inhabitants to invest in other non-farm industry such as petty trade and food processing because rural demand has been created. This widens the tax base that the local government is able to collect, thus benefiting both parties, the farmers and the local government. In Cambodia, the infrastructure such as rural roads and irrigation were found to significantly improve consumption of the poor quintile (Phim, 2011).

Table 2.1 The Impact of the Growth of Agricultural Productivity

Impact of Agricultural Growth
Farm Economy ▪ Higher income for all types of farmers including smallholder ▪ Increased on-farm employment
Rural Economy ▪ More employment upstream and downstream of the agricultural sector and food chain ▪ More employment in the rural non-farm economy will be created because farmers and farm laborers make use of extra income to spend on non-food items ▪ Increased jobs and income permits farmers and other rural population to increase nutritious intake, which improve their health, and allow them to invest more on education. Healthier and better educated farmers and rural population means that their welfare is improved, and their productivity is enhanced. ▪ Better linked production chain allows rural population to communicate with each other more often, which facilitates trust building and improves rural social capital, thus it becomes easier for them to share information on non-farm investment. ▪ Food prices become cheaper benefiting the net food consumers in rural areas ▪ Generates more local tax revenues lead to more supply of better infrastructure that contributes to the second round effects promoting the rural economy
National Economy ▪ Cheaper prices of agricultural products, food for consumers and raw materials for non-agricultural sectors, increase real wages of the urban workers, decrease the wage costs of the non-agricultural sectors ▪ Financial capital generated from agriculture makes investment in the other sectors possible, which create employment and raise incomes in those sectors ▪ Accumulated foreign exchange from agricultural export increase the country’s capacity to import capital goods and other necessary inputs for the production in the non-agricultural sectors ▪ Release of farm labor permit more production in other non-agricultural industries

Source: Modified by author based on Irz et al. (2001)

At the national level, it is generally argued that increased agricultural output is likely to drive down the prices of food and other raw materials. The reduction in food prices benefits net food consumers but may hurt the net food producers; hence, the overall effect depends on the magnitude of the price decrease. Additionally, in developing countries, agriculture is often the largest sector that has the potential to mobilize resources to support the investment and economic activities in other sectors. Large portion of the population engages in agriculture and agriculture-related activities. Therefore, the increased production that raise farmers' income will contribute to higher national saving. Some governments provide incentives for voluntary savings (Griffin, 1979), other directly or indirectly tax agriculture to accelerate the process of savings. Thailand has imposed substantial tax on rice export although the tax rate has reduced as the successful industrialization of the economy has been achieved. The main rationales to tax rice export are to increase government revenue and to curb inflation (Hong et al., 2006). Ghatak & Ingersent (1984) stated that the early industrialization in Japan was financed mainly by land tax, which account for about 80% of the fiscal revenue at that time. In many developing countries, substantial government revenue is still generated from the agricultural sector (Schiff & Valdes, 1992). Saving is important for the economy, so is the foreign exchange because foreign currency are needed to import capital goods in many developing countries as they are incapable of manufacturing machinery and inventing new technology by themselves. Many developing countries lack foreign exchange to purchase capital goods and other imports necessary for investment. Yet again, the growth of agricultural output can increase foreign exchange through either substituting imports or increasing exports. If the supply of domestic agricultural products can substitute for the import, developing countries can save the foreign exchange that previously was used to purchase imports. Instead, the saved foreign exchange may be mobilized to purchase the needed capital goods that cannot be produced in the country. While an agrarian society, Cambodia imports millions of dollar worth of agricultural products every year. If the local products can substitute these imports, millions of dollars may be saved and mobilized every year to purchase the needed capital goods and machinery[11]. In addition to substituting imports, exporting agricultural products is a promising means to accumulate foreign exchange in many developing countries in the early stage of development. According to Mao & Schive (1995), the exports of rice and sugar provided at least half of Taiwan's imports of capital goods in the 1950s and 1960s, which are essential to the industrialization process. Many developing countries are major exporter of agricultural commodities. They should grab this precious opportunity to promote development and industrialize their economies. Specifically, they should make use of an agricultural sector as a bridge to industrialization rather than relying too much on agriculture without clear and concise industrialization plan.

To conclude, agriculture is generally viewed as an important precondition for the industrialization and particularly for poverty reduction as, in the developing countries, the majority of the poor engages in agriculture or agriculture-related activities. There are several pathways such as income growth, employment opportunities, prices reduction, wage increase and multiplier from the non-agricultural sectors, through which the growth of agricultural productivity affects poverty in all level of the economy from the farm to national level. The subsequent section tries to review in detail each pathway through which agricultural growth reduces poverty.

2.5 Previous Literature on Pathway through which Agricultural Growth Reduce Poverty

Different direction can lead the growth of agricultural productivity to poverty reduction. Studies in different countries and time period have confirmed this poverty-reducing effect of the improved agricultural productivity. It is important for policy makers to know each pathway and decide which pathway they should direct their development and poverty reduction policies. Each pathway is discussed in the following section.

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[11] http://www.thesoutheastasiaweekly.com/cambodia-needs-at-least-420000-tons-of-vegetable-annually/. Last accessed January 13, 2015.

2.5.1 On-Farm Employment

Agricultural productivity growth increases production that demands the increase of farm labor through the increase in cultivated area, intensity if cultivation, i.e. more labor is required per unit of land, and frequency of cropping. Depending on the proportion of the poor working in agriculture, the impact of the productivity growth may vary. Also, technology may operate against the growth of on-farm employment because some technology may change the composition of input to be less labor intensive. For example, a new crop technology may reduce input use, increases yield, improves labor productivity or, in the case of short-season maize variety, allows the cultivated areas to be enlarged. Reducing input use raises profit but may not increase on-farm jobs (Irz et. al, 2001). In other words, if the improved agricultural productivity is the result of capital intensive technology that needs fewer farm laborers (for example, mechanization), the on-farm employment is not necessarily increased, especially the low-skilled labor. But the demand for skilled labor such as machine operators may increase.

Irz et al. (2001) stated that if no outcome can be predicted a priori, there is evidence that agricultural growth driven by improving yield increase the demand for farm labor. For example, in the study of Hayami & Ruttan (1985), it was found that the introduction of modern rice and wheat varieties in Asia increased the labor requirement per unit of land and increased the cropping intensity. Lipton and Longhurst (1989) found that the demand of labor per unit of land increased by 20% at the early stage of the green revolution, although it diminished gradually due to the subsequent adoption of the labor replacing technology. This is true because when the demand for farm laborers increases, wage tends to go up; thus, some farmers may switch to capital intensive technology if the cost is less than employing farm laborers. This argument is supported by the study of Binswanger and Quizon (1986) that found relatively slow increase in labor when agricultural output grows. For this reasons, the government in developing countries should encourage the adoption of appropriate technology. When the wage is high, capital intensive technology should be encouraged but when the wage is low, more labor intensive technology should be promoted. In order to do so, they should be knowledgeable of the level of skills of the labor forces so that they can formulate appropriate policy, whether to encourage labor intensive or capital intensive technology.

2.5.2 Real Agricultural Wages

The growth of agriculture contributes directly and indirectly to poverty reduction through the increased real agricultural wage rate. However, the impact of the demand for farm labor is debatable as other factors may also affect farm wages such as the availability of off-farm jobs and the degree of mechanization (Irz et al., 2001). Studies examined the impact of real agricultural wage on poverty found mixed results. In India, using the survey data from 1958 to 1994, Datt & Ravallion (1998) found that improving agricultural productivity, which was defined as output per unit of land, contributed to poverty reduction. The increased agricultural productivity improved real wages and eventually reduced absolute poverty, and even the poorest quintile also benefited. Nonetheless, Estudillo & Otsuka (1999) found that the adoption of improved rice technologies did not change farm wage in central Luzon, the Philippines. Mellor (1999) suggested that the increase in agricultural productivity does not increase real wage if there is unemployment in rural areas. Real wages in those areas are unlikely to increase in response to agricultural growth because increased output tends to drive down real prices unless effective demand of the products expands. The increased productivity of agriculture may not directly raise farm wage but because it tends to reduce the crop prices, in particular food crop, the purchasing poverty of the poor farm laborers may be improved although the nominal wage does not increase.

2.5.3 Food Price Effects

Increased agricultural production may reduce food prices, which benefit the net food consumers in both rural and urban areas, but it may hurt the net food producers. Otsuka (2000) and Binswanger & Quizon (1986) found that lower food prices caused by increased production were the primary factors that the green revolution reduced poverty and inequality. However, as previously mentioned, the impact of food prices on poverty depends on the structure of the agricultural sector and the employment composition of the sector. The fluctuation in food prices may reduce or increase poverty. The exogenous shocks of food price rise also impact the poor in developing countries. Ivanic & Martin (2015) found that in the short-run, rising food prices tend to increase poverty but, in the long-run, it will reduce poverty as the wage will adjust, and the supply will respond. This long-run result was analogous to the finding by Headey (2014) but contrasting to that of Binswanger & Quizon (1986). Headey (2014) found that, in the long run (over five years), increased food prices reduce poverty in the poorest countries due to wage adjustment and supply response of the food producers to the rising food prices. Although, in aggregate, the country as a whole may benefit from the rising food prices, many individuals may be adversely affected. This effect is evident in Brazil (Ferreira et al., 2013). Therefore, the fluctuation of food prices may create losers and winners within the country.

2.5.4 Multipliers in the Rural Non-Farm Economy

Irz et al. (2001) argued that the enlarged agricultural production generates demand for goods and services both downstream industries such as processing, storage and transport, and upstream industries (services for agriculture). In addition, as production increases, farmers' income also increases, which create consumption links because farmers will consume more of goods and services from other sectors. This process is termed multiplier effect. The degree of multiplier effect depends on a number of factors. It depends, for instance, on the availability of the rural infrastructure, the portion of population that reside in rural areas, the extent of the need to process agricultural products, whether the change in technology is more labor-intensive or capital-intensive, and whether or not goods and services produced and consumed by the agricultural communities are tradable (Irz et al, 2001). The studies by Reardon et al. (2001) suggested that the growth of the rural non-farm sector was the fastest and the most poverty alleviating in the areas where agriculture was the most dynamic. Otherwise, the rural non-farm sector only plays the role as employers of last resort providing low-wage jobs to the population (Irz et al., 2001).

2.6 The Relationship between Agricultural Efficiency and Poverty

In previous section, efficiency is defined as the ratio of the observed and optimal outputs and inputs. There are several types of efficiency such as technical efficiency, profit efficiency, allocative efficiency, revenue efficiency and cost efficiency. Efficiency can be an input-oriented when producer tries to produce a certain level of output by minimizing the input while output-oriented efficiency is a situation when producer tries to use a fixed amount of input but maximize the output. Efficient production either helps producers save their scarce resources or maximize output to obtain higher economic profit. Therefore, it is preferable to be efficient producers, in particular, poor producers of agricultural crops such as rice farmers.

Oladeebo (2012) investigated the effect of technical efficiency on poverty of farmers in the Southern part of Nigeria and found that improving technical efficiency is likely to reduce rural poverty. The author suggested that to improve the technical efficiency, institutional support, and credit access should be provided to farmers. In addition, young and educated farmers should be encouraged to participate in farm work as educated farmers can easily access to new technology. Because young farmers appear to lack interest in agriculture, the government should provide infrastructure such as potable water, health facilities, electricity and good road to the rural areas. Factors that affect the efficiency need to be simultaneously enhanced in order to reduce poverty. Ulimwengu (2009) found that farmers' health significantly affect their efficiency of production. However, in the simulation of the effect of health on efficiency and effect of efficiency on poverty, it was found that efficiency did not influence the level of poverty, which could imply that other additional policy instruments are needed in that the improved efficiency could reduce poverty.

2.7 Conclusion

Although the theory suggests that agricultural growth reduce poverty, in empirical researches, there are also researches that found that agriculture did not affect poverty. Several preconditions have to be met before the benefit of agricultural growth can be reaped. The most important precondition is the structure of the agricultural sector. Countries with small-scale agriculture and more equitable distribution of agricultural land appear to benefit more. Different time period and locality are also the factors that contribute to the different impact of agricultural growth. The case of Indonesia shows that agriculture highly contributes to poverty reduction in the early stage of development and the contribution is to both the reduction in poverty in the rural and urban areas. However, as time passes, agriculture is only relevant for poverty reduction in the rural area. It should be noted that most of the studies use the aggregate agriculture data to examine its poverty-reducing impact, but it may produce biased result due to the fact that farmers produce different crops in different agro-climatic regions. The growth of agriculture may represent the growth of some particular agricultural crops. The growth of some crops is likely to benefit a particular group of farmers but not necessarily all farmers as what was found in the Pakistani case. Therefore, it is important to examine poverty by focusing on a specific group of farmers cultivating a certain crop rather than study in an aggregate manner. This is more useful in terms of formulating policy as different farmer groups may need different policy intervention. The next chapter explores the situation of Cambodian poverty and following the chapter, the role of rice industry in the Cambodian economy is explored as rice is farmers' most important crop so it has the potential to be a promising industry in reducing poverty among the Cambodian farming households.

Chapter 3: Poverty in Cambodia: A Rural Phenomenon

3.1 Introduction

Cambodia is one of the poorest countries in the world. The atrocity of war that the country has suffered more than two decades was often blamed for the current hardship of the people. The war has destroyed almost all crucial infrastructures, physical and especially human capital that is fundamentally the backbone of the economic growth. After the end of the conflict, with the support of the international communities, Cambodia has reintegrated into the world economy and has made great endeavor to revitalize many aspects of the socio-economy. Economic growth mainly fueled by foreign aid and FDI has been spectacular and specifically in the last 15 years, Cambodia has been one of the world's fastest growing economies. The average rate of the economic growth has been approximately 8.2% per annum (ADB Key Indicators, 2014) and the number of people living below poverty line has been reduced significantly from 53.2% of the population in 2004 to just around 20.5% in 2011 (Sobrado et al., 2013: 106). The reduction speed of poverty in Cambodia has been astonishing and praised. Averaging 1.5% from the year 2004 to 2010, it is the fastest in the ASEAN region (Menon, 2013: 40); however, the poverty rate is still high, which means millions of people still live in destitute. By the World Bank's international classification, Cambodia is in the low-income group or least developed countries (LDC), the poorest group of countries in the world, because the country's per capita GNI in 2013 is only US$ 950[12]. According the data compiled by Menon (2013), in ASEAN, only Myanmar and Cambodia are in the low-income category and poverty in Cambodia is more server than in Myanmar in several poverty indicators such as the poverty headcount at the national poverty line and the poverty headcount at the rural poverty line.

Theory and large body of literatures demonstrate that economic growth works as the precondition and catalyst of poverty reduction and, in the Cambodian context, the economic growth does contribute to poverty reduction; however, examining carefully the poverty data, the striking fact emerges. Poverty in Cambodia is much rampant in rural areas. Table 3.1

[12] World Development Indicator: http://data.worldbank.org/country/cambodia. Last accessed December 20, 2014.

shows that, in 2011, 23.7% of the rural population is living below the rural poverty line, which is 7.6 percentage points higher than the urban poverty rate and about 22 percentage point higher than the rate of poverty in Phnom Penh, the country's capital city, even though, from 2008 to 2009 the speed of poverty reduction in rural areas[13] is faster than the urban areas. This may be interpreted that the economic growth has been quite unlevel and benefitted the urban segment of the population more than their rural fellows. It may be that industries that locate in the urban areas may have grown faster or the growth in the urban areas may have outperformed that of the rural areas, where most of the poorest quintile resides and carries out their livelihood. This phenomenon in Cambodia is not an exception. Also, in other developing countries, the economic growth was found to have reached the poor with a limited degree (Ahluwalia et al.,1979).

Table 3.1 Cambodian Poverty Rate

Year	National	Phnom Penh	Other Urban	Rural
2004	53.2	15.8	39.7	59.0
2007	50.1	2.7	35.0	57.9
2008	38.8	2.5	26.8	46.6
2009	23.9	4.3	12.7	27.5
2010	22.1	4.5	12.6	25.4
2011	20.5	1.5	16.1	23.7

Source: Modified by author based on Sobrado et al. (2013), pp. 9

Given the demographic structure of the Cambodian population, who overwhelmingly resides in rural areas[14], the higher rate of rural poverty means that that large portion the poor concentrate in rural areas or millions of rural people are living in rural areas. This makes tackling poverty in Cambodia synonymous with alleviating rural poverty. In this endeavor, we need to be knowledgeable of the necessary information such the locality as well as the

[13] According to Sobrado et al. (2013), the speedy reduction was due to the increase in food price, rice price, in particular, which benefits many rural rice farming households. Another notable point is the increase in poverty in urban areas from 2010 to 2011; this is probably the result of Lehman shock that hurt the garment industry, the base of the urban economy, severely.

[14] The urbanization rate of Cambodia is in the early stage and it is relatively low (Roberts & Kanaly, 2006: 73).

characteristics of the poor in order that effective poverty reduction policies are possible to be formulated. Without knowing who and where the poor are, what they are making for their livelihood, and what their characteristics and endowment are, it is hard to fight against poverty. According to the statistics, it is well known that the Cambodian poor are overwhelmingly in rural areas but more detail information shall be helpful.

3.2 Distribution of the Rural Poor

About one-fifth of Cambodian people are poor, but this does not mean that they are equally distributed in different regions and provinces. Poverty rate varies from region to region as each region has different endowment from one another in terms of the availability of agricultural land, common pool resources, access to seaport, irrigation, road, electricity and topography, which provide important resources for the poor to generate income, and which can affect the poor's livelihood activities. Due to the topography, Cambodia is officially is divided into four regions[15], namely the Plain, Tonle Sap, Plateau/ Mountain and Coast. The Plain region is in the Southern part of the country; it is the most densely populated areas. Agricultural land in this region is fertile and suitable for growing many different agricultural products, staple and industrial crops as the region has plenty of sources of water due to its proximity to the Mekong River and its subsidiaries. Farmers in this region also can benefit from being close to the capital Phnom Penh, which provide a big market for their products. In addition, the thriving garment and textile, construction, and tourism industries provide many off-farm jobs to the people in this region. In fact, all Cambodian people can work in those industries but people in the Plain region have an advantage of being close to the sources of employment, thus do not need to pay the cost of migration. The Tonle Sap region is in the central part of Cambodia surrounding the country's great lake, the Tonle Sap Lake[16]; this

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[15] Based on CSES 2009, the Plain region includes the province of Kampong Cham, Kandal, Prey Veng, Svay Rieng and Takeo. The Tonle Sap region comprises of the province of Banteay Meanchey, Battambang, Kompong Thom, Siem Reap, Kampong Chhnang and Pursat. Provinces in the Coast are Kampot, Preah Sihanouk, Kep and Koh Kong. The Plateau/Mountain region includes the province of Kampong Speu, Kratie, Mondul Kiri, Preah Vihear, Ratanak Kiri, Stung Treng, Otdar Meanchey and Pailin.

[16] Tonle Sap is the biggest freshwater lake in Southeast Asia (Kummu &Sarkkula, 2008).

region is less densely populated compared to the Plain, which implies that households in this region should hold larger agricultural land. The Tonle Sap Lake provides not only water for agriculture but also other sources of livelihood activities such as fishing[17] and tourism. The Plateau/Mountain region covers vast areas in the Northern and Northeastern part of the country. In this region, forest is dense but population is sparse so people make their livelihood mainly from exploiting the forest products and agriculture, and physical infrastructures such as road and irrigation system is less developed compared to other regions. Slash and burn, and traditional agriculture have been and continued to be practiced until recently. When private company tries to acquire traditional agricultural land to venture in industrial agriculture such as planting rubber or pepper, people in this region, many of them are ethnic minorities, face difficulty in continuing their traditional way of cultivation. There are many reported conflicts with regard to the right to use of the agricultural land. The Coast region is in the Southwestern part of Cambodia, which is comprised of all Cambodian coastal provinces. The advantage of this region lies in its close proximity to sea, where fishing, trading and tourism are conducive, and recently investors become interested in investing in this region as it is less costly to export because the Cambodian seaport is located in this region. Therefore, there are multiple sources of income that people can depend on, and the prospect of better livelihood is high in the Coast region.

ADB (2014) calculated the poverty rate based on the ID poor that is a proxy means test with participatory elements. Households are classified as poor category 1 (very poor), poor category 2 (poor), or not poor. In general, provinces in the Plateau/Mountain region have the highest poverty rate. As mentioned above, this region is sparsely populated with dense forest; people depend on forest products for their livelihood as the landscape are not suitable for growing staple crop such as rice or corn. It is one of the underdeveloped regions and is quite isolated as it is not well connected with the big cities since physical infrastructure such as road and electricity is poorly developed. This region is home to many different indigenous populations, and it seems that they are among the poorest quintile. Recently, this

[17] Tonle Sap is one of the most productive freshwater fisheries in the world. http://www.worldfishcenter.org/resource_centre/WF_3454.pdf. Last accessed January17, 2015.

region becomes a tourist attraction, especially eco-tourists as still there is vast areas of forest, where tourists can take a glimpse of wild animal and goes trekking. In addition, thanks to the recent development of infrastructure, this region becomes more accessible. Many ethnic minorities become integrated with the mainstream Cambodian population although there are some conflicts. In the Tonle Sap region, people are better off than those in the Plateau/Mountain region. People in the former region generate income mainly through wet season rice cultivation and because there is a big lake in the middle of the region, fishing is also one of the main sources of income generation. In addition, Siem Reap, Cambodia's most popular tourist destination, locates in this region. It provides opportunities for off-farm employment in tourism-related industries such hotel and restaurant jobs and souvenir business for people who are able to migrate, especially young labor forces.

Both the Plain and the Coast regions are less poor. There are several factors that can explain why these two regions are less poor than the previous two regions. The Plain is the most densely populated region. As mentioned above, geographically, it is in the region where it is favorable for agriculture and agriculture-related activities. This is one of the reasons that many people reside in this region as agriculture has been one of the most important sources of income for Cambodian people. Furthermore, the region's close proximity to the capital Phnom Penh is another advantage since farmers can get better access to big market for their farm products, and garment factories around Phnom Penh and the thriving labor intensive industries such as garment and footwear, and construction provide thousands of jobs to young workforces mainly from the Plain region. Thus, it is no doubt that people in the Plain region is relatively better off than other parts of Cambodia.

The Coast is another better off region due to its proximity to the sea, where people are able to diversify their sources of income from agriculture and agriculture-related activities. Fishing for seafood is one of the sources of income in addition to rice cultivation, which is not so favorable in this region. Also, the beautiful beach attracts increasing number of tourists. This region is one of the main tourist attractions after Angkor Wat in Siem Reap. The growing number of tourists means that the demand for local products, such as seafood and services also increase, which provide jobs to the local. In addition, the presence of seaport attracts investor to locate their factories in that region because export is less costly; this will increase the job opportunities and chances for self-employed for the local.

3.3 Characteristics of the Rural Poor

The overwhelming majority of the poor in Cambodia resides in rural areas. Table 3.2 compares the selected indicators of the poor and the average households in Cambodia. These two groups of people have similar characteristics because many average people are living very close to the poverty line although they are not poor. Given small reduction in income, they will become poor. The table combines the rural poor and the urban poor. However, as the rural poor predominate, it is assumed that these indicators, to a large extent, represent, the characteristics of the rural poor.

According to the table, the percentage of the poor households that are in rural areas has increased by about two percentage points in the period of seven years from 89.8% in 2004 to 92.2% in 2011. The rural poor households appear to have larger household size than the average households. In addition, the number of dependencies is higher among the poor. The poor spends more on food and less on other expenditure such as housing, services, and transportation, and communication compared to the average households. Both the poor and the average households have improved the housing condition and have improved access to infrastructure such as electricity.

Table 3.2 The Comparison of the Poor and the Average Households in Cambodia, 2004-2011

Indicator	Poor		Average	
	2004	2011	2004	2011
Rural Households	89.8%	92.2%	81.4%	79.3%
Household size	5.59	5.67	4.98	4.53
#of 0-6 years old	0.93	1.05	0.70	0.63
#of 7-20 years old	2.19	1.98	1.82	1.36
#of 21-59 years old	2.19	2.31	2.15	2.19
#of 60 years & older	0.28	0.33	0.31	0.35
Food/Total Consumption*	63.3%	63.8%	59.5%	56.1%
House+Servies/Total Consumption*	21.1%	16.6%	19.5%	18.7%
Transport & Communication/Total Consumption*	1.3%	4.0%	3.0%	6.4%
Roof of hard material: tiles, metal	59.1%	73.1%	71.0%	88.5%
Piped water or protected well in wet & dry season	42.7%	43.5%	46.9%	45.9%
Electricity	5.4%	8.5%	19.7%	37.4%
Average years of education for 20-60 years old	3.1	3.3	3.9	5.1
Agricultural land: hectares	104.0%	96.0%	98.0%	97.0%
Rice producing household	75.0%	69.0%	65.0%	59.0%
Refrigerator	0.0%	0.0%	1.9%	4.7%
Wardrobe/cabinets	5.3%	14.2%	18.2%	44.1%
Mobile	1.4%	39.1%	12.7%	63.0%
Bed sets	17.5%	26.1%	30.4%	44.3%
Motorbike	12.9%	29.7%	28.6%	56.5%
Bicycle	64.1%	67.4%	64.0%	68.0%

*Values are the average of individual household percentages.

Note: numbers are household averages and not population averages.

Source: World Bank staff estimated based on CSES (as cited by Sobrado et al. (2013), pp. 20)

The poor households appear to have lower average years of schooling than the average households. The table also shows that higher percentage of the poor depend on rice growing for their livelihood compared to the average households although both households hold an equivalent size of agricultural land.

In an agrarian society, agricultural land is one of the people’s most important assets, especially for the rural poor, it is their source of livelihood. Holding small plot of land or being landless, and holding large plot of land indicates significant differences in well-being among the rural households. In the case of Cambodian rural households, owning farmland significantly improves consumption. Sobrado et al. (2013) reported that owning even half of a hectare of land improved household consumption. Although agricultural land is important for the livelihood of the rural population, the number of the landless households actually has increased. In 1999, only two or three percent of Cambodian population were landless but it increased to 25% in 2007 (Sida, 2014). Factors forcing the people to become landless include land grabbing and socio-economic shock. As the market price of land increases, the powerful elites try to capture and own land for the purpose of manipulating market prices or for the purpose of showing off their wealth. The poor becomes the victim because most of them, in general, do not have appropriate land deed[18]; thus their land is easily seized. Even though they are not victims of land grabbing, due to the fast growing number of household members, the land each household owns becomes smaller. Another factor that also contributes to the landlessness of the rural households is socio-economic shock such as the death of the breadwinner, the illness of the family members and the demanding to carry out traditional ceremonies such as wedding or funeral ceremonies, which require that households have to spend large sum of cash. Rural households often do not have large sum of cash when needed, thus they may need to borrow from loanshark at usurious rate, which makes them difficult to pay back or they may need to sell off their agricultural land to get cash. In the case of health related shock, because there is practically no functioning medical insurance or other insurance scheme in the rural areas, households need to pay full cost of medical fee and it was found that sickness of family member can cause more severe economic distress even than the crop failure (Yagura, 2005).

Besides land holding, which is surrounded by many problems that urgently need to be solved, the possession of other durable goods that are also indicators of the welfare of the rural households, has been improving. In addition to the Table 3.2, whose data includes both the urban and rural poor, according to Sobrado et al. (2013), for the rural poor households

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[18] The problem of having no land deed is one of the legacies of the war. In the Khmer Rouge era, most documents including land deed were destroyed. Since the collapse of the Khmer Rouge until now, many households still has no proper document to claim the ownership of their land (Pearce, 2012). This also prohibits them to access to formal finance as a land deed is usually used as collateral in the Cambodian banking system.

from 2004 to 2011, the percentage of households with thatched-roof houses have reduced from 24% to 10%. In Cambodia, thatched-roof house indicates the severe extent of poverty of the household as living in this kind of houses is not comfortable especially during the rainy season when torrential rain may cause leakage or even destroy the house. Thus, people tend to renovate their thatched-roof house when they can afford to live comfortably as well as showing their prosperity. The better types of houses are the ones with a roof made of galvanized-iron and concrete or fibrous cement. Households with a permanent roof made of galvanized-iron increased from 31% in 2004 to 48% in 2011. And households with concrete or fibrous cement roof have increased from 5% in 2004 to 10% in 2011. In addition to the improving housing condition, the possession of durable goods also indicates the improving welfare of the rural households. Durable goods such as television, mobile phone, and motorbikes are crucial for rural households. It provides means of communication, information, and transportation that rural households can exploit to improve their productivity, increase network, and employment opportunity. From 2004 to 2011, households having television have increased from 43 % to 61%; households having mobile phones have dramatically increased from 8% to 85% as mobile phones have become more affordable and the services of the mobile operator have reached the rural areas. Households having motorbikes have increased from 27% to 64%. Although, it is astonishing that the welfare of the rural households has improved in many aspects, as in the case of poverty rate, the effort to improve the welfare of the rural households is still far from complete. We may not be able to judge that these improvement have already brought the poor to the decent standard of living, that is the objective of development, because there is no threshold to determine the decent living standard. What need to be done is to keep improving the welfare of people as there is no end in the journey to development.

3.4 Sources of Income for Rural Households

Income and its sources are the main determinants of household welfare and poverty status. People need decent jobs to earn a decent income for their livelihood. In developed countries, it is hard to live without a proper job. However, in an agrarian society like

Cambodia, agriculture is always an employer of last resort, which means that people can always return to work in agriculture whenever they have problems with unemployment in other sectors. Higher income allows households to afford higher consumption including consumptions such as education and health that are widely considered as investment in human capital that will yield high return, in the long run. Although the income of the average Cambodian has increased and lifted them from poverty, they are susceptible to falling back into poverty provided small reduction in their income. This makes it indispensable to examine their income sources and exploring ways to sustain the income. In rural setting, households tend to generate income from diversified sources. Sobrado et al. (2013) identified seven sources of rural household income, which are income from waged employment, from agricultural crops, from livestock, from fishing, from forestry and hunting, from non-farm self-employment, and from remittances and transfers. Among the seven sources of income, four of them contribute about 80% of the daily income of the rural households (Table 3.3). The four sources of income, the income from agricultural crops, income from waged labor, income from non-farm self-employed and income from remittances and transfers, are to be explored in the following section.

3.4.1 Income from Agricultural Crops

In Cambodia, approximately 64.3% of the population engages in agricultural activities; thus, income from agricultural crops is one of their main sources of income. The income from agricultural crops is the second largest among other income sources and has continued to grow (Sobrado et al., 2013; Tong et al., 2013). The daily income from this source has risen from 507 KHR in 2004 to 1,101 KHR, which is more than double (Table 3.2); the increase is mostly from rice production (Sobrado et al., 2013). The income from rice production has increased for two reasons: first, the increase in yield, and second the rise in the prices of rice. Increased yield allows farming households to produce more surplus, thus permitting them to sell more to the market to obtain more cash income, and the hike in the prices of rice enlarges the profit margin of the Cambodian farmers because their main input are labor; therefore, price increase translates into higher income for farmers themselves although other input prices may also minimally increase.

3.4.2 Income from Waged Employment

According to Table 3.3, income from waged employment is the biggest contributor to the rural households' income and this income source also has continued to grow. In 2004, it accounts for only about 22.4% of the total income, and has grown to 23% in 2009 and around 30% in 2011. This increase is attributable to the fact that rural households engage more in waged employment, and are working longer hours than before and in more than one job.

Table 3.3 Income Composition of Rural Households

	Income (KHR per day)			Percentage		
	2004	2009	2011	2004	2009	2011
Waged Employment	918	1,355.0	1,835.0	22.4%	23.0%	29.9%
Agricultural Crops	507	1,101.0	1,232.0	12.4%	18.7%	20.1%
Livestock	377	295.0	317.0	9.2%	5.0%	5.2%
Fishing	201	219.0	151.0	4.9%	3.7%	2.5%
Forestry & Hunting	286	319.0	324.0	7.0%	5.4%	5.3%
Non-Farm Self-Employment	856	1,398.0	1,211.0	20.9%	23.8%	19.7%
Remittances & Transfers	957	1,197.0	1,073.0	23.3%	20.3%	17.5%
Total	4,102.0	5,884.0	6,143.0	100.0%	100.0%	100.0%

Source: Sobrado et al., 2013, pp. 41

3.4.3 Income from Non- Farm Self-Employment

Poorer rural households are likely to diversify their sources of income than the better-off households because their ability to resist crop failure and income shock is less than the more wealthy households. According to FAO (1998), there are pull and push factors that motivate farmers to participate in non-farm employment. The main pull factor is the relatively high return in the non-farm sector, and there are four push factors including an inadequate farm output resulted from agricultural shock such as flood and drought, or land constraints, an imperfect or absence of market for consumption credit, the risk of farming, which motivate farmers to diversify their sources of income to other sectors to cope with shock, and the failure or absence of agricultural input markets or credit market for farm inputs, which force farmers to pay for the inputs with their own cash. In Cambodia, about one-third of the rural households engage in non-farm self-employment as their primary or secondary source of employment (Sobrado et al., 2013). Rahut & Scharf (2012) found that the rural poor and the less well-educated participated less in the non-farm sectors and they were likely to work in low paid job in the non-farm sector so they earned lower income. They also found that gender, ethnic minority and the size of agricultural land possession did not impact the participation in non-farm employment. Table 3.3 shows that rural households' income from this category rose by 63% from 2004 to 2009, that is, from 856 KHR in 2004 to 1,398 KHR in 2009, but declined about 13% in 2011, when the non-farm self-employment income was only 1,211 KHR.

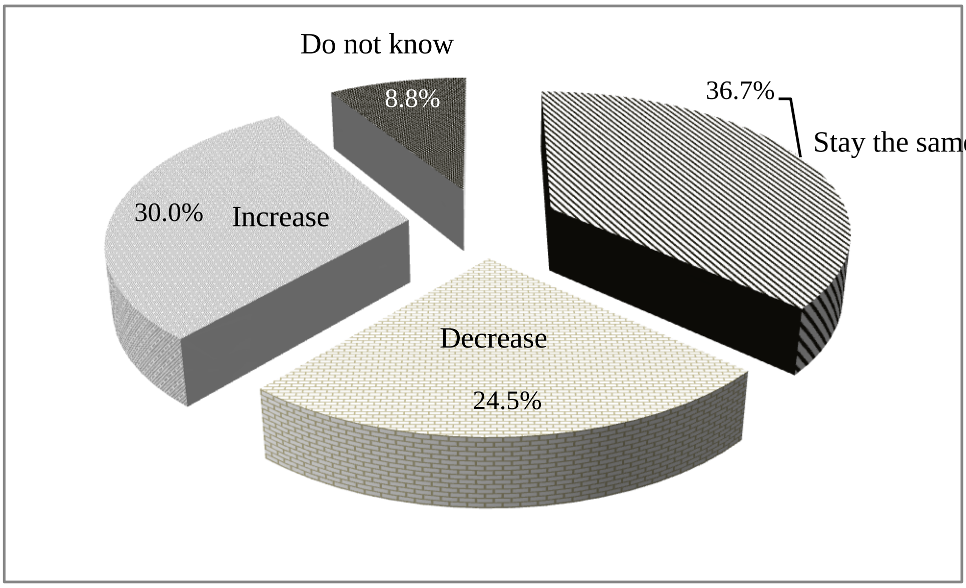
3.4.4 Income from Remittances and Transfers

Income from remittances and transfers is the smallest among the major income sources. In 2004, it was only 957 KHR and increased to 1,197 KHR in 2009 but dropped slightly to 1,073 KHR in 2011 (Table 3.3). International experiences reveal that remittance data tends to be underreported for several reasons. Households may decide to underreport their remittances because if they truly report the remittances they have received, they may not be qualified for state support such as cash transfer or aid from the non-governmental organization (NGO), and in poor neighborhood, households tend to understate their real wealth to avoid the demand for help or loan from poorer relatives (Shonkwiler et al., 2008). According to Acosta et al. (2006), the reasons for underreported remittances may be due to the inappropriate design of the data collection so households may not be nationally represented. In addition, there is the problem of the recall bias. Households tend to pool their income from various sources, thus may not remember the exact amount they have been remitted at the time of interview. And remittance income tends to be fluctuating so if households are asked to report their monthly remittance, they may underreport the true remittance due to the fact that in the month they are asked, they do receive little remittance. This means that asking the sum of the total remittances in longer period such as one year is more practical. These may also be the reasons that the reported income from remittances is small in the case of Cambodia. In addition, there is no significant cash transfer program that the poor can benefit, so the combination of income from these two sources appears to be relatively small.

3.4.5 Perceptions from Households

In addition to statistics on the households' income from various sources that are important for rural households, the perception of the rural poor on the prospect of their income is also vital because it shows the viewpoint and prospect of the households on their future. Sobrado et al. (2013) asked the rural people their perception of their income in the next three years and reported that some rural people were optimistic about the rise of their income from farming and wage employment although many other are not. 30% of the 1,535 who were interviewed and who engaged primarily in agricultural activities mentioned that their income from agricultural activities would increase because they thought the productivity and prices of agricultural products would increase. Around 37% thought that their income would remain the same, while other 24% thought their income would decline because of the increase in input cost and the unpredictable weather and crop diseases. The perception on income from agriculture appears to be in line with the percentage of households who are net buyers and net producers of rice. About 37% of the rural households are net producers of rice, 17-24% is net consumers and the rest is self-sufficient rice producers. It is likely that the net producers of rice are more optimistic about the increase of income from agriculture. Among the 1,128 informants who were engage in waged employment, 40% thought their income from wage would increase and other 34% thought it would stay the same, while other 16% thought it would decline without elaborating the reason.

Figure 3.1 Households' Perceptions of Income from Agricultural Income



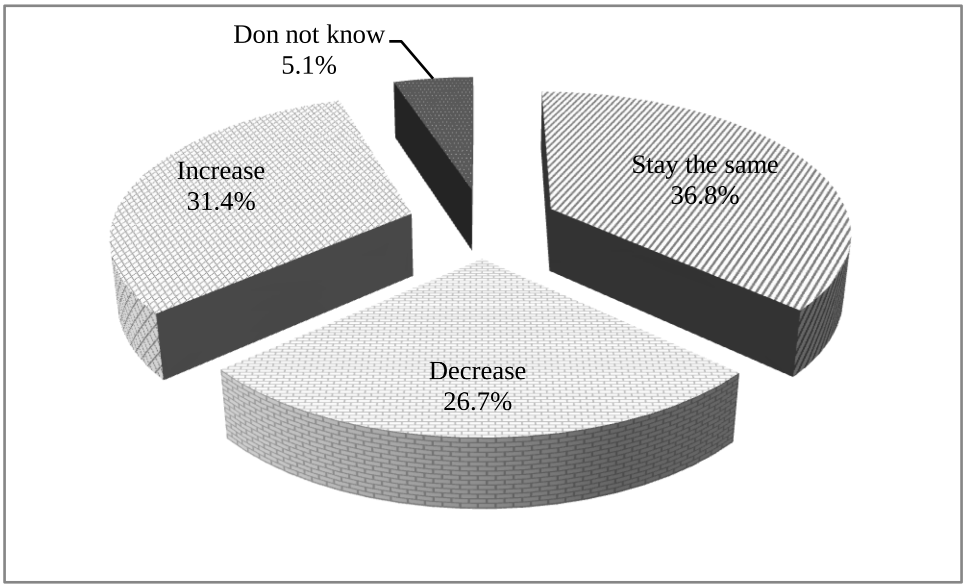
Source: Modified by author based on Tong et al. (2013), pp. 17

Tong et al. (2013) also conducted a similar interview about the perception of rural households on their main income sources. Like what was found in the study of Sobrado et al. (2013), one of the main sources of rural households' income is from agricultural activities. Figure 3.1 shows that among the 1,535 households engaging in agricultural activities, about 37% of them thought their income from agriculture would remain the same while around 30% of them thought it would increase due to the productivity improvement and price rise although the price of factors of production would be likely to increase as well but may be offset by the increase in prices of agricultural crops. Only a few households thought that infrastructure would increase their income from agriculture even though infrastructure is always considered the important factor in agricultural production. On the other hand, about 25% of the respondents thought that their income from agriculture would decrease over the next three years citing bad weather[19], crop diseases, increasing the prices of inputs, and shortage of

[19] What farmers thought about the effect of weather on their agricultural production somewhat coincide with that of scholars'. In this era of climate change, Cambodia is identified as a vulnerable country that is likely to be nagatively affected by the global warming, especially for the country's agricultural sector because the adaptive capacity is low (Thomas et al., 2013).

factors of production such as labor and land as the main sources of the declining. About 9% of them did not have any idea whether their income would decrease or increase or stay the same.

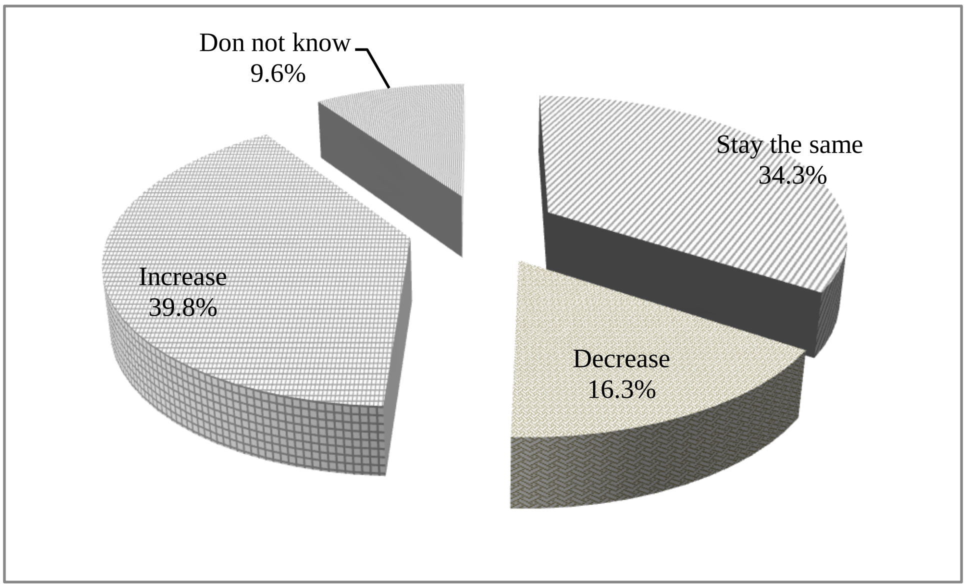
Figure 3.2 Households' Perceptions of Income from Self-employment



Source: Modified by author based on Tong et al. (2013), pp.18

Self-employment is another important source of rural households' income. Their perceptions on this income source are not much different from that of income from agriculture. 551 households who engaged in self-employment were interviewed. About 31% of them thought their income from this source would improve. Intensifying their labor and capital, and increasing income of other villagers were believed to improve the self-employment income. Steady increase of income of other villagers means a steady increase of demand from self-employed business. However, around 27% of them believed that their income from self-employment would decrease over the next three years because of decreasing capital and labor, and decreasing income of other villagers, which is contrary to the respondents who thought income from self-employment would increase. This indicates the importance of labor, capital and fellow villagers' income prospects on self-employment. And the respondents' perceptions about those factors are likely to be different in a different context. As some villages consist of many well-off households while, in other villages, there not are so many. About 5% of the respondents did not know whether their income would increase or decrease or stay the same, and about one-third of them believed that their income would stay the same.

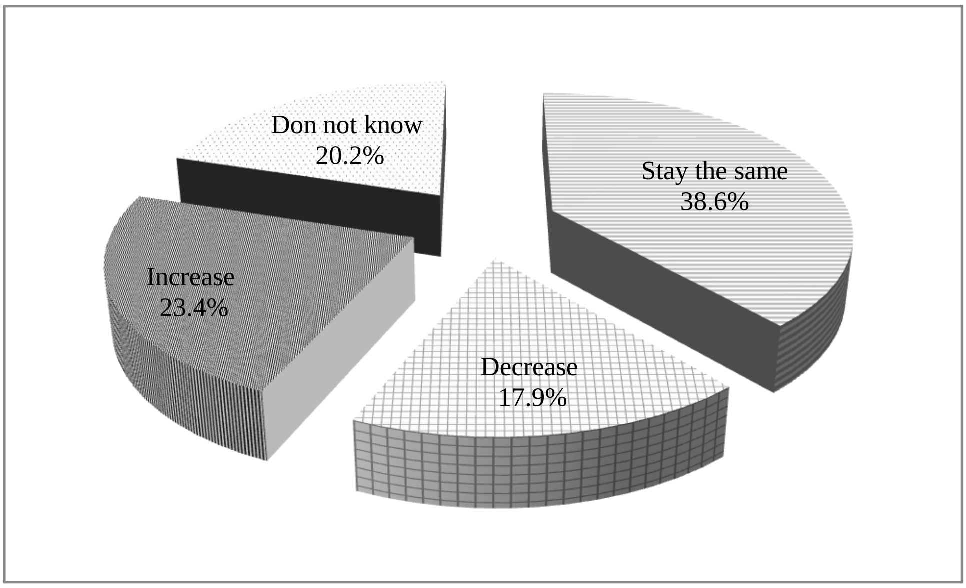
Figure 3.3 Households' Perceptions of Income from Wages



Source: Modified by author based on Tong et al. (2013), pp. 19

There were 1,126 among all household interviewed whose household members engaged in waged employment. About 40% of them believed that their income would increase in the next three years, which were more optimistic than the cases of income from agriculture and income from self-employment. These households thought that the employment opportunity would increase as more jobs would become abundant in the near future. In addition, their skills, experiences and work performances would improve. These perceptions coupled with the belief that employers' business would prosper were factors that households thought would make their income from waged employment grow. Nonetheless, about 33.4% of the households believed that their income would stay the same and 9.6 % did not have any clear perception about whether their income would stay the same, increase or decrease. There were about 16% of the households who were quite pessimistic about the income from waged employment. These households believed that jobs in the village would decrease, and the employers' business would not go well. The waged occupations predominated in the villages are farm work, construction, and manufacturing. Manufacturing works is mainly gotten from the garment and footwear industry, which are available for villages surrounding Phnom Penh. These three occupations are in general viewed as unskilled or low-skilled. Income from wage is the most important income source for rural households and among the respondents, about 70% of them had at least one members working for wage although due to their low school attainment, many member of the rural households worked in low-paid job in non-farm sectors.

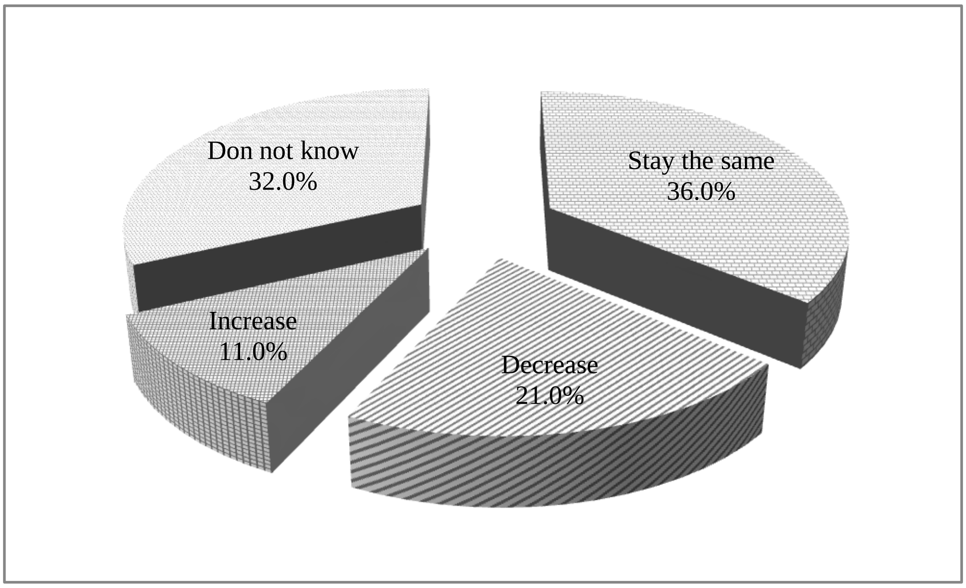
Figure 3.4 Households' Perceptions of Income from Remittances



Source: Modified by author based on Tong et al. (2013), pp. 20

Besides income from agriculture, self-employment, and waged employment, income from remittances become one of the main sources of the contemporary rural households in Cambodia and it has been in the increasing trend as more people migrate to find job opportunities either internally or internationally. This is because the size of each household has expanded, thus creating a labor surplus for the households' farm work. In addition, there is too little job opportunity in the rural and remote areas, which makes migration one of the available options. Among all respondents, 526 households who received remittances from family members or relatives were interviewed. About 39% of them thought that their income from remittances would stay the same as the income of their migrant relatives would not increase, and there would be no more family members who would migrate. Approximately 20% of them did not know whether the income would increase or decrease or stay the same. Only about 23% of them thought that the income would increase since their migrant relatives' wage would increase, and more family members could migrate. About 18% of them thought that their income from remittances could decrease as the wage of the migrant relatives could decline, and they could return back home.

Figure 3.5 Households' Perceptions of Income from Transfer and Scholarship



Source: Modified by author based on Tong et al. (2013), pp. 20

Another source of income, although not contribute much to the rural households' pool of income is income from transfer and scholarship. Among the households interviewed, only 109 households received income transfer either from the government or from NGO. About 36% of the households interviewed thought that their income from transfer or scholarship would stay the same as there would be no additional support from the government, or the number of NGO providing support would not increase. Only roughly 11% of them believed that their income from this source would increase while 32% other did not have any idea, and 21% thought it would decrease. Cash transfer provides a safety net and social protection to the poor, thus encouraging them to carry out productive and higher return activities. In the case of Cambodia, conditional cash transfer was found to be effective in reducing poverty and enhancing the poor's productivity if social protection and rural development policies were simultaneously implemented (Levy & Robinson, 2014). In addition, considering that educational attainment is important for the poor to get jobs, particularly the waged employment, scholarship was found to play some role. Filmer & Schady (2008) found that, in Cambodia, the enrollment and attendance rate of students who participated in a scholarship program were 30% higher than if the program did not exist. Therefore, although income from transfer and scholarship is small compared to other sources of income, it can play a big role in poverty reduction if appropriately implemented.

3.5 Conclusion

In order to reduce poverty, it is important to know who the poor and what their endowments are because this knowledge can contribute significantly to the formulation of effective poverty reduction. Recently, poverty in Cambodia become a rural phenomenon as the poverty rate in rural areas is much higher than that of the urban areas and the urbanization rate in Cambodia is among the lowest in Asia even though recently the speed of urbanization become faster[20]. With the current poverty rate and level of urbanization, it can be concluded that millions of rural people are living under poverty line, and many others are living close to the poverty line. These people engage mainly in agriculture, agriculture-related and labor intensive activities. Their main sources of income include income from agricultural crops, waged employment, self-employment, and remittances. These people are considered unskilled or low-skilled. For this reason, although they work in waged employment, their jobs are largely in low-skilled industries such as construction, and garment and footwear industry. Recently, many households send their member to work outside their locality. Whether it is internal or international migration, they still work in low-skilled jobs. It is, therefore, crucial

[20] Although Cambodia is mostly rural, recently, the speed of urbanization in Cambodia becomes one of the fastest in East Asia, threatening the urban areas' infrastructure. For detail, Please see http://www.phnompenhpost.com/business/capitals-rapid-urban-migration. Last accessed January 29, 2015.

to recognize that creating low-skilled jobs can be indispensable in providing employment to the rural poor households in addition to agricultural activities, which household have engaged for ages. In the case of agriculture, agricultural development such as mechanization, commercialization and intensification of farming, which can improve farmers' income should be prioritized.

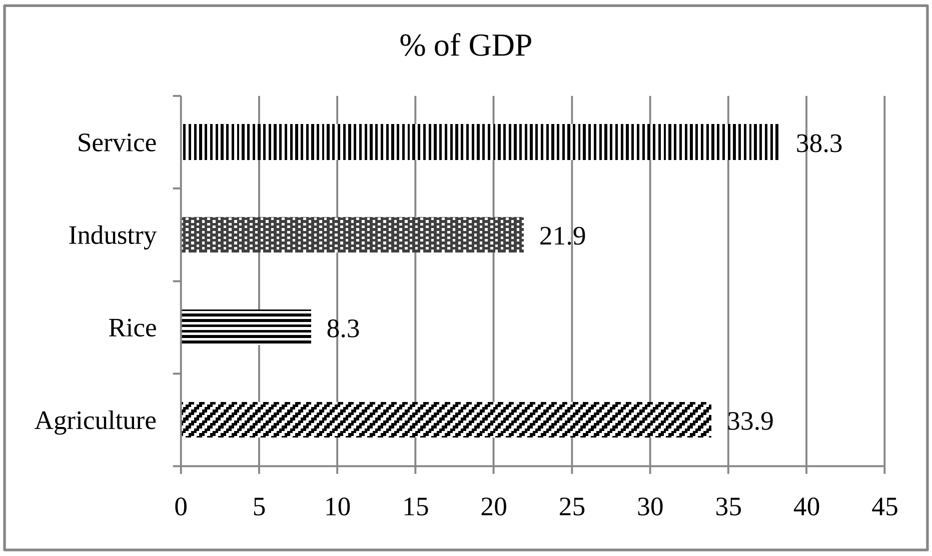
The rural households do not have high prospects for their future as indicated by their perceptions on their income. In all sources of income, only about one-third of the responds thought that income would increase. This indicates that many rural households live in the uncertain future, which can impact their investment behavior. Farmers may not invest in upgrading their farmland if the prospect of a return from that investment is low. And workers may not work hard enough if they think that their working place is going to shut down in the near future. It is important to raise the prospect of the people as it can affect their investment behavior, thus their productivity, which then impacts their poverty status. Safety net and social protection such as conditional cash transfer can raise people' confidence, thus should be considered in implementing. As income from agricultural crops, which is predominated by income from rice, is one of the rural households' main sources of income, the subsequent chapter will scrutinize the role of rice industry in the Cambodian economy and compare its productivity vis a vis other rice producing countries.

Chapter 4: Cambodian Rice Industry and the Comparison of Rice Productivity

4.1 Introduction

Agricultural sector plays an important role in the economy of the agrarian Cambodia. It is a source employment and income for a large portion of the rural population, and also a source of foreign exchange for the country. The contribution of the agricultural sector in the national GDP is still high although it has been gradually declining as the economy progresses, thus changing its structure. It is not unusual that when the economic growth sustains for some consecutive years, the share of agriculture will be declining, and the manufacture and service sector will take the lead. Cambodia has followed this pattern of structural change although as of 2010, agriculture still accounts for about 33.9% of the GDP, while industry and service sectors account for about 21.9% and 38.3% respectively (Figure 4.1). This share has been shrinking as it used to be as high as 46.5% in 1996 (ADB Key Indicators, 2014).

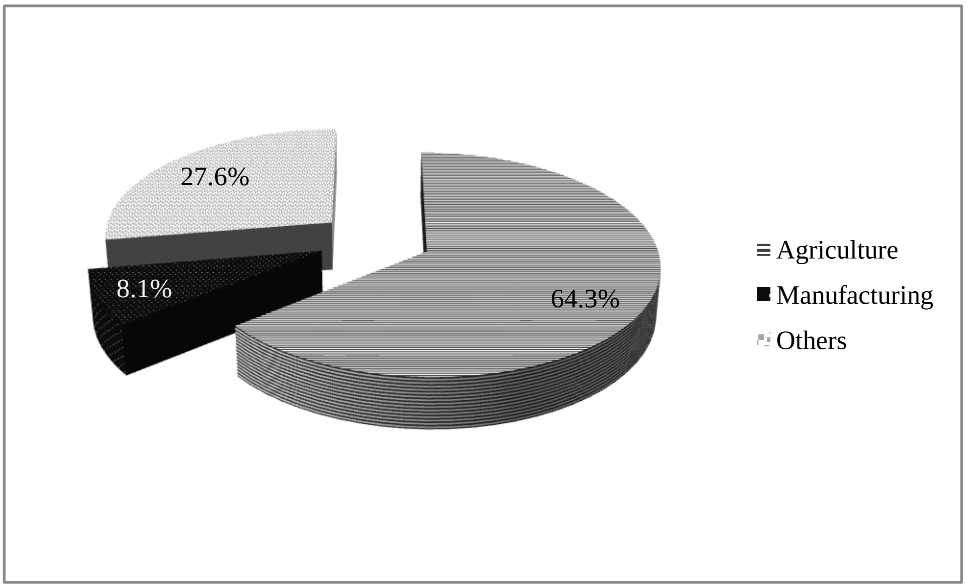
Figure 4.1 Structure of the Cambodian Economy in 2010



Source: Compiled by author based on NIS (2011)

In terms of employment, about 64.3% (Figure 4.2) of Cambodian labor forces engage in agricultural activities. This is considerably large percentage signifying the importance of the agricultural sector as a source of employment. When discussing the Cambodian agriculture, it is worth noting that the sector is very much undiversified with rice being the dominant food crop, and it is a lifeline of most of the Cambodian rural households. Rice provides important sources of employment, income as well as protein to the farming households. The crop is said to have been cultivated in Cambodia since about 2,000 years ago in the case of upland rice but may be more recent for other type of rice cultivation such as the floating rice (Helmers, 1997). Large portion of the agricultural resources, labor, capital and land, are devoted to rice cultivation.

Figure 4.2 The Aggregate Employment by Sector, 2013



Source: Compiled by author based on ADB Key Indicators (2014)

This chapter describes the characteristics of and the role rice industry plays in the Cambodian economy, and compare the productivity of Cambodian rice production vis a vis other rice producing countries, mainly in Asia because rice is the staple food for most of the Asian countries. Two productivity indicators, yield and gross rice value per hectare, are compiled, computed and compared to determine the status of the productivity of the Cambodian rice. At the end of the chapter, factors affecting rice productivity are also explored.

4.2 The Cambodian Rice Industry

4.2.1 Agricultural and Rice Land Use

Cambodia is located in the tropical Southeast Asian region. Like that of other countries in the region, the climate in Cambodia is dominated by the monsoon with distinct dry and wet season, which is favorable for the cultivation of many tropical crops. Cambodia has one of the highest per capita arable land (hectare per person) in the world. In Southeast Asian region, Cambodia's per capita arable land is the highest (0.28 hectare per person), which is higher than that of Thailand (0.25 hectare per person[21]) although for the agricultural land (as percentage of total land area), Cambodia has only 32.6% while Thailand has 42.8%[22]. This indicates that Cambodia has an abundant land resource per farmer that is one of the important factors in agricultural production. Agricultural land is devoted largely to rice cultivation as indicated in Figure 4.3. According to the figure, rice dominates about 80% of the agricultural land, with other crops such as corn, cassava and soybean take up the rest of the agricultural land.

Based on differences in agro-climatic condition, land for rice cultivation in Cambodia is diverse and can be classified as rainfed upland, rainfed lowland, deep water or floating rice, and irrigated dry season or recession rice, yet the predominant rice area is the rainfed lowland, which accounts for 90% of the total wet season rice area (USDA, 2010).

4.2.2 Rice Production

There is no record of the exact time when rice was cultivated in Cambodia but it has been assumed that long time ago rice has been cultivated by Cambodian farmers, at least as long as 2,000 years ago with the irrigation technology being introduced around 1,500 years ago (Chandler, 1993). Rice production is the backbone of the Cambodian economy in the Angkorian period, when the Khmer empire reached the zenith of prosperity. Since then, growing rice has been one of the main economic activities of the Cambodian people. By 1940,

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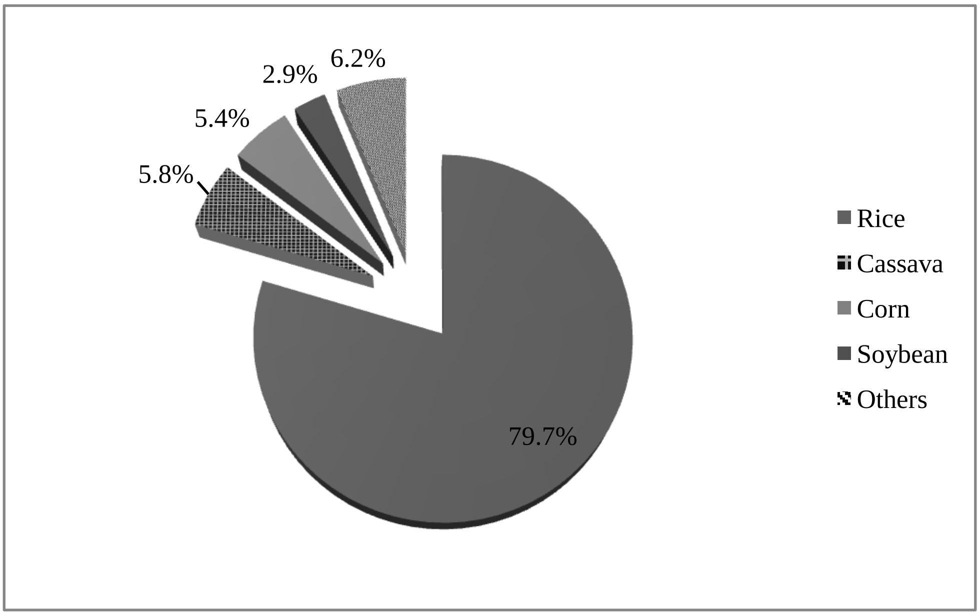
[21] Data from WDI: http://data.worldbank.org/indicator/AG.LND.ARBL.HA.PC. Last accessed November 8, 2014.

[22] Data from WDI: http://data.worldbank.org/indicator/AG.LND.AGRI.ZS. Last accessed November 8, 2014.

during the French protectorate, Cambodia became the third largest rice exporting countries in the world (Munson et al., 1968 as cited in Helmers, 1997). In the 1960s, after gaining independence from the French colonization in 1953, Cambodia had continued to be one of the main rice producers and exporters. The revenue from rice export was then the main source of foreign exchange of the newly independent state. Unfortunately, due to the lingering war, rice production had been declining significantly to the level that domestic production was not enough to feed the population. People of the once thriving agrarian society had to survive on food aid, if existed, or reduce consumption or switch to other close substitutes such as corn and root crops. In the worst situation such as during the Khmer Rouge regime, many people had been starved to death.

Figure 4.3 Crop Cultivated Areas, 2010



Source: Compiled by author based on NIS (2011)

In early 1970 Cambodia became fully engaged in the second Indochina war fighting the Khmer Rouge and the Vietnamese communist forces. This war lasted until 1975 when the Khmer Rouge took power. During this war, rice production, economy and the livelihood of the rural population were devastated. Official statistics showed that by 1974, rice growing areas declined by 77% and rice production declined by 84% of the level produced in early 1970 (Helmers, 1997)

The Khmer Rouge seized poverty in April 17, 1975. Agriculture, rice production, in particular, was the main focus of the development policy of the utopian regime. The objective of the government was to cultivate rice two or three shift per years, substitute the high yielding varieties for the local varieties and expand cultivated areas into cleared forest. Irrigation system was expanded but due to the lack of technical knowledge many irrigation systems built during this regime was unusable. The agricultural development in the Khmer Rouge regime was dubbed a complete failure although there is no accurate statistics about the production of rice during this period.

In early 1979, the Khmer Rouge was overthrown, and another communist force governed Cambodia. A socialist development policy was pursued by the new regime. Solidarity groups consisting of 20 or 25 families were formed to cultivate rice, and the output was shared among the farming households. In practice, the collectivization was not strictly pursued. During the period from 1979 to 1989, the agricultural knowledge has improved due to the training provided to Cambodian students by the Eastern bloc. In 1989, the government implemented a new policy providing private ownership of land to the people. The size of land was distributed equitably but due to the different density of the population among regions and provinces, inequity of land holding existed. Although agricultural knowledge has improved, rice production during this period has not reached self-sufficiency level yet. And, the exact data of the production was not available or at best unreliable. After the collapse of the Khmer Rouge, Cambodia had the first democratic election in 1993, and the government policy started to change, from the planned to the market economy, and rice production among other things also has changed.

Until the harvesting season of 1995/96 that Cambodia was able to produce rice surplus and since then the production has been gradually increasing so has the surplus. Cambodia managed to resume the rice-exporting-country role, and Cambodian rice in the forms of milled rice and paddy rice has been penetrating the international market although less significantly compared to others established rice exporters such as Thailand and Viet Nam.

Since the surplus of production was achieved, rice production has been increased steadily, more than double from approximately 4 million tonnes in 2000 to around 9.4 million tonnes in 2013 (Table 4.1). Rice production is separated between wet and dry season production. In 2000, the yield of both season's production was very low, only 1.9 tonnes per hectare and 3.2 tonnes per hectare for the wet and dry season production respectively. Yield has been gradually increasing to 2.9 tonnes per hectare for wet season and 4.4 tonnes per hectare for dry season. Harvested area is another factor contributing to the increased production; total harvested area was only 1.9 million hectares in 2000, but it has expanded to around 3 million hectares in 2013. Landmine clearing and the exploitation of the unused agricultural land has contributed to the expansion of land for rice cultivation. Area expansion has great impact on the production of wet season rice; however, it is only a short-term solution, in the longer run, for sustainable growth, the improvement in productivity in the only feasible approach because land area cannot keep expanding indefinitely (Yu & Fan, 2011).

4.2.2.1 Wet Season Production

Wet season rice is the main production of Cambodian rice; it represents around 80% of the total production and an average of about 85% of the harvested area. This share has been stable for last 13 years (Table 4.1). With limited access to irrigation, wet season rice farmers depend heavily on rainfall. Farmers start planting rice in May, and they are able to harvest until around December or maybe longer depending on seed varieties planted. In MAFF's agricultural statistics, wet season rice is categorized into five types: early, medium, late, upland and floating rice in accordance with the time needed from planting to harvesting and topography. In general, the early rice takes a shorter period, from planting to harvesting, than the medium rice, and the late variety rice needs the longest period to be harvested. The Upland rice is normally planted in mountainous areas in Plateau/Mountain region while floating rice is common in flooding areas around the Tonle Sap and the Mekong River.

Cheu (2011) stated that cultivation process of wet season rice, especially during seedling, uprooting, transplanting and harvesting time is relatively labor intensive because the method of rice transplanting is applied. Moreover, farmers are observed to still use traditional cultivation practice and mostly family labors. Nonetheless, since many farmers cultivate wet season rice, during the harvesting period, shortage of labors is not uncommon; therefore, farmers either need to hire labor or exchange labor with fellow farmers. This practice requires that farmers have good communication skills and prepare well in advance the cash to hire labor, or else they need to take loan, which they need to have collateral if they want to access the formal financial institution otherwise they have to borrow from the village money lenders, who always charge usurious interest rate.

Table 4.1 Cambodian Rice Production, Harvested Area and Yield (2000 to 2013)

Year	Production (1000 tonnes)			% of Total Production		Havested Area (1000 ha)			% of Harvested Area		Yield (tonne/ha)		
	Total	Wet	Dry	Wet	Dry	Total	Wet	Dry	Wet	Dry	Total	Wet	Dry
2000	4,026.1	3,212.3	813.8	79.8	20.2	1,903.2	1,647.8	255.3	86.6	13.4	2.1	1.9	3.2
2001	4,099.0	3,276.0	823.1	79.9	20.1	1,980.3	1,723.4	256.9	87.0	13.0	2.1	1.9	3.2
2002	3,822.5	2,915.9	906.6	76.3	23.7	1,994.6	1,709.7	285.0	85.7	14.3	1.9	1.7	3.2
2003	4,711.0	3,838.0	873.0	81.5	18.5	2,242.0	1,967.0	275.0	87.7	12.3	2.1	2.0	3.2
2004	4,170.3	3,132.6	1,037.7	75.1	24.9	2,109.1	1,815.6	293.4	86.1	13.9	2.0	1.7	3.5
2005	5,986.2	4,734.3	1,251.9	79.1	20.9	2,414.5	2,093.6	320.9	86.7	13.3	2.5	2.3	3.9
2006	6,264.1	4,973.7	1,290.4	79.4	20.6	2,516.4	2,188.7	327.7	87.0	13.0	2.5	2.3	3.9
2007	6,727.1	5,363.7	1,363.4	79.7	20.3	2,567.0	2,222.6	344.4	86.6	13.4	2.6	2.4	4.0
2008	7,175.5	5,722.1	1,453.3	79.7	20.3	2,613.4	2,252.7	360.6	86.2	13.8	2.7	2.5	4.0
2009	7,585.9	6,001.4	1,584.5	79.1	20.9	2,674.6	2,290.6	384.1	85.6	14.4	2.8	2.6	4.1
2010	8,249.5	6,548.7	1,700.7	79.4	20.6	2,777.3	2,372.5	404.8	85.4	14.6	3.0	2.8	4.2
2011	8,779.4	6,700.4	2,078.9	76.3	23.7	2,766.6	2,294.8	471.8	82.9	17.1	3.2	2.9	4.4
2012	9,290.9	7,136.1	2,154.8	76.8	23.2	2,980.3	2,484.8	495.5	83.4	16.6	3.1	2.9	4.3
2013	9,390.0	7,271.3	2,118.7	77.4	22.6	2,969.0	2,485.5	483.4	83.7	16.3	3.2	2.9	4.4

Source: Compiled by author based on Agricultural Statistics, from 2000 to 2014

The yield of wet season rice is generally lower than that of dry season rice. Cheu (2011) claimed that wet farmers do not use chemical fertilizers as they mainly cultivate for family consumption, and they believe that using chemical fertilizers harm the soil quality and lower the quality of rice. Yu & Fan (2011) also stated the insufficient use of chemical fertilizers among Cambodian farmers. The low usage of chemical fertilizers, limited access to irrigation, traditional farm practice and natural disasters such as flood and drought are the main causes of low yield.

4.2.2.2 Dry Season Production

Dry season rice is generally cultivated from December to March; it takes fewer months than wet season rice, in general. To cultivate dry season rice, farmers need at least partial access to an irrigation network. Given that the access to irrigation infrastructure is very limited, farmers usually cultivate dry season rice in the location close to water source such as river or lake, where they can easily pump water into their rice field when needed. Consequently, the area devoted to dry season rice is much smaller than that for wet season rice. In the last 13 years, the harvested area of dry season rice is on average around 15% of the total harvested area. However, its yield is higher than the wet season; therefore, with only 15% of harvested area, the production of dry season rice account for approximately 22% of the total production on average for the last 13 years (Table 4.1).

Cheu (2011) asserted there are many favorable conditions for dry season production such as the shorter period for cultivation, normally less than 120 days, and manageable water supply as farmers need to have at least partial access to irrigation. Moreover, the cultivation method is less complicated and less labor-intensive than the wet season production; hence, farmers do not need to manage labor as required in wet season production.

4.3 Rice Promotion Policies

As the role of rice in the economic growth, poverty reduction and food security have been fully recognized, the Cambodia government has paid special attention to this industry. Rice appears in many government policies, strategies and planning documents whenever agriculture is mentioned. For instance, for agricultural growth, the improvement of rice yield through farming intensification, that is use more of input such as fertilizers, has been a top priority rather than expanding the agricultural land and diversification of crop cultivation. The measures to increase yield includes the construction and maintenance of the irrigation facilities, improving the supply and delivery of inputs, and improving the water resource management.

In the major government policy documents such as the National Strategic Development Plan (NSDP), the target of rice output was clearly set along with the action plans that need to be carried out to achieve the target. Following the Rectangular Policy 2004, for example, in the 2006-2010 NSDP, the target of rice output was set at 5.5 million tonnes by 2010. In order to reach this target, rice yield was expected to increase from 2.0 tonnes per hectare in 2005 to 2.4 tonnes per hectare in 2010. The increase of 20% in rice yield in five years is quite an ambitious target because, in order to increase yield, the government has to increase the proportion of the land with access to either full or partial irrigation, which means huge public investment needs to be financed. In NSDP 2006-2010, the growth target of the irrigated land area was from 20% in 2005 to 25% in 2010, i.e. the portion of agricultural land with access to irrigation would expand from 588,687 hectares in 2005 to 650,000 hectares in 2010. The target was revised to a higher level in the Mid-Term Review of NSDP in 2008 to reflect the achievement in the previous years. The original target of rice production, 5.5 million tonnes, was adjusted to 7.5 million tonnes. To achieve the revised target, the new target of rice yield improvement has risen to 2.8 tonnes per hectare instead of the former target of 2.4 tonnes per hectares in the original NSDP 2006-2010. The revised target irrigated land areas for rice production for 2010 was set at 867,000 hectares, which is an increase of 200,000 hectares from the initial plan. In order that these ambitious goals of rice development be realized, the budget of US$990 million, which is 13.8 % of the total budget for 2006-2010, has been allocated to improve the management of agricultural land, development of rural areas and seasonal crops (mainly for development of rice production).

In addition to the above mentioned improvement and development strategies, the Strategy for Agriculture and Water (SAW) that is specific for particular agricultural sectors in 2006-2010 was also required under the NSDP. The goal of the SAW is twofold. First, it aims at improving the agricultural productivity and promoting crop diversification, and secondly, it aims to develop and improve the management of water resources. The target of rice production in SAW is the same as the target in the 2006-2010 NSDP but was lower than the revised target in the Mid-Term Review NSDP 2008. Different types of irrigations such as supplementary irrigation during the wet season and full irrigation in the dry season were also prioritized in the SAW.

Because the Cambodian irrigation is poorly developed, the investment in constructing and renovating the existing irrigation infrastructure, as well as its management, has been considered as significant factors in developing Cambodia's rice industry and a priority for the country's public investment. The proportion of public investment devoted to investment in an irrigation system has been increasing in recent years. Consequently, the average rice cultivating areas with access to irrigation per commune, both the supplementary irrigation for wet season production and the full irrigation for dry season production, increased by 50 hectares, about 17%, from 270 hectares to 320 hectares per commune (Phyrum, 2007). Between 2007 and 2009, the irrigation investment, which is under management of the Ministry of Water Resources and Meteorology (MOWRAM), was doubled. Total budget allocated to develop irrigation system from the Cambodian government and other sources was US$31.8 million in 2007 and rose to US$59.2 million annually in the next three consecutive years (Sophal et al., 2010). The investment expenditure on building new irrigation scheme and renovating the existing ones has been increasing substantially compared with expenditure on other agricultural sub-sectors. Based on the SAW budget allocation, the amount of US$100 million will be earmarked for the Agricultural Program, and another US$100 million will be allocated to the Water Resource and Irrigation Program. In both programs, significant amount of investment will be allocated for rice production improvement. Rice is also emphasized in the Agricultural research investment program, and in particular the SAW focuses on promoting high quality and high yielding varieties of rice. In addition, the rice varieties that are more tolerant to unfavorable weather and climate change are also mentioned. According the MAFF & MOWRAM (2009), in the Research and Extension Program of SAW, about one-third of budget that is allocated for research in 2010-2014 would be spent on the agricultural and water resource management.

4.4 The Comparison of Rice Productivity

Total factor productivity (TFP) is one of the most comprehensive and sophisticated indicators of productivity, which can also be used to measure agricultural productivity yet it is often difficult to obtain sufficient data to calculate TFP in developing countries like Cambodia, where the capacity to collect quality data is limited. This section aims to compare rice productivity among a group of Asian rice producing countries in order to gauge the level of productivity of Cambodian rice. It is generally mentioned that the productivity of Cambodian rice is low, but to be able to confidently judge whether the productivity is low or high, it has to be compared with the level of productivity in other countries. Due to data limitation, TFP will not be calculated; thus, rice yield, which is the most commonly used proxy for productivity, is applied as an indicator of productivity in this study. The comparison of yield alone may misrepresent a country's productivity status. For instance, farmers may decide to grow a low-yielding variety because its economic value is higher. In general, the low-yielding traditional variety, which has superior taste, can be marketed dearly in the international market, so although farmer produces less per hectare, but they are able to fetch higher profit. Some traditional varieties can only be grown in a specific region with appropriate soil quality and topography. Therefore, in addition to yield, gross rice value per hectare is calculated and compared. The gross rice value per hectare provides additional information on the economic benefits farmers can reap from cultivation.

Countries included in the comparison of rice productivities are the major rice producing countries in East, Southeast and South Asia, as shown in Table 4.2. Rice is one of the most important staple foods in all these countries. It is also a strategic food crop, so important in terms of food security. Many governments try to regulate and control the production and trade of rice. More developed countries like Japan[23] tend to subsidize farmers to keep producing rice, whereas less developed countries try to tax rice export to ensure cheap and sufficient supply for the domestic market. A rise in rice price may lower welfare of many poor consumers. As result, the volume of rice trade is relatively thin. To some extent, the volume of production reflects the domestic demand of each country. Large countries like China and India produce a huge amount of rice, whilst the production of rice in Malaysia and

[23] Since 1971, the Japanese government has implemented a rice diversion program. Rice farmers are paid to keep some proportion of their farmland fallow each year to control supply and stabilize the domestic market prices. Income from rice is not their main source of income. Many farmers generate income from non-farm sources (Ito, 2010).

Lao PDR are negligible by international standard although they do not have a shortage in rice supply.

Table 4.2 traces the production of rice in different countries from the year 2000 to 2012. Except for Japan, the Republic of Korea and Bangladesh, the production of rice in other countries have increased, most likely to feed the growing population or export, in the case of net exporting countries. The production in Japan and the Republic of Korea is quite stable reflecting the stagnant demand and strict control of production. The production in Bangladesh is every much fluctuating likely due to unfavorable weather condition as the country is prone to frequent natural disasters such as flood and drought.

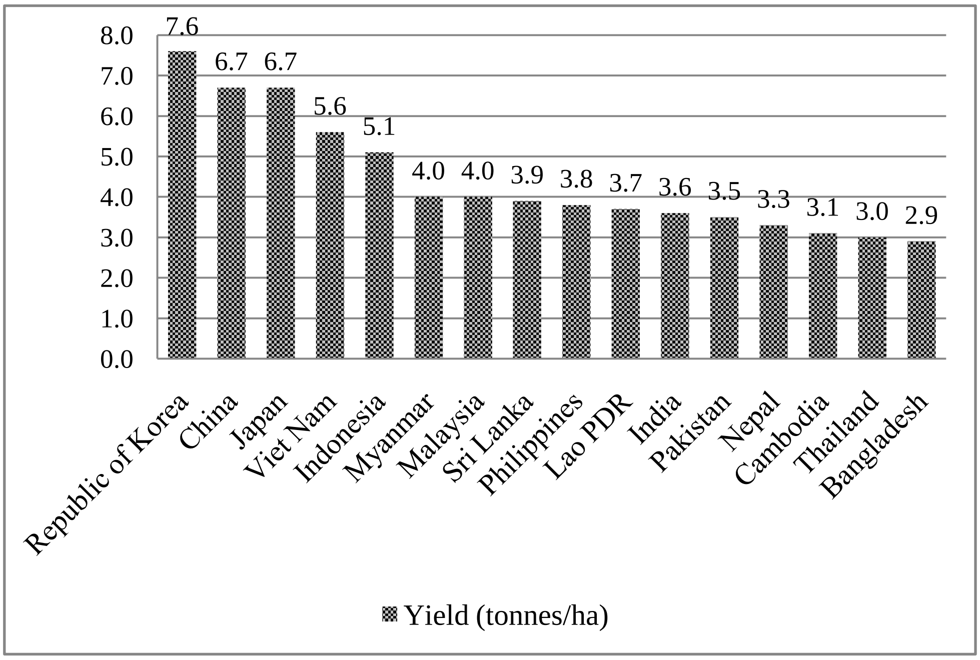
Table 4.2 Rice Production in Asian Countries (million tonnes), 2012

Countries/Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
China	189.8	179.3	176.3	162.3	180.5	182.1	183.3	187.4	193.3	196.7	197.2	202.7	206.0
India	127.5	139.9	107.7	132.8	124.7	137.7	139.1	144.6	148.0	135.7	144.0	157.9	152.6
Indonesia	51.9	50.5	51.5	52.1	54.1	54.2	54.5	57.2	60.3	64.4	66.5	65.7	69.0
Viet Nam	32.5	32.1	34.4	34.6	36.1	35.8	35.8	35.9	38.7	39.0	40.0	42.4	43.7
Thailand	25.8	28.0	28.0	29.5	28.5	30.3	29.6	32.1	31.7	32.1	35.6	34.6	37.8
Bangladesh	37.6	36.3	37.6	38.4	36.2	39.8	40.8	43.2	46.7	48.1	50.1	50.6	33.9
Myanmar	21.3	21.9	21.8	23.1	24.9	27.7	30.9	31.5	32.6	32.7	32.6	29.0	33.0
Philippines	12.4	13.0	13.3	13.5	14.5	14.6	15.3	16.2	16.8	16.3	15.8	16.7	18.0
Japan	9.4	9.0	8.8	7.8	8.7	9.1	8.6	8.7	8.8	10.6	10.6	10.5	10.7
Pakistan	7.2	5.8	6.7	7.3	7.5	8.3	8.2	8.3	10.4	10.3	7.2	9.2	9.4
Cambodia	4.0	4.1	3.8	4.7	4.2	6.0	6.3	6.7	7.2	7.6	8.2	8.8	9.3
Republic of Korea	7.2	7.4	6.7	6.0	6.7	6.4	6.4	6.0	6.9	7.0	6.1	6.3	6.4
Nepal	4.2	4.2	4.1	4.1	4.5	4.3	4.2	3.7	4.3	4.5	4.0	4.5	5.1
Sri Lanka	2.9	2.7	2.9	3.1	2.6	3.2	3.3	3.1	3.9	3.7	4.3	3.9	3.8
Lao PDR	2.2	2.3	2.4	2.4	2.5	2.6	2.7	2.7	3.0	3.1	3.1	3.1	3.5
Malaysia	2.1	2.1	2.2	2.3	2.3	2.3	2.2	2.4	2.4	2.5	2.5	2.6	2.8

Source: Compiled by author based on FAOSTAT (2013)

Figure 4.1 presents rice yield in different Asian countries in 2012. The Republic of Korea with the yield of 7.2 tonnes per hectare is the most productive country in rice production followed by China and Japan with the yield of 6.7 tonnes per hectare. The three least productive countries are Cambodia, Thailand and Bangladesh having rice yield of about 3 tonnes per hectare, less than half of the level in the three most productive countries. From the table, it is apparent that the more developed countries tend to have higher rice productivity as they have technology and human resource to develop the variety that are suitable for the climate and soil condition in their countries. In addition, they also have more developed irrigation system and factors of production to support rice cultivation. Surprisingly, Thailand, the long-time-biggest rice exporter, and relatively more developed country, has the yield level comparable to low-income countries like Cambodia and Bangladesh. That Thailand lacks the capacity to improve rice yield is dubious. Let us turn to the other indicator of rice productivity, the gross rice value per hectare and see whether this puzzle can be solved.

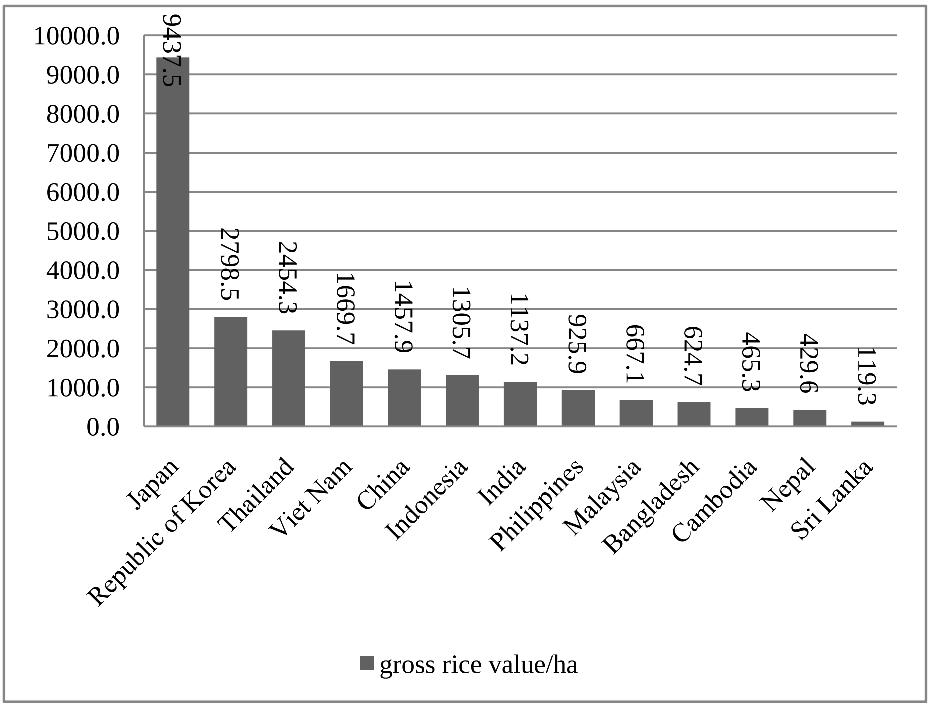
Figure 4.4 Rice Yield in Selected Countries in Asia, 2012



Source: Compiled by author based on FAO STAT (2013)

The gross rice value per hectare is calculated by multiplying the producer price by the total production, and then divided by the harvested area in hectare. Because the most recent data available for Cambodia is the data in 2007, for all countries, the data for 2007 are also used for the sake of comparison although many countries have more recent data. The comparison of the gross rice value per hectare shows interesting results. According to Figure 4.5, the most productive countries are Japan followed by the Republic of Korea and Thailand. Thailand ranks among the lowest in the comparison of yield. This can explain why the yield of Thai rice is low. Thailand is well-known in producing and exporting premium quality rice, jasmine rice; thus, although the yield is low, Thai farmers can earn more per hectare than other rice producing countries with higher yield such as Viet Nam and Indonesia. To illustrate, Thai farmers can gain about US$ 2,454.3 per hectare compared to only US$ 465.4 for farmers in Cambodia. The governments of Japan and the Republic of Korea heavily subsidize rice farmers, so it is difficult to know the exact value of rice in these two countries. For the least productive countries, Cambodia, Bangladesh, and Nepal are still the least productive regardless of whether the yield or the gross rice value per hectare is compared. It is worth mentioning that Sri Lanka, which is average in rice yield, becomes the least productive if the gross rice value per hectare is used instead of yield.

Figure 4.5 Gross Rice Value per Hectare in Selected Asian Countries in 2007



Source: Compiled by author based on FAOSTAT (2013)

4.5 Factors Constraining the Growth of Cambodian Rice

In many Asian countries, the growth of agricultural productivity is a precondition for industrialization. In Cambodia, because rice is a predominant crop in the country's undiversified agriculture, the growth of rice productivity is expected to play an important role in the process of economic development. The low level of both rice yield and gross rice value per hectare, which are indicators of rice productivity, indicates that the Cambodian rice industry is underdeveloped, and its full potential has yet to be fully exploited. Producers including rice growers always aim for high and optimal productivity, but the low productivity indicates both the poor performance of the industry and the potential to be further improved. In the case of Cambodian rice, the study by Yu & Fan (2011) revealed that although rice yield has been increasing gradually, it is much lower than its full potential, thus can grow further. In 2012, for instance, the yield of Cambodian rice is merely 3.1 tonnes per hectare, while that of the Republic of Korea, the most productive country in terms of rice production, is 7.6 tonnes per hectare. This implies that it is possible to double the yield of Cambodian rice. If the yield increases to the level closer to that of Korea's, substantial production will be realized; farming households will be able to obtain higher income from rice and increase their consumption and welfare. Improving rice productivity is thus a task that all relevant stakeholders need to carry out in order to diversify the agricultural sector, to create a more robust rural sector, to achieve more broad-based growth and development and to reduce rural poverty.

In order to improve rice productivity, we need know factors that constrain its growth. In Thailand, where rice is also a most important crop, factors of production such as rice land, farm labor, rainfall, and price of rice were found to have influenced the growth of rice production, although price of rice was found to have less significant effect (Sachchamarga & Williams, 2004), while in Laos, factors such as soil quality, flood, drought, insect pest, rodents and weed affect significantly the production of rice (Schiller et al., 2001). In Cambodia, according the USDA (2010), various factors inhibit the growth of Cambodian rice[24]. The most severe constraint is the farmers' knowledge of agricultural technique. This may be resulted from their low level of educational attainment. Many Cambodian farmers have not even completed primary education. Low education may inhibit them from accessing to new technology and technique of production although it is widely available. In addition, the funding for agricultural extension program is extremely limited. This leads to a shortage of

[24] This section draws largely from USDA (2010).

qualified agricultural officers and extension workers, who are responsible for providing training and transferring technology of production to farmers. As result, new technology of production and farming knowledge has not been efficiently transferred; therefore, many farmers still practice traditional cultivation and have to deal with problems such as drought, flood and pest outbreak by themselves. As a consequent, the productivity of their rice production is low. Besides funding for extension program, the funding for agricultural research and development is insufficient. The government relies heavily on foreign donation in the field of research and development. USDA (2010) reported that the funding crisis may become an obstacle to the operation of the Cambodian Agricultural Research and Development Institute (CARDI), one of the most modern government agricultural research institutes in Cambodia.

The third factor is the low production and availability of improved rice seed. High quality rice seed is important for the production but the improved seed has been produced so little in Cambodia due to the low funding for government agricultural institute, and due to the fact that private sector cannot take financial risk in entering the market to produce rice seed. Improved rice seed has been produced only sufficient for 1.2% of the rice area (USDA, 2010). This means that the majority of farmers produce their own seed with limited quality rendering the low productivity of their cultivation. In addition, the growth of rice crop yield has stagnated because the easy yield improvement has already been achieved but farmers do not have enough capacity to refresh planting seed stocks. Also, the new rice varieties require more usage of fertilizer and better water management yet farmers lack capital, training, and credit to fund needed investment. Commercial farm credit system is generally not available in Cambodia, which inhibits farmers from mechanizing their technology of production and adopting new technology such as improved seed and fertilizers. To access to formal finance, land collateral is needed. However, only 10% of farmers have the land deed (USDA, 2010), which mean that other 90% of farmers cannot access to formal finance due to lack of collateral. In fact, those who cannot access formal credit, have to borrow from village loanshark with usurious interest rate. This makes them unable to venture on profitable investment because the risk is so high that the chance to reap the return becomes so slim.

Finally, the expansion of irrigation system is threatened. Irrigation is one of the most important factor inputs in rice production, but the number of rice farms having access to irrigation is low in Cambodia due to limited availability of the irrigation scheme. Moreover, the existing irrigation system is dilapidated because of poor engineering design, and lack of maintenance and poor management from the side of farmers. There are many issues with regards to the water usage among farmers in low stream and upstream of the irrigation. Some irrigation projects are developed in the region with unsuitable soil condition. In some countries, small-scale irrigation equipment such water pump and shallow well are successfully made use of; however, due to a credit constraint, Cambodian farmers cannot afford to adopt this kind of small-scale irrigation technology.

4.6 Conclusion

Rice is an important food crop in Cambodia's undiversified agriculture. It is a source of income, employment and protein intake for most of the rural households and is a source of foreign exchange for the country. Anecdotal evidences suggest that the productivity of Cambodian rice is low and needs to be improved so that its full contribution to the economy can be obtained. This chapter examines the status of Cambodian rice productivity by comparing the yield and gross value per hectare of Cambodian rice with other rice producing countries. The result showed that regardless of the indicator of productivity applied, the productivity of Cambodian rice is irrefutably low. Low productivity may be interpreted in two ways: first, the performance of the Cambodian rice industry is poor; second, there is chance that the productivity can be improved. Because the gap between the productivity of Cambodian rice and that of Korea's, the most productive country, is big, there is a big room for the formers' productivity to improve. How to improve the productivity? This chapter reports the factors that constraint the growth of Cambodian rice. It is expected that if those constraints can be removed, the rice productivity will increase. Many constraints are on the side of the government and institutional. Problems such as the low funding for agricultural research and extension, the provision of irrigation system, the provision of land deed to farming households so that they can access to formal finance and the production of quality rice seed have the nature of public goods, thus cannot be solved by the market or private agent. Of course, there are also problems on farmers' side. Many farmers are not high-educated, so they do not have the capacity to absorb new technology although it is widely available. Some farmers believe that applying chemical fertilizers may affect the taste of their crops and the quality of soil. If they are knowledgeable about the proper application of chemical fertilizers, they may be able to produce more output without compromising the quality of their farmland and the taste of their crop. The private sectors simply are not able to service most of the need for the rice industry, so the government has to play more active role in the agricultural sector in general and rice industry, in particular.

Chapter 5: Factor Affecting Cost Efficiency of Cambodian Rice Farming Households

5.1 Introduction

Rice is one of the key industries, important in promoting Cambodia's economic growth and poverty reduction because of its large contribution to the GDP as well as employment, especially for the relative poor quintile of the population. The preceding chapter shows that the productivity of Cambodian rice, as measured by yield and gross rice value per hectare, is low and thus can be further improved to obtain optimal production. This chapter tries to assess the cost efficiency (another indicator of economic performance besides productivity) of farming households by testing the hypothesis of whether or not farming households are cost efficient. Efficiency is basically defined as the comparison of the observed and the optimal values of its outputs and inputs. We can measure efficiency by measuring the observed output to the maximum potential output obtainable from the input (output-oriented efficiency), or comparing the observed input to the minimum potential input needed to produce the output (input oriented efficiency), or some mixture of the two approaches. Efficient producers are able to produce more outputs given the same amount of inputs or can produce the same level of output with less input than other producers. Therefore, being efficient allows producers to save resources, which can be reallocated to use in other activities, or to produce more output, which allow them to obtain higher economic benefit, using the same amount of inputs. The formal and technical definition of efficiency is provided in the following section. In addition to testing whether or not Cambodian farming households are cost efficient, this chapter also aims at exploring factors, which influence the level of cost inefficiency.

It is undeniable that farming households are poor because they reside in rural areas, where poverty is widespread and rice cultivation is one of their main sources of income. Although they may not be poor as indicated by the defined poverty line, they are concentrating close to the poverty line, which mean that they are vulnerable to becoming poor given small income shock. Therefore, being efficient rice producers may bring many benefits to farmers; they may be able to produce more output or may spend less money on input to produce the same level of output. The finding in this chapter expects to contribute to resource saving of those poor farming households in that if it is found that they are not cost efficient in rice cultivation, this chapter will explore factors that influence cost inefficiency so that farmers can apply to improve their production and save resources, which may be used for consumption and investment. Following the introduction is the formal concept of economic efficiency.

5.2 Definition and Measurement of Economic Efficiency

This section draws heavily from Fried et al. (2008) and Fried et al. (n.d.). They defined efficiency as a ratio of the observed and optimal value of its outputs and inputs. The objective of being efficient can be to maximize outputs given the same level of inputs or to minimize input but still being able to produce the same amount of output. Depending on the behavioral goal of producers, efficiency can be computed by dividing the observed and optimal cost (cost efficiency), revenue (revenue efficiency), and profit (profit efficiency) subject to any appropriate constraints on quantities and prices. We can decompose economic efficiency into technical and allocative efficiency. Being technical efficient allows the producer to reduce or

> "avoid waste either by producing as much as the technology and input usage allow or by making use of as little input as required by the technology and output production. In other words, the technical efficiency can be an output-augmenting or input-conserving, while the allocative efficiency refers to the ability of the producer to combines inputs and/or outputs in optimal proportion"[25]

[25] Fried et al. (n.d.). *Efficiency and productivity*. Retrieved May 12, 2015 from: http://pages.stern.nyu.edu/~wgreene/FrontierModeling/SurveyPapers/Lovell-Fried-Schmidt.doc

taking into account given prices. Koopmans (1951) defined technical efficiency as the ability of the producer to produce the same outputs with less of at least one input or to use the same inputs to produce more of at least one output. Formally, a producer is technically efficient if any output is increased, at least one other output needs to be reduced or at least one input need to be increased, and “if a reduction in any input requires an increase at least one other input or reduction in at least one output”[26].

The measurement of technical efficiency was introduced by Debrue (1951) and Farrel (1957). They measured the “input-oriented technical efficiency as one (minus) the maximum equiproportionate (i.e.., radial) reduction in all inputs”, Fried et al. (n.d.), which is possible to be obtained given the prevailing outputs and technology. We can measure the output-oriented technical efficiency by computing the maximum radial expansion in all output that is obtainable given the prevailing inputs and technology. The value of one that is computed using both measurements indicates that the producer is technical efficient, and if a value that is different from one is obtained, we can conclude that the producer is technical inefficient.

Suppose the producer uses inputs $\mathbf{x} = (x_1,...,x_N) \in \mathbf{R}_+^{\mathbf{N}}$ to produce outputs $\mathbf{y} = (y_1,...,y_M) \in \mathbf{R}_+^{\mathbf{M}}$, we can represent production technology by the following production set

$$\mathrm{T} = \{(\mathbf{y},\mathbf{x}) : \mathbf{x} \text{ can produce } \mathbf{y}\} \tag{5.1}$$

$(\mathbf{y},\mathbf{x}) \in \mathrm{T}$ is technical efficient if and only if $(\mathbf{y}',\mathbf{x}') \notin \mathrm{T}$ for $(\mathbf{y}',\text{-}\mathbf{x}') \geq (\mathbf{y},\text{-}\mathbf{x})$ is the formal definition of technical efficiency.

Technology can also be represented by input sets

$$\mathbf{L}(\mathbf{y}) = \{\mathbf{x} : (\mathbf{y},\mathbf{x}) \in \mathbf{T}\} \tag{5.2}$$

which have input isoquants

$$\mathbf{I}(\mathbf{y}) = \{\mathbf{x} : \mathbf{x} \in \mathbf{L}(\mathbf{y}), \lambda\mathbf{x} \notin \mathbf{L}(\mathbf{y}), \lambda < 1\} \tag{5.3}$$

for every $\mathbf{y} \in \mathbf{R}_{\mathbf{M}}^{+}$

and have input efficient subsets

[26] Fried et al. (n.d.). *Efficiency and productivity*. Retrieved May 12, 2015 from: http://pages.stern.nyu.edu/~wgreene/FrontierModeling/SurveyPapers/Lovell-Fried-Schmidt.doc

$$\mathbf{E}(\mathbf{y}) = \{\mathbf{x} : \mathbf{x} \in \mathbf{L}(\mathbf{y}), \mathbf{x}' \notin \mathbf{L}(\mathbf{y}), \mathbf{x}' \leq \mathbf{x}\} \tag{5.4}$$

the three sets satisfy $\mathbf{E}(\mathbf{y}) \subseteq \mathbf{I}(\mathbf{y}) \subseteq \mathbf{L}(\mathbf{y})$.

Shephard (1953) was a pioneer in introducing the input distance function in order to provide a functional representation of the production technology, which is defined as:

$$\mathrm{D_I}(\mathbf{y},\mathbf{x}) = \max\{\lambda : (\mathbf{x}/\lambda) \in \mathbf{L}(\mathbf{y})\} \tag{5.5}$$

for $\mathbf{x} \in \mathrm{L}(\mathbf{y}), \mathrm{D_I}(\mathbf{y},\mathbf{x}) \geqq 1$ and for $\mathbf{x} \in \mathrm{I}(\mathbf{y}), \mathrm{D_I}(\mathbf{y},\mathbf{x}) = 1$. Give standard assumption on the production technology **T**, the input distance function $\mathrm{D_I}(\mathbf{y},\mathbf{x})$ is non-increasing in **y** and non-decreasing, homogenous of degree +1, and concave in **x**.

Following the above notation, we can interpret the measure of input-oriented technical efficiency, which is proposed by Debreu (1951) and Farrell (1957), as the value of the following function.

$$\mathrm{TE_I}(\mathbf{y},\mathbf{x}) = \min\{\theta : \theta\mathbf{x} \in \mathrm{L}(\mathbf{y})\}, \tag{5.6}$$

and from (5.5) $\mathrm{TE_I}(\mathbf{y},\mathbf{x}) = 1/\mathrm{D_I}(\mathbf{y},\mathbf{x})$ (5.7)

for $\mathbf{x} \in \mathrm{L}(\mathbf{y})$, $\mathrm{TE}(\mathbf{y},\mathbf{x}) \leqq 1$, and for $\mathbf{x} \in \mathrm{I}(\mathbf{y}), \mathrm{TE}(\mathbf{y},\mathbf{x}) = 1$.

Usually, the measurement of technical efficiency tends to orient toward increasing output so it is useful that the above development that is oriented in that direction should be replicated. Then, the production technology can be represented by the following output sets.

$$\mathrm{P}(\mathbf{x}) = \{\mathbf{y} : (\mathbf{x},\mathbf{y}) \in \mathrm{T}\}, \tag{5.8}$$

and for all $\mathbf{x} \in \mathrm{R}_+^{\mathrm{N}}$ has output isoquants

$$\mathrm{I}(\mathbf{x}) = \{\mathbf{y} : \mathbf{y} \in \mathrm{P}(\mathbf{x}), \lambda\mathbf{y} \notin \mathrm{P}(\mathbf{x}), \lambda > 1\} \tag{5.9}$$

and has output efficient subsets

$$\mathrm{E}(\mathbf{x}) = \{\mathbf{y} : \mathbf{y} \in \mathrm{P}(\mathbf{x}), \mathbf{y}' \notin \mathrm{P}(\mathbf{x}), \mathbf{y}' \geq \mathbf{y}\} \tag{5.10}$$

the three subsets satisfy $\mathrm{E}(\mathbf{x}) \subseteq \mathrm{I}(\mathbf{x}) \subseteq \mathrm{P}(\mathbf{x})$.

Another functional representation of the production technology was provided by the output distance function that was proposed by Shephard (1970). The output distance function is defined as follows.

$$\mathrm{D_o}(\mathbf{x},\mathbf{y}) = \min\{\lambda : (\mathbf{y}/\lambda) \in \mathrm{P}(\mathbf{x})\}. \tag{5.11}$$

For $\mathbf{y} \in \mathrm{P}(\mathbf{x}), \mathrm{D_o}(\mathbf{x},\mathbf{y}) \leqq 1$, and for $\mathbf{y} \in \mathrm{I}(\mathbf{x}), \mathrm{TE_o}(\mathbf{x},\mathbf{y}) = 1$.Given standard assumption on production technology**T**, the output distance function $\mathrm{D_o}(\mathbf{x},\mathbf{y})$ is non-increasing in **x** and is non-decreasing, homogeneous of degree +1, and convex in **y**.

The Debreu (1951) and Farrell (1957)'s measurement of technical efficiency $\mathrm{TE_o}$ can now be given somewhat more formal representation as the value of the following function.

$$\mathrm{TE_o}(\mathbf{x},\mathbf{y}) = \max\{\phi : \phi\mathbf{y} \in \mathrm{P}(\mathbf{x})\}, \tag{5.12}$$

and it follows from (5.11) that

$$\mathrm{TE_o}(\mathbf{x},\mathbf{y}) = \left[\mathbf{D_o}(\mathbf{x},\mathbf{y})\right]^{-1} \tag{5.13}$$

For $\mathbf{y} \in \mathrm{P}(\mathbf{x}), \mathrm{D_o}(\mathbf{x},\mathbf{y}) \leqq 1$, and for $\mathbf{y} \in \mathrm{I}(\mathbf{x}), \mathrm{TE}(\mathbf{x},\mathbf{y}) = 1$.

The preceding analysis presumes that $M > 1, N > 1$. In the single input case,

$$\mathrm{D_I}(\mathbf{y},\mathbf{x}) = \mathbf{x}/\mathrm{g}(\mathbf{y}) \geqq 1 \Leftrightarrow \mathbf{x} \geqq \mathrm{g}(\mathbf{y}), \tag{5.14}$$

where $\mathrm{g}(\mathbf{y}) = \min\{\mathbf{x} : \mathbf{x} \in \mathrm{L}(\mathbf{y})\}$ is an input requirement frontier. It is generally defined as the minimum amount of scalar input *x* that the producer needs to produce output vector **y**. Therefore, the ratio of the minimum to the actual input defines the input-oriented measure of technical efficiency (5.7) in this case. The functional representation is as follows.

$$\mathrm{TE_I}(\mathbf{y},\mathbf{x}) = 1/\mathrm{D_I}(\mathbf{y},\mathbf{x}) = \mathrm{g}(\mathbf{y})/\mathbf{x} \leqq 1. \tag{5.15}$$

In the single output case,

$$\mathrm{D_o}(\mathbf{x},\mathbf{y}) = \mathbf{y}/\mathrm{f}(\mathbf{x}) \leq 1 \Leftrightarrow \mathbf{y} \leqq \mathrm{f}(\mathbf{x}), \tag{5.16}$$

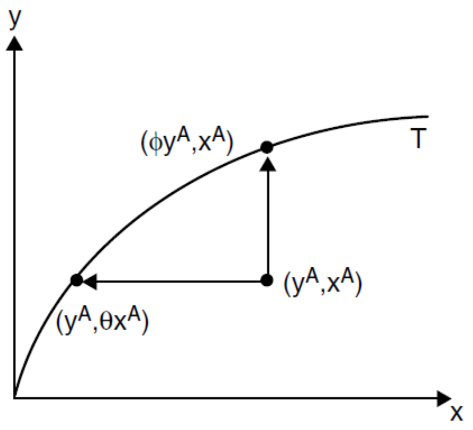
where $\mathrm{f}(\mathbf{x}) = \max\{\mathbf{y} : \mathbf{y} \in \mathrm{P}(\mathbf{x})\}$ is a production frontier, which we, generally, can define as the "maximum amount of scalar output *y* that can be produced with input vector **x**. In this case, we define the output-oriented technical efficiency in (5.13) as the ratio of maximum to actual output"[27], which is represented by the following equation.

$$\mathrm{TE_o}(\mathbf{x},\mathbf{y}) = \left[\mathrm{D_o}(\mathbf{x},\mathbf{y})\right]^{-1} = \mathrm{f}(\mathbf{x})/\mathbf{y} \geqq 1. \tag{5.17}$$

The two technical measurement of technical efficiency is presented in Figure 5.1—5.3.

[27] Fried et al. (n.d.). *Efficiency and productivity*. Retrieved May 12, 2015 from: http://pages.stern.nyu.edu/~wgreene/FrontierModeling/SurveyPapers/Lovell-Fried-Schmidt.doc

Figure 5.1 Technical Efficiency



Source: Fried et al. (2008), pp. 23

In Figure 5.1, the technical efficiency of a producer A, which is located in the interior of T, can be estimated horizontally (input-oriented efficiency) and vertically (output-oriented efficiency). Using equation (5.6), the input-oriented efficiency can be expressed as $\mathrm{TE}_\mathrm{I}(\mathbf{y}^\mathrm{A}, \mathbf{x}^\mathrm{A}) = \theta\mathbf{x}^\mathrm{A}/\mathbf{x}^\mathrm{A} \leq 1$ and using (5.12), the output-oriented efficiency can be expressed as $\mathrm{TE}_\mathrm{O}(\mathbf{x}^\mathrm{A}, \mathbf{y}^\mathrm{A}) = \phi\mathbf{y}^\mathrm{A}/\mathbf{y}^\mathrm{A} \geq \mathbf{1}$.

Increasing output and reducing input can be combined simultaneously,

"either hyperbolically or along the right angle, to reach the efficient point on the surface of **T** between $(\mathbf{y}^\mathrm{A}, \theta\mathbf{x}^\mathrm{A})$ and $(\phi\mathbf{y}^\mathrm{A}, \mathbf{x}^\mathrm{A})$. A hyperbolic measure of technical efficiency TE is defined as:

$$\mathrm{TE}_\mathrm{H}(\mathbf{y}, \mathbf{x}) = \max\{\alpha : (\alpha\mathbf{y}, \mathbf{x}/\alpha) \in \mathrm{T}\} \geqq 1, \tag{5.18}$$

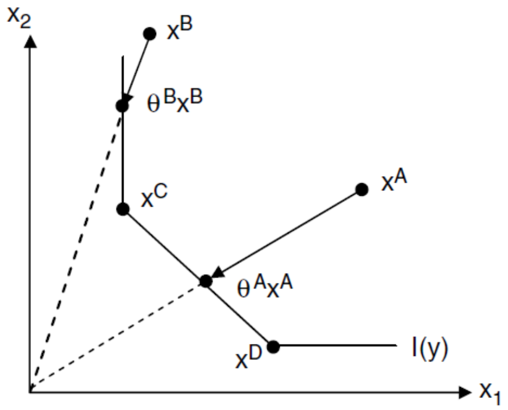
and $\mathrm{TE}_\mathrm{H}(\mathbf{y}, \mathbf{x})$ is the reciprocal of a hyperbolic distance function $\mathrm{D}_\mathrm{H}(\mathbf{y}, \mathbf{x})$. If the constant returns to scale is the production technology, $\mathrm{TE}_\mathrm{H}(\mathbf{y}, \mathbf{x}) = [\mathrm{TE}_\mathrm{H}(\mathbf{y}, \mathbf{x})]^2 = [\mathrm{TE}_\mathrm{H}(\mathbf{y}, \mathbf{x})]^{-2}$, and $\mathrm{TE}_\mathrm{H}(\mathbf{y}, \mathbf{x})$ is a dual to a profitability function. We can define one version of the directional measure of technical efficiency as the following.

$$\mathrm{TE_D}(\mathbf{y},\mathbf{x}) = \max\{\beta : [(1+\beta)\mathbf{x}] \in \mathrm{T}\} \geqq 0, \tag{5.19}$$

and $\mathrm{TE_D}(\mathbf{y},\mathbf{x})$ is equal to a directional distance function $\mathrm{D_D}(\mathbf{y},\mathbf{x})$. $\mathrm{TE_D}(\mathbf{y},\mathbf{x})$ can be related to $\mathrm{TE_o}(\mathbf{y},\mathbf{x})$ and $\mathrm{TE_I}(\mathbf{y},\mathbf{x})$ is dual to a profit function"[28],

although the production technology may not be constant returns to scale.

Figure 5.2 Input-Oriented Technical Efficiency



Source: Fried et al. (2008), pp.23

In Figure 5.2, the input vector $\mathbf{x^A}$ and $\mathbf{x^B}$ are on the interior of I(**y**), so both can be radially contracted and the level of production **y** remain the same as before. We cannot radially contract the input vectors $\mathbf{x}^{\mathrm{C}}$ and $\mathbf{x}^{\mathrm{D}}$ and still keep producing the same output vector **y** as before because they are located on the input isoquant I(**y**). Consequently, we see that $\mathrm{TE_I}(\mathbf{y},\mathbf{x^C}) = \mathrm{TE_I}(\mathbf{y},\mathbf{x^D}) = 1 > \max\{\mathrm{TE_I}(\mathbf{y},\mathbf{x^A}), \mathrm{TE_I}(\mathbf{y},\mathbf{x^B})\}$ but the radially scaled input vector $\theta^B\mathbf{x^B}$ contains slacks in input x_2, we have some reserve to describe input vector $\theta^B\mathbf{x^B}$ as being technically efficient in the production of output vector **y**. For the input vector $\theta^A\mathbf{x^A}$, we do not have such a problem. Therefore, $\mathrm{TE_I}(\mathbf{y},\theta^A\mathbf{x^A}) = \mathrm{TE_I}(\mathbf{y},\theta^B\mathbf{x^B}) = 1$ although $\theta^A\mathbf{x^A} \in \mathrm{E}(\mathbf{y})$ but $\theta^B\mathbf{x^B} \notin \mathrm{E}(\mathbf{y})$.

[28] Fried et al. (n.d.). *Efficiency and productivity*. Retrieved May 12, 2015 from: http://pages.stern.nyu.edu/~wgreene/FrontierModeling/SurveyPapers/Lovell-Fried-Schmidt.doc

Figure 5.3 represents the output-oriented technical efficiency and tells a similar story. Given input vector $\mathbf{x}$ output $\mathbf{y^C}$ and $\mathbf{y^D}$ are technically efficient, while output vector $\mathbf{y^A}$ and $\mathbf{y^B}$ are not. Radially scaled output vector $\phi^{\mathrm{A}}\mathbf{y^A}$ and $\phi^{\mathrm{B}}\mathbf{y^B}$ are technically efficient but there remain slack in output $\mathbf{y_2}$ at $\phi^{\mathrm{B}}\mathbf{y^B}$. Thus, $\mathrm{TE_o}(\mathbf{x},\phi^A\mathbf{y^A}) = \mathrm{TE_o}(\mathbf{x},\phi^B\mathbf{y^B}) = 1$ although $\phi^{\mathrm{A}}\mathbf{y^A} \in \mathrm{E}(\mathbf{x})$ but $\phi^B\mathbf{y^B} \notin \mathrm{E}(\mathbf{x})$.

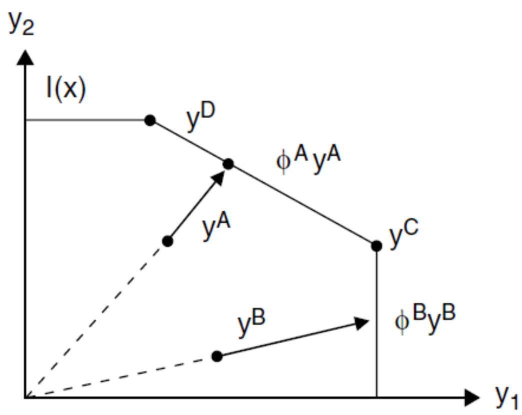
Technical efficiency satisfies several properties such as:

- $\mathrm{TE_I}(\mathbf{y},\mathbf{x})$ is homogeneous of degree -1 in inputs, and $\mathrm{TE_o}(\mathbf{x},\mathbf{y})$ is homogeneous of degree -1 in outputs.

- $\mathrm{TE_I}(\mathbf{y},\mathbf{x})$ is weakly monotonically decreasing in inputs, and $\mathrm{TE_o}(\mathbf{x},\mathbf{y})$ is weakly monotonically decreasing in outputs.

- $\mathrm{TE_I}(\mathbf{y},\mathbf{x})$ and $\mathrm{TE_o}(\mathbf{x},\mathbf{y})$ are invariant with respect to changes in units of measurement.

Figure 5.3 Output-Oriented Technical Efficiency



Source: Fried et al. (2008), pp.24

If the objective of the producer is to minimize cost, the cost efficiency can be computed as the ratio of the minimum feasible cost to the actual cost. This measure depends on input prices. If the producer is cost efficient, the value of the cost efficiency is unity and the cost efficiency value of less than unity indicates the extent of cost inefficiency.

Suppose the producers face input prices $\mathbf{w} = (w_1,...,w_n) \in \mathrm{R}^{\mathrm{N}}_{++}$ and seek to minimize cost. Then, a cost frontier or a minimum cost function is defined as

$$c(\mathbf{y},\mathbf{w}) = \min_{\mathbf{x}} \{\mathbf{w}^{\mathbf{T}}\mathbf{x} : D_I(\mathbf{y},\mathbf{x}) \geqq 1\} \tag{5.20}$$

If the input set $L(\mathbf{y})$ is closed and convex, and if inputs are freely disposable, the cost frontier is dual to the input distance function in the sense of (5.20) and

$$D_I(\mathbf{y},\mathbf{x}) = \min_{\mathbf{w}} \{\mathbf{w}^{\mathbf{T}}\mathbf{x} : c(\mathbf{y},\mathbf{w}) \geqq 1\} \tag{5.21}$$

A measure of cost efficiency CE is provided by the ratio of minimum cost to actual cost:

$$CE(\mathbf{x},\mathbf{y},\mathbf{w}) = c(\mathbf{y},\mathbf{w}) / \mathbf{w}^{\mathbf{T}}\mathbf{x} \tag{5.22}$$

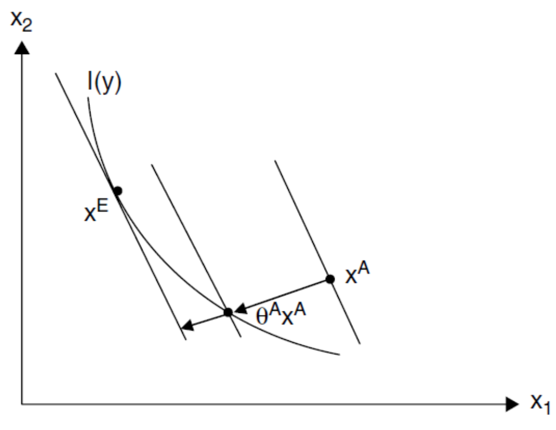
A measure of input-allocative efficiency AE_I is obtained from (5.6) and (5.22) as

$$AE_I(\mathbf{x},\mathbf{y},\mathbf{w}) = CE(\mathbf{x},\mathbf{y},\mathbf{w}) / TE_I(\mathbf{y},\mathbf{x}) \tag{5.23}$$

$CE(\mathbf{x},\mathbf{y},\mathbf{w})$ and its two components are bounded above by unity, and $CE(\mathbf{x},\mathbf{y},\mathbf{w}) = TE_I(\mathbf{y},\mathbf{x}) \times AE_I(\mathbf{x},\mathbf{y},\mathbf{w})$.

Figure 5.4 and Figure 5.5 illustrate the measurement and decomposition of cost efficiency. In Figure 5.4, the input vector $\mathbf{x}^{\mathbf{E}}$ minimizes the cost of producing output vector $\mathbf{y}$ at input prices $\mathbf{w}$, so $\mathbf{w}^{\mathbf{T}}\mathbf{x}^{\mathbf{E}} = c(\mathbf{y},\mathbf{w})$.The cost efficiency of $\mathbf{x}^{\mathbf{A}}$ is given by the ratio $\mathbf{w}^{\mathbf{T}}\mathbf{x}^{\mathbf{E}} / \mathbf{w}^{\mathbf{T}}\mathbf{x}^{\mathbf{A}} = c(\mathbf{y},\mathbf{w}) / \mathbf{w}^{\mathbf{T}}\mathbf{x}^{\mathbf{A}}$. The Debreu (1951) and Farrell (1957) measure of the technical efficiency of $\mathbf{x}^{\mathbf{A}}$ is given by $\theta^A = \theta^A\mathbf{x}^{\mathbf{A}} / \mathbf{x}^{\mathbf{A}} = \mathbf{w}^{\mathbf{T}}(\theta^A\mathbf{x}^{\mathbf{A}}) / \mathbf{w}^{\mathbf{T}}\mathbf{x}^{\mathbf{A}}$.

Figure 5.4 Cost Efficiency I

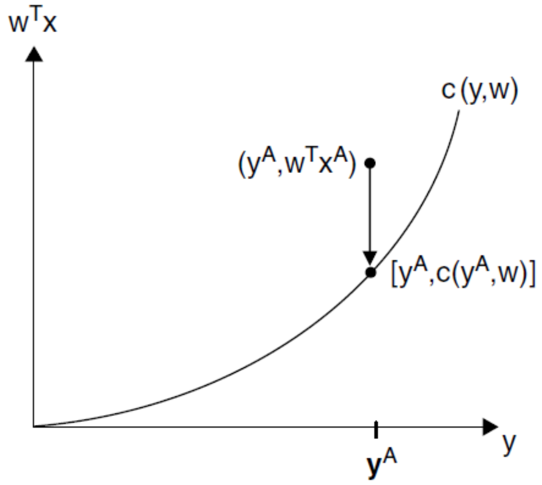


Source: Fried et al. (2008), pp. 27

We determine the allocative efficiency of $\mathbf{x}^{\mathbf{A}}$ by computing the ratio of cost efficiency to technical efficiency or by the ratio $\mathbf{w}^{\mathbf{T}}\mathbf{x}^{\mathbf{E}} / \mathbf{w}^{\mathbf{T}}(\theta^A\mathbf{x}^{\mathbf{A}})$. Then we can measure the magnitudes of technical, allocative, and cost inefficiency by calculating the ratios of price-weighted input vectors. The direction of allocative inefficiency is revealed by the input vector difference $\left(\mathbf{x}^{\mathbf{E}}-\theta^{A}\mathbf{x}^{\mathbf{A}}\right)$. Figure 5.5 provides an alternative view of cost efficiency, which is represented by the equation $\mathrm{CE}\left(\mathbf{x}^{\mathbf{A}},\mathbf{y}^{\mathbf{A}},\mathbf{w}\right)=\mathrm{c}\left(\mathbf{y}^{\mathbf{A}},\mathbf{w}\right)/\mathbf{w}^{\mathbf{T}}\mathbf{x}^{\mathbf{A}}$.

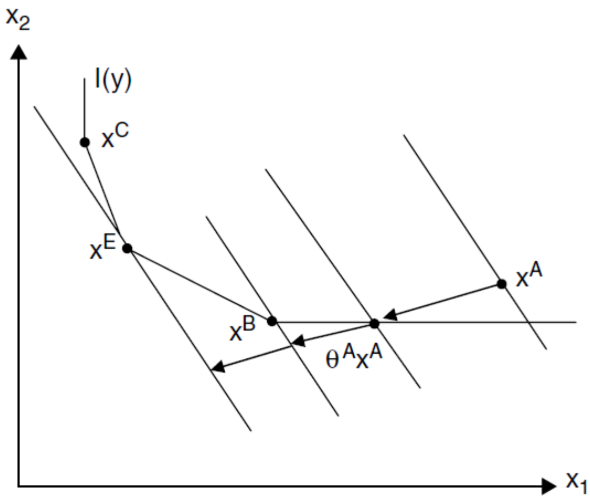
In the case that the efficient subset is a proper subset of the isoquant, the measurement and decomposition of cost efficiency is illustrated by Figure 5.6. We can analyze in similar manner as the analysis we have done previously. The cost efficiency of the input vector $\mathbf{x}^{\mathbf{A}}$ now comprises of three components, radial technical component $\left[\mathbf{w}^{\mathbf{T}}\left(\theta^{A}\mathbf{x}^{\mathbf{A}}\right)/\mathbf{w}^{\mathbf{T}}\mathbf{x}^{\mathbf{T}}\right]$, an input slack component $\left[\mathbf{w}^{\mathbf{T}}\mathbf{x}^{\mathbf{B}}/\mathbf{w}^{\mathbf{T}}\left(\theta^{A}\mathbf{x}^{\mathbf{A}}\right)\right]$, and an allocative component $\left(\mathbf{w}^{\mathbf{T}}\mathbf{x}^{\mathbf{E}}/\mathbf{w}^{\mathbf{T}}\mathbf{x}^{\mathbf{B}}\right)$. If the input price data is available, we can identify all the three components. However, the input price data is rarely available. The slack component is routinely assigned to the allocative component.

Figure 5.5 Cost Efficiency II



Source: Fried et al. (2008), pp. 27

Figure 5.6 Cost Efficiency III



Source: Fried et al. (2008), pp. 28

Suppose next that producers face output prices $\mathbf{p} = (p_1, \ldots, p_M) \in R^M_{++}$ and seek to maximize revenue. We then define a maximum revenue function, or revenue frontier, as

$$\mathbf{r}(\mathbf{x}, \mathbf{p}) = \max_y \{\mathbf{p}^T\mathbf{y} : D_o(\mathbf{x}, \mathbf{y}) \leqq 1\} \tag{5.24}$$

If the output sets P(**x**) are closed convex and if outputs are freely disposable, the revenue frontier is dual to the distance function in the sense of (5.24) and

$$D_o(\mathbf{x}, \mathbf{y}) = \max_{\mathbf{p}} \{\mathbf{p}^T\mathbf{y} : r(\mathbf{x}, \mathbf{p}) \leqq 1\} \tag{5.25}$$

We can measure the revenue efficiency RE as the ratio of maximum revenue to actual revenue, which is in the following functional form.

$$RE(\mathbf{y}, \mathbf{x}, \mathbf{p}) = r(\mathbf{x}, \mathbf{p}) / \mathbf{p}^T\mathbf{y} \tag{5.26}$$

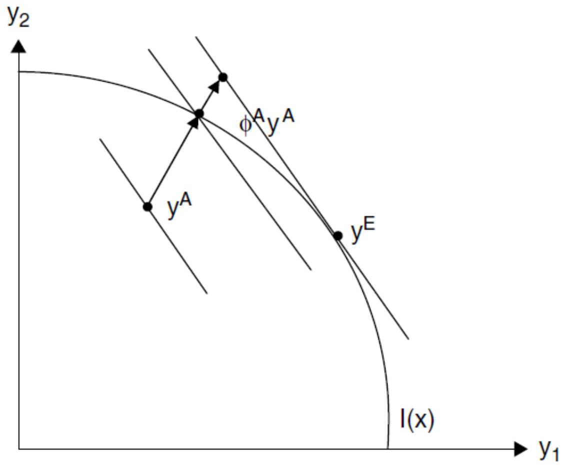
A measure of output-allocative efficiency AE_O is obtained from (5.12) and (5.26) as

$$AE_o(\mathbf{y}, \mathbf{x}, \mathbf{p}) = RE(\mathbf{y}, \mathbf{x}, \mathbf{p}) / \mathbf{TE_o}(\mathbf{x}, \mathbf{y}) \tag{5.27}$$

$RE(\mathbf{y}, \mathbf{x}, \mathbf{p})$ and its two components are bounded below by unity, and $RE(\mathbf{y}, \mathbf{x}, \mathbf{p}) = TE_o(\mathbf{x}, \mathbf{y}) \times AE_o(\mathbf{y}, \mathbf{x}, \mathbf{p})$.

The measurement and decomposition of revenue efficiency in Figure 5.7 and Figure 5.8 follow exactly the same steps.

Figure 5.7 Revenue Efficiency I



Source: Fried et al. (2008), pp. 29

"The measurement and decomposition of revenue efficiency in the presence of output slack follow along similar lines as in Figure 5.6. Revenue loss attributable to output slack is typically assigned to the output-allocative efficiency component of revenue efficiency.Cost efficiency and revenue efficiency is important performance indicator but each reflects just one dimension of a firm's overall performance. A measure of profit efficiency captures both dimensions"[29].

Suppose that the producer faces output price $\mathbf{p} \in R_{++}^{M}$ and input prices $\mathbf{w} \in R_{++}^{N}$ and seek to maximize profit. We define the maximum profit function, or profit frontier, as

$$\pi(\mathbf{p},\mathbf{w}) = \max_{\mathbf{y},\mathbf{x}} \left\{ \left(\mathbf{p}^{\mathbf{T}}\mathbf{y} - \mathbf{w}^{\mathbf{T}}\mathbf{x} \right) : (\mathbf{y},\mathbf{x}) \in \mathrm{T} \right\} \tag{5.28}$$

"If the production set T is closed and convex, and if outputs and inputs are freely disposable, the profit frontier is dual to T in the sense of (5.28) and

$$\mathrm{T} = \left\{ (\mathbf{y},\mathbf{x}) : \left(\mathbf{p}^{\mathbf{T}}\mathbf{y} - \mathbf{w}^{\mathbf{T}}\mathbf{x} \right) \le \pi(\mathbf{p},\mathbf{w}) \, \forall \mathbf{p} \in R_{++}^{M}, \mathbf{w} \in R_{++}^{N} \right\} \tag{5.29}$$

[29] Fried et al. (n.d.). *Efficiency and productivity*. Retrieved May 12, 2015 from: http://pages.stern.nyu.edu/~wgreene/FrontierModeling/SurveyPapers/Lovell-Fried-Schmidt.doc

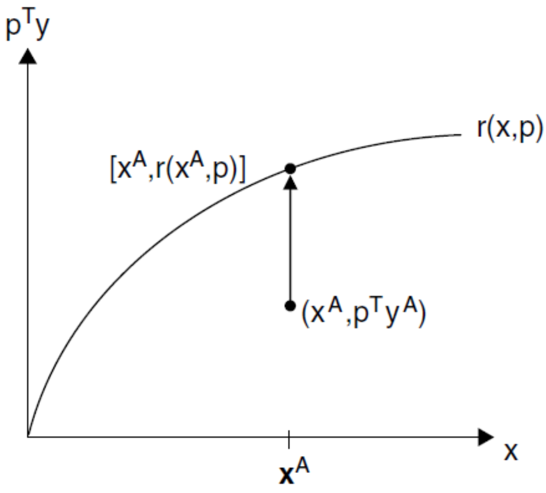
A measure of profit efficiency is provided by the ratio of maximum profit to actual profit

$$\pi E(\mathbf{y},\mathbf{x},\mathbf{p},\mathbf{w}) = \pi(\mathbf{p},\mathbf{w}) / (\mathbf{p}^T\mathbf{y} - \mathbf{w}^T\mathbf{x}) \quad (5.30)$$

provided $(\mathbf{p}^T\mathbf{y} - \mathbf{w}^T\mathbf{x}) > 0$, in which case $\pi E(\mathbf{y},\mathbf{x},\mathbf{p},\mathbf{w})$ is bounded below by unity", Fried et al. (n.d.).

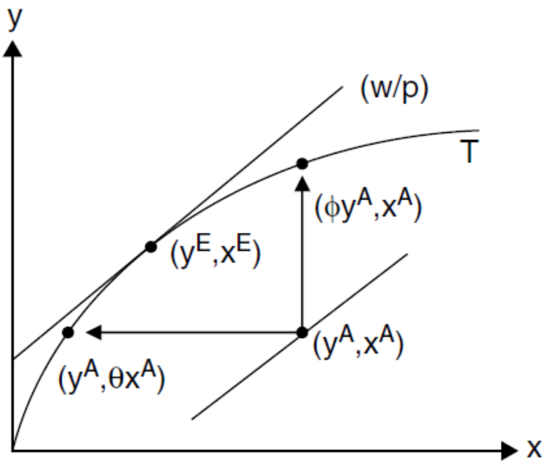
The decomposition of profit efficiency is partially illustrated in Figure 5.9, which builds on Figure 5.1.

Figure 5.8 Revenue Efficiency II



Source: Fried et al. (2008), pp. 29

Figure 5.9 Profit Efficiency



Source: Fried et al. (2008), pp. 30

In Figure 5.9, the two decompositions of profit efficiency are illustrated. We observe that the profit at $\left(y^A, x^A\right)$ is smaller than optimal profit at $\left(y^E, x^E\right)$.

> "One of the decompositions takes an input-conserving orientation to the measurement of technical efficiency. For this approach, it is visible that the residual allocative component follows the path from $\left(y^A, \theta x^A\right)$ to $\left(y^E, x^E\right)$. We also observe that an output-augmenting orientation to the measurement of technical efficiency is taken by other component, and its residual allocative component follows the path from $\left(\phi y^A, x^A\right)$ to $\left(y^E, x^E\right)$. The residual allocative component comprises of an input-allocative efficiency component and an output-allocative efficiency component in both approaches, although the sizes of each component may differ"[30].

We cannot see these two components in the two-dimensional graph in Figure 5.9. According to Fried et al. (n.d), the scale component remains a part of the residual allocative efficiency component in the two approaches. Figure 5.9 also illustrates this point. The scale

[30] Fried et al. (n.d.). *Efficiency and productivity*. Retrieved May 12, 2015 from: http://pages.stern.nyu.edu/~wgreene/FrontierModeling/SurveyPapers/Lovell-Fried-Schmidt.doc

component's direction may widely vary given the orientation of the technical efficiency component; therefore, the analyst is pressured to get the orientation right. In this context,

> "hyperbolic and directional technical efficiency measures are appealing as profit efficiency involves adjustments to both outputs and inputs. The profit inefficiency is attributable to technical inefficiency, to an inappropriate scale of operation, to the production of an inappropriate output mix, and to the selection of an inappropriate input mix"[31]

regardless of the orientation of the technical efficiency measure.

Several techniques can be applied to compute the efficiency. Among them, the generally used methods are the Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA). Each has its own advantages and disadvantages. According to Coelli et al. (2005), the limitations of DEA are:

- The measurement error and other noises may affect the position of the frontier.
- Outliers can have an impact on the results.
- The exclusion of important outputs and inputs may produce biased results.
- The efficiency score obtained are only from the comparison among the sample observations. If extra observation (for example, producers from other countries) is included, the efficiency score may be reduced.
- Efficiency scores in a study reflect the dispersion only within the sample. Therefore, researchers have to be cautious when the average efficiency scores from two different studies are compared.
- Adding extra inputs or outputs in a DEA analysis does not produce an increase or decrease in the technical efficiency of the existing observations.

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[31] Fried et al. (n.d.). *Efficiency and productivity*. Retrieved May 12, 2015 from: http://pages.stern.nyu.edu/~wgreene/FrontierModeling/SurveyPapers/Lovell-Fried-Schmidt.doc.

- -When observations are few but there are several inputs and/or outputs, many observations will seem to be efficient, i.e. appear on the frontier of the production or cost function.
- -DEA may produce biased result if heterogeneous inputs and outputs are treated as homogeneous ones.
- -DEA does not account for the differences in the environment; thus, it may produce results that do not truly reflect the managerial competence of each observation.
- -Issues such as multi-period optimization or risk in management decision making are not taken into account in the standard DEA.

SFA has some advantages over DEA because it accounts for noises and it can be used to conduct conventional tests of hypotheses. It should also be noticed that there are several disadvantages of SFA in that we need to specify a distributional form of the inefficiency term, and specify a functional form for the production or cost or profit function.

In the subsequent analysis, the SFA method is used to estimate the Cobb-Douglas cost function of rice farming households and test the efficiency hypotheses. The detailed discussion of stochastic cost frontier analysis is provided in the methodology part.

5.3 Methodology

The stochastic frontier methodology based on the Cobb-Douglas cost function is employed to test whether or not rice farming households in Cambodia is cost efficient and to compute the inefficiency scores if inefficiency exists. These cost inefficiency scores are used as the dependent variable in the inefficiency model and are thus regressed on households' and farms' characteristics to explore the factors affecting the cost inefficiency. These two stages of estimations, the cost function and the inefficiency model, are estimated in a single step procedure using STATA software package.

5.3.1 Stochastic Frontier Model

Stochastic frontier analysis was pioneered by Aigner, Lovell, & Schidt (1977), and Meeusen & Broek (1977); since then it has become one of the popular tools for empirical research in applied economics.

Following the specification in Coelli et al. (2005) and Hazarika &Alwang (2003), who used the cost frontier model in their study, the model is generally expressed as

$$c_i \geq c(p_{1i}, p_{2i}, ..., p_{Ni}, q_{1i}, q_{2i}, ..., q_{Mi}) \quad (5.31)$$

where c_i is the observed cost of producer *i*, p_{ni} is the *n*-th input price; q_{mi} is the *m*-output; and $c(.)$ is a cost function that is non-decreasing, linearly homogenous and concave in prices. The cost function $c(.)$ gives a minimum cost of producing outputs $q_{1i}, q_{2i}, ..., q_{Mi}$ when a producer incurs prices $p_{1i}, p_{2i}, ..., p_{Ni}$.

To estimate this cost function, we have to specify the functional form of the function $c(.)$. If Cobb-Douglas type of the cost function is specified, equation (5.31) becomes:

$$\ln c_i \geq \beta_0 + \sum_{n=1}^{N} \beta_n \ln p_{ni} + \sum_{m=1}^{M} \beta_m \ln q_{mi} + v_i \quad (5.32)$$

where v_i is a symmetric random variable and represents the error of approximation and other sources of statistical noises. Equivalently:

$$\ln c_i = \beta_0 + \sum_{n=1}^{N} \beta_n \ln p_{ni} + \sum_{m=1}^{M} \beta_m \ln q_{mi} + v_i - u_i \quad (5.33)$$

In the equation (5.33), we have two composite error terms, v_i and u_i,. v_i is assumed to be independently and identically distributed, which represents the variation in production cost due to uncontrollable factors such as weather shock or crop diseases. u_i represents producer's cost efficiency relative to the stochastic cost frontier, which may be resulted from the mismanagement or misallocation of resources. u_i is one-sided and negatively distributed. In other words, u_i=0 if production cost is at the minimum; if $u_i > 0$, cost efficiency is imperfect.

The objective of this chapter is to test the hypothesis of whether or not rice farming households are cost efficient. To achieve the objectives, the unrestricted and restricted forms, assuming u_i, of equation (5.33) will be estimated. Then, the hypothesis testing will be applied by using the generalized likelihood-ratio statistics given as:

$$\lambda = -2\left[\ln L\left(H_0\right) - \ln L\left(H_A\right)\right] \tag{5.34}$$

where H_0 is the value of the likelihood function of the restricted model

H_A is the value of the likelihood function of the unrestricted model

This test follows the $\chi^2(1)$, the χ^2 distribution with one degree of freedom. If the hypothesis testing shows that the cost inefficiency exists, we can explore the determinants of cost inefficiency estimating the following OLS equation as suggested by Hazarika &Alwang (2003):

$$u_i = \delta_0 + \sum_{k=1}^{n} \delta_k z_{ki} + \xi_i \tag{5.35}$$

where z are independent variables that influence cost inefficiency.

The methodology is composed of estimating maximum likelihood of the restricted and unrestricted models of equation (5.33), testing the hypothesis of equation (5.34) and finally estimating OLS regression of equation (5.35). This procedure has been criticized because in the OLS regression, the assumption of identically distributed inefficiency effects was violated (Battese and Coelli, 1995).

To correct this problem of assumption violation, Battese and Coelli (1995) combined the two stages of estimation into a single step, keeping the same the assumption of v_i, independently and identically distributed; nevertheless u_i, the cost inefficiency component, was alternately assumed to be independently, but not identically distributed as truncation (at 0) of the normal distribution, indicating that the mean cost inefficiency was assumed to be a function of variables z_i as specified in equation (5.35). This new method allows the estimation of the coefficients as well as the test of the hypothesis in a single step. This chapter follows the corrected single step estimation procedure.

5.3.2 Empirical Model

The empirical studies using stochastic frontier model are diverse, from the field of agricultural economics to banking and tourism. In agriculture, studies using stochastic frontier cost function include the study of economic efficiency in Pakistani agriculture by Parikh et al. (1995), the studies of cost efficiency of small-scale maize production by Diae et al. (2010) and Orgundari et al. (2006), the study of cost efficiency of maize production in Nepal by Paudel & Matsuoka (2009), and the study of cost efficiency of smallholder tobacco cultivators in Malawi by Hazarika & Alwang (2003). In the case of rice, there several efficiency studies using production frontier model and data envelopment analysis (DEA) such as the study of economic inefficiency of Nepalese rice farms by Dhungana et al. (2004) and rice farming households' efficiency in Bangladesh by Wadud &White (2000). There has been no study on rice efficiency using stochastic frontier cost model yet. Therefore, the study will shed light on how to increase rice production in Cambodia by the examining the extent to which it is possible to raise the efficiency of rice farming households with the existing resources and available technology, and contribute to the literature in the field of agricultural economics.

In this study, the Cobb-Douglas stochastic cost frontier was applied, and the specific empirical model was specified as follows:

$$\begin{aligned}\ln c_i &= \beta_0 + \beta_1 \ln p_{1i} + \beta_2 \ln p_{2i} + \beta_3 \ln p_{3i} + \beta_4 \ln p_{4i} + \beta_5 \ln p_{5i} + \beta_6 \ln p_{6i} \\ &+ \beta_7 \ln p_{7i} + \beta_8 \ln p_{8i} + \beta_9 \ln p_{9i} + \beta_{10} \ln p_{10i} + \beta_{11} \ln p_{11i} + \beta_{12} \ln q_i + \left(v_i + u_i\right)\end{aligned} \tag{5.36}$$

where,

c_i: the total production cost of rice in Cambodian Riel[32] (KHR) / ha

p_{1i}: the cost of chemical fertilizers, insecticide, weedicide and fungicide in KHR/ha

p_{2i}: the cost of planting materials in KHR/ha

p_{3i}: the cost of animal manure in KHR/ha

p_{4i}: the cost of oil, gasoline and diesel in KHR/ha

p_{5i}: the cost of storable items in KHR/ha

[32] In January 2015, one US dollar is about 4050 KHR

p_{6i} : the cost of draft power, tractor in KHR/ha

p_{7i} : the cost of hired labor in KHR/ha

p_{8i} : the cost of irrigation in KHR/ha

p_{9i} : the cost of transportation in KHR/ha

p_{10i} : the cost of repair and maintenance in KHR/ha

p_{11i} : the cost of rent in KHR/ha

q_i : rice output in kg/ha

The choice of the Cobb-Douglas functional form is based upon the fact that the methodology requires the function to be self-dual as the case of the cost function that the analysis is based on.

Moreover, the inefficiency model (u_i) is specifically defined as:

$$u_i = \delta_0 + \delta_1 z_{1i} + \delta_2 z_{2i} + \delta_3 z_{3i} + \xi_i \tag{5.37}$$

where,

u_i : the cost inefficiency scores

z_{1i} : farmers per hectare

z_{2i} : age of the household head

z_{3i} : household head education

The single step estimation of the parameters of equation (5.36) and equation (5.37) are carried out using STATA software package.

5.4 Data and Limitation

Data applied in this study was obtained from the Cambodian Socio-Economic Survey (CSES) of 2009. The Ministry of Planning's National Institute of Statistics (NIS) is responsible for conducting the survey and publishing its result. The survey was conducted from January to December, 2009. It is a nationwide survey covering the sample of 12,000 households within 720 villages, which are divided into 12 monthly samples of 1,000 households in 60 villages.

In this study, only rice farming households were selected for the analysis. Diversified farmers, i.e. farmers producing rice and other crops, are not included in the data to be estimated to ensure that bias in sample selection is minimized. Several data modification was performed to ensure that the unit of measurement of each variable is consistent with the study objective, and the quality of data is satisfied. The description of the data is provided in Table 5.1 in section 5.5.1

As briefly mentioned in Chapter 4, rice production in Cambodia is divided into wet season and dry season, and within wet season production, there are 5 different kinds of rice, namely, early, medium, late, upland and floating rice. However, in CSES 2009, only the broad categories of the wet season and the dry season rice were recorded. Therefore, in the analysis in the subsequent section, only wet season and dry season rice will be analyzed. This is one of the limitations of the study because farmers may grow different varieties and apply different technology in the production; the other limitation is that in applying cost function, price data of the input is required. Nonetheless, since price data is not available, this study will follow the approach of the study of Paudel & Matsuoka (2009) by using the cost of input per harvested area as a proxy for input price.

5.5 Empirical Results and Discussion

5.5.1 Summary Statistics

The summary statistics of the variables used in estimating the stochastic frontier cost function and the inefficiency model are presented in Table 5.1. The table shows the mean, standard deviation, minimum and maximum value of each variable along with its contribution to the total cost for all cost variables.

The cost of rice cultivation was calculated in KHR. On average, in order to produce 2,097.7 kg/ha of wet season rice, a total cost of 641,611.7 KHR is required with a standard deviation of 402,916.9 KHR. In dry season, to produce 3,508.5 kg/ha of rice, the amount of 1,209,836.0 KHR is needed with a standard deviation of 535,548.0 KHR. The big standard deviation of the total cost and other cost variables indicates that farmers operate on a different level of cost of production. Farming households may apply different intensity of inputs. Some farming households spend a lot of money on fertilizers while other spends very little. Some farming households may spend money on irrigation while others depend solely on rainfall and so on.

Among the various factors of production, in wet season, the cost of chemical fertilizer, insecticide, weedicide, and fungicide accounts for the highest share (33.5%) of the total cost of production followed by the cost of draft power or tractor (18.5%), the cost of planting materials (14.5%), the cost of hired labor (12.7%), and the cost of animal manure (10.9%). These five types of factor costs represent 90.1% of the total cost of rice production incurred by Cambodian farmers. The other six different types of cost account for only 9.9% of the total cost. In dry season, the highest share of cost is also the cost of chemical fertilizer, insecticide, weedicide and fungicide, which is 27.4% of the total cost followed by the cost of planting materials (19.5%), the cost of draft power or tractor (15.6%), the cost of oil, gas and diesel (13.1%), and the cost of hired labor (10.4%). These five types of factor cost represent 86.0% of the total cost. The other six different types of cost account for the other 14.0%. The notable difference between the wet season and the dry season production is the use of oil, gas and diesel. In dry season, farmers spend much more on oil, gas and diesel than in wet season because in this season, rainfall is very scarce so farmers need to pump water into their rice field; thus, they have to spend money on buying diesel and gasoline for that purpose.

The socio-economic and demographic characteristics of the farmers, which are used to examine their effects on the inefficiency level, are also reported in the table. It includes the ratio of farmers to the harvested area, the age and education of the household heads. On average, there are 2.4 farmers per households for wet season rice farming households and 2.2 for dry season rice farming households. The small standard deviation of 1.2 for both seasons indicates that the number of farm laborers is not much different. Each household has almost the same number of farmers. The average age of the farm head household is 41.7 and 44.3 years old for wet season and dry season rice farmers respectively, indicating that they are largely middle-aged; however, the standard deviation of 11.4 and 14.5 are quite big, suggesting that there are varieties of age groups among the farm household heads. There are young and elderly farmers growing rice in Cambodia. With an average number of years of schooling of 5.6 years for wet season and 5.8 years for dry season rice farmers with the same standard deviation of 2.6, many farm household heads are not highly educated.

The results of the estimation of equation (5.36) and (5.37) are presented in the following sub-section. The maximum-likelihood (ML) estimates of the parameters of the frontier cost function and the inefficiency model was obtained using STATA software package in two stages. In the first stage, the inefficiency evidence will be tested; if evidence of inefficiency is not found, the frontier cost function will become OSL cost function. If there is evidence of cost inefficiency, in the second stage, the inefficiency will be regressed on socio-economic variables in order to explore the relationship among those variables and the cost efficiency. These two stages are obtained using a single step procedure.

Table 5.1 Summary Statistics

Variable	Unit	Wet season rice: Mean	Std.deviation	Min	Max	% of total cost	N^0 of Obs	Dry season rice: Mean	Std.deviation	Min	Max	% of total cost	N^0 of Obs
Total cost	KHR/ha	641,611.7	402,916.9	16,666.7	2,091,667.0		3168	1,209,836.0	535,548.0	88,000.0	2,100,000.0		346.0
Cost of chemical	KHR/ha	215,174.2	238,043.0	0.0	1,635,000.0	33.5	3168	330,938.6	278,649.8	0.0	1,587,500.0	27.4	346.0
Cost of planting material	KHR/ha	92,725.1	80,824.2	100.0	1,060,000.0	14.5	3168	236,234.2	154,692.2	25,000.0	1,080,000.0	19.5	346.0
Cost of animal manure	KHR/ha	70,124.2	107,961.6	0.0	1,666,667.0	10.9	3168	20,991.9	62,533.5	0.0	625,000.0	1.7	346.0
Cost of oil gasoline diesel	KHR/ha	11,643.5	45,865.5	0.0	799,999.9	1.8	3168	159,085.2	180,720.7	0.0	999,999.9	13.1	346.0
Cost of storable items	KHR/ha	19,678.1	34,254.3	0.0	600,000.0	3.1	3168	39,559.3	52,680.3	0.0	733,333.3	3.3	346.0
Cost of draft power/tractor	KHR/ha	118,664.4	166,587.0	0.0	1,333,333.0	18.5	3168	189,315.1	174,552.7	0.0	1,000,000.0	15.6	346.0
Cost of labor	KHR/ha	81,684.4	133,437.0	0.0	1,428,572.0	12.7	3168	126,254.2	178,945.6	0.0	999,999.9	10.4	346.0
Cost of irrigation	KHR/ha	5,090.5	31,724.6	0.0	666,666.7	0.8	3168	36,019.6	102,011.7	0.0	600,000.0	3.0	346.0
Cost of transportation	KHR/ha	14,399.6	35,245.6	0.0	500,000.0	2.2	3168	48,875.6	66,378.9	0.0	330,000.0	4.0	346.0
Cost of repair and maintenance	KHR/ha	6,581.3	34,530.4	0.0	766,666.6	1.0	3168	1,836.4	15,924.4	0.0	250,000.0	0.2	346.0
Cost of rent	KHR/ha	5,236.0	39,801.7	0.0	700,000.0	0.8	3168	18,378.4	90,245.7	0.0	833,333.3	1.5	346.0
Rice output	kg/ha	2,097.7	950.0	971.9	6,800.0		3168	3,508.5	1,747.7	381.0	10,000.0		346.0
Harvested area	ha	1.1	1.2	0.0	26.0		3168	1.1	1.1	0.1	7.5		346.0
Number of farmers in the household	person	2.4	1.2	0.0	9.0		3168	2.2	1.2	0.0	6.0		346.0
Age of household head	year	41.7	11.4	15.0	69.0		3168	44.3	14.5	20.0	85.0		346.0
Household head education	year	5.6	2.6	0.0	18.0		2434	5.8	2.6	0.0	14.0		275.0

Note: Cost of oil, gas and diesel included only those used for rice production; household expenditure for oil, gas and diesel was excluded. Family labor plays important role in Cambodia’s rice production. Cost of labor in CSES 2009 includes hired labor in kind and in cash; thus, this is of the limitation in that family labor has not been incorporated.
Source: Compiled by author based on CSES (2009)

5.5.2 Estimates of the Stochastic Frontier Cost Function Parameters

The results showed only evidence of cost inefficiency among farming households in the wet season while no evidence of cost inefficiency among farming households in the dry season was found. When taking into account differences in agro-climatic zones, still there is no evidence of inefficiency found in the case of dry season farming households. Surprisingly, in wet season, there is evidence of inefficiency only among farming households in the Tonle Sap and the Plateau/Mountain region, but there was no evidence of cost inefficiency among farming households in the Plain and the Coast regions. This section presents only the interpretation of the result of regions where the evidence of inefficiency was found, in Table 5.2 below; otherwise, the results are reported in the appendices.

Table 5.2 shows that all the independent variables' estimated coefficients are in conformity with the prior expectation, but the cost of irrigation, and the cost of repair and maintenance were not significant in the Tonle Sap region. In the Plateau/Mountain region, the coefficients of the cost of storable items and the cost of transportation were found to have no significant correlation with the total production cost, probably due to the fact that in this region, rice cultivation is not the main income generating activity because the topography is not suitable for growing rice and transportation system is more underdeveloped than other region. Many farming households may still use traditional transportation such as animal and human power to transport agricultural inputs and outputs. The coefficients of all the input cost and output that are positive and significant suggest that the cost function monotonically increases with the input prices.

Since the Cobb-Douglas type of the cost function was applied to estimate the stochastic frontier cost function, the coefficient of the cost function serves as the cost elasticity of the production. Therefore, interpreting the result of the Cambodia's wet season case, 10% increase in the cost of chemical fertilizer, insecticide, weedicide and fungicide will increase the total production cost by approximately 0.5%. 10% increase in the cost of planting materials will increase the total production cost by 3.3%. 10% increase in the cost of animal manure will increase the total production cost by around 0.3%. An increase of 10% in the cost of oil gasoline diesel will increase the total production cost by around 0.2%.

10% increase in the cost of storable items will increase the total production cost by around 0.04%. An increase of 10% in the cost of draft power/tractor will increase the total production cost by around 0.4%. 10% increase in the cost of hired labor will increase the total production cost by around 0.3%. 10% increase in the cost of irrigation will increase the total production cost by around 0.2%. An increase of 10% in the cost of transportation will increase the total production cost by around 0.1%. 10% increase in the cost of repair and maintenance will increase the total production cost by around 0.1%. An increase of 10% in the cost of rent will increase the total production cost by around 0.2%. An increase of 10% in the total output will increase the total production cost by around 3.6%. One of the important coefficients, the cost elasticity of rice output, which has the second largest value, is in the range of the estimated values from the literature. In the case of maize production in Nepal, Paudel & Matsuoka (2009) found that output contributed around 0.21 % of the total cost which is equal to the estimated value of 0.21% in the study of small-scale maize production in Adamawa state, Nigeria, by Dia et al. (2010). Another study of small-scale maize production in Ondo state, Nigeria, by Ogundari et al. (2006) found that output would contribute to 0.48% of the total cost of production, which is the largest value among the studies applying the Cobb-Douglas cost function.

The interpretation of the result of the Tonle Sap and Plateau/Mountainous regions follows the same fashion.

Table 5.2 Maximum-likelihood estimates of parameters of the Cobb-Douglas frontier cost function for wet season production, 2009

Variable	Parameters	Cambodia	Tonle Sap	Plateau/Mountain
		Estimates		
General Model				
Constant	β_0	4.101***	4.714***	4.101***
		(5.379)	(0.327)	(0.436)
Cost of chemical	β_1	0.054***	0.046***	0.052***
		(0.001)	(0.003)	(0.004)
Cost of planting material	β_2	0.328***	0.426***	0.399***
		(0.013)	(0.023)	(0.031)
Cost of animal manure	β_3	0.030***	0.023***	0.031***
		(0.002)	(0.003)	(0.004)
Cost of oil gasoline diesel	β_4	0.015***	0.008*	0.031**
		(0.002)	(0.004)	(0.006)
Cost of storable items	β_5	0.004**	0.008*	0.002
		(0.002)	(0.003)	(0.005)
Cost of draft power/tractor	β_6	0.037***	0.030***	0.043***
		(0.001)	(0.003)	(0.004)
Cost of hired labor	β_7	0.026***	0.024***	0.028***
		(0.001)	(0.002)	(0.004)
Cost of irrigation	β_8	0.017***	0.006	0.019**
		(0.003)	(0.008)	(0.009)
Cost of transportation	β_9	0.005***	0.014***	0.008
		(0.002)	(0.003)	(0.005)
Cost of repair and maintenance	β_{10}	0.009***	0.005	0.023**
		(0.002)	(0.004)	(0.009)
Cost of rent	β_{11}	0.022***	0.029***	0.044***
		(0.004)	(0.006)	(0.046)
Rice output	β_{12}	0.358***	0.290***	0.404***
		(0.019)	(0.036)	(0.046)
Inefficiency Model				
Constant	δ_0	-3.059***	-2.920***	-2.752***
		(0.448)	(0.741)	(1.001)
Farmers per hectare	δ_1	0.062***	0.042*	0.073*
		(0.016)	(0.023)	(0.041)
Household head education	δ_3	0.019	0.069	0.041
		(0.033)	(0.062)	(0.079)
Age of household head	δ_4	-0.019**	-0.027*	-0.022
		(0.009)	(0.015)	(0.019)
Diagnostic Statistics				
log-likelihood		-1861.342	-386.212	-274.127
σ_u^2		-3.360***	-3.319***	-2.908***
		(0.216)	(0.314)	(0.311)
$\sigma^2 = \sigma_u^2 + \sigma_v^2$		0.190	0.146	0.194
$\lambda = \sigma_u / \sigma_v$		0.472	0.573	0.625
Likelihood ratio test H_0: $\sigma_u^2 = 0$		12.960***	7.720***	10.210***
Number of observations		3168	851	461

Note: figures in parentheses are value of SE. ***, ** & *indicate significant at 1%, 5% and 10%.

Source: Calculated by author based on CSES (2009)

5.5.3 Cost Efficiency Analysis

The above Table 5.2 shows the statistical evidences of cost inefficiency among wet season rice farming households in general, and wet season rice farming households in the Tonle Sap and the Plateau/Mountain regions, in particular. In addition, the efficiency (or inefficiency) score of each rice farming household can be generated to examine how far from the cost frontier they are producing. If the efficiency scores equal unity, the rice farming households are cost efficient. If the score is greater than unity, the farming households are not cost efficient; the greater the cost efficiency is, the more inefficient the level the farming households are operating at. The predicted cost efficiency scores range from 1.1 to 3.5 for the sample of wet season rice farming households in general. In the case of the Tonle Sap region, the efficiency score range from 1.1 to 3.2, and from 1.1 to 5.0 in the cease of the Plateau/Mountain region (Table 5.3).

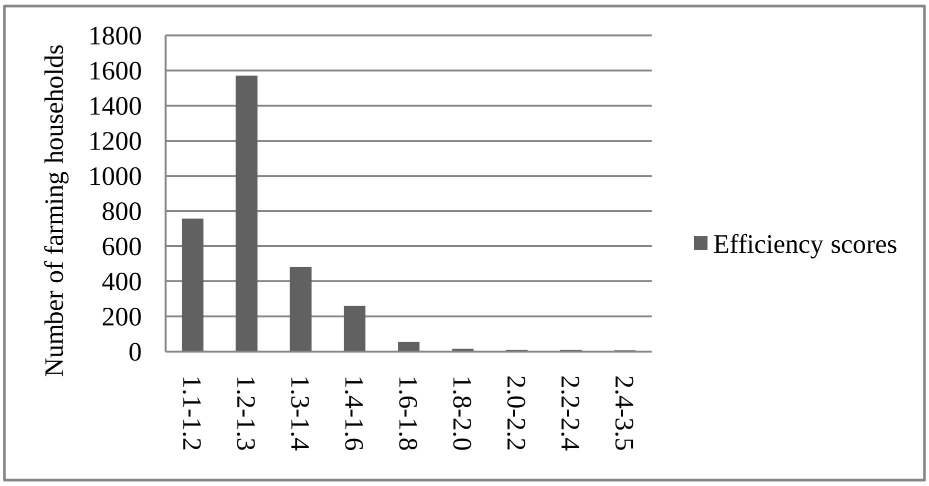
Table 5.3 Cost efficiency scores of wet season rice farming households

Efficiency Scores	Number of Farming Households			% of Farming Households		
	Cambodia	Tonle Sap	Plateau/Mountain	Cambodia	Tonle Sap	Plateau/Mountain
1.1-1.2	758	228	57	23.9	26.8	12.4
1.2-1.3	1571	389	196	49.6	45.7	42.5
1.3-1.4	482	129	111	15.2	15.2	24.1
1.4-1.6	260	74	59	8.2	8.7	12.8
1.6-1.8	55	11	24	1.7	1.3	5.2
1.8-2.0	16	14	3	0.5	1.6	0.7
2.0-5.0	26	6	11	0.8	0.7	2.4
Total	3168	851	461	100.0	100.0	100.0
Mean	1.2	1.2	1.3			
Std. Deviation	0.2	0.2	0.3			
Min	1.1	1.1	1.1			
Max	3.5	3.2	5.0			

Source: Calculated by author based on CSES (2009)

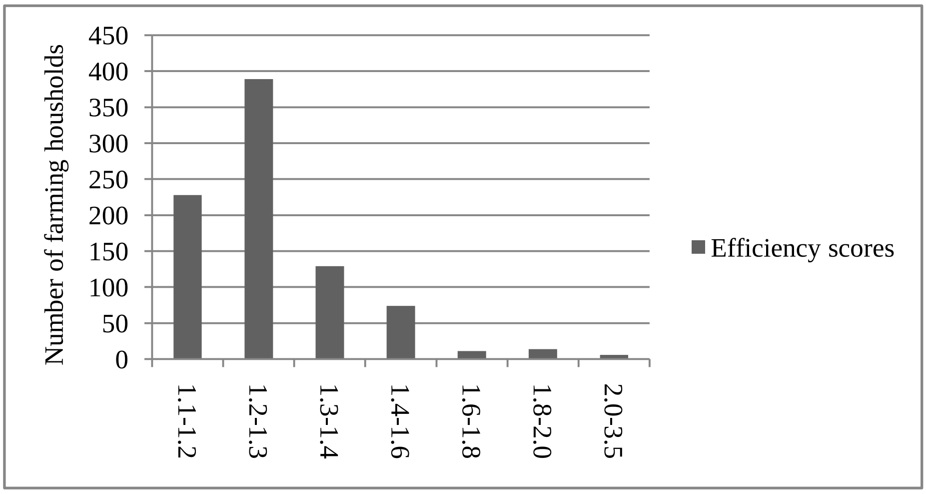
In the general wet season sample, the mean cost efficiency score was estimated to be 1.2 indicating that, on average, wet season rice farming households incurred cost that was roughly 20 % over the minimum cost defined by the frontier. In other words, about 20% of the cost incurred was lost or wasted if compared to the best practice farming households facing the same production technology. In the Tonle Sap and the Plateau/Mountain region, the interpretation follows the same fashion, that is, in the Tonle Sap region farmers wasted 20% of their resources and in the Plateau/Mountain region, farmers wasted up to 30% of their resources.

Figure 5.10 Distribution of cost efficiencies (Cambodia)



Source: Calculated by author based on CSES (2009)

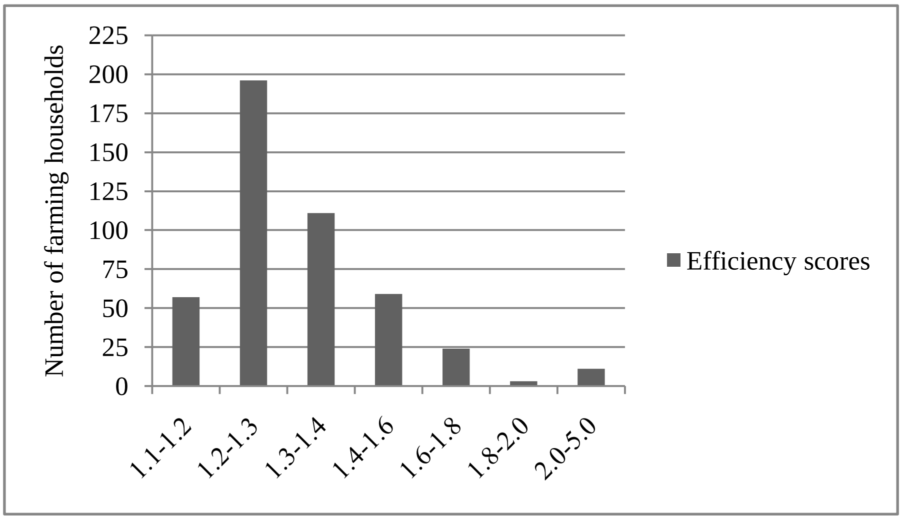
Figure 5.11 Distribution of cost efficiencies (Tonle Sap)



Source: Calculated by author based on CSES (2009)

Figure 5.10, Figure 5.11 and Figure 5.12 show the distribution of the cost efficiencies. We can see that many rice farming households, in all cases, were operating close to the cost frontier, households having efficiency scores ranging from 1.1 to 1.3 represent 73.5% of all farming households in the whole sample of wet season while the figure is 72.5% in the Plateau/Mountain region but less than 55% in the Tonle Sap region, which indicate that rice farming households in the later region is the most cost inefficient.

Figure 5.12 Distribution of cost efficiencies (Plateau/Mountain)



Source: Calculated by author based on CSES (2009)

5.5.4 Factors Affecting Cost Inefficiency

The lower part of Table 5.2 presents the result of the inefficiency model. In this model, the dependent variable is the inefficiency score, and the explanatory variables are the farm characteristics and the socio-economic status of the farming households. Those explanatory variables are the ratio of farmers to the harvested area, the household head education and age of household head.

The ratio of farmers to the harvested area is significant in all the three cases. The positive coefficient indicates that, on the one hand, if there are more farmers per harvested area, the households will be less efficient. In this case, if one unit of this variable is added, the efficiency score will increase by 0.062 in Cambodia’s case, 0.043 in the case of the Tonle Sap region and 0.073 in the case of the Plateau/Mountain region (the larger the efficiency score, the more inefficient the farming households are). The logic is that many Cambodian farming households own a small plot of land, and there are not many off-farm employment opportunities; therefore, if a lot of farmers work in the same plot, the plot becomes crowded and farmers cannot work efficiently. In the case of Nepali maize production, Paudel & Matsuoka (2009) found a negative but not significant relationship between family size and cost efficiency. They explained that farmers with a larger family size rely on family labor so the cost inefficiency will be reduced. However, if family labor is imputed, this can be a source of cost inefficiency because if not working on the family farm, they can work in other's farm or in other sectors to generate income.

On the other hand, if the harvested area is increased, assuming that the number of farmers in the household stays the same, the farm household will be more efficient suggesting the merit of large-scale production. This finding is consistent with the studies by Dia et al. (2010) in the case of Nigerian maize production, and Paudel & Matsuoka (2009) in the case of Nepali maize production.

Age of household head had a negative relationship with efficiency score but significant only in the general wet season and Tonle Sap sample. Age of farmer can be a proxy for farming experiences; hence, if a farmer becomes older or more experienced, the efficiency will improve. This result refutes the finding by Paudel & Matsuoka (2009) for the cost efficiency of maize farms in Nepal and Ojo (2003) for the study of efficiency of poultry egg production in Nigeria. They found the positive coefficient of age and interpreted that young farmers have greater access to extension services, and are likely to have better knowledge about the cost of production since they are relatively better educated than senior farmers.

The education level of the household head was not found to affect farm efficiency in this study. In the study of the effects of farmers' formal education on Cambodian rice production, Cheu (2011) found only primary education completion, up to six years of schooling, significantly affected wet rice production but there was no significant evidence in dry season case. Yu & Fan (2011), in their Cambodian rice production function estimation, also found inconclusive evidence with regards to the effect of farmers' education on rice production. In the literature, the effects of education on cost efficiency are inconclusive. In the studies of Pakistani agriculture by Parikh et al. (1995), and Nepali maize production by Paudel & Matsuoka (2009), education was found to significantly improve cost efficiency. Nonetheless, in the studies of maize production in Nigeria by Ogundari et al. (2006) and Dia et al. (2010), the opposite results were obtained. In agricultural sector, it is difficult to estimate the impact of formal education on production since highly educated farmers may not necessarily be more productive or efficient than lower educated farmers. Many scholars suggest variables such as training on agricultural technique as a proxy for education rather than years of schooling, but this information is not available in the CSES 2009.

5.6 Conclusions and Policy Implications

This chapter applies the stochastic frontier cost function to examine the cost efficiency among Cambodian rice farming households and to explore the factors affecting cost inefficiency. A Cobb-Douglas functional form was used. It was found that cost inefficiency prevails among wet season rice farming households in Cambodia's Tonle Sap and Plateau/Mountain region. The estimated coefficients of almost all input cost are in conformity with the prior theoretical expectation, except for the cost of repair and maintenance which was not significant in the Tonle Sap region and the cost of transportation, which was not significant in the Plateau/Mountain region.

On the effects of socio-economic status and farm characteristics on cost inefficiency, the ratio of farmers to harvested area were found to significantly affect the cost inefficiency in all cases. Age of household head was significant only in the overall wet season and the Tonle Sap case while head household education level was not significant in any case.

Based on the findings, several implications can be suggested. First and foremost, because inefficient farming households concentrated in the Tonle Sap and the Plateau/Mountain region, farm efficiency in these two agro-climatic zones must be improved so that farmers can save input cost as well as produce more output given the same level of input cost. The Tonle Sap region plays an important role in the Cambodian rice production, especially the upmarket fragrant rice such as the Jasmine rice. From the finding, to increase farm efficiency, the ratio of farmers to harvested area should be reduced. The reduction in this ratio can be achieved by creating more diverse sources of income generation in the rural areas, including both on-farm and off-farm job opportunities, so that farming households can divide their labor for working in rice cultivation and other rural industries. In other words, this finding also suggests disguised unemployment in rural areas. In this regard, the government with the private sector should cooperate to create new industries that can provide more jobs to the rural people so that disguised unemployment can be remedied and efficiency of rice cultivation can be improved. There are many possibilities to create jobs in rural areas such as creating value added of the farm products or food for work program. In addition, creating more jobs in urban and semi-urban areas also reduces disguised unemployment in rural areas for farmers migrate to work during the off-season. Moreover, rural and agriculture usually function as a buffer for unemployment but if disguised unemployment exists, this role is limited; hence, disguised unemployment needs to be remedied.

Otherwise, the harvested area should be increased to reap the scale merit. One way to increase cultivated area is that the government distributes the unused or uncultivated land to households possessing smaller plots of land. Thus far, the data on unused land is not yet widely available; however, there is evidence that unused land exists. Cambodia's total cultivated land has expanded from 2.3 million hectares in 2004 to around 3 million hectares in 2011 from the land which has been cleared from degraded forests or demining (Sobrado et al., 2013). In addition, with the aim of boosting the agricultural sector, the Cambodian government, in fact, has formulated policies to distribute land to the poor and the landless rural households since 2003 according the sub-decree[33] No.19 dated March 19, 2003.However, even with the support of development partners, the effectiveness of this policy was limited due to the complicacy of the implementation. Bickel & Löhr (2011) mentioned that in 7,299 villages in 16 Cambodian provinces, the landless rural households could be provided with an average of one hectare of farmland provided that the village would identify 14.5 hectares of

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[33] The sub-decree is available at http://www.cambodiainvestment.gov.kh/sub-decree-146-on-economic-land-concessions_051227.html. Last accessed, April 3, 2014.

land for pro-poor purposes. When data is widely available, the issues of land distribution and its effect on agricultural efficiency should be a topic for future research.

Distributing unused land is not the only remedy. Creating farming cooperatives so that small holding households can cooperate with each other in cultivating rice is also one of the means to garner the benefit of larger scales of cultivation. Creating cooperative may be easier said than done but it has been proved successful in many Asian countries including Japan. Besides, since many farming households cultivate rice once a year, it is possible to increase the cropping intensity as a means of increasing cultivated areas. This policy involves constructing infrastructure such as a water reservoir and irrigation system so that farming households will be able to cultivate in the dry season. Irrigation is very important in Cambodian agriculture because, compared to other countries in the region, the access to irrigation among Cambodian farmers are still low[34] so irrigation renovation and construction is quite an urgent policy action that the government shall implement. Access to irrigation does not only increase the intensity of rice cultivation but also allows farmer to diversify their crop from growing just rice to other vegetables and cash crop, which bring them year round jobs and increase their income.

Although the results showed no significant effects of educational level on efficiencies in this study, and inclusive results from the literature, it is widely believed that education will improve efficiencies, in particularly, education in the form of training in agricultural technique suggesting the importance of extension works, which have been almost no existent in Cambodia. From the descriptive statistics, many farmers have only primary education; therefore, extension work should be accessible to these groups of farmers.

[34] In 2005, the data from the government showed that irrigated land in total arable land was about 20%, on par with that of Myanmar but the data from FAO was only about 5%, much lower (Yu & Diao, 2011: 11).

Chapter 6: Impact of the Productivity of Land and Labor and Efficiency on Poverty among Rice Farming Households

6.1 Introduction

Since the end of the internal conflict in the early 1990s, efforts have been made by the Cambodian government with the gracious support from the international community to eradicate poverty. Significant reduction of poverty has been achieved, and Cambodia is on the right track to reach the MDGs' goal of halving poverty by 2015. However, the number of people living below poverty line in Cambodia is among the highest in the world signifying that persistent and greater effort will need to be carried out in order that Cambodia can catch up with countries in the ASEAN region and the rest of the world in term of poverty reduction. Actually, Cambodia is one of the poorest countries Southeast Asia. In some poverty indicators, the extent of poverty in Cambodia is even severe than in Myanmar that is also one of the poorest countries in Southeast Asia (Menon, 2013). Data suggests that poverty in Cambodia is concentrated in rural areas because the percentage of rural inhabitants is large, about 80% of the total population, and the rural poverty rate is much higher than that of urban areas. Therefore, it is obvious that reducing rural poverty will contribute significantly to overall poverty reduction.

In addition to the knowledge of who are the poor group, it is widely believed that to effectively reduce poverty, we need to know what the poor are endowed so that the endowment can be optimally employed. In Cambodia, most of the poor are rural unskilled labor forces. They engage in agriculture and agriculture-related activities, especially rice growing and selling labor in informal sectors. Even if they work in non-farm waged employment, they mainly work in labor intensive industries such as garment and footwear, and construction, which are now Cambodia's booming industries. Since long time ago, the usual practice of the poor rural labor force is to grow rice during rice growing season and migrate to the city or other rural areas to sell their labor in off-season in informal sectors (Solocomb, 2010). Perceiving this fact, Engvall et al. (2008) recommended two pathways to reduce poverty in Cambodia, first increase the productivity of agriculture, otherwise rural non-farm income generating activities needs to be created. Increasing agricultural productivity is synonymous with increasing rice productivity because rice is a dominant crop, which most of the Cambodian farmers cultivate and devote their resources on.

Rice growing is not the only source of income of the rural poor because in order to survive the poor needs to engage in several income generating activities, but rice growing is one of the main stable sources of income[35] and it is undeniable that promoting the productivity of rice will increase rural households' income, thus reduce the number of people living in poverty. Previous chapters clearly indicate that there is huge potential to increase rice productivity and also reveal that farming households have been growing rice inefficiently. If the productivity and efficiency of rice are increased, the farm income will likely to rise. But how much improved productivity and efficiency contributes to poverty reduction in different regions is not yet studied. The objective of this chapter is to examine the relationship between the productivity of land and labor and efficiency of rice farming households on their poverty status. Following this introduction is the research framework, the research methodology, the result of the analysis and the policy implication.

6.2 Analytical Framework

Figure 6.1 illustrates this chapter's analytical framework. The figure shows the effect of the improved productivity and efficiency on poverty. First, let us explain the pathways through which improved agricultural productivity reduce poverty. According to the figure, the improved agricultural productivity[36] will boost up consumption through the following channels. First, it increases production, which will obviously increase farmers' income if the increase in productivity will not exert too much pressure on price. Depending on different elasticity of agricultural products, increased production may reduce prices so much that farmers may gain little from the improved productivity. In addition, the increased production creates more farm

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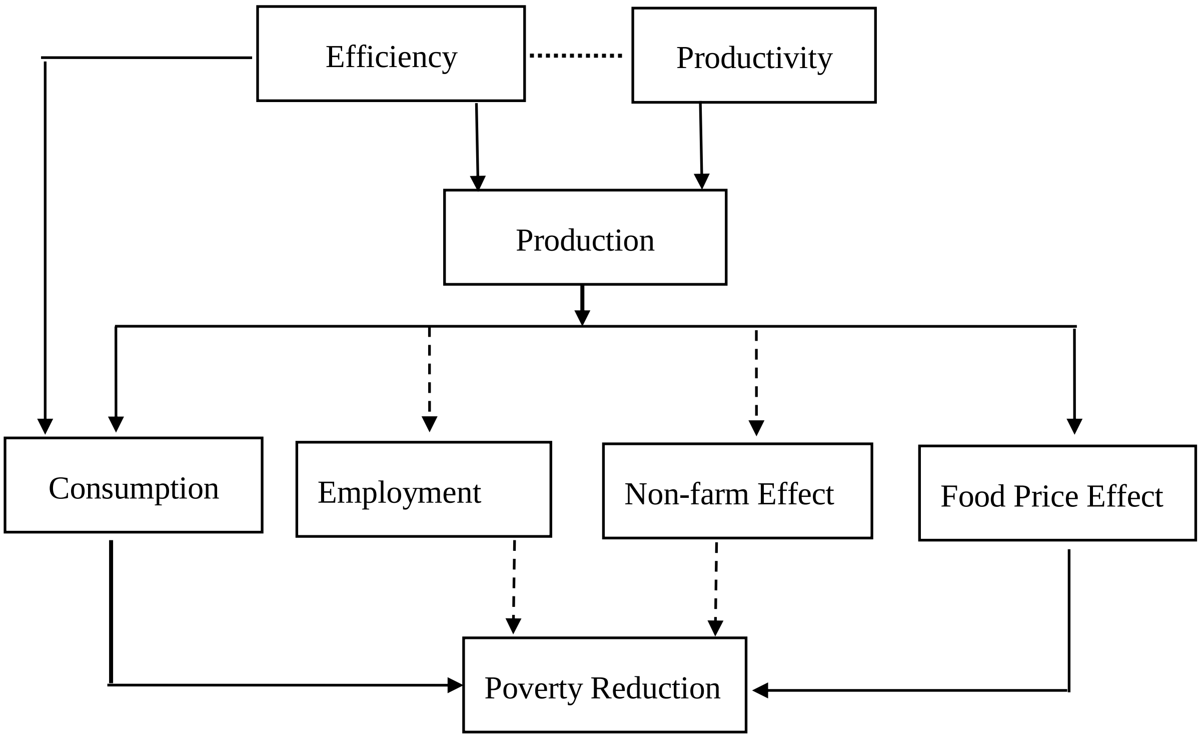
[35] In Chapter 3, it has been shown that the income from agricultural crops, largely rice, is the second largest contributor to the total income of the rural households.

[36] In the analytical framework, for generality, the term agricultural productivity is used. However, it should be noticed that the crop focused in the dissertation is rice.

jobs for the rural people, especially the rural landless and land poor because more farm laborers are needed to cultivate the increased production per harvested areas. Land poor farmers can find more work with other farmers, who own large plot of land, after they finish harvesting their small agricultural land. More income enable farmers to enjoy higher consumption thus increase welfare and analogously reduce poverty. This is the direct effect of the growth of agricultural productivity on farmers' income and consumption.

Figure 6.1 Analytical Framework



Source: Author (adapted from the literature)

Besides the direct benefit, farmers also benefit indirectly from the spillover of agricultural productivity growth to other non-farm sectors. For example, when agricultural production increases, farmers, and farm laborers get extra income and thus spend more on necessary goods in other sectors or invest in human capital, health, and education. This induces growth in those sectors, which then increase demand from the agricultural sectors. The inducement process may keep continuing and benefiting farmers and farm laborers. Moreover, farmers' increased income can be saved and mobilized to invest in other industries that need capital or to import capital goods such as machinery that is needed in other sectors but cannot be produced locally leading to the growth of the overall economy. Saving from farmers is huge as the number of farmers is large; therefore, if it can be mobilized, the whole economy will be supplied with huge fund. In addition, the growth of agricultural productivity may create the opportunity for the local government to generate extra tax revenue so that they can invest in rural infrastructure development which create rural jobs and further increase agricultural productivity at the advantage of farming households. Beside the benefit accrued to the farming households, agricultural productivity growth may lower the price of food and raw material which benefit the poor net food buyers although it is against the net producers of food, and the industry that demand raw material from the agricultural sector can benefit from the cheaper raw materials. However, the magnitude of the effect depends on the structure of the food industry and elasticity of demand and supply of the particular agricultural product. With regard to poverty reduction, it depends on whether the majority of the poor is net producers or consumers of the food. In a nutshell, the growth of agricultural productivity is beneficial for farming households and other poor segments of the society regardless of whether they are rural or urban poor.

On the effect of farm efficiency on the consumption of farming households, i.e. their poverty, it is worth noting that there are two types of efficiency, the output-oriented efficiency and the input-oriented efficiency. The output-oriented efficiency refers to the situation when farmers try to move close to the production frontier, increasing the production as much as possible by keeping the amount of input use constant. In this case, the impact of improved efficiency in farmers' income is similar to that of the growth of productivity as the objective of farmers is to increase production and when production is increased, the effect is the same as those discussed in the earlier section. On the other hand, the input-oriented efficiency refers to the fact that farmers may try to minimize the amount of input use but aiming for the same level of production as before. This means that farmers try to save the resources and reduce waste. The saved resources can be utilized for other productive activity, which will further increase their income, or for consumption, and finally increase their welfare. Nonetheless, whether the saved resources are used for consumption or productive investment depends on each farmer's decision.

The indirect effects, i.e. the employment and non-farm effect, on farmers' consumption are not considered in this analysis because the required data is not available. Thus, this chapter analyzes only the impact of the improvement of productivity and efficiency on poverty among rice farming households. The analysis is conducted in two stages: first, the per capita total consumption[37] and per capita food consumption (the food price effect) of rice farming households are regressed on a set of explanatory variables including the main variables, labor and land productivity, and efficiency. From the regressions, the elasticity of the productivity and efficiency variables are obtained and then are utilized to compute the impact of the change of productivity and efficiency on per capita total consumption, which is then used to calculate the change in poverty. This method enables us to comprehend the impact of the improved productivity and efficiency on poverty among rice farming households. It is expected that the improvement of the productivity and efficiency will raise the level of total and food consumption, and, therefore, reduce poverty among rice farming households.

6.3 Previous Studies on Cambodian Poverty

There are many literatures on the Cambodian poverty but most of them are qualitative, and poverty profile studies because data required to study poverty such as panel data is not widely available in Cambodia. Thus, most of the research is based on the field survey data or survey data published by the government agency such as CSES, which is published by the Ministry of Planning. A study by Phim (2012) suggested that household's asset, agricultural land size, irrigated land, and access to microfinance[38] have a positive relationship with consumption, which means that these factors contribute to the reduction of households' poverty.

[37] Total consumption data used in this study was obtained by summing up all the expenditure on a basket of food and non-food items. See MOP (2013) for detail.

[38] In a later study by the same author, microcredit was also found to contribute significantly to the reduction of rural households (Phim, 2013).

The increased agricultural land size and the ratio of irrigated land, and the access to common pool resources help move impoverished households out of poverty while shock, aging of the household head and the increase in dependency ratio may force non-poor households to become impoverished. Regarding the importance of agricultural land for the poor, Engvall & Kokko (2007), in their studies on land policy in Cambodia, suggested that improving land tenure system will help reduce poverty. There is various benefit of strict land tenure system as it provides security for farming households to invest in their land, and it allows them to use land as collateral to access to formal financing.

There are different types of the poor group in Cambodia. Engvall et al. (2008) suggested that, in Cambodia, the main causes of poverty are different among the landless and those owning land and between different regions. They also found that increasing input in agriculture will increase welfare of the poor who owns land. And the linkage from agriculture to the rest of the economy benefits both the land owner and the landless poor. The Cambodian poor engage in both farm and non-farm economy but when the poor works in the non-farm sectors, they usually get low-paid. Rahut & Scharf (2012) found that education plays an important role in letting the poor access to remunerative non-farm employment. Geography is also an influential factor in getting non-farm jobs indicating the benefit of locality. People living closer to major cities may have higher chances to get employed in non-farm jobs. Other factors such as ethnic minority, gender, or land holding do not influence non-farm employment.

6.4 Data, Scope of Study and Poverty Measurement

6.4.1 Data

This chapter also employs the data from the CSES 2009 to carry out the regression analysis and compute poverty indices. CSES is a survey conducted by Ministry of Planning (MOP)'s National Institute of Statistics (NIS) from January to December 2009. It is a nationwide survey covering the sample of 12000 households in 720 villages, which are divided into 12 monthly samples of 1000 households in 60 villages. The nationwide survey is conducted once every five years and more than a hundred socio-economic variables are included.

6.4.2 Scope of the Study

The study focuses on the direct impact of the improvement of land and labor productivity, and efficiency on the per capita total consumption and per capita food consumption among rice farming households. The change in consumption level can be translated into the change in poverty status; households who can afford higher consumptions mean they are less poor. The indirect impact is also important in poverty analysis but due to the limitation of the data, it is impossible to incorporate indirect impact in the analysis. Although only direct impact is to be examined, it is expected that the result will shed more light on the role of improved performance of farming households and rice industry as a whole on poverty reduction and can be used as a reference for future research in similar manner when sufficient data is available as well as a reference in poverty reduction policy formulation. In addition, this study is only conducted in one period of time (cross-sectional study), thus may not be able to capture the dynamic impact of productivity and efficiency on poverty and the structural change of the economy. The share of the agricultural sector in the Cambodian economy may not be the same in different time period and the income from agricultural crops may not be a significant portion of the income of the rural households as the economy develops. Therefore, we need to account for the structural change of the economy in the future study.

6.4.3 Poverty Measurement

In Cambodia, poverty lines are calculated for three designated regions: the capital Phnom Penh, other urban areas, and rural areas[39]. In this study, for only rice farming households is included in the sample, they are assumed to be all rural inhabitants. Therefore, the rural poverty line will be used to construct poverty indices for Cambodia, the nationwide data, and the four regions, the Plain, the Tonle Sap, the Plateau/ Mountain and the Coast. The

[39] Among the three poverty lines, rural poverty line is the smallest monetary value reflecting the higher cost in urban areas and the capital Phnom Penh. Included in the poverty line is the allowance for food, non-food and clean water which is highest in rural are because significant number of rural households have no access to clean water, an indicator of their poverty. For more detail see MOP (2013).

new poverty line was redefined by MOP in 2013; it includes the consumption expenditure of food, non-food allowance, and the expenditure for clean water; the rural poverty line was set at 3,503 KHR, 290 KHR higher than the previous rural poverty line which was 3,213 KHR (MOP, 2013).

Using the rural poverty line as a benchmark, three different poverty indices, namely poverty headcount, poverty gap and poverty severity, are computed by applying the formula proposed by Foster, Green & Thorbeke (1984). The formula is expressed in the following equation:

$$P_\alpha = \frac{1}{N}\sum_{i=1}^{q}\left(\frac{z-y_i}{z}\right)^\alpha \qquad (6.1)$$

Where,

N is the total population

q is the number of the poor

z is the poverty line

y is the welfare indicator (per capita total consumption in this study)

Equation (6.1) can be interpreted as follows. If $\alpha = 0$, P_0 becomes poverty headcount ratio, which is the percentage of people living below poverty line; if $\alpha = 1$, P_1 become poverty gap, the amount of consumption the poor need to reach the poverty line and if $\alpha = 2$, P_2 become poverty severity index, which capture the inequality among the poor. The computed poverty indices are to be presented in the following section.

6.5 Regression Discussion and Result

6.5.1 Regression Model

The rice farming households' per capita total consumption and per capita food consumption are regressed on two main productivity variables, land and labor productivity, and inefficiency scores obtained from Chapter 5, and other independent variables including farm characteristics and the characteristics of household heads.

The regression equation is in the following form:

$$\mathbf{y} = \mathbf{X\beta} + \boldsymbol{\varepsilon} \tag{6.2}$$

Where,

$\mathbf{y}$ is a vector of the per capita total consumption or per capita food consumption

$\mathbf{X}$ is a matrix of independent variables

$\boldsymbol{\varepsilon}$ is a vector of error terms

Different definitions of labor and land productivity were applied in the literature. Land productivity was defined as crop yield or gross crop value per acre by several studies including those by Datt & Ravallion(1998), Sarris et al. (2006), and de Janvary & Sadoulet (2009), while Irz et al. (2001) defined land productivity as the gross output net of the intermediate input cost, arguing that this method could reduce the effect of input intensification during production. For example, in the same size of agricultural land area, a farmer may produce larger output by applying more input. Therefore, it does not imply that a particular land is more productive; it is, in fact, the result of intensified input use. Farmers who apply more input are able to produce more output but may not obtain higher income. Labor productivity was defined by Irz et. al (2001) and de Janvary & Sadoulet (2009) as per worker average value added. This dissertation adopted the definition of land productivity by Irz et al. (2001) and labor productivity by de Janvary & Sadoulet (2009) and Irz et al. (2001)[40].

Irz et al. (2001) examined several models using land and labor productivity because it is not clear whether labor or land productivity which has a positive impact on poverty (contribute to poverty reduction). Also, they used different indicators of poverty such as poverty headcount ratio and Human Development Index (HDI). In the same manner, this study regresses per capita total consumption and per capita food consumption on both land and labor productivity, yet because other poverty indicator such as HDI is not available at the household level, this dissertation will use only per capita total consumption and per capita food consumption as indicators of farming households' welfare. Both Ordinary Least Square (OLS) and Instrumental Variable (IV) Regression methods are employed.

[40] Yield is one of the proxies of productivity. By plotting the available data from Sobado et al., (2013), rice was found to reduce rural poverty although it is not a rigorous estimation. Please refer to the Appendix 6.1.

6.5.2 The Characteristics of Rice Farming Households and Their Poverty Status

6.5.2.1 The Characteristics of Rice Farming Households

According to the Table 6.1, the average size of the households' harvested area is 1.3 hectare. This indicates that Cambodian rice farming households are small-scale producers so only growing rice will not provide sufficient income for many households. They have to find extra employment opportunities to supplement the income from growing rice. With average family size of five and small farmland, not all households are able to produce for household consumption let alone producing surplus to sell in the market. According to Sobrado et al. (2013), only just about 40% of the households are capable of producing rice surplus. If the productivity of rice improves, more farming households will be able to produce more for household consumption, and the number of farming household capable of producing surplus will increase. Farmers previously produce just enough for the household consumption will be able to produce some surplus to market to earn cash, and farmers previously produce a small surplus will increase the volume and earn more cash.

The head of rice farming households are relatively young. Their average age is only 42.8 years old compared to the average age of 70 years old for Japanese farmers[41]. The aging of farming population and the lack of interest among youth in farm works become worrying factors for Japan and many other countries, but it is not yet a significant problem for Cambodia. However, one of the main problems is that the education of farmers is very low; on average, Cambodian farmers have attained only about 5 years of schooling, one year less than the total six years required to complete primary level education[42]. Young farmers are energetic and are seen to be ready to accept newly invented technology in their production; nevertheless, without sufficient education attainment, their absorptive capacity is low; hence, they may not necessarily be able to apply the new knowledge properly.

[41] See the Economist, April 13th, 2013. Available at: http://www.economist.com/news/asia/21576154-fewer-bigger-plots-and-fewer-part-time-farmers-agriculture-could-compete-field-work

[42] The basic education system in Cambodia is six years for primary school, 3 years for junior high school and 3 years for senior high school.

Table 6.1 Summary Statistics of the Variables

	Unit	Mean	Std. Dve.	Min	Max	Obs
Household Charaterirsitcs						
Harvested area	ha	1.3	1.2	0.0	15.0	2713
Household size	persons	5.0	1.7	1.0	13.0	2713
Head of household age	year	42.8	13.2	15.0	87.0	2713
Head of household education	year	5.4	6.0	0.0	16.0	2713
Gender of head of household	dummy	0.8	0.3	0.0	1.0	2713
Non-agricultural income	000 KHR	1206.6	3360.0	0.0	24600.0	2713
Dependency Ratio	ratio	0.4	0.2	0.0	0.8	2713
Fertilizer	dummy	0.7	0.4	0.0	1.0	2713
Percapita consumption expenditure	KHR	5457.0	1897.1	1450.5	10152.9	2713
Percapita food consumption	KHR	3191.4	1207.7	379.6	7933.3	2713
Infrastructure						
Phone	dummy	0.3	0.5	0.0	1.0	2713
Irrigation	dummy	0.4	0.5	0.0	1.0	2713
Electricity	dummy	0.1	0.3	0.0	1.0	2713
Productivity						
Land productivity	ratio	14.3	1.3	7.5	19.5	2606
Labor productity	ratio	13.3	1.1	7.7	16.9	2485
Land endowment	ratio	-1.0	0.9	-5.3	2.2	2587
Rice Production Factors						
Hand tractor	dummy	0.1	0.3	0.0	1.0	2713

Source: Compiled by author based on CSES (2009)

In Cambodia, where the extension service is hardly available, farmers have to search and learn by themselves new technology of production. Only farmers with a certain level of education can perform this task. In addition, only small portion of the households has access to production infrastructures such as irrigation and electricity. There is a popular Cambodian proverb: "*cultivating rice requires water resources, waging war requires food supplies*", which suggests that people are well aware of the importance of water in rice cultivation long time ago, yet irrigation is poorly developed and maintained. As a result, only a small portion of rice farming households gets access to irrigation while many other still depend profoundly on rainfall and climate making their production unstable and vulnerable. Lacking access to water imposes considerable risk to rice cultivation. Farmers may decide not to invest in soil leveling, which enable them to gain higher yield, or invest in inputs such as fertilizers because they face high future uncertainty. Also, without access to irrigation, they have to depend on the climate. If the rain is sufficient, they may have a good harvest but if the rain is not sufficient, they will lose all the investment. The weather is very much unpredictable; recently, because of the effect of global warming, the climate has become more unfavorable to farmers in developing countries like Cambodia, who lack the capability to resist. Sometimes, there is too much rain but other time, the drought is too long. These pose higher risk for farmers, especially the poor rice farmers. In a nutshell, water is indispensable for Cambodian rice farmers, and the current rate of access to irrigation has to be improved. Irrigation does not only reduce the risk of farm investment but also enable farmers to increase cropping intensity and diversify their crops. They may be able to grow rice more than one time per year or grow other crops than rice. Besides, the rate of the possession of modern capital goods such as hand tractor is also low; however, the majority of farmers are able to use tractor or hand tractor for plowing their rice field by hiring farmers who own tractor or hand tractor to plow for them. This practice is found common among rice farmers in other Southeast Asian countries such as farmers in the Philippines (Hayami & Kikuchi, 1999). The problem is that farmers need to have sufficient confident on their investment in hiring tractors or hand tractors. Just like other investment, farmers need to make sure that after investing in plowing, they will be able to gain satisfactory return. Increasing mechanization must be encouraged so that farmers can operate faster and can reduce the number of people required to operate in their small plot of rice growing land.

6.5.2.2 Poverty Status of the Rice Farming Households

Until recently the rural population in Cambodia represents more than 70% of the total population, and the latest data shows that the rural poverty rate is much higher than that of urban areas. Basically, in many rural areas, there is no presence of any sort of industry. People depend to a significant extent on agriculture and agriculture-related activities. The rice industry plays a significant role as many households engage in rice growing, and it is undeniable that there are many poor rice farming households because the rate of rural of rural poverty is so high. Using the MOP's rural poverty line discussed above and equation (6.1), the poverty indices among the rice farming households are constructed using the data from CSES 2009. Initially, poverty indices of the nationwide sample are computed. Subsequently, the sample is separated based on the different ago-climatic region, and the poverty indices of those regions are computed. By so doing, it is possible to explore the deviation of the regional poverty from that of the national. The computed poverty indices are presented in Table 6.2.

Table 6.2 Poverty Rate among Cambodian Rice Farming Households, 2009

	Cambodia	Plain	Tonle Sap	Plateau/Mountain	Coast
Poverty Headcount P(0)	0.163	0.155	0.169	0.196	0.113
Poverty Gap P(1)	0.029	0.027	0.030	0.035	0.020
Poverty Severity P(2)	0.008	0.007	0.008	0.009	0.006
Mean Cons.	5456.994	5610.060	5385.787	5159.899	5487.158

Source: Calculated by author based on CSES (2009)

Table 6.2 only shows the poverty rate among rice farming households; it is different from the poverty rate presented in Figure 3.1 in Chapter 3, which presents the poverty rate for all Cambodian households. Among the rice farming households, the poverty rate is lower than that for all Cambodian. For example, the poverty headcount in 2009 for all Cambodian is 23.9% but it is only 16.3% among rice farming households. This shows that rice farming households are not the poorest group. Included in the calculation are only farming households who own farmland but, in Cambodia, the poorest group are vulnerable groups such as slum dwellers in big cities and female headed households, and landless households whose number are increasing because of growing number of family members and socio economic shocks. The average per capita total consumption of rice farming households is about 5,456 KHR, roughly US$ 1.35. Households in the Plain region have the highest average per capita consumption of 5,610 KHR followed by 5,487 KHR in the Coast, 5,385 KHR in the Tonle Sap and 5,159 KHR in the Plateau/Mountain region. Nonetheless, the poverty rate among rice farming households in different region follow the pattern of poverty rate computed for the whole population presented in Figure 3.1 in Chapter 3, that is, the Plateau/Mountain region represents the worst off region followed by the Tonle Sap, the Plain and the Cost region. Thus, although the poverty rate is different, the pattern of poverty in each region is the same regardless of whether the sample is the Cambodian population as a whole or just the rice farming households.

6.5.2.3 Total Consumption and Food Consumption

It is common that the poor spends a large portion of their meager income on food consumption because food is the basic need for their livelihood. Some groups of the poor, the severely poor, cannot even afford to have income sufficient for food consumption so among their family members, there are problems of malnutrition such as stunting and wasting, especially among the kids. The total consumption and food consumption is connected in that if income shock occurs like crops being destroyed by flood or drought, or the diseased of the bread winners and the like, the poor may reduce the consumption of non-food items and devote almost 100% their income on food. However, if income increases, food consumption also tends to increase but at a diminishing rate reflecting the Engel's law. Table 6.3 presents the consumption items of the Cambodian rice farming households. As in the table of poverty status, the total consumption and food consumption in the four regions are presented along with the national average. Important items of food and non-food consumptions are also exhibited to shed more light on what consumption items rice farming households spend most of their little budget on.

According to the table, on average, Cambodian rice farming households spend around 65.7 % of their income on food. The biggest expenditure among food consumption is on cereal[43], which accounts for 11.1% of the total consumption, and fish, meat and poultry account for 10.0% and 6.9% respectively. The biggest portion of non-food consumption is the expenditure for medical care, 6.8% of the total consumption. In Cambodia, there is generally no medical insurance. People have to bear the full cost of medical fee, which is often so expensive that when members of a household get seriously sick, land or other assets is sold to pay up the medical charge. This creates economic distress to the poor and was found to cause more economic damage to rural households than crop failure (Yagura, 2005). The weak health infrastructure coupled with unhygienic lifestyle make poor households susceptible to many

[43] In CSES 2009, cereal includes rice and other food items made from rice. Therefore, rice is one of the important food items that the rice farming households spend their income on because, as mentioned earlier, only about 40% of the farming households are capable of producing rice surplus. Many households still cannot produce sufficient amount for the household consumption.

diseases and health related problems. Because medical fee is expensive, some of the poor turn to the village shaman or untrained or unlicensed health worker for treatment and health advices, which often end up in a worse result[44].

Table 6.3 The Consumption Items of Rice Farming Households, 2009

	Cambodia		Plain		Tonle Sap		Plateau/Mountain		Coast	
	Value in Riels	% of Total Cons.	Value in Riels	% of Total Cons.	Value in Riels	% of Total Cons.	Value in Riels	% of Total Cons.	Value in Riels	% of Total Cons.
Food Consumption										
Cereal	3592.7	11.1	3494.9	10.6	3677.1	11.1	3805.3	11.8	3396.7	10.2
Fish	3258.4	10.0	3267.0	9.9	3257.8	9.9	3246.7	10.1	3238.9	9.7
Meat & Poultry	2240.0	6.9	2236.2	6.8	2123.7	6.4	2268.0	7.0	2564.6	7.7
Food take away from home	1382.1	4.3	1270.5	3.8	1406.9	4.3	1494.1	4.6	1588.2	4.8
Fresh Vegetables	1288.4	4.0	1261.2	3.8	1293.6	3.9	1338.8	4.2	1313.4	3.9
Others	9578.0	29.5	9430.3	28.5	9603.5	29.1	9577.6	29.7	10556.4	31.6
Total Food	21339.7	65.7	20960.1	63.3	21362.6	64.6	21730.5	67.4	22658.3	67.8
Non-food Consumption										
Medical care	2216.7	6.8	2128.7	6.4	2250.0	6.8	2704.9	8.4	1727.5	5.2
Transportation	1554.1	4.8	1478.7	4.5	1812.7	5.5	1428.3	4.4	1301.5	3.9
Commucation	754.5	2.3	738.2	2.2	831.4	2.5	675.0	2.1	689.7	2.1
Cothing	844.7	2.6	826.1	2.5	863.8	2.6	892.0	2.8	783.4	2.3
Education	653.6	2.0	660.2	2.0	684.2	2.1	404.9	1.3	893.3	2.7
Others	5140.6	15.8	6300.5	19.0	5249.5	15.9	4402.0	13.7	5343.5	16.0
Total Non-food	11164.2	34.3	12132.4	36.7	11691.5	35.4	10507.1	32.6	10738.9	32.2
Total Consumption	32503.8	100.0	33092.5	100.0	33054.2	100.0	32237.6	100.0	33397.2	100.0

Source: Compiled by author based on CSES (2009)

The regional consumption is not much different from that of national. In the four regions, the food consumption ranges from 63.3% in Plain to 67.8% in Coast. People in Plateau/Mountain region spend more on cereal and medical care than other three regions probably due to the low productivity of rice; many households are not able to produce a sufficient amount of rice for consumption so they have to spend more cash to buy rice than people in other regions. In addition, the region is more prone to tropical diseases such as malaria because of dense forest and lower coverage of medical staff and shortage of infrastructure such as health care center. Also, the region is home to many ethnic minority groups, who often still practice traditional agriculture and do not access to modern medical care.

[44] There are many reported death incidences caused by unlicensed health workers. Recently, an unlicensed health worker was found to have spread HIV to dozens of villagers in rural Battambang Province. Please see http://www.phnompenhpost.com/national/hiv-nightmare-battambang. Last accessed January 26, 2015.

These may be the causes of higher expenditure on medical fee among people in this region. The two types of expenditure in the Plateau/Mountain region are higher than the national average.

6.5.3 Regression Note and Results

The regression analysis was carried out using STATA software, and the result is presented in Table 6.4, the per capita total consumption regression, and Table 6.5, the per capita food consumption regression. Initially, the OLS regression was estimated. Since, in the study on the relationship between agricultural productivity and poverty in Tanzania by Sarris et al. (2006), which also estimated the consumption function, the productivity variable was found to have the problem of endogeneity, the consumption functions to be estimated in this chapter are also suspected to have the problem of endogeneity. Then, in addition to the OLS regression, I estimated the IV regression to check whether or not the endogeneity problem occurs. If the problem of endogeneity occurs, the coefficient of the independent variables become unreliable because it is biased, thus cannot be used as a reliable estimate of the computed regression coefficients. This endogeneity problem is corrected by using the valid instruments for the endogenized variables, i.e. the productivity variables. The two regression tables present the result of the OLS along with that of the IV estimates. In general, if the OLS coefficients are different from the IV coefficients, we may have a valid reason to estimate the IV regression.

In all regression, the main variables are the productivity and the inefficiency. Others are control variables. The natural logarithms of land and labor productivity are highly correlated[45]; therefore, the regressions are separated into Model 1 with the land productivity and the inefficiency as the main variables, and Model 2 with the labor productivity and the inefficiency as the main variables. For the interpretation, because not all the regression has the endogeneity problem, the results will be interpreted based on the OLS regression if there is no evidence of an endogeneity problem. If the problem of endogeneity occurs, the results will be interpreted based on the IV regression.

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[45] Please refer to the Appendix 6.2 through the Appendix 6.6 at the end of the dissertation for the correlation matrix.

Table 6.4 Regression Results of the Relationship between the Productivity and Efficiency, and the Per Capita Total Consumption

	Dependent Variable: Logpc_cons											
	Cambodia				Plain				Tonle Sap			
	OLS		IV		OLS		IV		OLS		IV	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Household Charateristics												
Age	0.005	0.006*	0.005	0.004	0.001	0.002	0.003	-0.006	0.005	0.006	0.008	0.001
	(0.003)	(0.003)	(0.004)	(0.004)	(0.007)	(0.007)	(0.018)	(0.011)	(0.006)	(0.006)	(0.010)	(0.010)
Age^2	0.000	-0.000	-0.000	-0.000	-0.000	-0.000	0.000	0.000	-0.000	-0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Gender	-0.019	-0.011	0.012	0.017	-0.027	-0.025	-0.003	-0.031	-0.025	-0.011	0.115	0.064
	(0.020)	(0.020)	(0.026	(0.027)	(0.031)	(0.031)	(0.089	(0.047)	(0.041)	(0.041)	(0.099)	(0.072)
Lognon_agr_inc	0.006***	0.006***	0.006***	0.006***	0.008***	0.008***	0.007	0.007***	0.008***	0.008***	0.002***	0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.005)	(0.003)	(0.002)	(0.002)	(0.004)	(0.004)
Hh_size	-0.073***	-0.075***	-0.067***	-0.064***	-0.056***	-0.057***	-0.043*	-0.041***	-0.076***	-0.077***	-0.054***	-0.049***
	(0.004)	(0.004)	(0.006)	(0.006)	(0.008)	(0.008)	(0.023)	(0.014)	(0.008)	(0.008)	(0.016)	(0.016)
Dep_ratio	-0.169***	-0.158***	-0.206***	-0.221***	-0.281***	-0.277***	-0.449*	-0.398***	-0.084	-0.069	-0.038	-0.088
	(0.037)	(0.038)	(0.047)	(0.051)	(0.067)	(0.067)	(0.237)	(0.121)	(0.065)	(0.065)	(0.119)	(0.114)
Fertilizer	0.036**	0.045***	0.035*	0.031	-0.029	-0.021	0.216	0.027	0.063	0.083***	0.172**	0.101**
	(0.015)	(0.015)	(0.018)	(0.019)	(0.034)	(0.033)	(0.242)	(0.059)	(0.028)	(0.027)	(0.071)	(0.045)
Infrastructure												
Phone	0.121***	0.127***	0.081***	0.068***	0.145***	0.147***	-0.022	0.044	0.116***	0.122***	0.007	-0.009
	(0.015)	(0.015)	(0.021)	(0.024)	(0.025)	(0.025)	(0.164)	(0.061)	(0.027)	(0.027)	(0.069)	(0.066)
Electricity	0.134***	0.138***	0.093***	0.077**	0.107**	0.107**	-0.186	-0.033	0.137***	0.138***	0.045	0.045
	(0.025)	(0.025)	(0.029)	(0.031)	(0.046)	(0.046)	(0.284)	(0.084)	(0.039)	(0.039)	(0.083)	(0.075)
Productivity												
Logland_prod	0.011*		0.205***		0.019*		0.857		0.013		0.476**	
	(0.006)		(0.060)		(0.011)		(0.753)		(0.012)		(0.219)	
Loglabor_prod		0.016***		0.249***		0.024**		0.405**		0.021*		0.438***
		(0.006)		(0.064)		(0.010)		(0.179)		(0.011)		(0.157)
Logland/labor ratio	0.049***		0.200***		0.038**		0.511		0.049***		0.347**	
	(0.009)		(0.047)		(0.015)		(0.425)		(0.016)		(0.143)	
Inefficiency	0.075**	0.043	0.026	0.026	-32.030	-31.967	355.619	195.269	0.163**	0.131*	0.143	0.248*
	(0.037)	(0.036)	(0.054)	(0.055)	(52.736)	(52.758)	(357.908)	(155.653)	(0.075)	(0.074)	(0.134)	(0.130)
Constant	8.563***	8.448***	5.932***	5.355***	40.716	40.539	-359.137	-191.929	8.345***	8.191***	1.799	2.481
	(0.122)	(0.119)	(0.825)	(0.853)	(52.783)	(52.805)	(368.206)	(157.687)	(0.227)	(0.219)	(3.118)	(2.169)
Number of Obs	2484	2484	2484	2484	919	919	919	919	754	754	754	754
Adjusted R^2	0.203	0.196			0.152	0.151			0.229	0.223		
GMM C statistic												
Chi-sqr			15.495	22.049			1.557	7.556			14.724	21.256
P-value			0.000	0.000			0.212	0.006			0.000	0.000
Hansen's J												
Chi-sqr			0.537	3.066			0.389	1.557			0.231	0.289
P-value			0.464	0.216			0.532	0.459			0.631	0.866
F Statistics (weak instrument test)			17.346	12.196			0.789	4.511			3.497	4.346
P-value			0.000	0.000			0.455	0.004			0.031	0.005

Table 6.4 Regression Results of the Relationship between the Productivity and Efficiency, and the Per Capita Total Consumption (Cont.)

	Dependent Variable: Logpc_cons							
	Mountain/Plateau				Coast			
	OLS		IV		OLS		IV	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Household Charateristics								
Age	0.009	0.011	0.010	0.011	0.023	0.018	0.025	0.027
	(0.009)	(0.009)	(0.008)	(0.008)	(0.016)	(0.016)	(0.017)	(0.018)
Age^2	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Gender	0.049	0.054	0.048	0.056	-0.041	-0.015	-0.077	-0.036
	(0.054)	(0.054)	(0.059)	(0.061)	(0.071)	(0.073)	(0.073)	(0.067)
Lognon_agr_inc	0.005*	0.005	0.004	0.005*	-0.001	0.000	-0.003	-0.002*
	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)
Hh_size	-0.087***	-0.089***	-0.090***	-0.088***	-0.093***	-0.102***	-0.093***	-0.109***
	(0.010)	(0.010)	(0.012)	(0.011)	(0.017)	(0.017)	(0.021)	(0.024)
Dep_ratio	-0.194**	-0.170*	-0.124	-0.188	-0.177	-0.089	-0.193	-0.091
	(0.094)	(0.094)	(0.194)	(0.164)	(0.142)	(0.144)	(0.149)	(0.152)
Fertilizer	0.050	0.047	0.071	0.042	-0.066	-0.035	-0.070	-0.035
	(0.032)	(0.032)	(0.062)	(0.058)	(0.064)	(0.066)	(0.059)	(0.055)
Infrastructure								
Phone	0.058	0.071*	0.087	0.069	0.130***	0.158***	0.120**	0.179***
	(0.038)	(0.038)	(0.077)	(0.066)	(0.048)	(0.049)	(0.047)	(0.046)
Electricity	0.163***	0.167***	0.148**	0.170***	0.051	0.061	0.048	0.057
	(0.056)	(0.056)	(0.059)	(0.055)	(0.100)	(0.103)	(0.074)	(0.064)
Productivity								
Logland_prod	-0.017		-0.075		0.016		-0.061	
	(0.014)		(0.145)		(0.023)		(0.077)	
Loglabor_prod		-0.022		-0.007		0.049**		-0.009
		(0.014)		(0.121)		(0.022)		(0.082
Logland/labor ratio	0.039		-0.028		0.124***		0.087*	
	(0.025)		(0.170)		(0.030)		(0.048)	
Inefficiency	-0.016	-0.031	0.002	-0.037	0.217	0.224	0.169	0.214
	(0.057)	(0.057)	(0.073)	(0.066)	(0.269)	(0.277)	(0.224)	(0.261)
Constant	8.972***	8.963***	9.686***	8.785***	8.281***	7.775***	9.436***	8.438***
	(0.281)	(0.283)	(1.786)	(1.544)	(0.573)	(0.570)	(1.185)	(1.266)
Number of Obs	424	424	424	424	199	199	199	199
Adjusted R^2	0.235	0.221			0.262	0.218	0.266	0.232
GMM C statistic								
Chi-sqr			0.177	0.015			1.274	0.771
P-value			0.674	0.903			0.259	0.379
Hansen's J								
Chi-sqr			0.000	0.620			0.095	7.779
P-value			0.985	0.733			0.758	0.021
F Statistics (weak instrument test)			2.455	2.059			9.447	4.796
P-value			0.087	0.105			0.000	0.003

Note: - Instrumented Variables:

Logland_prod (instruments: irrigation, household head education)

Loglabor_prod (instruments: irrigation, household head education, hand tractor)

- *, ** & *** significant at 10%, 5% and 1% respectively.

Source: Calculated by author based on CSES (2009)

The interpretation of the control variables is briefly presented first. According to Table 6.4 and Table 6.5, the age of the household head does not have any relationship with the per capita total consumption and the per capita food consumption of the rice farming households. Gender of the household head has a positive relationship with the per capita food consumption only in the Plateau/Mountain region but in other regions regardless of whether it is per capita total consumption or per capita food consumption, there is no significant relationship. The positive relationship between the gender of the household head and per capita food consumption implies that if the household head is male, the per capita food consumption is higher. In general, female headed households tend to be poorer, and also in the case of Cambodia, Sobrado et al. (2013) reported that female headed households are poorer than households headed by male. The non-agricultural income has a significant and positive relationship with the per capita total consumption and the per capita food consumption in almost all regression, suggesting that the non-agricultural income is important for the Cambodian rural poor. People cannot depend solely on agricultural income such as the income from rice growing because it cannot be enough to sustain the households for the land they are cultivating rice is small so they cannot produce big surplus to sell. And those who have an additional job in other industries can enjoy higher consumption. In the reports by Sobrado et al. (2013) and Tong et al. (2013), Cambodian rural households generate income mainly from agricultural crops, self-employment, waged employment and remittances. Household size and the dependency ratio have the negative relationship with both the per capita total consumption and the per capita food consumption. In Cambodia, large households tend to have a bigger number of dependence because the population is very young. Large portion of the population is below 15 years old. At this age, they cannot work and generate income yet, so the working age members of the households have to work and share the consumption with the dependence. Fertilizer has a mixed relationship with the dependent variables. In some regression, the coefficient negative and in other, the coefficient is positive. There is no established theory proving the direction of the relationship between the accesses to fertilizer and the level of consumption; nonetheless, Sarris et al. (2006) hypothesized that households with access to fertilizer tends to have higher consumption than those not applying fertilizers in their agricultural production. In Cambodian context, Engvall et al. (2008) stated that increasing agricultural input such as fertilizer improves welfare of the landowner and the landless also benefit from the linkage effect. In addition, An & Culas (2013) found that limited access to fertilizer due to financial constraint is the challenge to increase farmers' income. It seems that farmers' income and access to fertilizers has a bidirectional relationship, i.e. having access to fertilizers improve farmers' income and farmers with higher income have more access to fertilizer. Phone and electricity represent the access to infrastructure, which is important for farmers to access the information and the market. Phim (2011) found that infrastructure improved the consumption of the poor in the border provinces of Cambodia. And in this chapter, it is found that, in general, infrastructure raises the total consumption and the food consumption of the rice farming households.

Table 6.5 Regression Results of the Relationship between the Productivity and Efficiency, and the Per Capita Food Consumption

	Dependent Variable: Logpcfood_cons											
	Cambodia				Plain				Tonle Sap			
	OLS		IV		OLS		IV		OLS		IV	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Household Charateristics												
Age	0.003	0.004	0.003	0.002	-0.004	-0.003	-0.002	-0.005	0.008	0.008	0.009	0.005
	(0.004)	(0.004)	(0.004)	(0.004)	(0.007)	(0.007)	(0.011)	(0.007)	(0.006)	(0.007)	(0.008)	(0.008)
Age^2	-0.000	-0.000	-0.000	-0.000	0.000	0.000	0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Gender	-0.004	-0.011	0.018	0.016	0.002	0.002	0.016	0.003	-0.065	-0.066	0.016	-0.028
	(0.023)	(0.023)	(0.026	(0.025)	(0.033)	(0.033)	(0.056	(0.032)	(0.046)	(0.045)	(0.075)	(0.054)
Lognon_agr_inc	0.005***	0.005***	0.005***	0.005***	0.006***	0.006***	0.006**	0.006***	0.005**	0.005**	0.002	0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
Hh_size	-0.069***	-0.069***	-0.064***	-0.063***	-0.049***	-0.049***	-0.043***	-0.046***	-0.071***	-0.071***	-0.059***	-0.057***
	(0.005)	(0.005)	(0.006)	(0.006)	(0.009)	(0.009)	(0.015)	(0.009)	(0.009)	(0.008)	(0.013)	(0.013)
Dep_ratio	-0.096**	-0.091**	-0.123***	-0.129***	-0.192***	-0.191***	-0.292*	-0.223***	-0.038	-0.039	-0.008	-0.045
	(0.042)	(0.042)	(0.047)	(0.049)	(0.072)	(0.072)	(0.150)	(0.084)	(0.072)	(0.072)	(0.093)	(0.087)
Fertilizer	0.027	0.031*	0.027	0.023	-0.067*	0.065*	0.072	-0.050	0.077**	0.075**	0.137**	0.083**
	(0.017)	(0.017)	(0.019)	(0.019)	(0.036)	(0.035)	(0.143)	(0.038)	(0.031)	(0.029)	(0.054)	(0.035)
Infrastructure												
Phone	0.041**	0.044***	0.012	0.007	0.079***	0.079***	-0.013	0.054	0.012	0.012	-0.050	-0.053
	(0.017)	(0.017)	(0.022)	(0.024)	(0.027)	(0.027)	(0.097)	(0.038)	(0.030)	(0.029)	(0.054)	(0.050)
Electricity	0.151***	0.152***	0.122***	0.118**	0.182***	0.182***	0.018	0.150**	0.102**	0.102**	0.048	0.054
	(0.027)	(0.027)	(0.029)	(0.029)	(0.049)	(0.049)	(0.171)	(0.059)	(0.043)	(0.043)	(0.063)	(0.058)
Productivity												
Logland_prod	-0.001		0.137**		-0.001		0.467		0.022*		0.286*	
	(0.007)		(0.060)		(0.012)		(0.442)		(0.013)		(0.165)	
Loglabor_prod		0.001		0.144***		-0.001		0.086*		0.022*		0.234*
		(0.007)		(0.061)		(0.011)		(0.107)		(0.012)		(0.126)
Logland/labor ratio	0.017*		0.123***		0.003		0.267		0.019		0.189*	
	(0.010)		(0.048)		(0.016)		(0.249)		(0.018)		(0.109)	
Inefficiency	0.089**	0.074	0.055	0.065	91.029	91.042	300.783	144.784*	0.052	0.055	0.047	0.121*
	(0.041)	(0.040)	(0.056)	(0.054)	(56.277)	(56.248)	(206.715)	(83.682)	(0.083)	(0.082)	(0.092)	(0.092)
Constant												
	8.156***	8.103***	6.292***	6.211***	-82.671	-82.707	-299.340	-137.651***	7.786***	7.797***	4.039*	4.882***
	(0.135)	(0.133)	(0.829)	(0.817)	(56.327)	(56.298)	(212.662)	(84.804)	(0.252)	(0.242)	(2.345)	(1.734)
Number of Obs	2484	2484	2484	2484	919	919	919	919	754	754	754	754
Adjusted R^2	0.119	0.117			0.090	0.091			0.127	0.129		
GMM C statistic												
Chi-sqr			6.208	6.603			-1.136	-2.117			4.149	4.255
P-value			0.013	0.010			1.000	1.000			0.042	0.039
Hansen's J												
Chi-sqr			0.349	0.290			2.954	6.872			0.548	0.890
P-value			0.554	0.865			0.086	0.032			0.459	0.641
F Statistics (weak instrument test)			17.346	12.196			0.789	4.511			3.497	4.346
P-value			0.000	0.000			0.455	0.004			0.031	0.005

Table 6.5 Regression Results of the Relationship between the Productivity and Efficiency, and the Per Capita Food Consumption (Cont.)

	Dependent Variable: Logpcfood_cons							
	Mountain/Plateau				Coast			
	OLS		IV		OLS		IV	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Household Charateristics								
Age	0.008	0.009	0.011	0.011	0.008	0.005	0.010	0.016
	(0.011)	(0.011)	(0.013)	(0.012)	(0.018)	(0.018)	(0.008)	(0.019)
Age^2	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Gender	0.111*	0.115*	0.106	0.106	-0.063	-0.043	-0.059	-0.033
	(0.064)	(0.065)	(0.082)	(0.078)	(0.079)	(0.079)	(0.083)	(0.079)
Lognon_agr_inc	0.006*	0.006*	0.002	0.003	-0.001	-0.000	-0.001	-0.002
	(0.003)	(0.003)	(0.006)	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)
Hh_size	-0.087***	-0.088***	-0.101***	-0.099***	-0.088***	-0.095***	-0.087***	-0.098***
	(0.012)	(0.012)	(0.019)	(0.016)	(0.019)	(0.019)	(0.023)	(0.025)
Dep_ratio	-0.049	-0.029	0.299	0.243	-0.066	0.004	-0.078	-0.026
	(0.112)	(0.112)	(0.294)	(0.229)	(0.158)	(0.157)	(0.174)	(0.175)
Fertilizer	0.054	0.052	0.159*	0.143*	-0.077	-0.053	-0.076	-0.0642
	(0.039)	(0.039)	(0.092)	(0.079)	(0.071)	(0.072)	(0.053)	(0.054)
Infrastructure								
Phone	-0.035	-0.024*	0.116	0.094	0.066	0.088	0.064	0.103*
	(0.045)	(0.045)	(0.122)	(0.096)	(0.054)	(0.054)	(0.054)	(0.053)
Electricity	0.241***	0.244***	0.159	0.172*	0.126	0.134	0.132*	0.117
	(0.067)	(0.067)	(0.099)	(0.089)	(0.111)	(0.113)	(0.076)	(0.078)
Productivity								
Logland_prod	-0.036**		-0.333		0.029		0.038	
	(0.017)		(0.216)		(0.026)		(0.086)	
Loglabor_prod		-0.041**		-0.285*		0.055**		0.083
		(0.017)		(0.165)		(0.024)		(0.089)
Logland/labor ratio	0.011		-0.335		0.114***		0.116**	
	(0.030)		(0.255)		(0.034)		(0.056)	
Inefficiency	-0.038	-0.051	0.053	0.038	0.575*	0.580*	0.598**	0.667**
	(0.068)	(0.068)	(0.091)	(0.082)	(0.299)	(0.303)	(0.275)	(0.279)
Constant	8.605***	8.598***	12.254***	11.655***	7.468***	7.067***	7.288***	6.408***
	(0.335)	(0.337)	(2.652)	(2.068)	(0.631)	(0.624)	(1.283)	(1.334)
Number of Obs	424	424	424	424	199	199	199	199
Adjusted R^2	0.165	0.158			0.189	0.166	0.237	0.201
GMM C statistic								
Chi-sqr			3.069	3.098			0.006	0.118
P-value			0.079	0.078			0.937	0.731
Hansen's J								
Chi-sqr			0.474	0.629			0.410	5.128
P-value			0.491	0.729			0.522	0.077
F Statistics (weak instrument test)			2.455	2.059			9.447	4.796
P-value			0.087	0.105			0.000	0.003

Note: - Instrumented Variables:

Logland_prod (instruments: irrigation, household head education)

Loglabor_prod (instruments: irrigation, household head education, hand tractor)

- *, ** & *** significant at 10%, 5% and 1% respectively.

Source: Calculated by author based on CSES (2009)

The productivity and efficiency variables are the main focus in this chapter. In Table 6.4 and Table 6.5, there are two productivity variables, the land productivity and labor productivity, and for ease of explanation, the efficiency variable is rewritten as the inefficiency because the expected relationship between the inefficiency, and the per capita total consumption and per capita food consumption is negative. In other words, it is expected that if the inefficiency increases, per capita consumption will decline. In the per capita total consumption regression, the endogeneity problem occurs only in the regression of the Cambodia, the countrywide sample, and in the regression of the Tonle Sap region. Therefore, the interpretation of these two regressions follows the IV regression results while the interpretation of other region's regressions is based on the result of the OLS regression. In Cambodia's case, efficiency did not influence the level of per capita consumption. Only the land and labor productivity did. The coefficient of the land and labor productivity is 0.21 and 0.25 respectively. Both are significant at 1% level. Thus, 10% increase in the productivity of land raises the per capita total consumption by 2.1% while 10% increase in the productivity of labor raise the per capita total consumption by 2.5%. In the Plain region, efficiency also has no impact on the per capita total consumption, and the impact of the productivity of land and labor on the per capita total consumption is very small. Also, the two productivity variables are less significant than in the Cambodia's case. The coefficient of the land productivity is significant at 10% and that of the labor productivity is at 5%. 10% increase in the productivity of land or labor adds to only 0.19% or 0.24% of the per capita total consumption. The Plain region is actually the most productive region in terms of rice production in Cambodia; hence, this small contribution to the per capita total consumption may reflect the fact that there is smaller room to further improve the productivity of rice in this region. Farmers in the Tonle Sap region are among the less productive and less efficient. In this region, the contribution of the improved land and labor productivity is the highest. The coefficient of the land productivity is 0.48 and significant at 1% level as the coefficient of the labor productivity is 0.44 and also significant at 1% level. Thus, 10% increase in the productivity of land contribute to 4.8% increase in per capita total consumption and 10% increase in the productivity of labor adds to 4.4 % of the per capita total consumption. However, in this region, the inefficiency is positively significant at

5% in Model 2, the labor productivity model, which is contrary to the prior expectation. It is expected that the increase in the inefficiency reduces the per capita total consumption, but the results show the reverse. It is probably due to the fact that the inefficiency has some degree of correlation with the labor productivity although not strong enough to be separated into different model. This correlation may influence the sign of the coefficient of the inefficiency variable. In the Plateau/Mountain region, there is no evidence of the relationship between the productivity and efficiency, and the per capita total consumption. And in the Coast region, only the labor productivity has a positive but small impact on the per capita total consumption. The coefficient value is 0.05 and significant at 5% level, which means that if the productivity of labor increases by 10%, the per capita total consumption will increase by 0.5%.

Food consumption is an important component of the total consumption for the poor. If the income increases, the poor may not necessarily increase their consumption of food, but in the time of crisis such as reduction in income, the poor usually devote most of their income on food. Therefore, on top of the total consumption analysis, the food consumption is analyzed. As in the regressions of the per capita total consumption, if the endogeneity problem does not occur, the interpretation follows the results of the OLS regression. In the case of Cambodia, the efficiency of production did not influence the level of food consumption but the productivity of land and labor did. The coefficient of the land and labor productivity is 0.14 and is significant at 5% and 1% respectively. It could be interpreted that 10% increase in the productivity of land or labor adds 1.4% to the per capita consumption of food among rice farming households. The increase in food consumption is smaller than that of per capita total consumption. So, we can state that the improved productivity of land and labor raise both the food and non-food consumption, which link to the other sectors of the economy. In the Plain region, the interpretation is based on the results of the OLS regression, and there is no evidence whatsoever of the relationship between the productivity and the efficiency, and the food consumption. We do not know whether or not the increase in the productivity and efficiency will raise the food consumption but it is clear that it will raise the total consumption; thus, it is likely that in the Plain region, the increase in the productivity and efficiency improves the consumption of the non-food item. As in the Cambodia’s case, in Tonle Sap region, the increase in the productivity and the efficiency increase the consumption of food but the magnitude are smaller than the increase in total consumption; hence, the increase in the productivity and the efficiency of rice production in Tonle Sap region raise both the consumption of food and non-food items. The coefficient of the land productivity is 0.29 and is significant at 10% level while the coefficient of the labor productivity is 0.23 and is also significant at 10%. Therefore, 10% increase in the productivity of land increase the consumption of food by 2.9% and 10% increase in the productivity of labor add 2.3% to the consumption of food. The sign of the coefficient of the inefficiency is still contradictory to the prior expectation. And it may be due to the correlation between the labor productivity and the inefficiency level although, in the correlation matrix, this correlation is not that strong. In the case of the Plateau/Mountain region, the results show no relationship between the land productivity and the efficiency, and the food consumption but it was found that the productivity of labor reduce the consumption of food, which is contradictory to the expected outcome. It was expected that the increase in the productivity raises the consumption. This unexpected result may be due to the fact that, in the Plateau/Mountain region, households are in deficit of rice; thus, when the productivity of rice increases, households switch the consumption from other food items to rice. By so doing, they reduce the expenditure on food items; therefore, the consumption level is reduced. In the Coast region, the productivity of land does not affect the consumption of food but the productivity of labor does although the effect is small. The coefficient of the labor productivity is 0.06 and is significant at 5% level, which means that 10% increase in the productivity of labor increases the consumption of food by only 0.6%. The inefficiency also influences the consumption of food but in reverse direction. This may be caused by the correlation between the productivity and the inefficiency variables.

It is evident that only the growth of the productivity increases the per capita consumption of the rice farming households. There is no evidence supporting the role of the efficiency in raising the consumption. However, if disaggregating the effect into a different region, only in the Plain and the Tonle Sap region that the improved productivity has a positive and significant relationship with the consumption. In the subsequent section, the elasticity of the productivity variable from the Table 6.4 in the regressions of the Cambodia, Plain and the

Tonle Sap regions are used to compute the effect of the improved productivity on poverty among rice farming households in these regions. From the Table 6.4, in Cambodia as a whole, 10% increase in the land and labor productivity contribute to 2.1 % and 2.5% increase in per capita total consumption respectively. In the Plain region, 10% increase in the land and labor productivity raise the per capita total consumption by 0.19% and 0.24% respectively. And in the Tonle Sap region, 10% increase in the land productivity raise the per capita total consumption by 4.8% and 10% increase in the labor production raise the per capita total consumption by 4.4%. The results of the 10% increase in the land and labor productivity are presented in Table 6.6.

Table 6.6 Impact of 10% Increase in Land and Labor Productivity on Poverty

	Cambodia				Plain				Tonle Sap			
	Mean Cons.	P(0)	P(1)	P(2)	Mean Cons.	P(0)	P(1)	P(2)	Mean Cons.	P(0)	P(1)	P(2)
Base	5456.994	0.163	0.029	0.008	5610.060	0.155	0.027	0.007	5385.787	0.169	0.030	0.008
Land	5571.591	0.153	0.026	0.007	5620.719	0.148	0.027	0.007	5644.305	0.142	0.024	0.006
Labor	5593.419	0.148	0.025	0.007	5621.841	0.148	0.027	0.007	5622.762	0.143	0.025	0.011
Change												
Land	2.1%	-6.1%	-9.4%	-11.1%	0.2%	-4.8%	-1.1%	-1.1%	4.8%	-16.3%	-19.7%	-23.4%
Labor	2.5%	-8.8%	-11.1%	-13.1%	0.2%	-4.8%	-1.2%	-1.2%	4.4%	-15.6%	-18.2%	42.6%

Source: Calculated by author based on CSES (2009)

In Cambodia, 10% increase in the land productivity raises the average consumption from 5,456 KHR to 5,571 KHR while the 10% increase in the labor productivity increases the consumption to 5,593 KHR. In the Plain region, the average consumption barely changes because the impact is too small, whilst in the Tonle Sap region, 10% increase of the productivity of land raise the average consumption from 5,385 KHR to 5,644 KHR and the 10% increase in the productivity of labor raises the average consumption from 5,385 KHR to 5,622 KHR. Given the same 10% increase in the productivity, the average consumption among the rice farming households in the Tonle Sap region improves more than those in the Plain region. As a result, the farming households in the Tonle Sap region become better as indicated by the lower poverty rate.

6.5 Conclusion and Policy Implications

This chapter aims at examining the impact of the productivity and the efficiency of farming households' rice production on their poverty. The countrywide data was examined, and then different regions were separated. The improved productivity was found to have raised the consumption among farmers in the Plain and Tonle Sap regions, where most of the Cambodian rice is cultivated. Farming households in the Tonle Sap region stands to gain more from the growth of rice productivity than the farming households in the Plain region, while in the Plateau/Mountain and Coast region, the study cannot find the evidence of the relationship between the consumption and the improved productivity. Also, it is not clear whether improving the efficiency reduce or increase the consumption. Thus, it can be concluded that improving rice productivity is one of the main tools to reduce poverty in Cambodia.

Improving the productivity of rice requires many policy actions such as renovating and constructing irrigation system, promoting rice research, improving extension service to disseminate new production knowledge to farmers, improving the access to credit by farmers and so on. Because of the budget constraint, the government should prioritize the investment in the region that the investment will yield highest return. For this reason, the Tonle Sap region should be the first priority for the policy to improve rice productivity in Cambodia.

Chapter 7: Conclusion and Policy Recommendations

7.1 Introduction

Despite the impressive economic growth in the last decade that contributes to the increased income and improved welfare, the number of people living in poverty in Cambodia is still high and the gap between the rich and the poor is widening. The growth of the Cambodian economy has been fueled mainly by the growth of the garment, construction and tourism industry, and, to less extent, by the growth of the agricultural sector. The growth of these sectors, except that of agriculture, has been confined to big cities such as the capital Phnom Penh and the tourist attraction Siem Reap. Inevitably, the urban segment of the population is the main beneficiary, and little has been trickled down to the rural inhabitants who accounts for more than 70% of the total population. In fact, it is not fair to say that the rural inhabitants gain nothing from the growth process. Many rural households sent their family members to work in the city although those living close to the cities have more advantages; the bottom line is that not enough jobs have been created to supply the growing number of young Cambodian rural workforces who are mostly low-skilled and are ready to migrate to find a decent employment. As a result, poverty in rural areas is prevalent, and its rate is much higher than that of urban areas. This fact suggests that reducing poverty in Cambodia is equivalent to reducing rural poverty and it is conventional that to reduce poverty we need the knowledge of the characteristics and the endowment of the poor so that effective poverty reduction policies can be formulated.

Cambodia is an agrarian society, and it is unique in that many farmers engage in the cultivation of a single food crop, rice, which is the predominant crop in the country's undiversified agriculture. Most rice farming households possess small plot of agricultural land, that is land for growing rice and are basically low-skilled. Because rice is one of their main sources of their income, promoting the production of rice shall be one of the possible means to help them increase income and consumption, and thus reduce poverty. This dissertation has analyzed the economic performance, i.e. productivity and efficiency, of the Cambodian rice industry and actors involved in the rice industry, i.e. farming households, at both the macro (national) and micro (household) level and come up with the recommendation that hopefully will be supportive in helping farming households to escape poverty. Following the introduction, this chapter summarizes the main findings of the dissertation and then concludes the study by providing policy recommendations.

7.2 Key Findings

7.2.1 Status of Cambodian Rice Productivity

There are different indicators of productivity, and each has advantage and disadvantage over others. TFP is the most effective and comprehensive indicator of productivity as it captures all aspect of production, but due to the limitation of data, the TFP of rice production in Cambodia and other countries could not be computed. Instead, two indicators of rice productivity, rice yield and gross rice value per hectare, which are partial productivity, among selected rice producing countries are compiled, computed and compared in order to gauge the status of Cambodian rice productivity. Without comparison, we cannot judge whether the productivity is high or low. Yield provides information about the production technology but does not capture the economic profit that farmers gain from adopting different technology. For example, farmers growing newly developed high yielding varieties usually produce more per harvested area. We may say that they are more productive but they may not necessarily gain more economic benefit than farmers who produce less per harvested area but the varieties, mostly traditional varieties, they produce can be sold dearly. In general, the price of the high yielding variety is cheaper than that of the traditional variety due to the latter’s superior taste. For this reason, farmers may decide to grow the traditional variety although they have the technology to grow the high yielding one. Therefore, in addition to yield, gross rice value per hectare is computed and compared among different rice producing countries. As expected, these two indicators showed some contrasting results. In the case of Thai rice, for instance, the yield is among the lowest but gross rice value per hectare is among the highest. It means that although Thai farmers produce less per hectare, they are able to get higher profit because the varieties they grow are more valuable in the market.

The yield of Cambodian rice has been growing gradually. However, compared to other countries, the yield level in 2012 is among the lowest. So is the gross rice value per hectare in 2007. This indicates that Cambodian farmers grow rice less productively and also cannot obtain high economic profit. It is quite a heartbreaking result, but it shows that Cambodian rice production is far from the frontier of production; therefore, there is much room to improve both the yield and the profit that farmers should reap. There are many factors that inhibit the growth of Cambodian rice such as the inadequate funding for agricultural research and extension, the dilapidated irrigation system, the low availability of improved seed, the inaccessible to formal funding by the farmers due to lack of collateral, the stagnant of yield increase and the lack of human capital. Removing these constraints shall improve the productivity of Cambodian rice and help farming households increase income.

7.2.2 Factor Affecting Cost Efficiency of Cambodian Rice Farming Households

Besides productivity, efficiency is another indicator of economic performance. Improving efficiency of production allows a producer to minimize cost and conserve resources. There are different types of efficiency such as productive efficiency, cost efficiency, revenue efficiency and profit efficiency. Chapter 5 of this dissertation tests the cost efficiency of Cambodian rice farming households. The results reveal that the wet season rice farming households in the Tonle Sap and Plateau/Mountain region are cost inefficient with the mean cost efficiency score of 1.2 and 1.3 respectively. These mean scores indicate that in the Tonle Sap region, farming households wasted about 20% of their input in the production of rice while, in the Plateau/Mountain region, farmers wasted as much as 30% of their resources. Had these wasted resources been saved, farming households would have been able to allocate their scarce resources to consumption and other productive activities, thus improving welfare and income. There is no evidence of cost inefficiency among dry season farming households in all regions, and wet season farming households in the Plain and Coast. Because the majority of rice farming households is poor or near poor, improving production efficiency is one of the keys to enhance their welfare, especially for farmers in the inefficient regions.

As there is evident of cost inefficiency, the next step was to explore what influences the level of the cost inefficiency. Those influencing factors are the ratio of farmers to harvested areas, the education level of the household head and the age of the household head. The ratio of farmers to harvested area is significant in all cases. This ratio has a negative relationship with cost efficiency. The large ratio implies that either there are many farmers working in a plot of agricultural land, or the agricultural land is so small that the farmers cannot fully employ their potential labor, i.e. disguised unemployment. If it is the case, the farming households are less cost efficient. This is a real situation in Cambodia, where rural households' agricultural land size have been shrinking due to the growing number of family members and economic shock, which they often resort to selling their agricultural land to solve, such as paying medical fee, marrying off their children or the loss of breadwinner. The age of the household head was found to significantly improve cost efficiency in the nationwide sample and in the Tonle Sap region but was not significant in the Plateau/ Mountain region. Age may represent the experience of farmers; older farmers often have spent many years growing crop. They are more experienced in cultivating crop than younger farmers, thus more cost efficient. However, there is no consistent interpretation of the relationship between the age of farmers and the efficiency of production. Scholars like Paudel & Matsuoka (2009) and Ojo (2003) argued that young farmers are more efficient because they are likely to have higher educational attainment than elder farmers so they may get better access to extension service and knowledge of production. Education of the household head is not significant in all cases. This reflects that general education may not necessarily improve agricultural efficiency as many agricultural techniques require special training, which is not widely provided in Cambodia.

7.2.3 The Impact of Land and Labor Productivity on Poverty

Land and labor are the two most important assets of the farming households. For this reason, increasing the productivity of land and labor of farming households will eventually increase their income; thus consumption will be increased and finally poverty reduction will be realized. The improvement in productivity of these two assets do not just benefit farming households but the economy as a whole through potential of saving that may be able to be mobilized from the better off farming households and through increased consumption of products and services from other non-farm industries. Like productivity, efficiency of production also contributes to the improvement of welfare of the farming households as they may be able to use wasted or saved resources for consumption or investment. I have analyzed the impact of land and labor productivity, and efficiency on rice farming households' per capita total consumption and per capita food consumption, and confirmed that the increased productivity have significant impact on both the per capita total consumption and per capita food consumption. However, there is no sufficient evident to support to relationship between efficiency and the two per capita consumption. The rationale that the per capita food consumption is used in addition to the per capita total consumption is to capture the heterogeneity of farming households. Three types of rice farming households can be observed: market oriented households who are able to market large surplus, households who produce little surplus or just enough for household consumption and households who produce less than sufficient for consumption. The impact of the increase in the productivity on poverty is different among the three groups of households. For households producing at less than sufficient and producing just enough for household consumption, the increase in production may raise food consumption more than total consumption. The reverse is true for market oriented households who already have a large surplus of rice to market before the increase in productivity.

In Chapter 6, it is evident that only the growth of the productivity increases the per capita total consumption of the rice farming households. There is no evidence supporting the role of the efficiency in raising the consumption. However, if disaggregating the effect into different regions, only in the Plain and the Tonle Sap region that the improved productivity has a positive and significant relationship with the consumption. In Cambodia as a whole, 10% increase in the land and labor productivity contribute to 2.1 % and 2.5% increase in per capita total consumption respectively. In the Plain region, 10% increase in the land and labor productivity raise the per capita total consumption by 0.19% and 0.24% respectively. And in the Tonle Sap region, 10% increase in the land productivity raise the per capita total consumption by 4.8% and 10% increase in the labor production raise the per capita total consumption by 4.4%. The elasticity was used to compute its effect on mean consumption and the result showed that, in Cambodia, 10% increase in the land productivity raise the average consumption from 5,456 KHR to 5,571 KHR, while the 10% increase in the labor productivity increases the consumption from 5, 456 KHR to 5,593 KHR. In the Plain region, the average consumption barely changes because the impact is too small, whilst in the Tonle Sap region, 10% increase of the productivity of land raise the average consumption from 5,385 KHR to 5,644 KHR and the 10% increase in the productivity of labor raises the average consumption from 5,385 KHR to 5,622 KHR. Given the same 10% increase in the productivity, the average consumption among the rice farming households in the Tonle Sap region improves more than those in the Plain region. As a result, the farming households in the Tonle Sap region become better as indicated by the lower poverty rate after the production increase.

The different results obtained for each region indicates the effect of different agro-climatic and topography of each region. Significant production of rice is concentrated in the Plain and the Tonle Sap region because the soil and climate in these two regions is more suitable for rice cultivation than the Coast and the Plateau/Mountain. Although the two regions are major rice producing areas, farming households and land areas in the Plain and the Tonle Sap region possess different characteristics. In the Plain, households' agricultural land size is small. Short maturation period and high yielding varieties are widely cultivated. In addition, access to irrigation is better than other region, so farmers can grow rice in dry season as well. In the Tonle Sap region, agricultural land is larger but access to irrigation is limited. The soil in this region is more suitable for traditional fragrant varieties whose yields are lower than the modern variety widely planted in the Plain region, but the variety is more resilient to the weather condition. Due to limited access to irrigation, local varieties are widely cultivated. The soil condition in the Coast and the Plateau/ Mountain region is not suitable for growing rice. Mountains and dense forests characterize these two regions. Also the shortage of water sources and limited irrigation are the main obstacles for rice cultivation. As the results, these two regions are always in deficit of rice.

7.3 Conclusion and Policy Implication

Rice is a lifeline of the Cambodia's poor rural population as it is the source of their income, employment and protein intake. Although having gradually improved, the performance of the Cambodian rice industry is far from satisfaction and far from its full potential. Due to many factors, the productivity of Cambodian rice is very low compared to other rice producing countries, and farmers are cultivating inefficiently. Farmers wasted resources that could have been used in other productive activities and to increase their consumption. As the majority of the rural Cambodian is poor and by and large engage in growing rice, improving rice productivity and raising farmers' efficiency will undoubtedly increase their income and eventually reduce their poverty. With the evidence that improving the performance of the rice industry will have positive effects on farming households' welfare, increasing income and reducing poverty, this dissertation offer policy recommendations as follows.

First and foremost, policies to increase rice productivity must be prioritized with the consideration of differences in agro-climatic zones. The experiences of other current Asian industrialized countries demonstrate that the growth of agricultural productivity is the pre-requisite for industrialization. In Cambodia, because rice is a dominant food crop, promoting rice productivity is likely to be the first step in building the strong foundation for industrialization. Then, diversifying agricultural sector, producing other crops than rice needs to be the next priority in order that the agricultural sector can play complete role as the basis for industrialization and development. We need to know what constraints the growth production of rice in order to formulate policies that are effective in promoting its growth. From various reports, the main constraints on the growth of rice production include the inadequate funding for agricultural research and development, inadequate extension service provision, dilapidated irrigation system, the problem of accessing to finance by rice farmers. Most of the constraints have been well-known for decades but have not been solved. Everyone knows, for example, that irrigation is important in growing rice but because of prioritization and budget constraint, the government may have decided not to venture in irrigation development. And the bottom line is that all the constraints mentioned above have the nature of public goods, which require careful and wise intervention from the government. It is less likely that private sectors will be interested in providing irrigation, extension service and agricultural research in Cambodia. Therefore, the government needs to be active in this field. In addition, credit is still a big challenge for many farmers although there are many microfinance institutions operating in rural and remote areas. Collateral requirement and high interest rate that needs to be paid in a short period of time still prohibit farmers from profitable investment. The provision of irrigation system and credit, if targeting rice farmers, should be zoning because not all Cambodian provinces specialize in growing rice and not all rural households are rice farming households. Zoning may help reduce the cost of investment because large-scale investment such as that of irrigation has to be carried out in only regions that are promising, i.e. the return on investment is high.

The aforementioned implications focus mainly on improving productivity, which the government shall play an active role because those constraints have the nature of public goods and services. Besides, farmers' efficiency of production needs improving. The results revealed that, in general, there are too many farmers growing rice in a plot of agricultural land. This situation is a result of the steady growth of Cambodian population in the last decades, while their agricultural land stay constant or is shrinking although the overall agricultural areas have increased thanks to the reclaim of unused land and landmine clearing. The remedies for this problem are twofold, either reducing the number of farmers or enlarging the area of rice cultivation. Reducing the number of farmers means reallocating them into other industries. Therefore, the government and other relevant stage holders should create more diverse jobs in other industries, especially labor intensive type of industries that fit the skill level of rural farming households. Cambodia has huge potential in agribusiness and food industry thanks to its topography, and abundant land and water resources. If created, employment in agribusiness and food industry can absorb labor from rice farming that benefit farmers in many ways by providing them more sources of income and helping them grow rice more efficiently. This will eventually reduce their poverty. The new industry may locate in the rural areas or in urban and semi-urban areas. If it is in big cities, farmers may need to migrate to work. Migration, particularly cross-border migration, has been found to have a positive impact on farm efficiency. In Lesotho, a study found that farming households sending family members to work as a migrant workers in South Africa are more efficient than households that did not have members as migrant workers (Mochebelele &Winter-Nelson, 2000). In Burkina Faso, migration improves efficiency of cereal producers because it takes away surplus labor from cereal production (Wouterse, 2010). There is no study on the relationship between migration and farm efficiency in Cambodia, but there are many negative reports about migrants having been abuse abroad. Thus, this policy should be cautiously formulated.

The other option is to enlarge the agricultural land. With the current population size and land area, Cambodia is among the less densely populated countries. The per capita arable land is higher than many countries in the ASEAN region. Thus, it is possible to enlarge cultivated areas. Several possible ways to expand the agricultural land in the short and medium term include clearing landmine and increasing cropping intensity. After the end of the internal strife, vast areas of landmine exist in Cambodia, in particular, in the regions suitable for rice growing. The government with the support from development agencies has been actively clearing landmine to reclaim back the agricultural land. As the result, the agricultural land areas has been increasing, and it is still possible to further increase. The land cleared of mine may be redistributed to farmers as a social land concession, which is one of the government policies, or may be sold at an affordable price to poor farmers. This way may be more effective in that only productive farmers will be willing to acquire agricultural land. Otherwise, the government should encourage double or triple cropping, which has been done in countries like Viet Nam and Thailand. Resembling enlarging cultivation areas, increasing cropping intensity help farmers become more efficient. This increases their income because double cropping is likely to double income from agricultural crop as well. Farmers who have been growing rice just for household consumption can now become commercialized due to increased efficiency and output. Therefore, they may be able to graduate from poverty. However, increasing cropping intensity requires reliable irrigation system and effective water management and coordination. On the one hand, constructing an irrigation system involves huge public investment. On the other hand, after being constructed, irrigation needs to be well maintained mainly by the users of water, farmers. There are many cases reported that because of mismanagement and careless maintenance, many irrigation projects becomes ruined just a few years after being constructed. In addition, management of water is cumbersome. Because of lack of or difficulty in coordination, farmers located in upstream and downstream often fight over the use of water resulted in inefficient use of the irrigation system. In short, in order to increase the cropping intensity, the government should invest in an irrigation system and encourage the formation of good management of irrigation by the water users. Or else, although the huge investment in irrigation is made, it will not serve its objectives. Creating cooperative is another option to exploit the scale merit of production. Cambodian rice farmers are producing at small-scale level. With the presence of well-functioning cooperative, farmers can coordinate the production and cultivate more efficiently. Cooperative has been successful in countries like Japan and Thailand. Through the cooperative, the production of Japanese rice has been effectively controlled. Cambodia should learn from the successful experiences of the Japanese cooperative. Again, the government is expected to play a large role in this regard.

Although the education level of the household head was not found to have a significant impact on the efficiency level, in the literature it is one of the significant determinants. More educated farmers can produce rice more efficiently because they can access the state of the art technology faster, and they can read the instruction on how to properly apply modern inputs such as fertilizer, pesticide and the like. Formal education may not necessary be beneficial to farmers if it is not relevant to agricultural practices. In this connection, the government should encourage supplementary or non-formal training to farmers of specific agricultural produce so that they can switch from traditional practice and increase efficiency. Training should not be confined to a classroom type, providing extension services is one way of training farmers. Extension workers may work closely with farmers to learn their problem and help them solve the problem hands-on. Unfortunately, the number of extension workers in Cambodia is too few, and their performance is far from satisfactory. There are several NGOs providing limited extension services to farmers, but the government should play a bigger role. The government has more resources than NGOs in many aspects. Hence, the government should train more extension workers and dispatch them to rural areas to work with farmers. The presence of extension workers is indispensable in agricultural production.

The age of the household head was found to significantly affect the level of efficiency even though not in the case of Plateau/Mountain region. This may imply that because many farmers still practice traditional cultivation, education is not important but experience is. This is not a favorable situation as it is well-known that the traditional way of cultivation does not produce high output. Many countries have transformed their agricultural sector from being traditional to modern or mechanized and transformed their farmers from being subsistent to being commercialized. We also should transform the Cambodian agricultural sector. In this process, the role of public policies is indispensable. The government should disseminate the knowledge of modern agriculture and encourage farmers to adopt the knowledge through training and workshop. With wise intervention from the government, it is hopeful that the agricultural sectors can be transformed and directed to the right direction. In addition, market access is important for commercialized farmers. There are many anecdotes about the limited access to the market. Farmer cannot sell their output in a competitive market so they are likely to be exploited, which discourage them from improving the agricultural production. The government must play a large role in connecting farmers to the market. In conclusion, the Cambodian government should play more active role in directing the economy, especially the agricultural economy, rather than leave it to the private sectors or the market since many goods and services demanded by the agricultural sector have the nature of public goods, which the private sectors are not likely to be interested in and although they are interested, the huge sunk cost may discourage them from investing and providing the goods like irrigation and extension services. In a country like Cambodia, where everything needs to be built from scratches including many agricultural institutions, the role of the government should be more than coordinating the market. The government should have a clear perspective on the direction towards which the economy should progress.

7.4 Future Research

This dissertation discusses the way to improve the economic performance, that is productivity and efficiency, of the Cambodian rice industry, and explore how it contributes to poverty reduction among rice farming households. Nonetheless, in the analysis of the impact of the productivity and efficiency on poverty among Cambodian rice farming households in Chapter 6, I regressed the per capita consumption on different independent variables; however, one of the main explanatory variables in conventional consumption function that is the per capita income variable is not available in the CSES 2009 dataset. Therefore, the per capita income variable was not included in estimation equation. Based on the findings and limitation, several areas are suggested for further research:

First, the total factor productivity (TFP) is the most holistic and comprehensive approach to measuring productivity. However, due to data limitation, TFP was not computed in this dissertation. As a substitute, yield and gross rice value hectare were applied. It is widely accepted that partial productivity, in some cases, may not be useful because its change cannot be clearly measured. For instance, if yield increases, it is not known whether it is resulted from the improved seed or mechanization or improved human capital. For future research, if data is available, I suggest that the TFP of Cambodian rice be computed, and its determinants be explored to provide implications for further improvement of the rice industry.

Secondly, again because of limited data, this study examined only the impact of productivity and efficiency on per capita total consumption (consumption effect) and per capita food consumption (food price effect) of rice farming households without taking into account the employment effect and the inducement effect from other sectors. With sufficient data, the future study on this topic should aim for analyzing all effect and also should apply more sophisticated analytical tool such as the computable general equilibrium (CGE) model. In addition, in this study, only data in one period is examined; therefore, it may not be able to capture the dynamic and the structural change of rice industry as well as Cambodian economy as a whole. It is likely that the role of the agricultural sector in the economy is shrinking as the economy develops. For further study, if the survey data is used, it is recommended that the survey in two different time periods be analyzed, so that it is possible to see the structural change of the economy such as the change of the contribution of the agricultural sector to the economy.

Thirdly, most rice farming households have more than one job. Other than growing rice, they work in informal sectors in the cities or involve the job in other primary sectors such as fishing and exploiting forest products. Examining only the role of the rice industry on poverty reduction is incomplete. The contribution of other industries to poverty reduction should also be considered. The study in the future should combine the effect of rice and other non-rice industries on poverty reduction. That will provide complete picture of poverty study in the case of Cambodia.

Finally, this study did not capture the effect of different rice varieties adopted among rice farming households. The information about rice varieties was not recorded in the CSES 2009. However, it is important to understand the perception of farmers regarding modern and traditional varieties, and how it affects their practice of cultivation and production. Many scholars propose that farmers adopt new varieties to increase production, as well as income. Therefore, although no concrete data available, it is widely believed the adoption rate among Cambodian farmers is no that high. Research on a topic such as how adoption of modern varieties affects the poverty status of rice farming households should be conducted in the future.

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Appendix 5.1 Maximum-likelihood estimates of parameters of the Cobb-Douglas frontier cost function for wet season production (Plain and Coast zones), 2009

		Plain	Coast
Variable	Parameters	Estimates	
General Model			
Constant	β_0	6.609***	5.299***
		(2.451)	(0.698)
Cost of chemical	β_1	0.048***	0.071***
		(0.003)	(0.006)
Cost of planting material	β_2	0.279***	0.273***
		(0.022)	(0.048)
Cost of animal manure	β_3	0.023***	0.018***
		(0.003)	(0.006)
Cost of oil gasoline diesel	β_4	0.018***	0.016*
		(0.003)	(0.009)
Cost of storable items	β_5	0.000	0.029***
		(0.003)	(0.007)
Cost of draft power/tractor	β_6	0.034***	0.027***
		(0.002)	(0.005)
Cost of hired labor	β_7	0.019***	0.031***
		(0.002)	(0.009)
Cost of irrigation	β_8	0.010***	0.014
		(0.004)	(0.009)
Cost of transportation	β_9	0.003	0.024***
		(0.003)	(0.006)
Cost of repair and maintenance	β_{10}	0.005*	0.018*
		(0.003)	(0.011)
Cost of rent	β_{11}	0.009*	0.009
		(0.006)	(0.012)
Rice output	β_{12}	0.338***	0.420***
		(0.033)	(0.082)
Diagnostic Statistics			
log-likelihood		-529.033	-129.477
σ_u^2		-13.446	-3.937***
		(506.615)	(1.376)
$\sigma^2 = \sigma_u^2 + \sigma_v^2$		0.159	0.165
$\lambda = \sigma_u / \sigma_v$		0.003	0.366
Likelihood ratio test H_0: $\sigma_u^2 = 0$		0.000	0.190
Number of observations		1056	250

Note: figures in parentheses are value of SE.

***, ** & *indicate significant at 1%, 5% and 10% respectively.

Source: Calculated by author based on CSES (2009)

Appendix 5.2 Maximum-likelihood estimates of parameters of the Cobb-Douglas frontier cost function for dry season production, 2009

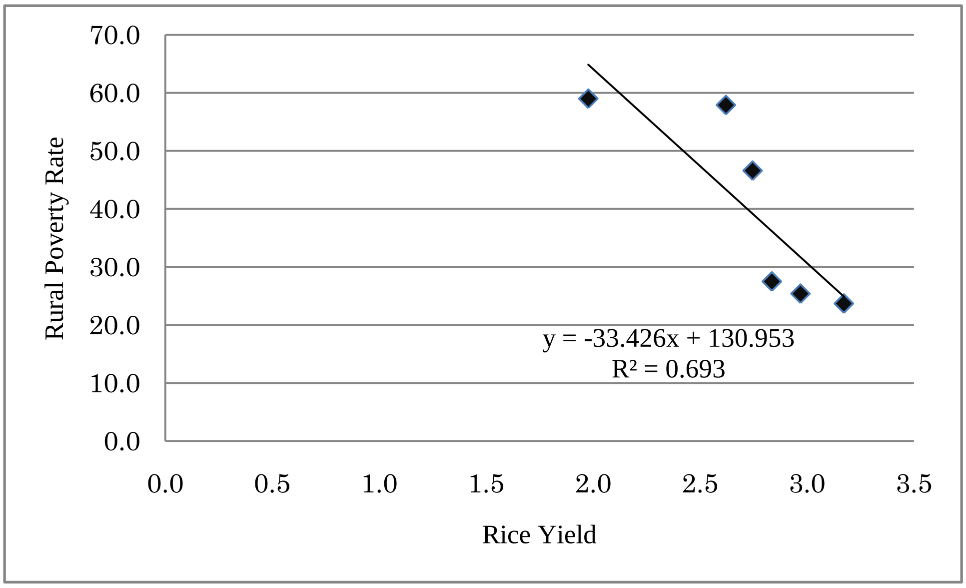
		Cambodia	Plain	Tonle Sap
Variable	Parameters		Estimates	
General Model				
Constant	β_0	6.849**	7.253**	6.155***
		(3.022)	(2.963)	(0.925)
Cost of chemical	β_1	0.031***	0.020**	0.037***
		(0.005)	(0.008)	(0.010)
Cost of planting material	β_2	0.325***	0.326***	0.456***
		(0.031)	(0.041)	(0.072)
Cost of animal manure	β_3	0.011**	0.012**	0.015
		(0.004)	(0.005)	(0.013)
Cost of oil gasoline diesel	β_4	0.023***	0.023***	0.042***
		(0.004)	(0.005)	(0.008)
Cost of storable items	β_5	0.022***	0.024***	-0.015
		(0.005)	(0.006)	(0.019)
Cost of draft power/tractor	β_6	0.024***	0.021***	0.020**
		(0.004)	(0.005)	(0.008)
Cost of hired labor	β_7	0.015***	0.018***	0.015**
		(0.003)	(0.004)	(0.007)
Cost of irrigation	β_8	0.024***	0.024***	0.012
		(0.005)	(0.006)	(0.017)
Cost of transportation	β_9	0.009**	0.009**	0.001
		(0.004)	(0.005)	(0.008)
Cost of repair and maintenance	β_{10}	0.011	0.022*	-0.024
		(0.011)	(0.013)	(0.020)
Cost of rent	β_{11}	0.015**	0.014*	0.024
		(0.006)	(0.008)	(0.038)
Rice output	β_{12}	0.233***	0.195***	0.142
		(0.037)	(0.047)	(0.094)
Diagnostic Statistics				
log-likelihood		-124.056	-85.351	-4.032
σ_u^2		-14.646	-15.340	-6.429
		(11394.460)	(15697.320)	(15.695)
$\sigma^2 = \sigma_u^2 + \sigma_v^2$		0.001	0.124	0.069
$\lambda = \sigma_u / \sigma_v$		0.002	0.001	0.154
Likelihood ratio test H_0: $\sigma_u^2 = 0$		0.000	0.000	0.003
Number of observations		346	277	47

Note: The Plateau/Mountain and coast zones do not have sufficient observation for the estimation. Figures in parentheses are value of SE.

***, ** & *indicate significant at 1%, 5% and 10% respectively.

Source: Calculated by author based on CSES (2009)

Appendix 6.1 The Relationship between Rice Yield and Rural Poverty



Source: Calculated by author based on Sobrado et al. (2013) and Agricultural Statistics from 2004 to 2011

Appendix 6.2 Correlation Matrix for Cambodia

	Logpc_cons	Logpc_ foodcons	Age	Age^2	Gender	Lognon_ agr_inc	Hh_size	Dep_ratio	Fertilizer	Phone	Electricity	Loglabor _prod	Logland _prod	Logland/labor ratio	Inefficiency
Logpc_cons	1														
Logpc_foodcons	0.826*** (0.000)	1													
Age	0.003 (0.084)	-0.035 (0.032)	1												
Age^2	0.010 (0.539)	-0.026 (0.119)	0.986*** (0.000)	1											
Gender	-0.025 (0.134)	-0.017 (0.314)	-0.187*** (0.000)	-0.181*** (0.000)	1										
Lognon_agr_inc	0.141*** (0.000)	0.090*** (0.000)	-0.004 (0.829)	-0.011 (0.492)	0.034 (0.039)	1									
Hh_size	-0.319*** (0.000)	-0.295*** (0.000)	0.164*** (0.000)	0.112*** (0.000)	0.175*** (0.000)	0.082*** (0.000)	1								
Dep_ratio	-0.201*** (0.000)	-0.138*** (0.000)	-0.255*** (0.000)	-0.214*** (0.000)	0.085*** (0.000)	0.008 (0.651)	0.187*** (0.000)	1							
Fertilizer	0.122*** (0.000)	0.072*** (0.000)	0.008 (0.631)	0.006 (0.735)	0.003 (0.860)	0.053*** (0.001)	-0.087*** (0.001)	-0.055*** (0.001)	1						
Phone	0.207*** (0.000)	0.079*** (0.000)	0.064*** (0.001)	0.044*** (0.007)	0.076*** (0.007)	0.240*** (0.007)	0.164*** (0.007)	-0.094*** (0.000)	0.075*** (0.000)	1					
Electricity	0.157*** (0.000)	0.117*** (0.000)	0.079*** (0.000)	0.076*** (0.000)	0.001 (0.973)	0.109*** (0.000)	0.071*** (0.000)	-0.059*** (0.000)	0.009 (0.576)	0.229*** (0.000)	1				
Loglabor_prod	0.109*** (0.000)	0.061*** (0.000)	-0.067*** (0.000)	-0.063*** (0.000)	0.019 (0.263)	0.050*** (0.037)	-0.062*** (0.000)	0.047*** (0.007)	0.029* (0.084)	0.092*** (0.000)	0.057*** (0.001)	1			
Logland_prod	0.004 (0.794)	0.013 (0.427)	-0.036** (0.032)	-0.029* (0.085)	-0.045*** (0.008)	0.022 (0.186)	-0.027 (0.109)	0.009 (0.565)	-0.078*** (0.000)	0.001 (0.939)	0.022 (0.195)	0.752*** (0.000)	1		
Logland/labor ratio	0.129*** (0.000)	0.055*** (0.001)	-0.018 (0.291)	-0.024 (0.165)	0.078*** (0.000)	0.028** (0.098)	-0.027 (0.109)	0.043 (0.011)	0.132*** (0.000)	0.114*** (0.000)	0.035 (0.036)	0.181*** (0.000)	-0.513*** (0.000)	1	
Inefficiency	0.044*** (0.007)	0.036** (0.029)	-0.194*** (0.000)	-0.218*** (0.000)	0.012 (0.455)	0.063*** (0.000)	-0.014 (0.384)	-0.019 (0.229)	-0.089*** (0.000)	0.043*** (0.009)	-0.008 (0.619)	0.043** (0.012)	0.160*** (0.000)	-0.173*** (0.000)	1

Note: figures in parenthesis are p value. ***, **, and * indicates significant at 1%, 5% and 10% respectively.

Source: Calculated by author based on CSES (2009)

Appendix 6.3 Correlation Matrix for the Plain Region

	Logpc_cons	Logpc_ foodcons	Age	Age^2	Gender	Lognon_ agr_inc	Hh_size	Dep_ratio	Fertilizer	Phone	Electricity	Loglabor _prod	Logland _prod	Logland/labor ratio	Inefficiency
Logpc_cons	1														
Logpc_foodcons	0.839*** (0.000)	1													
Age	0.016 (0.570)	-0.026 (0.355)	1												
Age^2	0.019 (0.505)	-0.021 (0.449)	0.987*** (0.000)	1											
Gender	-0.026 (0.358)	-0.007 (0.815)	-0.178*** (0.000)	-0.173*** (0.000)	1										
Lognon_agr_inc	0.179*** (0.000)	0.134*** (0.000)	-0.043 (0.125)	-0.048* (0.084)	0.042 (0.131)	1									
Hh_size	-0.247*** (0.000)	-0.216*** (0.000)	0.185*** (0.000)	0.150*** (0.000)	0.177*** (0.000)	0.081** (0.004)	1								
Dep_ratio	-0.211*** (0.000)	-0.145*** (0.000)	-0.424*** (0.000)	-0.397*** (0.000)	0.100*** (0.000)	0.033 (0.245)	0.208*** (0.000)	1							
Fertilizer	0.012 (0.682)	-0.037 (0.181)	-0.024 (0.392)	-0.022 (0.439)	0.007 (0.813)	0.057** (0.043)	-0.099*** (0.000)	-0.027 (0.342)	1						
Phone	0.229*** (0.000)	0.118*** (0.000)	0.065** (0.021)	0.055** (0.047)	0.069** (0.013)	0.238*** (0.000)	0.164*** (0.000)	-0.063** (0.024)	0.070** (0.012)	1					
Electricity	0.138*** (0.000)	0.126*** (0.000)	0.110*** (0.000)	0.114*** (0.000)	-0.003 (0.929)	0.135*** (0.000)	0.055* (0.051)	-0.063** (0.023)	-0.007 (0.816)	0.131*** (0.000)	1				
Loglabor_prod	0.139 (0.000)	0.072** (0.013)	-0.084** (0.004)	-0.085*** (0.004)	0.057* (0.052)	0.059** (0.044)	0.007 (0.806)	0.072** (0.014)	-0.029 (0.306)	0.105*** (0.000)	0.103 (0.000)	1			
Logland_prod	0.062** (0.030)	0.053* (0.066)	-0.066** (0.022)	-0.059** (0.039)	0.011 (0.706)	0.036 (0.215)	0.059** (0.038)	0.070** (0.014)	-0.171*** (0.000)	0.026 (0.359)	0.079*** (0.006)	0.731*** (0.000)	1		
Logland/labor ratio	0.109*** (0.000)	0.034 (0.237)	-0.014 (0.633)	-0.022 (0.447)	0.041 (0.150)	0.026 (0.366)	-0.056* (0.051)	0.008 (0.778)	0.156 (0.000)	0.087*** (0.002)	0.029 (0.298)	0.338 (0.000)	-0.395*** (0.000)	1	
Inefficiency	-0.010 (0.718)	0.049* (0.077)	-0.111*** (0.000)	-0.144*** (0.000)	-0.091*** (0.001)	0.034 (0.230)	-0.064** (0.022)	-0.028 (0.313)	-0.109*** (0.000)	-0.054* (0.055)	-0.149*** (0.000)	-0.099*** (0.001)	-0.058** (0.042)	-0.053* (0.064)	1

Note: figures in parenthesis are p value. ***, **,and * indicates significant at 1%, 5% and 10% respectively.

Source: Calculated by author based on CSES (2009)

Appendix 6.4 Correlation Matrix for the Tonle Sap Region

	Logpc_cons	Logpc_ foodcons	Age	Age^2	Gender	Lognon_ agr_inc	Hh_size	Dep_ratio	Fertilizer	Phone	Electricity	Loglabor _prod	Logland _prod	Logland/labor ratio	Inefficiency
Logpc_cons	1														
Logpc_foodcons	0.816*** (0.000)	1													
Age	-0.001 (0.969)	-0.069 (0.017)	1												
Age^2	0.011 (0.709)	-0.056 (0.049)	0.986*** (0.000)	1											
Gender	0.003 (0.908)	-0.023 (0.423)	-0.159*** (0.000)	-0.149*** (0.000)	1										
Lognon_agr_inc	0.152*** (0.000)	0.075*** (0.009)	0.037 (0.203)	0.025 (0.378)	0.021 (0.470)	1									
Hh_size	-0.331*** (0.000)	-0.328*** (0.000)	0.239*** (0.000)	0.184*** (0.000)	0.155*** (0.000)	0.095*** (0.001)	1								
Dep_ratio	-0.184*** (0.000)	-0.139*** (0.000)	-0.225*** (0.000)	-0.197*** (0.000)	0.098*** (0.001)	-0.021 (0.463)	0.162*** (0.000)	1							
Fertilizer	0.180*** (0.000)	0.108*** (0.000)	-0.006 (0.828)	-0.018 (0.560)	0.103*** (0.000)	-0.007 (0.811)	-0.047*** (0.001)	-0.075*** (0.001)	1						
Phone	0.236*** (0.000)	0.076*** (0.009)	0.080*** (0.005)	0.061** (0.033)	0.065** (0.023)	0.279*** (0.000)	0.157*** (0.000)	-0.098*** (0.001)	0.130*** (0.000)	1					
Electricity	0.212*** (0.000)	0.127*** (0.000)	0.103*** (0.000)	0.102*** (0.000)	-0.008 (0.783)	0.132*** (0.000)	0.075*** (0.009)	-0.049* (0.092)	0.042 (0.141)	0.332*** (0.000)	1				
Loglabor_prod	0.129*** (0.000)	0.102*** (0.001)	-0.042*** (0.163)	-0.039 (0.188)	0.033 (0.277)	0.089** (0.003)	-0.103*** (0.001)	0.028 (0.347)	-0.004* (0.909)	0.137*** (0.000)	0.085*** (0.005)	1			
Logland_prod	-0.003 (0.907)	0.046 (0.115)	-0.016 (0.592)	-0.009 (0.762)	-0.067** (0.021)	0.031 (0.291)	-0.065** (0.025)	-0.029 (0.313)	-0.210*** (0.000)	-0.007 (0.939)	0.036 (0.219)	0.708*** (0.000)	1		
Logland/labor ratio	0.152*** (0.000)	0.053* (0.076)	-0.008 (0.779)	-0.016 (0.603)	0.126*** (0.000)	0.060** (0.042)	-0.025 (0.392)	0.062** (0.037)	0.277*** (0.000)	0.179*** (0.000)	0.048 (0.109)	0.259*** (0.000)	-0.498*** (0.000)	1	
Inefficiency	0.083** (0.016)	0.080** (0.019)	-0.079** (0.020)	-0.083** (0.015)	-0.002 (0.953)	0.094*** (0.006)	-0.052 (0.128)	0.063* (0.066)	-0.134*** (0.000)	-0.037*** (0.286)	0.027 (0.441)	-0.132*** (0.000)	0.059* (0.087)	-0.205*** (0.000)	1

Note: figures in parenthesis are p value. ***, **, and * indicates significant at 1%, 5% and 10% respectively.

Source: Calculated by author based on CSES (2009)

Appendix 6.5 Correlation Matrix for the Tonle Sap Region

	Logpc_cons	Logpc_ foodcons	Age	Age^2	Gender	Lognon_ agr_inc	Hh_size	Dep_ratio	Fertilizer	Phone	Electricity	Loglabor _prod	Logland _prod	Logland/labor ratio	Inefficiency
Logpc_cons	1														
Logpc_foodcons	0.805*** (0.000)	1													
Age	0.013 (0.752)	0.008 (0.841)	1												
Age^2	0.026 (0.522)	0.020 (0.621)	0.986*** (0.000)	1											
Gender	-0.011 (0.795)	-0.001 (0.988)	-0.198*** (0.000)	-0.204*** (0.000)	1										
Lognon_agr_inc	0.075* (0.069)	0.061 (0.142)	0.067 (0.106)	0.063 (0.126)	0.064 (0.121)	1									
Hh_size	-0.371*** (0.000)	-0.319*** (0.000)	0.211*** (0.000)	0.154*** (0.000)	0.174*** (0.000)	0.105** (0.010)	1								
Dep_ratio	-0.236*** (0.000)	-0.154*** (0.000)	-0.329*** (0.000)	-0.303*** (0.000)	0.042 (0.308)	0.007 (0.859)	0.215*** (0.000)	1							
Fertilizer	0.122*** (0.003)	0.095** (0.021)	0.053 (0.199)	0.050 (0.222)	-0.034 (0.409)	0.046 (0.269)	-0.039 (0.344)	-0.107*** (0.009)	1						
Phone	0.154*** (0.000)	0.017 (0.677)	0.116*** (0.005)	0.101** (0.014)	0.118** (0.004)	0.221*** (0.000)	0.133*** (0.001)	-0.109*** (0.008)	-0.007 (0.872)	1					
Electricity	0.153*** (0.000)	0.128*** (0.002)	0.087** (0.034)	0.087** (0.034)	0.007 (0.873)	0.094** (0.022)	0.081** (0.049)	-0.057 (0.163)	0.071 (0.086)	0.267*** (0.000)	1				
Loglabor_prod	-0.026 (0.537)	-0.082* (0.053)	-0.103** (0.015)	-0.092** (0.029)	-0.009 (0.829)	-0.011 (0.799)	-0.075* (0.076)	0.109*** (0.009)	0.143*** (0.001)	0.086** (0.042)	-0.037 (0.381)	1			
Logland_prod	-0.108*** (0.009)	-0.127 (0.002)	-0.035 (0.395)	-0.028 (0.505)	-0.045 (0.281)	-0.012 (0.780)	-0.062 (0.136)	0.025 (0.542)	0.119*** (0.004)	0.018 (0.663)	-0.051 (0.221)	0.822*** (0.000)	1		
Logland/labor ratio	0.139*** (0.001)	0.106** (0.011)	-0.076* (0.068)	-0.077* (0.066)	0.054*** (0.194)	-0.005 (0.897)	0.014 (0.743)	0.105** (0.012)	-0.002 (0.969)	0.072 (0.083)	0.028 (0.509)	-0.075* (0.073)	-0.629*** (0.000)	1	
Inefficiency	0.062 (0.881)	-0.046 (0.263)	-0.135*** (0.001)	-0.151*** (0.000)	-0.062 (0.132)	0.012 (0.781)	-0.008 (0.845)	0.018 (0.668)	-0.086*** (0.038)	0.022 (0.598)	0.008 (0.839)	0.049*** (0.247)	0.095** (0.022)	-0.099** (0.018)	1

Note: figures in parenthesis are p value. ***, **, and * indicates significant at 1%, 5% and 10% respectively.

Source: Calculated by author based on CSES (2009)

Appendix 6.6 Correlation Matrix for the Coast Region

	Logpc_cons	Logpc_ foodcons	Age	Age^2	Gender	Lognon_ agr_inc	Hh_size	Dep_ratio	Fertilizer	Phone	Electricity	Loglabor _prod	Logland _prod	Logland/labor ratio	Inefficiency
Logpc_cons	1														
Logpc_foodcons	0.857^{***} (0.000)	1													
Age	0.021 (0.719)	-0.024 (0.682)	1												
Age^2	0.021 (0.718)	-0.016 (0.785)	0.986^{***} (0.000)	1											
Gender	-0.055 (0.347)	-0.081 (0.166)	-0.216^{***} (0.000)	-0.215^{***} (0.000)	1										
Lognon_agr_inc	0.047^{***} (0.426)	0.024 (0.683)	-0.050 (0.393)	-0.065 (0.273)	0.027 (0.648)	1									
Hh_size	-0.404^{***} (0.000)	-0.397^{***} (0.000)	0.065 (0.269)	-0.005 (0.938)	0.172^{***} (0.003)	0.011 (0.856)	1								
Dep_ratio	-0.232^{***} (0.000)	-0.145^{**} (0.013)	-0.284^{***} (0.000)	-0.251^{***} (0.000)	0.068 (0.246)	-0.000 (0.995)	0.197^{***} (0.000)	1							
Fertilizer	0.007 (0.907)	-0.029 (0.618)	-0.069 (0.235)	-0.054 (0.357)	-0.014 (0.809)	0.037 (0.512)	-0.137^{**} (0.019)	-0.027 (0.687)	1						
Phone	0.144^{***} (0.014)	0.026 (0.656)	0.081 (0.171)	0.042 (0.473)	0.119^{**} (0.042)	0.208^{***} (0.000)	0.204^{***} (0.001)	-0.123^{**} (0.036)	0.009 (0.869)	1					
Electricity	0.081 (0.168)	0.099^{*} (0.092)	-0.011 (0.849)	-0.013 (0.832)	0.026 (0.662)	0.007 (0.904)	0.094 (0.108)	-0.019 (0.739)	-0.103^{*} (0.080)	0.109^{*} (0.064)	1				
Loglabor_prod	0.142^{**} (0.018)	0.139^{**} (0.021)	-0.104^{*} (0.083)	-0.105^{*} (0.082)	-0.049 (0.412)	-0.042 (0.482)	-0.145^{**} (0.015)	0.029 (0.634)	0.137^{**} (0.022)	-0.026 (0.667)	-0.015 (0.805)	1			
Logland_prod	-0.059 (0.324)	0.004 (0.944)	0.013^{**} (0.826)	0.016 (0.790)	-0.157^{***} (0.008)	-0.090 (0.129)	-0.084 (0.158)	-0.078 (0.191)	0.034 (0.569)	-0.126^{**} (0.035)	-0.019 (0.739)	0.722^{***} (0.000)	1		
Logland/labor ratio	0.247^{***} (0.000)	0.161^{***} (0.006)	-0.136^{**} (0.022)	-0.141^{**} (0.018)	0.152^{**} (0.010)	0.096 (0.106)	-0.072 (0.225)	0.069 (0.247)	0.131^{**} (0.027)	0.144^{**} (0.015)	-0.015 (0.799)	0.295^{***} (0.000)	-0.448^{***} (0.000)	1	
Inefficiency	0.067 (0.292)	0.129^{**} (0.042)	-0.017 (0.795)	-0.009 (0.893)	-0.023 (0.713)	0.083 (0.189)	-0.017^{**} (0.788)	0.059 (0.347)	-0.167^{***} (0.008)	0.118^{*} (0.063)	-0.023 (0.719)	-0.051 (0.435)	-0.001^{**} (0.989)	-0.062 (0.336)	1

Note: figures in parenthesis are p value. ***, **,and * indicates significant at 1%, 5% and 10% respectively.

Source: Calculated by author based on CSES (2009)