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Sustainability Analysis of the Lao Farming System

Thanongsai SOUKKHAMTHAT

Summary

The rapid economic growth in Laos over the last two decades has been driven by the extremely utilization of natural resources and commercial production. Through this production system, subsistent and smallholder agricultural farms are gradually being replaced by large-scale plantations dominated with a few commercial crops. The capacity of these commercialized agricultural plantations for poverty reduction is increasingly weighed against its long-term impacts on sustainability of land and natural resources. In this perspective, the objective of dissertation is to analyze the sustainability of the Lao farming system with regard to three aspects: environmental, socioeconomic, and technological.

Regarding to the environmental aspect, this study looks at the economic valuation of land uses with the potential incentives of the Reducing Emissions from Deforestation and forest Degradation (REDD+) mechanism can contribute towards poverty alleviation. The results demonstrate that commercial agriculture (maize and rubber plantations) does have the potential to support poverty alleviation in the short-run. It, however, exposes the land to serious environmental risks. By comparison, the traditional land uses studied (upland rice farming and non-timber forest products collecting) are largely subsistent activities that are still considered as sustainable, though this is increasingly affected by changing market and population dynamics. The results suggest that longer-term environmental costs can potentially cancel out short-term gains from the commercialization to mono-crop agriculture. Incentives for conserving ecosystem services, such as REDD+, may have a potential role in supporting diversification of traditional livelihoods and increasing the competitiveness of maintaining forests.

With respect to the socioeconomic aspect, the analysis on the impact of cassava contract farming on poverty reduction in Savannakhet and Vientiane provinces provides significant findings. Contract farming is a strategy with good potential to modernize agriculture and reduce

rural poverty. Many farmers in both regions, however, failed to understand the details of the signed contracts because most of them were less educated and there was little explanation on the details of the contract. The main problem observed was the improper practices of the 2+3 modality in Savannakhet. Farmers were required to follow the counterpart contractors and provide capital, which disposed them to the risk of indebtedness. In addition, the contribution toward poverty reduction in these regions was not significant because the result indicates the negative value of net return per capita of cassava compared with that of the alternative crops. These results imply that contract farming suffers from several weaknesses; if not carefully managed, it could lead to farmer exploitation. Therefore, intervention from a third party, particularly the public sector and corresponding partners, is necessary to solve these issues.

The empirical economic analysis on the technical efficiency of small-scale cassava farming in the two provinces also indicates unique findings. The elasticity of mean value of cassava output is estimated to be an increasing function of farm size, labor cost and variety cost in Vientiane and Savannakhet. There are, however, limitations on increasing farm investment, because smallholders often have less labor and small land size. The increasing return to scale was found for smallholder cassava farming in Savannakhet. The estimated mean score of technical efficiency are 75% and 72% for Savannakhet and Vientiane, respectively. The significant highlight of the determinant on technical efficiency in Vientiane expressed that planting cassava with good land preparation, suitable time period for plantation and young farmers play a key role in the improvement of technical efficiency for cassava farming.

In term of the technological aspect, the study investigates the economies of scale of smallholder rubber farming in Luangnamtha province, Laos. The pioneer results indicate the existence of economies of scale in rubber plantation as the significant reduction in the costs per unit of output year over year. This implies that rubber plantations in this area could benefit from large-scale farming with the potential capacity to minimize the cost of rubber plantation, while smallholders tend to integrate with the large-scale farming for survival. The result also highlights the increasing returns to scale in cost of rubber farming. This implies that at the beginning stage, the initial cost (land clearing and planting costs) for rubber plantation is very important. There is a tendency that large-scale plantations have better condition and it is concerned that individual small-scale farmers would be replaced by large-scale concessions. When rubber plantation operate year over year, then the operating cost (labor use for tapping and management cost) will later become essential, due to all of the costs depend on the variable cost and the proportion of variable cost to fixed cost increase (Onishi H., 2015). This means that smallholders could compete with the large-scale farming in terms of efficiency of operating cost. If smallholders overcome such difficult situations by their own competitiveness and public support, their management for farming practices will better improve.

The analyses on sustainability of the Lao farming system add important unique view points to the accumulation of literatures. Commercial crop production (rubber, maize and cassava) generates sufficient income and potentially reduces poverty in the short run; however, it exposes the land to serious environmental risks in the long term. In contrast, the traditional land-use practices in terms of upland rice farming and NTFP gathering are largely subsistence activities that can be considered as sustainable, but their contribution to poverty reduction is less.

The competitive investments for valuable resource utilization by large-scale plantations over smallholder ones poses many challenges for long term availability of land and forest resources. Both large and small scale farmers can equally contribute toward social stabilization through rigorously taken in to account the environmental, socioeconomic, and technological aspects of sustainability analysis of the Lao farming system in order to promote sustainable agricultural development and significantly support poverty reduction in Laos.

Summary in Japanese*

Sustainability Analysis of the Lao Farming System

近年におけるラオス経済の急発展の裏にはラオス農業における自然資源の過度な利用やその商業化があった。このもとで、ラオス農業は小農による自家消費を主目的とした多種作物の土地利用が全般を覆っていたものの中に、限られた商業作物を栽培する少数の大規模プランテーション農業が入り込むようになりつつある。しかし、この土地利用には農家の所得拡大策としての効果だけでなく、土地などの自然資源の利用における持続可能性の問題がある。このため、本論文は環境上、社会経済上および技術上の観点からラオス農業システムの持続可能性を分析する。

環境上の観点からは、森林減少・劣化に由来する排出の削減(REDD+)を推進するための経済的なインセンティブ・メカニズムと貧困対策との関係を本論文は研究する。その結果、トウモロコシやゴムなどの商業作物の栽培が短期的には貧困の削減に有益であることと同時に、環境上のリスクを孕んでいることが示された。これと比較すれば、市場や人口といった条件の変化にさらされてはいるものの、陸稲栽培や非木材林産物採取のような伝統的な土地利用の方が持続可能性の点で優れている。これらの結果は、農業の商業化によるモノカルチャー化が長期的な環境コストが短期的な経済的便益を潜在的に相殺することを示している。したがって、REDD+のような環境保全的なインセンティブ・システムが森林維持に役立つ伝統的な土地利用を支援し、その経済的競争力を増大させることになることを明らかとした。

社会経済的な観点からは、キャッサバの契約農業が貧困削減に対して持つ効果をサワナケット県とビエンチャン県を対象に分析した。契約農業は農業を近代化し、農村の貧困を削減するための有効な戦略としてある。しかし、多くの農民は教育の不足や契約自身の説明不足などの原因により、どちらの県においてもよく理解しないままに契約を結んでいるという問題がある。特に、この問題はサワナケット県における 2+3 モデルと呼ばれる不適切なやり方に見られる。そこでは農民たちは契約相手の要求によって資本の提供を求められて負債のリスクを負うこととなっている。加えて、この結果、他の作物に比べたキャッサバ栽培による１人当たりの実質収入が少なくなり、この地域におけるキャッサバ栽培の貧困削減に対する効果は少なくなっている。したがって、もしうまくマネージされなければ契約農業は農民を搾取するといった否定的な結果を招くこととなる。このため、公共セクターや関連団体などの第三者からの適切な介入が求められている。.

この 2 県におけるキャッサバ農業の技術効率性の分析も興味ある結果を導いている。たとえば、キャッサバ生産の弾力性は農場規模や労働力などの投入コストの増加関数となった。このため、労

* The summary in Japanese language is kindly done by Professor Dr. Hiroshi ONISHI.

働力も土地も小さなものしか持たない小農の経営は投資規模も小さいための困難も大きくなっている。特にサワナケット県では規模に関する収穫逓増が検出され、この傾向が強くなる。また、サワナケット県とビエンチャン県の技術効率性はそれぞれ 75% と 72%と推計された。さらに、ビエンチャン県の技術効率性の分析によって適切な農地の整備、栽培時期の選択、若年世代による耕作は技術効率性の改善に有益であることが分かった。

技術的な問題については、ルアンナムタ県における小規模ゴム農園を対象に規模の経済性についての研究を行っている。そして、その結果、ここでの規模の経済性は年を経るにしたがって減少することが分かった。これが示唆するのはこの地域のゴム農園は 大規模農場が競争の優位から小規模農場を併合する可能性である。こうした規模の経済性は経営の当初における整地や植林などの初期費用が非常に重要なことを示している。しかし、年とともに樹液採取や経営管理などの労働コストといった経常的なコストがより重要となり、最後には初期費用はサンク・コストとなって費用のほぼすべてが経常費用となる。そして、この時、小規模経営も大規模経営と競争可能となるのである。そのため、小規模経営が長期に生き残るには、その初期における大規模経営との競争に耐えられるかどうかにかかっている。これは、この時期における彼らのサポートが意味を持つことを示している。

こうしたラオス農業の持続可能性に関する研究は、商業作物の生産についてのこれまでの諸研究に新たな視点を付け加えている。ゴムやトウモロコシやキャッサバといった商業作物の生産は短期的には農家の貧困削減に役立つが、長期的には環境上の問題を引き起こす。対照的に陸稲や非木材林産物の採集といった伝統的な土地利用は持続可能性の点で優れてはいても貧困削減への貢献が小さなものとなっている。

大規模農業の小規模農業に対する土地利用上の競争的投資は土地と森林資源の長期的利用可能性に対するひとつの挑戦である。大樹穂農業も小規模農業もともに、環境や社会経済的影響、それに技術的視点を適切に考慮した投資を行うなら、それは貧困削減を含む社会の持続可能な安定化に寄与することができるのである。

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Chapter 1: Introduction

1. Economic Background of Lao PDR

Since the proclamation renamed the country as the Lao People's Democratic Republic (called Lao PDR hereafter) on December 2nd, 1975, the Lao government adopted a centrally planned economic system as its key economic strategy, with its main goals to rebuild and reconstruct the nation following the long-term war-related ruination, to enrich and strengthen the nation, to promote the civilization, and to encourage the well-being of its citizens. In order to support economic development, the Lao government also implemented the "Three Revolutions," which included the production revolution, the science and technology revolution, and the ideological and cultural revolution (Stuart-Fox, 1986 and Arshad, 2003). The main revolution in terms of economic development was the production revolution. This revolution led to the emergence of agricultural collectivism, large industrial firms, a state marketing board, and the distribution network, which affected agricultural production. The goal of the science and technical revolution was to improve the education system and transfer technology that had been supported mainly by the former Soviet Union and Vietnam, while the ideological and cultural revolution was less related to economic development (Arshad, 2003).

Under the centrally planned economic system of 1975 to 1985, the Lao government set up three national plans to further support socioeconomic development: the one-year plan (1976-1977), the medium-term three-year plan (1978-1980), and the first five-year socioeconomic development plan (1981-1985). The one-year plan was drawn up in order to provide guidelines and major targets for securing national defense, strengthening the new administration, boosting agricultural and industrial production, rebuilding the districts that had been destroyed during the war, and improving citizens' living standards. Consecutively, the medium-term three-year plan for socioeconomic development was introduced with the main objective to security self-sufficiency in rice production, further rebuild the area that had been affected by the war, and encourage people to earn a living. Agricultural collectivism played a key role in the design of the medium-term three-year plan, but the plan was abandoned due to a serious rice shortage and poor economic performance. In late 1979, the Central Committee passed the Seventh Resolution, which emphasized the importance of both socialist and capitalist concepts in the promotion of economic development. Furthermore, the Lao government paid increased attention to ensuring that the economy's five sectors (state, capitalist, joint state-capitalist, collective, and individual)[1] work more efficiently in order to benefit the whole Lao economy (Stuart-Fox, 1986). As a result, economic activities, especially rice cultivation, livestock farming, forestry production, profitable generation of hydroelectricity, and generation of government revenue, all increased.

The positive environment during the implementation of the medium-term three-year plan encouraged the Lao Third Party Congress to introduce its first five-year national socioeconomic development plan (NSEDP) in 1980, for 1981-1985. The objectives of this plan were to encourage agricultural and forestry production for the purpose of food security, improve existing and encourage new industrial plants and factories, and support the construction of infrastructure, especially national highways No.9 and No.13. In order to achieve these goals, the first five-year plan emphasized seven priorities: promotion of agriculture production, consolidation and restructuring of the organizations responsible for management of the economy and the state, development of strategically important enterprises, consolidation of the economic base of state-

[1] The state sector was composed of nationalized banks, national industries, state farms, and state trading and transport companies; the capitalist sector was composed of small-scale industrial and commercial enterprises; the joint state-capitalist sector was composed on joint ventures funded by investment from both the state and private enterprises; the collective sector was composed of agricultural cooperatives; and the individual sector was composed of individual farmers, traders, repair technicians, and other self-employed individuals).

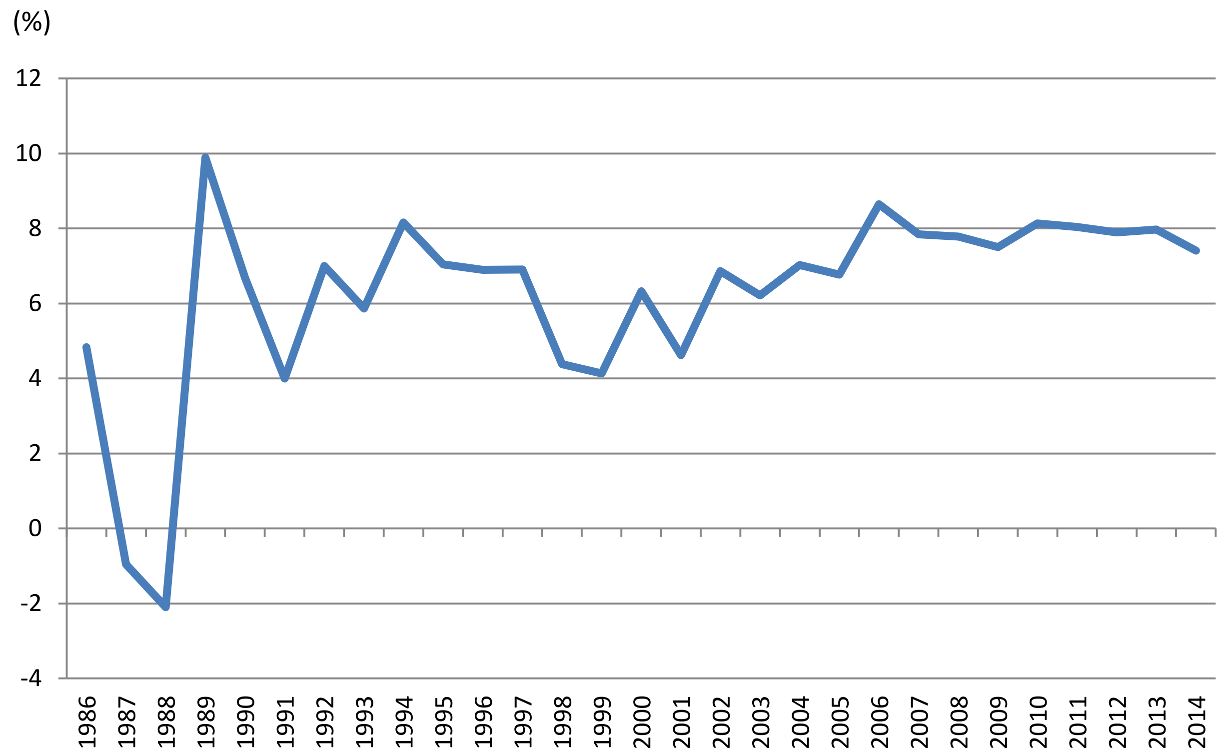
owned enterprises, training of economic managers and technicians, acquisition and efficient utilization of foreign economic assistance, and completion of the literacy campaign (Stuart-Fox, 1986 and Arshad, 2003).

Although effort was made in implementing the first five-year plan, several targets were not achieved, due to the lack of skilled labor, the poor condition of the infrastructure, and the inefficiency of the country's institutional and legal framework. In addition, under the centrally planned economic system, the economic situation deteriorated. Several industrial factories were negatively affected by the emigration of most of their skilled workers, managers, and technicians. Domestic prices were out of control, and the exchange rate fluctuated dramatically. In the agricultural sector, collectivization of agricultural production was established in 1978, but collective farms' practices were inefficient and unsuccessful. During that time, there were food shortages due to the reduction in rice cultivation; food security required the import of rice, which led to the budget deficit. The majority of farmers were small-scale, desperate, and lacking in agriculture specialty. The lack of capital prevented the economy from reaching its potential. The centrally determined pricing system was unable to stimulate commodity production. Farmers protested and then defected from the collectivized system of agricultural production. Thus, additional ambitious reforms were needed in order to improve the country's economic situation. Consequently, the Fourth Party Congress decided to convert the centrally planned economic system to a more comprehensive system and in 1986 declared the "New Economic Mechanism" (NEM) for socioeconomic development.

Since the start of economic reform in 1986, the Lao economy has transitioned from a centrally planned economy toward an open, liberalized market-oriented system. The combination of the economic reform and the application of open-door policies toward the global market have promoted and attracted foreign direct investment (FDI) and encouraged private enterprises to participate in production. The public sector is no longer directly involved with production. Instead, the public sector's role is to enhance management of the economy by monitoring and evaluating it and developing the appropriate legislative framework. Before the NEM was implemented, it was evaluated at the end of 1987 found to be consistent with the Lao economic conditions. Then the Lao government initiated wide-ranging economic reform programs: price liberalization, agricultural reforms, reforms of state-owned enterprises, reformed targeting the banking and financial sector, fiscal reforms, trade reforms, foreign investment policy reforms, and reforms of the legal and institutional frameworks (Arshad, 2003). After the implementation of these reforms, the socioeconomic situation of Lao PDR gradually improved, strengthening the country's integration with the regional and global economies.

The implementation of the economic reforms in the second five-year plan (1986-1990) supported Lao economic growth with distinctive performance in which the Gross Domestic Product (GDP) growth rate reached a record high of 9.89% in 1989. During the third five-year plan (1991-1996), GDP grew at an average annual rate of 6.5%, and the economy was stable. The Asian financial crisis in 1997, however, caused national income to drop and demand for Lao exports to decline, which reduced FDI inflow. Revenue declined, and Lao government expenditure rose (Arshard, 2003). As a result, the annual GDP growth rate dropped to 4.38% in 1998 and 4.13% in 1999 (see figure 1.1). After the crisis, the Lao economy gradually recovered and made good progress during the early 2000s, with the annual GDP growth rate averaging 7.33% between 2001 and 2014.

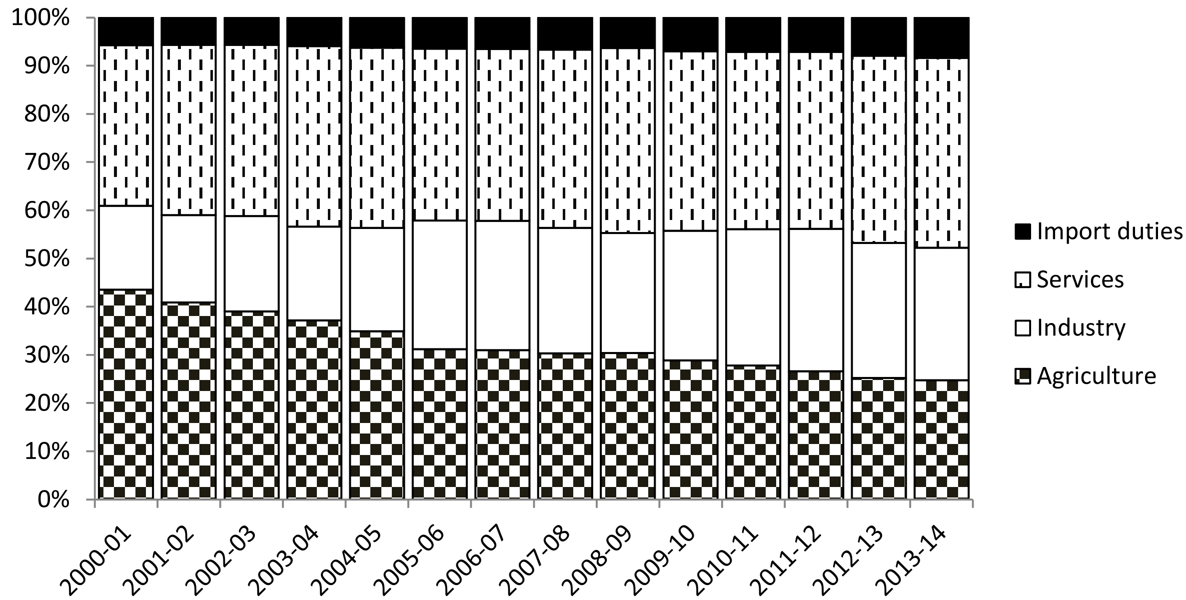
Figure 1.1: Lao PDR's real GDP growth rate



Source: CIA World Factbook

In term of real GDP, the industry sector contributed the most, followed by the service and agricultural sectors. According to estimates from the Lao Statistics Bureau (LSB) for 2000-2014, the average annual growth rates of the industry, service, and agricultural sectors were approximately 10.78%, 8.96%, and 2.91%, respectively. Consequently, the industry sector's share of GDP increased from 17.39% in 2000-01 to 27.49% in 2013-14, and the service sector's share of GDP increased from 30.43% in 2000-01 to 39.32% in 2013-14. Conversely, the agricultural sector's share of GDP gradually declined from 43.57% in 2000-01 to 24.76% in 2013-14 (see figure 1.2).

Figure 1.2: The composition of Lao PDR's GDP



Source: Lao Statistics Bureau, 2015

Although the agricultural sector's share of the Lao economy gradually declined from 2000 to 2014, it remains one of the main pillars of the economy and the main source of income for the country as a whole. The Lao economy depends heavily on subsistence agriculture, which employs over 66% percent of the labor force (Lao Statistics Bureau, 2013). It contributed not only to the strategy for poverty reduction but also to the broad distribution of the benefits of economic growth. In addition, the agricultural sector directly relates to improving living standards for much of the population (NERI, 2001b). In 2014, the proportion of the population, that was below the poverty line, declined to 22% (Lao Statistics Bureau, 2013).

After the enactment of the NEM in 1986, a priority program called the Promotion of Commodity Production Program (PCPP) was introduced, focusing mainly on supporting the transformation from a subsistence economy to a market-oriented economy by promoting the commercialization of agricultural production. Two years later, in 1988, the National Agriculture

Meeting chaired by President Kaysone PHOMVIHANE decided to pay closer attention to agricultural development and marked the sector as "the most important battlefield" in the fight to transition from subsistence agriculture to commercial agricultural production. Furthermore, the Lao government introduced eight national priority programs (food security, rural development, human resource development, infrastructure development, cultivation stabilization, promotion of commodity production, service sector development, and foreign relations development) for supporting the socioeconomic development of the country. These programs were considered national priorities of the Lao government in order to enhance agricultural development and reduce poverty, especially in rural areas.

At that time, however, the Lao economy was not in a strong position, because a large portion of the population, particularly those living in mountainous areas, relied on natural resources and engaged in slash-and-burn cultivation. In addition, most of the people living in rural areas were near-subsistence farmers, engaging in rice-based agriculture, gathering of non-timber forest products (NTFP), and livestock raising. Their traditional method of rice production, especially in the uplands, was low productivity and characterized by low-level use of purchased inputs (seeds and fertilizer) and a non-market orientation. Most Lao farmers were accustomed to subsistence farming, due to the lack of a supported agribusiness environment and infrastructure (roads, irrigation, extension facilities, etc.). The majority of the Lao population that lived in poverty seemed to be in the agricultural sector, due to their ineffective farming practices. Therefore, the government's policy for stabilizing agriculture concentrated on decreasing the practice of slash-and-burn cultivation, supporting the commercialization of agriculture in order to improve the income of farm families, and actively promoting alternative sustainable farming activities.

2. Defining of the Research Problems

In order to achieve the national vision of graduating from least developed nation status by 2020 and goal of poverty reduction, the government of Lao PDR implemented poverty reduction programs in the 6th five-year NSEDP (2006-2010) and prioritized poverty reduction in the 7th five-year NSEDP (2011-2015). In 2012-13, approximately one-fifth of the Lao population remained in poverty (NERI, 2013). One lesson learned from the implementation of the NSEDP is the need to make progress in the quality and sustainability of development by integrating three important aspects: economic growth; social equity, modernization, and industrialization; and environmental sustainability. Currently, most foreign currency revenues are generated from natural resources, and most of the population makes a living from agricultural production. Therefore, natural resource conservation and appropriate and sustainable land resource development in the agricultural sector are critical factors for Lao PDR.

One of the major priority programs of the Lao government is the industrialization and modernization of the agriculture and forestry sector. The goal of this program is to ensure sustainability of agricultural production and food security and improve the quality of life for Lao people. Reaching the goals of alleviating poverty and graduating from least developed country (LDC) status by 2020 is directly dependent on the efficiency of the agriculture and forestry sector. Therefore, the Lao government is highly focused on supporting agricultural production, especially of trees and commercial crops. In addition, in order to improve the quantity and quality of agricultural production, the forest resource must be managed in parallel with biodiversity conservation and the promotion of sustainable use.

Due to the abundance of land and forestry resources and cheap workforce, Lao PDR's agricultural sector, especially rubber and maize plantations, has benefited from a large influx of

FDI which has led to a dramatic increase in maize plantation land area during 2006-2010. The land area devoted to rubber plantations has increased many fold, to the extent that the Lao government has recently revised its policy on rubber plantations. The negative environmental effects land-use changes, from subsistence agricultural production to commercial and semi-commercial agricultural production, must be carefully considered. With a high poverty rate, these changes could greatly complicate sustainable farming and the reduction of poverty in rural communities.

In addition, previously agricultural production in Lao PDR was based on traditional practices, which did not take full advantage of the land's potential; therefore, farmers were unable to emerge from poverty. The rapid and extensive change in land use has also directly affected the natural resource base and, as emphasized earlier, land-use effects should be carefully assessed with regard to long-term sustainability. Decisions about the commercialization of agricultural production generally have been made without consideration of its benefits and costs. In addition, agricultural production has relied on market trends without proper market evaluation and appropriate land-use management; for example, the conversion of forest area to upland rice cultivation, maize and cassava growing, and rubber plantations is inconsistent with governmental policies.

In early of 2000s, the Lao government has focused on restructuring agriculture toward commercial agriculture. Contract farming was promoted as a strategic policy for improving farm income and modernizing agriculture. The government highlighted contract farming as the preferred alternative to concessions and plantations. The contract farming policy known as the

"2+3 or 1+4"[2] policy emphasized the sharing of costs and benefits between investors and farmers. The promotion of commercial agriculture and contract farming led to the establishment of agricultural plantations and field crops covering large areas of productive land, as well as a rapid rise in contract farming systems across the country. Over the past years, a growing body of literature has assessed and documented the effects of contract farming systems; however, the results have been inconclusive (e.g., Litter and Watts, 1994; Rosset *et al*., 1999; Delforge, 2007; Fullbrook, 2007; Setboornsang *et al*., 2008; Sriboonchitta and Wiboonpongse, 2008).

The majority of contract farming ventures in Lao PDR are informal arrangements between farmers and small traders and operate outside legal boundaries. The majority of farmers lack capital and are dependent on contract farming practices, because they do not understand the contract, they do not have the necessary knowledge of proper plantation practices (including chemical use), investors do not provide sufficient material, information and planting technique as their commitments. In addition, previous studies of contract farming in other countries have highlighted the financial benefits of contract farming; studies of the economic benefits and the social and environmental effects have been few in Lao PDR.

As already mentioned, previously agricultural production in Lao PDR was based on natural practices that did not take full advantage of the resource's potential and therefore had low productivity. The majority of farms were small and poor, which explains their practices. The problems faced by small farms are quite similar across commercial farms in Lao PDR. Small-scale farmers lack of the knowledge of techniques for proper land preparation and soil control. They have less knowledge about seedlings and plantation experience than do large-scale farmers. In addition, rural small-scale farmers do not have sufficient access to the financial funds required

[2] The numbers in the "2+3 or 1+4" policy name refer, respectively, to the following inputs: land, labor, other inputs, technology, and market. Farmers are expected to contribute land and labor, while investors are expected to contribute other inputs, technology, and market access.

in order to apply proper inputs, equipment, and techniques. Furthermore, their farm sizes are limited; therefore, their harvested yields cannot reach the optimum output. Given these issues, there are concerns that a majority of individual small-scale farmers will be replaced by large corporations or concessions (Yoav and Willis, 1991). Therefore, in order to enhance small-scale farming practices and reduce poverty in Lao PDR despite the challenge of limited resources, sustainable farming practices have to be analyzed.

From these points of view, the objective of this dissertation is to analyze the sustainability of the Lao farming system with regard to three aspects: environmental, socioeconomic, and technological. In terms of the environmental aspect, the objective is to examine how land-use change toward the commercialization of agricultural practice has affected land and forest resources, farmer livelihoods, and the ecosystem of Oudomxay province. In terms of the socioeconomic aspect, the objective is to examine the different types of contract farming and analyze the impact of contract farming on household poverty, particular for the cassava plantations in Savannakhet and Vientiane provinces. This objective, in response to policy query, has raised the research question of whether contract farming is an environmentally sound strategy for reducing rural poverty. An additional objective in this aspect is to investigate whether there is evidence of increasing or diminishing returns to scale for a cassava plantation with the given outputs and inputs, to estimate the technical efficiency of a cassava farm, and to determine the main factors that influence the efficiency of cassava plantations in Savannakhet and Vientiane provinces. In terms of the technological aspect, the specific objective is to investigate whether economies of scale exist for smallholder rubber farms in Luangnamtha province. Determining whether there are increasing, constant, or diminishing returns to scale is critical in deciding how to deal with large-scale plantations. If there are increasing returns to scale, small farms are not sustainable. However, if there are diminishing or constant returns to scale, small farms can survive.

In order to clarify the objectives mentioned above, the analytical framework for this study is divided into four parts. The first part is a cost-benefit analysis of various land-use systems and investigation of the potential role of the Reducing Emissions from Deforestation and Forest Degradation ($REDD^{+}$) incentive mechanism. The second part is a financial analysis of the net return from cassava contract farming as compared to the net returns from alternative land-use practices and estimation of the differential effects on poverty. The third part is a technical efficiency analysis, specifically a stochastic frontier analysis. The fourth part is a robust ordinary least squares (OLS) regression to examine the economies of scale for smallholder rubber farming. The details of the analytical methods for this study are separately discussed in Chapter 3, 4, 5 and 6 accordingly.

These have been the controversial issues for decades in the agricultural economic development field; however, very few studies and scant research have been conducted in Lao PDR, especially with regard to land-use change for commercial crop plantations combined with the Reducing Emissions from Deforestation and Forest Degradation ($REDD^{+}$) incentive in Oudomxay province, the impact of cassava contract farming and technical efficiency analysis in Vientiane and Savannakhet provinces, and the economies of scale for rubber farming in Luangnamtha province. The findings from this study will directly feed into various ongoing work and academic series to support the development of agricultural policy and human resource practices by researchers at existing institutions in Lao PDR.

3. Structure of the Dissertation

This dissertation is organized in seven Chapters, as follows:

Chapter 1 presents the process of Lao PDR's socioeconomic development, through the transformation from a centrally planned economy system toward an open, liberalized market-oriented system known as the New Economic Mechanism (NEM). This chapter also provides the study's background, rationale for defining the problems, objectives, significance, and scope.

Chapter 2 investigates agricultural development in Lao PDR. Particularly, it recounts the implementation of the policy and strategy for the agricultural sector, especially the agriculture strategic vision, the long-term Agricultural Development Strategy 2011-2020, the Agricultural Development Strategy 2025 and Vision 2030, and the Agriculture Master Plan. The contribution of the agricultural sector to Lao economy is also described. This chapter finally discusses land-use change, the agricultural system, and commercial crops plantations in Lao PDR.

Chapter 3 estimates the costs and benefits of various land-use systems of local farmers who actively practice a land-use system for non-timber forest product (NTFP) gathering, upland rice farming, maize growing, and rubber planting. This chapter also examines the potential role of incentives such as the $REDD^+$ mechanism can contribute in alleviating poverty in Lao PDR. The analysis focuses on assessing whether incentives, such as $REDD^+$, can have a viable role in influencing land-use behavior in this increasingly market-driven rural economy. Consequently, the implications of land-use change for poverty reduction, ecosystem service, and decision making and the role of $REDD^+$ as an incentive for maintaining forests are also discussed.

Chapter 4 employs a descriptive approach to review the business practices of cassava contract farming in Savannakhet and Vientiane provinces, focusing on four indicators: government policy, business partnership norms, accountability, and monitoring and evaluation. This chapter attempt to evaluate the impact of contract farming on the poverty situation of farming households, based on the government's concerns about socioeconomic and equity issues. This chapter further estimates the financial net return from contract farming as compared to those from alternative land-use practices. The differences are the impacts on the poverty condition of cassava farming households.

Chapter 5 presents a technical efficiency analysis of cassava farming in Savannakhet and Vientiane province, composed of three parts. The first part is a summary statistical analysis, specification of a model for a stochastic frontier production function, specification of an inefficiency effect model, and a test for constant returns to scale. The second part investigates whether cassava farming demonstrates returns to scale given the input factors and available technology and, through the application of the Cobb-Douglass stochastic frontier production function, estimates the level of technical efficiency. The third part identifies the factors that determine the technical inefficiency, based on the characteristics of small-scale cassava farms.

Chapter 6 examines whether economies of scale exist for smallholder rubber farming in Luangnamtha province. In the first stage of the analysis, a robust regression of rubber plantation costs and output is estimated, in search of evidence for returns to scale. In order to capture further evidence of economies of scale, a second-stage regression of costs per unit of output on a single variable of year for rubber tapping is estimated by the robust OLS regression method. Finally, this chapter discusses the implications of economies of scale for smallholder farming and proposes ideas for further research in this field.

Chapter 7 summarizes the main findings and provides policy recommendations and suggestions. The unique contribution of this study to existing literatures is also discussed. Finally, directions for further study in support of sustainability analysis of the Lao farming system are proposed.

Chapter 2: Development of Agricultural Plantations in Lao PDR

1. Introduction

In Lao PDR, over 70% of population across the country live in rural areas and rely on agricultural practices to support their food security, income generation and poverty alleviation. After the liberation of the country on December 1975, the agricultural sector of Lao PDR was very weak and the available infrastructure to support this sector was very poor. Many agriculture farming practices across the country were based on traditional practices that could only be enough for family consumption, while several rural people faced a shortage of foodstuff during that time. In order to solve the situation, the Party and Lao government introduced the renovation policy known as the NEM in 1986 and identified agriculture as the key national priority with an effort to transform the previous subsistence agriculture practice to a market-oriented commercial production.

The implementation of the policies made several positive improvements on the agricultural sector. The subsistence agricultural production had been gradually replaced by the commercial production. Agricultural infrastructure improved, as irrigation system and reservoirs were built to supply for agricultural production which enabled rice farming cultivation in 2 seasons in a year. Research and Development Centers and Stations for agricultural development within the country were constructed and expanded, coupled with provision of services regarding the technique and technology for farming practices that supported food security. As a result, some crops were planted for commercial purpose both to supply within the country and for export, for instance: coffee, maize, sugarcane, cassava, rubber, vegetables and fruits.

After initially investigating the development of the agricultural sector in Lao PDR in particular on the farming practice, section 2 discusses the agriculture policy status. Section 3 examines the composition of agriculture sector in the Laotian economy. Section 4 describes the socioeconomic perspective of the Lao farming system. Section 5 examines environmental aspect of sustainability of Lao farming and the last section concludes this chapter.

2. Policies and Strategies for Agricultural Development

Over the past decade, agricultural development has been made through the implementation of policies, decrees, strategy and decision which has its roots in the reforms since the Lao government announced its NEM in 1986. The NEM recognized the dominant role and devolved responsibility for agricultural production to support socio-economic development through significant reform measures designed to create better direction for an open market economy. The development of the agricultural sector, accounted as the primary sector of the national economy, follows the national direction through increasing the productivity in parallel with the rehabilitation for the fertility of land, water and forest for sustainable use and environment protection. Annex 1 highlights the major reforms and significant policies in the agricultural sector.

2.1. The Strategic Vision of the Agricultural Sector

In 1999, the Government's Strategic Vision for the Agriculture Sector was launched, having derived from the Agriculture Sector Strategy Study in 1998 and the government's review of agricultural strategy options (MAF, 1999). The strategic vision stipulated eight priority Thematic Approaches to drive programs: the planning approach, rural and agricultural planning and decentralization, business regulatory adjustment, external trade liberalization, lowland transformation, sustainable upland development and environmental management, diversification of water resources for sustainable irrigation utilization and elimination of shifting cultivation.

The strategic vision had been developed with the view to support the dual agricultural development of Lao PDR and its market expansion in both lowland and upland areas depending on different agricultural economies. In the lowland area, agricultural production was in the period of transformation where market forces were the main force driving rural economic development. The specific policies and strategies under the Thematic Approaches for the lowland agricultural development were identified for increasing production capacity and diversifying the farming practices on cash crop, livestock and fisheries production. They also aimed at developing the agricultural processing industry and intensifying value added through the promotion of domestic and foreign capital investment in agricultural sector. They further focused on improving the efficiency of agricultural marketing, market research and information systems in order to strengthen the regional linkages between producers, distributors and consumers. In addition, they emphasized developing the system on international accepted product grades and standards. The policies focused on strengthening the State Owned Commercial Bank and private commercial banks for rural and agribusiness credit accession and facilities at market interest rates. Finally, the implementation of the policies and strategies were targeted at improving the dry season irrigation schemes and their integration with the community participatory based management (MAF, 1999 and NERI, 2005).

As for the upland agricultural development, the polices under the Thematic Approaches were concentrated on arrangements for land use zoning based on bio-physical and socio-economic characteristics; allocating sustainable land use participatory and entitlement occupancy; managing community natural resources; diversifying farming systems through adaptive research, demonstrations on farmers' field and farmer demand-driven extension; expanding small scale community irrigation; controlling soil erosion and forest plantation and conservation; mobilizing rural saving and developing competitive rural finance system and microfinance extension; strengthening the capacity and legal framework for state own commercial banks for rural agribusiness; and upgrading feeder roads to open community market access and information delivery.

2.2. Long-term Strategies for Agricultural Development

The Agricultural Development Strategy (ADS) 2011-2020 is based on the foundation established by the "Four Goals and thirteen Measures" adopted by the 8th Party Congress in 2006. The first goal was to improve livelihoods through food production aiming at national food security and emphasized increasing the quality of food supply in 47 poorest districts (see the list in Annex 2) of Lao PDR by bringing it to the equivalence of the national level (350 kg per person per annum). The second goal was to increase and modernize agricultural commodity production targeting domestic, regional and global market. The third goal was on stopping slash and burn cultivation practices especially in 47 poorest districts and linking to the initiatives for rural development, poverty reduction and environment protection. Lastly, the fourth goal was sustainable forest management through preserving biodiversity and providing valuable environmental services that balanced the benefit to rural communities, public and private forest product processing enterprises. The effort of the Lao government was to increase forest cover within the country to 53% (12 million hectares) of the total land area by 2010 and to 70% (approximately 16 million hectares) by 2020 (MAF, 2005 and MAF, 2010).

The above four goals were expected to be achieved through the implementation of the 13 Measures, namely: (1) agriculture and forestry sector perspective, (2) survey and allocation of agriculture and forestry production zones, (3) seed and breed availability, (4) extension and technical services and human resources development, (5) establishment of village development groups linked to sector development, (6) organizing production and establishing economic structures from local/grassroots levels, (7) irrigation development and prevention of droughts and floods, (8) productivity improvement, (9) quality controlling and disease prevention, (10) financial mechanisms, (11) achieving economies of scale in production, (12) implementation of monitoring and evaluation and (13) Decentralization (MAF, 2010).

The policies for agricultural sector, in particular the small farm family, were also defined in the long term agricultural development strategy 2010-2020 as well as in the 5th National Socio-Economic Development Plan (2001-2005). The long term development goals for the sector were gradually introduced and increased the implementation of market-oriented agricultural production for smallholders. The policy also supported smallholder farmers to create and operate their farming practice as the producer groups, cooperative groups and commodity associations. These formulations were supported to play a strong role in community agricultural production and commerce. In addition, smallholder farming was further promoted and became more diversified in agricultural production for increasing the production and enhancing the linkage between farmer organizations and local traders, agro-processors, and agribusiness enterprises. The aim of the policy implementation was to create rural employment opportunity, transfer modern technologies to increase productivity, channel agricultural production inputs and finance accession, and facilitate the linkage between the rural agricultural products to regional and global markets. These focused on agricultural production to ensure food security for improving the livelihoods and poverty reduction, while being more market-oriented and environmentally sound (MAF, 2010).

In order to be inline with the latest global sustainable development agenda, the government of Lao PDR recently assigns the relevant public sectors at the central and local levels to formulate their long term socio-economic development strategies, in which the Agricultural Development Strategy 2025 and Vision 2030 is proceeding. The Agricultural Development Strategy 2025 and Vision 2030 is the current crucial direction for the agricultural development in Lao PDR that emphasize supporting the triangle directions for stable economic growth, human development and environment and natural resource protection. The Vision 2030 of the agricultural sector defined that "in order to ensure food security, agricultural commodities have to be produced based on their potential following agricultural development direction in the context of clean, safety and stability under the industrialization and modernization for rural and national economic development" (MAF, 2015a). The strategy has been developed with a number of prominent goals that have to be achieved. These include food and nutrition security, achieving Millennium Development Goals (MDGs) with zero hunger by 2025, commercialized commodity production, rural livelihoods and poverty alleviation, and sustainable forest utilization and conservation.

At the United Nations Sustainable Development Summit in September 2015, the member states of UN adopted the newly Sustainable Development Goals (SDGs) which will formally come into effect on January 1st 2016, replacing the Millennium Development Goals (MDGs). The new SDGs to be achieved by 2030 include ending hunger, achieving food security and improved nutrition, promoting sustainable agriculture, ensuring healthy lives and promoting well-being for all ages, ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all, achieving gender quality and empowering all women and girls, building resilient infrastructure, promoting inclusive and sustainable industrialization, and fostering innovation.

2.3. The Agricultural Master Plan

The key direction to boost the agricultural development is the implementation of the Five Year Agriculture Master Plan (AMP). From 1980-2015, the Lao government established 7 AMPs. The AMP is based on the eight priority programs, which will be implemented to achieve the Four Goals defined for the development of the agriculture and forestry sector in Lao PDR. The eight priority programs are: (1) food production, (2) commodity production and farmer organizations, (3) sustainable production patterns, land allocation and rural development, (4) forestry development, (5) irrigated agriculture, (6) other agriculture and forestry infrastructure, (7) agriculture and forestry research and extension and (8) human resource development.

The AMP is also a roadmap for implementing the agricultural development strategy 2011-2020. Specifically, the five years AMP (2016-2020) of the agriculture and forestry sector will be implemented following the direction and targets of the national socio-economic development. Based on the Agriculture and Forestry Strategy, the AMP (2016-2020) defined 3 main programs namely: (1) the national food security program, (2) agriculture and forestry commodity production program and (3) forestry protection and sustainable natural resource management programs (MAF, 2015b).

The national food security program is set to ensure the possibility, stability, accession and the cleanness and safety of foodstuff production. The agriculture and forestry commodity production program is defined for producing agriculture products and potential forestry and NTFPs products in a sustainable way under industrialization and modernization. It also further emphasizes on producing agricultural products and organic farming for domestic distribution and export to the regional and global markets. As for the forest protection and sustainable natural resource management program, it is defined with the aim to support the effort on implementing the plan for forest covered by 70% by the end of 2020. The plan focuses on implementing the production forest sustainable allocation linking with the rehabilitation for the degradation production forest to cover 650,000 hectares and expanding the additional potential forest, supporting the traditional tree planting and imported tree to cover the area of 100,000 hectares and formulating the village forest allocation planning for 1,500 villages across the country (MAF, 2015b).

3. Contribution of Agricultural Sector in Lao Economy

Over the past decades, the economy of Lao PDR has grown rapidly. The average growth rate of the Gross Domestic Product (GDP) has steadily increased from 6.27% in 2001-2005 to about 7.9% in 2006-2010 and to a stable level rate at 8.02% in 2011-2014 (LSB, 2013 and Central Intelligence Agency - CIA World Factbook, 2015). The GDP increased from US$10.19 billion in 2012-2013 to about US$11.31 billion in 2013-2014. The GDP per capita also showed a big improvement over the previous decades. It increased from US$571 in 2006 to US$ 1,026 in 2010 and to about US$ 1,725 in 2014 (LSB, 2015). The total investment in Lao PDR was estimated at about US$ 5.04 billion in 2013-2014, in which public investment was about US$ 1.168 billion, accounting for 23% of the total investment. Public investment increased by 7.14%, while private domestic and foreign investment increased by 26% compared with 2012-2013 (NERI, 2014).

In terms of the economic sector growth rate, the average annual growth rate of the industrial sector increased from 8.43% during 2001-2005 to about 11.65% in 2011-2014. The growth rate of the service sector showed stable level at about 8% from 2006 to 2014. While the growth rate of the agricultural sector increased from 1.76% in 2001-2005 to around 4.01% in 2006-2010, it then slightly deceased to the rate at about 3.17% in 2011-2014. The growth rate of the forestry sector dropped from 7.23% in 2006-2010 to a negative level of -14.04% in 2011-2014, mainly due to the country's economy being affected by natural disasters and the world economic crisis, for instance: Typhoon Ketsana in 2009, tropical storms Haima and Nok-Ten in 2011, flooding, climate change, price changing of agricultural products and inputs and other factors.

Table 2.1: The growth rate of economic sector of Lao PDR

Economic Sector	2001-2005	2006-2010	2011-2014
	(%)		
Agriculture	**1.76**	**4.01**	**3.17**
Crops and livestock	2.31	3.90	4.59
Forestry	-3.33	7.23	-14.04
Fishing	3.53	4.02	4.08
Industry	**8.43**	**12.64**	**11.65**
Mining and quarrying	182.81	25.92	9.09
Manufacturing	8.33	9.42	9.81
Electricity and water supply	0.13	9.01	16.33
Construction	2.97	11.26	15.95
Services	**10.16**	**8.11**	**8.46**
Wholesale and retail trade	14.56	7.68	7.84
Hotels and restaurants	2.44	6.57	7.22
Transport and communication	10.74	7.79	9.47
Financial intermediation	9.26	29.13	15.25
Real estate and business services	2.63	3.17	8.04
GDP at market prices	**6.27**	**7.90**	**8.02**

Source: Lao Statistics Bureau, 2015

In term of economic composition, the industrial sector makes up the most significant proportion, followed by the service and agricultural sectors. The average share of the industry and service sectors in GDP dramatically increased from 19% and 35% in 2000-2005 to about 27% and 37% in 2011-2014, respectively (see table 2.2). This improvement was driven by the growth rate of the mining sector in 2001-2005 and the benefits gained from the electricity production during 2006 and 2014 (see table 2.1). These figures illustrated the development in both industrial and service sectors in the current Lao economy. Conversely, the average share of the agriculture in GDP has steadily declined from 39% in 2000-2005 to 26% in 2011-2014. The declining of the share for the agricultural sector was mainly due to the expansion of several hydropower generations across the country.

Table 2.2: Composition of the economic sector of Lao PDR

Economic Sector	2000-2005	2006-2010	2011-2014
		(%)	
Agriculture	**39.10**	**30.36**	**26.95**
Crops and livestock	31.01	23.39	21.99
Forestry	3.82	3.48	1.84
Fishing	4.28	3.48	3.12
Industry	**19.23**	**26.25**	**27.91**
Mining and quarrying	1.94	9.69	8.05
Manufacturing	8.34	8.81	9.39
Electricity and water	4.38	2.91	4.19
Construction	4.57	4.84	6.28
Services	**35.82**	**36.80**	**37.71**
Wholesale and retail trade, repairs	17.85	18.77	19.15
Hotels and restaurants	0.80	0.67	0.67
Transport and communication	4.76	4.59	4.64
Financial intermediation	1.69	3.04	3.52
Real estate and business services	4.33	3.18	3.04
Other	6.40	6.56	6.68

Source: Lao Statistics Bureau, 2015

The production and export of electricity, at 16% of GDP growth rate during 2011-2014, contributed significantly to the economic sector. In addition, the development of mining sector since early 2000s has also made significant contribution. The share of the mining sector in GDP indicated a great increase from 1.94% in 2001-2005 to about 9% in 2006-2014. It is estimated that the export of refined copper, copper ore and gold in 2012 made a significant contribution covering about 52% of total export (US$2.13 billion) of Lao PDR (OECD, 2012). Regarding the agricultural sector, the greatest contributors were crops and livestock covering about 22% of

GDP in 2011-2014, while the forestry and fishing contributed only 1.84% and 3.12%, respectively. Despite the reduced share of the contribution to GDP, the agriculture sector is still the most important sector contributed for livelihood improvement and poverty alleviation in Lao PDR.

Table 2.3: Selected agricultural products exported by Lao PDR

P.code	Crops	2010	2011	2012	2013	2014
		Value in US Dollar thousand				
4001	Natural rubber, balata, gutta-percha	23,723 *(1.15)*	37,925 *(1.26)*	66,394 *(2.07)*	109,523 *(2.79)*	79,134 *(2.06)*
901	Coffee	45,076 *(2.18)*	100,152 *(3.32)*	83,823 *(2.61)*	83,142 *(2.12)*	64,551 *(1.68)*
1005	Maize (corn)	32,253 *(1.56)*	34,210 *(1.13)*	36,201 *(1.13)*	47,701 *(1.22)*	36,040 *(0.94)*
1701	Sugarcane or beet sugar and chemically pure sucrose, in solid form	18,848 *(0.91)*	31,121 *(1.03)*	33,491 *(1.04)*	33,743 *(0.86)*	26,913 *(0.7)*
2401	Tobacco unmanufactured, tobacco refuse	3,056 *(0.15)*	5,561 *(0.18)*	7,106 *(0.22)*	2,623 *(0.07)*	19,569 *(0.51)*
1006	Rice	7,643 *(0.37)*	4,322 *(0.14)*	14,184 *(0.44)*	13,946 *(0.36)*	10,770 *(0.28)*
1008	Buckwheat, millet and canary seed	3,300 *(0.16)*	6,887 *(0.23)*	4,341 *(0.14)*	3,640 *(0.09)*	3,419 *(0.09)*
902	Tea	425 *(0.02)*	153 *(0.01)*	401 *(0.01)*	455 *(0.01)*	1,007 *(0.03)*
	TOTAL export of All products	2,069,374 *(100)*	3,019,746 *(100)*	3,210,061 *(100)*	3,920,772 *(100)*	3,849,975 *(100)*

Source: Calculated by the author data provided by the International Trade Center http://www.trademap.org/Country_SelProductCountry_TS.aspx (Accessed on 14 December 2015). The data shown in blanket is percentage.

Overall, it could be observed that the total export, including agricultural and forestry products, increased over the last 5 years. Table 2.3 presents the main export of agriculture products of Lao PDR, including natural rubber, coffee, maize, sugarcane, tobacco and rice. The value of export of natural rubber, among those selected agricultural products, showed the largest proportion of total export from 2010-2014. Particularly, the value of export of natural rubber in 2013 reached US$ 109 million or about 2.79% of total export. The main export market of natural rubber is China accounted for 85% from 2010-2014. The export of maize also showed a slightly increasing value from US$ 32 million in 2010 to US$ 47.7 million in 2013, but it declined to US$ 36 million in 2014. The value of export of coffee reached its highest level at US$100 million in 2011, but then it showed a decreasing trend and was about US$ 64 million in 2014. Although the exports of sugarcane, tobacco, rice, buckwheat and tea covered a small proportion, their value of export showed an increasing trend over the period.

Table 2.4: Selected products imported by Lao PDR

P.code	**Crops**	**2010**	**2011**	**2012**	**2013**	**2014**
		US Dollar thousand				
31	Fertilizers	23,383 *(0.72)*	40,544 *(0.55)*	66,808 *(0.40)*	68,550 *(0.35)*	93,872 *(0.34)*
20	Vegetable, fruit, nut, food preparations	14,579 *(0.45)*	13,566 *(0.32)*	14,221 *(0.24)*	17,684 *(0.27)*	23,163 *(0.34)*
4001	Natural rubber, balata, gutta-percha	10,406 *(0.44)*	9,367 *(0.22)*	17,172 *(0.30)*	14,951 *(0.22)*	18,199 *(0.27)*
1701	Sugarcane or beet sugar and chemically pure sucrose, in solid form	18,493 *(0.57)*	32,372 *(0.76)*	48,840 *(0.84)*	18,692 *(0.28)*	17,828 *(0.26)*
1006	Rice	13,223 *(0.41)*	12,189 *(0.29)*	7,233 *(0.12)*	5,675 *(0.09)*	9,387 *(0.14)*
2401	Unmanufactured Tobacco; tobacco refuse	481 *(0.01)*	549 *(0.01)*	1,085 *(0.02)*	727 *(0.01)*	4,541 *(0.07)*
1101	Wheat or flour	2,957 *(0.09)*	3,838 *(0.09)*	3,473 *(0.06)*	4,048 *(0.06)*	3,118 *(0.05)*
4009	Tubes, pipes & hoses of vulcanized rubber other than hard rubber	1,294 *(0.04)*	1,910 *(0.05)*	2,691 *(0.05)*	2,804 *(0.04)*	2,464 *(0.04)*
1005	Maize (corn)	1,293 *(0.04)*	2,825 *(0.07)*	2,388 *(0.04)*	2,774 *(0.04)*	2,134 *(0.03)*
	TOTAL export of All products	3,263,981 *(100)*	4,243,564 *(100)*	5,807,962 *(100)*	6,650,378 *(100)*	6,801,560 *(100)*

Source: Calculated by the author data provided by the International Trade Center http://www.trademap.org/Country_SelProductCountry_TS.aspx (Accessed on 14 December 2015). The data shown in blanket is percentage.

Table 2.4 shows some selected products imported by Lao PDR, viz., fertilizer, vegetable, fruit, nut, natural rubber, rice, sugarcane, unmanufactured tobacco, wheat, and maize. It is necessary to observe that the proportion of each selected product covers less than one percent of total import. The imported fertilizer, however, dramatically increased about 4 times from US$ 23 million in 2010 to about US$ 93.8 million in 2014, mostly from Thailand (67%) and China (32%). The major agricultural imported products were vegetable, fruit, nut, and food preparations and were worth about US$ 23 million in 2014. Although rubber was planted and covered large area across the country, Lao PDR still imported natural rubber from Thailand and its value reached to US$ 70 million during 2010-2014. In addition, even though Lao PDR could export rice, sugarcane, unmanufactured tobacco, wheat, and maize, it needs to import these agricultural products in order to response to the domestic demand.

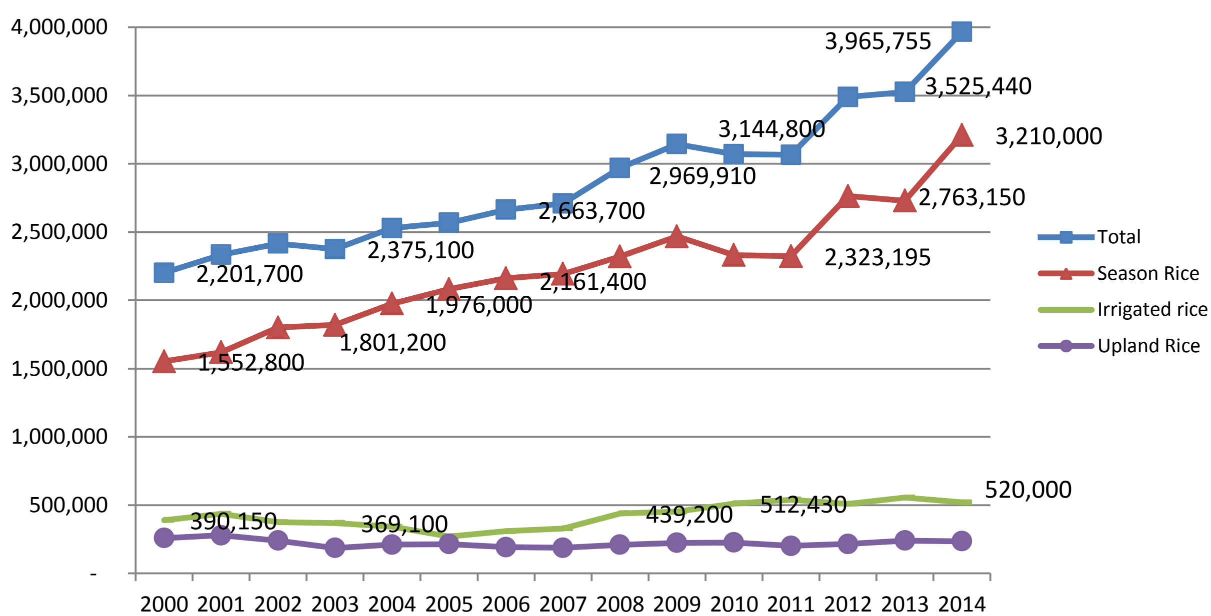
4. Socioeconomic Perspectives on the Lao Farming System

4.1. Crop Production under the Food Security Program

In order to achieve the goals identified in the seventh AMP, food security and commercial production programs are the two focused areas for agricultural production. Food security, also known as food production, is the top priority program. Food security is the concept defined as the terms of ensuring all people, at all time, could access to sufficient, safe and nutritious food that meet their dietary needs and food preferences for an active livelihood (Edward Clay, 2002). In the current food security in Lao PDR, rice constitutes as the principle meal. The total rice production across the country steadily increased from about 2.2 million tons in 2000 to 3.07 million tons in 2010 and to 3.9 million tons in 2014 with an average of 400-500 kg available per person per year (figure 2.1). The Lao government has paid its effort and focused on increasing annual rice per capita, especially in the 47 poorest districts at the average of 350 kg per person per year. It is estimated that the total rice production will be attained at about 4.2 million tons in 2015 (MFA, 2015b). It is expected that rice production at this level would be able to reach self-sufficiency status and the production could reach the target set in the 5 years agriculture and forestry plan.

There are 3 types of rice production systems identified in Lao PDR viz., season rice, irrigated rice and upland rice systems. The season and irrigated rice systems mainly dominate in the central and southern part areas, which are located along the Mekong River. The two systems accounted for 88% of total cultivated area in 2014 (LSB, 2015), particularly in Savannakhet and Champasak provinces and Vientiane Capital. The upland rice system dominates in the Northern region.

Figure 2.1: Rice production in Lao PDR (Unit: ton)



Source: Lao Statistics Bureau, 2015

From 2000-2014, the season rice production covered the highest proportion at the average of about 77%, irrigated rice production accounted for 15%, while the upland rice production accounted the minor proportion of only 8%. The productivity of the irrigated rice plantation in 2014 was about 5.07 ton/ha higher than the season rice and upland rice production where their productivity were at about 4.21 ton/ha and 2.03 ton/ha, respectively. Inthavong

(2005) investigated the technical efficiency of rice production in Ban Home, Lao PDR and found that the average deterministic and stochastic technical efficiency were respectively high at 63% and 72% and the technical efficiency was higher for the dry season than the wet season. It implies that rice farmers could produce only 63% and 72% of the maximum outputs. In addition to rice, other food productions to support food security are meat, eggs, fish and milk, all of which grow on average 5% per year, producing an average of 40-50 kg per person per year (MAF, 2015b).

4.2. Commercialized Agricultural Production

Commercialized agricultural production, implemented under the Commodity Production Promotion Program, is a significant policy for agriculture reforms in Lao PDR that support the transition from subsistent agricultural economy to a market-oriented commodity production system with the purpose to increase farmers' income and poverty reduction especially in rural areas. Through the implementation of this policy, a number of farmers and private investors (both local and foreign) begin to grow various type of crops integrated with the intensive agricultural production such as maize, sugarcane, soybean, sesame, cassava, job's tear, cotton, tobacco and rubber in order to response to the high demand from both within Lao PDR and neighboring countries namely Thailand, China and Vietnam.

In general, there are various concepts of commercialized agricultural production. Some farmers aim to increase their production above the subsistence level and any surplus is sold to market. These farmers emphasize on the capacity to access regional and international markets and stable procurement of raw material, while others highlighted that agriculture commercial production is specialized and based on modern technology. It is a way to build capacity for farmers and agribusiness entrepreneurs in order to stabilize income generation through the professional farming practice rather than the subsistence production (NERI, 2005).

Increasing farmer incomes under the commercial production is not merely about converting subsistence farming purposes to be purely commercial farms, but to improve from the low level of commercialized production to a higher one with any surplus then sold to the market. Meanwhile, to improve the farming practice to a high level of commercialized production does not mean to emphasize only the large size holding farmers and enterprises. Besides, professional farming to improve a previous traditional way of living and specialized production based on modern technology and new technique for stabilized income generation beyond food security have become the main interest of Lao farmers. There are several evidences and analysis on commercialized production referring to the farmer groups, cooperatives or associations consisting mostly of smallholder farmers who are the most productive farmers. Smallholder farmers, however, face several current difficulties and challenges especially on accessing technology, market information and finance support to boost their business in a sustainable commercialized manner (NERI, 2005).

4.3. Contract Farming Practices in Lao PDR

From 2000-2014, there had been a large influx of investments to Lao PDR, of which the share of the accumulated investment in agricultural sector covered about US$ 2.6 billion or 12.2% (ranking as the third largest accumulated value), where most of the share of the investment composed by the mining (US$ 6.75 billion or 30.7%) and hydropower (US$ 6.16 billion or 28.8%) sectors (see table 2.5). This investment has led to the increase of agricultural plantations covering large areas of productive lands in term of concession and contract farming systems across the country. The government's effort in the agricultural sector, as initially set out in the 6th NSEDP (2006-2010), consistently focuses on transferring the subsistence farming activities towards the commercialized agricultural production. More specifically, the NSEDP encourages all investors and traders to promote the contract farming practices, especially in tree and commercial crops plantation. The attention on contract farming has been raised in mid of 2007 when the Lao government announced a moratorium on land concessions, which makes particular reference to concessions that were granted for the purpose of establishing tree plantations.

Table 2.5: Accumulated domestic and foreign investment by sectors in Lao PDR

No	Sectors	2000-2014	
		(US$ million)	Percentage
1	Agriculture	2,607.85	12.21%
2	Banking	290.26	1.36%
3	Construction	743.31	3.48%
4	Consultant	50.66	0.24%
5	Industry & Handicraft	1,495.40	7.00%
6	Education	22.40	0.10%
7	Electricity Generation	6,161.98	28.85%
8	Garment	39.85	0.19%
9	Hotel & Restaurant	579.51	2.71%
10	Mining	6,570.48	30.76%
11	Public Health	60.46	0.28%
12	Services	2,146.53	10.05%
13	Telecom	164.93	0.77%
14	Trading	200.26	0.94%
15	Wood Industry	226.82	1.06%
16	TOTAL	21,360.71	100.00%

Source: Calculated by the author based on the data set on committed FDI provided by the Investment Promotion Department

4.3.1. Definition of Contract Farming

Contract farming can be arranged in a wide variety of forms, ranging from a simple verbal agreement to a written contract between farmers and entrepreneurs that explicitly details the obligations of each side. The majority of contract farming practices between farmers and small traders in Lao PDR are not in a formal arrangement but operate outside legal boundaries.

Some review of the gains and losses from farmers and investors participating in contract farming in the region has shown inconclusive results. Investors sometime blame losses on farmers who infringed the contract and sold their crops to the non-contract market. Farmers on the other hand reported some disadvantages including the fact that their contracting partner did not share the cost of a failed crop or did not collect the products after harvest as specified in the contract. In such cases, there is no legal platform for farmers or traders solve problems (ADB, 2007).

Previous literatures contain numerous perspectives on contract farming. Eaton and Shepherd (2001), Patrick (2004), Delforge (2007) and Singh (2005) emphasized on the role of both parties. Farmers prefer to contribute land and labor while investors provide credit, technique and marketing. Catelo and Costales (2008) defined contract farming as a binding forward agreement between a firm and an individual producer with well-defined obligations and specifications on products' properties such as volume, quality and timing of delivery. Rohber (2007) noted that contract farming is defined as a contractual arrangement between farmer and a firm, whether oral or written, that specified the conditions of production and marketing for an agricultural product.

In the perspective of the Ministry of Agriculture and Forestry of Lao PDR, contract farming is a form of production arrangement between farmer and buyer who made a decision based on the agreement in a contract in advance before the growing season begin. The buyer would receive a specific crop in terms of quantity, quality and time delivery at a fixed price, while benefits that the farmer obtains from the contract are technical support, credit, inputs and assuring the sale of the crop from the buyer (MAF, 2010b). In the perspective of the study on the impact of contract farming on poverty and environment in Lao PDR conducted by NERI, contract farming is defined as a verbal or written agreement between a farmer and an investor on specific production and outputs under the agreed future price (NERI, 2015b).

In general, the contract farming in Lao PDR practice in the form of 2+3 modality where the farmer contributes land and labor, while the investor provides capital, service extension on production technique and access to market (NERI, 2015b). In fact, there are not only these two partnerships that enter into the contract arrangement, the additional stakeholders involved in the contract farming usually are the village heads, heads of community group, district officials, small traders, large investors, firm representative, banks, microfinance institutes and other sources of credit and the concerned development officers. The responsibility of each party varies from cases to cases and time to time (Fullbrook, 2007).

4.3.2. Gains and Losses from Contract Farming Practice

The government of Lao PDR has promoted contract farming as a strategic policy to improve farm income, modernize agriculture and as the preferred alternative to the large size farming or concessions. Specifically, the contract farming in the form of 2+3 modality has been strongly promoted and widely practiced across the country. It is considered as a better alternative to ensure the benefits for investors and farmers and enhance rural development (PEI, 2010 and Fullbrook, 2007). In addition, the contract farming policy also emphasizes on the sharing of costs between the two parties. Since the promotion of such policy, commercialized agricultural production under the contract farming systems could now be applied to produce different commercial crops in several parts of Lao PDR.

The benefits of contract farming come with responsibilities and obligations to the contract parties. Contract farming mitigates production and marketing risks to the contract partners. Farmers have to produce products according to the contractual agreement and absorb opportunity loss from higher market prices. Investors are responsible for supplying farmers with inputs at a fair cost, transferring appropriate technology to contracted farmers and purchasing products at the agreed prices. The contract parties have to understand and agree on terms and conditions of contractual agreements. Furthermore, they have to be accountable for their actions and work performance.

Previous literature provides significant evidences that contract farming practice can contribute positively to poverty reduction, although high level of support by the public sector and financial institutions in several practice cases is needed (Somsak (1989), Litter and Watts (1999), Sriboonchitta and Wiboonpongse (2008), Silva (2005) and Punya (2007)). Saichay and Dusadee (2013) found that farmers who participated in sugarcane contract farming in rural area of Savannakhet province had better income earning, improvement of farming skill and better networking on accessing to information and farming extension. The study on the impact of contract farming on poverty and environment in Lao PDR conducted by NERI indicated that contract farming generally followed government policy. Maize, banana and cassava contract farming practices demonstrated financial gain above the poverty line and varied greatly among the difference crops. Farmers were still able to earn positive net returns despite some of the problems associate with contract farming, for instance: unfavorable land rental fee, inflated pricing on crop inputs, high cost of land clearing supplied by the investors and many farmers did not understand the detail of signed contracts. There is a concern that if it is not carefully managed, several weaknesses of contract farming could lead farmers being exploited (NERI, 2015b).

The successful practices of contract farming, as with most business operations, are highly depended on profit, benefit, risk, marketing and the effective management and resource accessibility. The 2+3 contract farming modality widely used in Lao PDR is developed based on these principles. A variant to the 2+3 modality has also been promoted in a 1+4 formation. This approach has only been applied in some areas of Lao PDR, for instance banana contract farming in Bokeo province (NERI, 2015b). In this sense, farmers only provide labor or land, while investor contributes the remaining inputs i.e. capital, production techniques and market.

Although the 2+3 or 1+4 modalities have been ensured for extension services and inputs accession for farmers, their implementation are weak and needed to improve in several areas. Majority of contract farming ventures in Lao PDR are not in a formal arrangements but are based on oral commitments between investors and farmers, which sometimes led to improper practices to contractual agreement. Saichay and Dusadee (2013) found that farmers faced several difficulties after participation in the contract farming. Farmers became indebted due to the high cost of inputs (fertilizer, stalk seed, and labor cost), exposed to chemical use and faced social relationship problems on livestock rising against sugarcane plantation. On the other hand, NERI (2015b) highlighted that farmers generally lack important business skills and sufficient knowledge of contract farming arrangements when negotiating the terms of contract. This has led to farmers exploitation through unfair pricing structure, prohibited sales and diverting most risks to the farmers.

4.4. Concession Farming in Lao PDR

4.4.1. Structure of Land Concession

In recent years, land use patterns in Lao PDR are rapidly changing for commercial purposes particularly in the agribusiness, mining, and forestry subsectors due to the increase of both domestic and foreign direct investments in land concessions and leases. During 2000-2009, the number of land deals skyrocketed fifty-fold totalling 2,642 land agreements which covered

1.1 million[3] ha for land concessions and leases (Schonweger *et al.,* 2012). In the agriculture and forestry subsectors, the inflow of the investments in large agricultural plantation has covered wide areas of productive lands in terms of crop concession, especially rubber, eucalyptus, sugarcane, Jatropha, acacia, sugarcane and cassava. The growth of the investment for these agribusiness concessions has been driven by high regional and global demands for these products, improvement in regional market access and commercial crop promotion by the Lao government in an attempt to eliminate shifting cultivation and encourage sustainable farming practices.

Table 2.6: Concession investment projects and land area by sector and subsector

Sector	Subsector	No. of Deals	Total Area (ha)	Percent (%) of land concession
Primary	Agriculture	360	140,015	12.7
	Forestry	367	306,234	27.8
	Mining	564	548,756	49.9
	Total of primary sector	**1,291**	**995,005**	**90.4**
Secondary	Construction	392	358	0.03
	Electricity	10	3,730	0.3
	Manufacturing/Processing	427	22,878	2.1
	Total of secondary sector	**829**	**26,966**	**2.4**
Tertiary	Communications	69	37	0.1
	Services/Utilities	144	1,956	0.1
	Tourism	156	75,182	6.8
	Transport	20	275	0.1
	Wholesale/Trade	121	107	0.01
	Total of tertiary sector	**520**	**77,557**	**7.2**
Quaternary	Education	2	5	0.0005
	Total	**2,642**	**1,099,534**	**100**

Source: Schonweger *et al.,* (2012)

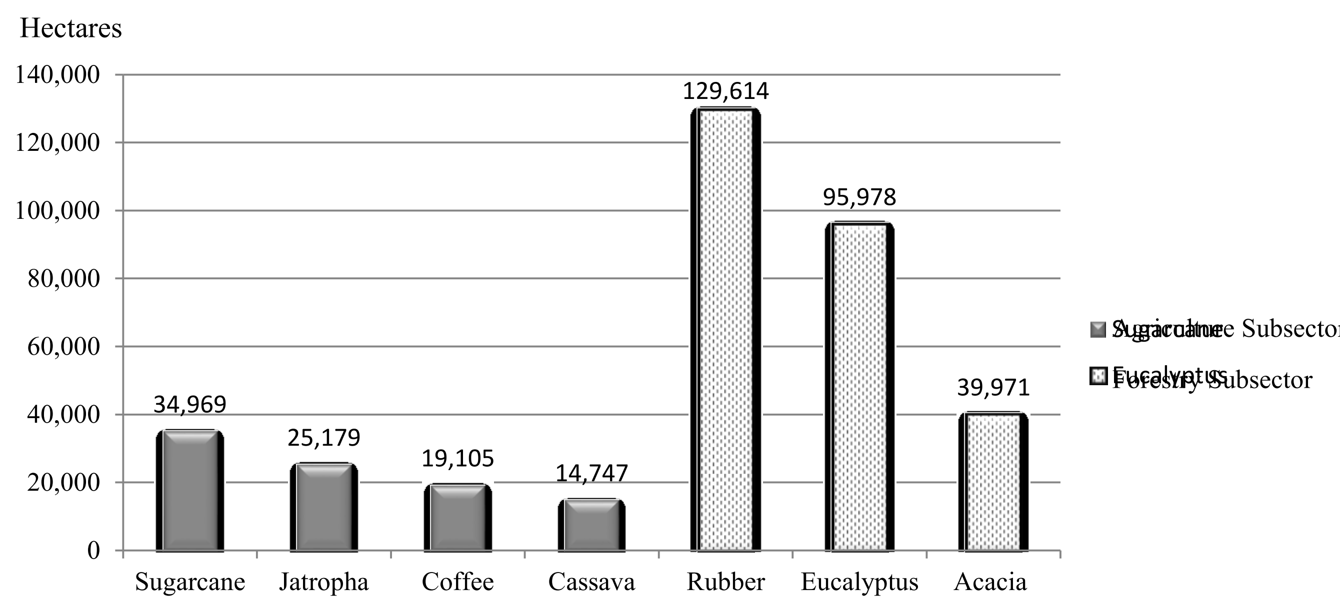
Concession investment projects are categorized into 4 types across the economic sectors, namely primary, secondary, tertiary and quaternary sectors (Schonweger *et al.,* 2012). The primary sector includes the mining extraction of raw material, forestry industries and agricultural

[3] The total concession area presented here did not include logging concession, contract farming, hydropower projects and mining exploration.

production for basic crops. The primary sector is the largest in terms of land deals and cover 91% of the total area of concession land (see table 2.6). The secondary sector includes construction, electricity and manufacturing of mostly finished goods, covering only 2% of total concession area. The tertiary sector consists of all service industries: communication, service/utilities, tourism, transport and wholesale/trade subsectors, altogether covering only 7% of land concession. The quaternary sectors comprise of intellectual activities covering only 2 projects totaling 5 ha.

The largest subsector in terms of concession area is mining, making up almost 50% of total concession land. The forestry and agriculture subsectors are the second and third largest and cover 28% and 13% of the total concession area respectively. Despite mining being the largest subsector in terms of both area and number of deals, the forestry and agriculture subsectors are still sizable and are the main focus of this study.

Figure 2.2: Main industrial crops by concession subsectors



Source: Schonweger *et al.,* (2012)

The combination of four main products namely sugarcane, Jatropha, coffee and cassava makes up 67% or about 94.000 ha of concession area in the agriculture subsector (see figure 2.2). Sugarcane (34,969 ha) covers the largest proportion and is mostly found in the south especially in Savannakhet Province. Jatropha plantations also contribute a significant proportion and cover land area of about 25,170 ha, and mostly grow in the Central region. Coffee is one of the main crops mostly planted in Champasack province and covers an area of about 19,105 ha, while cassava covers less proportion, approximately 14,747 ha. There are few agricultural concessions in the Northern region (less than 2% of the total area), whereas the majority of areas for agricultural concession grants are in the Centre and South (about 45% and 53%, respectively).

In the forestry subsector, the largest scale of granted concession area is dominated by rubber plantation covering 129,614 ha. Next in scale in terms of area are eucalyptus and acacia plantations, covering 95,978 ha and 39,971 ha, respectively. All three main products' areas combining together cover a large proportion of about 87% of total forestry subsector (306,234 ha). In rubber concession, Vietnamese investment makes up the largest area, followed by the Chinese and Thai. Rubber area under Vietnamese investment covers large part in the South region, Thai investment in the Center and Chinese investment in the North. The largest concession area in eucalyptus is granted to Indian investment (Schonweger *et al.,* 2012). In fact, the concession process in Lao PDR started booming when the big international companies took over the existing Lao concessions for eucalyptus and acacia tree plantation for paper production. Later, they began expanding new concessions (Hamssen, 2007).

4.4.2. Social and Environment Impact of Land Concession

While investments in natural resource based sector could deliver multiple socio-economic benefits including: government revenue (tax, royalties, customs and fee), incomes for rural households, employment, and rural infrastructure development, the granted land for concessions and leases for commercial operations may also have adverse impact on local communities' livelihoods and environment (Hamssen, 2007 and Jade *et al*., 2014).

Concessional land allocations often result in local communities being disadvantaged in land accession. Most of them lose agriculture land use for farming and livestock raising, and less area available for non-timber forestry products collection. There is weak social safeguard, whereas compensation is inadequate or non-existent. Land conflict and dispute between communities and concessions holders had been complained to the National Assembly (Vientiane Times, 2012). Local communities have limited political resource to protect their rights on land tenure due to lacking of statutory adherence (Jade *et al*., 2014). In some concession schemes, some households have ceded their land entirely to investors and have only wage labor as their resource (Samantha, 2009). In addition, a review from UNDP also demonstrated that the conflict between communities over resettlement territory and concessional obligations to provide social services on education and health facilities were failures and led to further increase of poverty, especially in rural area. In terms of environment impact, Hamssen (2007) and Jade *et al*., (2014) highlighted that concessions usually create pollution on water sources, loss of forest, ecosystem services and biodiversity.

Despite the existing of laws, decrees and regulations on land, investment and forest management applicable for concessions and leases, the capacity to ensure sound implementation and compliance with these legal frameworks has been limited. In addition, poor coordination between the national, provincial and district government bodies often caused conflict or inertia due to the national and provincial levels having different authorization in granting different-scale of land concessions (Jade *et al.,* 2014). For instance: The provincial authority is empowered to approve a land concession up to 150 ha for the investment in industrial farm, while the national authority is able to legally approve a maximum area of 10,000 ha in the same investment type. An area larger than 10,000 ha has to be approved by the National Assembly. These authorities of land approval also vary in different land types, viz., concession and leases for industrial plan, degraded and barren forestlands (Decree 135/PM dated 2009).

As a result, there are several critics who noted that concessional lands have been granted to investors with less adherence to national regulations, decrees and laws as well as with little regard to customary tenure. In 2011, the Lao government committed to revise various policies on land and natural resources utilization with the intentions to solve the conflict between local communities and large-scale operational concessions. This effort is to ensure that the utilization of the scarce land resources could be developed in a way that contribute to national sustainable development goals and poverty alleviation in Lao PDR (Jade *et al*., 2014).

5. Environmental Perspective on Sustainability of Lao Farming

Currently, the Lao government has paid attention to commercialized agricultural production toward sustainable farming practice. The government implemented fiscal policy incentive for smallholder farmers who use friendly environmental agriculture practices with good land management to avoid deforestation. The policies aim at supporting smallholder farmers who have good stewardship of land and natural resources by providing secure land tenure, reducing land tax, lowering interest loans from government banks and financial institutes and creating necessary infrastructure (irrigation, road access, water pumps and agricultural equipment) for agricultural activities (MAF, 2010).

As mentioned in the above section, there are three main characteristics of rice farming practices in Lao PDR. They are season rice, irrigated rice and upland rice traditional practice especially in the mountainous slopes. The season and irrigated rice farming as lowland farming system has been considered to be more sustainable by the adaptation of the traditional technique and technologies. The small-scale irrigation system has now been well developed and relatively secured rice production, even though its productivity is not so high. Lao PDR has met its first achievement on rice self-sufficiency in 1999 and then total rice production increased an additional 80% between 2000-2014 (United States Department of Agriculture, 2011 and LSB, 2015). The surplus rice production generally occurs in lowland areas along the Mekong River, while the highland regions, particularly the northern part of Lao PDR, with the upland rice farming practice, are the primary location of annual rice shortages and largely deficient in staple food production. In addition, the upland rice system faces many difficulties in terms of sustainability because of the pressure from population increase with limited agricultural land available and the expanding of industrial trees and crop plantations such as rubber, eucalyptus and acacia as a result of commercialized agricultural production.

The expansion of agricultural activities, by both the individual farmer and large-scale investment, development of industrial tree plantations and large hydropower, mining and infrastructure projects are the main direct forces of deforestation. This has an effect on food security and sustainable agriculture production. According to the data from MAF, the actual forest cover in Lao PDR decreased from 49% (11.6 million ha) of the country's total land area (23.68 million ha) in 1982 to 45% (11.16 million ha) in 1992, to 41.5% (9.82 million ha) in 2002, and then to 40% (9.5 million ha) in 2010 (MAF, 2011 and Lestrelin *et al*., 2013). Shifting cultivation and logging has been considered as one of the main causes of forest loss. In each year about 100,000 ha of primary forest and 300,000 ha of secondary forest are degraded by shifting cultivation (Fujisaka, 1991 and MAF, 2005). As a result, eliminating shifting cultivation by introducing permanent agricultural activities and increasing forest area coverage by 70% of total land area of the country by 2020 are high priority programs of the Lao government. A cultivation stabilization program has been implemented since 1989 (Prime Minister's Decree 117/1989) with the hard effort to stabilize shifting cultivation, stop indiscriminate logging and forbid improper land concession for industrial tree plantation. These taskforces have been done through the implementation of sustainable production patterns toward land allocation and rural development in order to improve a better livelihood, particularly upland rural people and support the sustainable farming system across the country (MAF, 2010).

The key sector target associated with the promotion of sustainable production patterns emphasizes on smallholder agricultural farmers to reduce shifting cultivation and adopt sustainable production system. The main area to be addressed in sustainable production patterns is the provision of improved seed varieties and fertilizer package (bio-fertilizer) for farmers who mainly relies on upland rice for food security. In addition, the other area to be addressed is the promotion of agricultural diversification, inter-cropping, integrated farming systems and modified cropping practice. In order to ensure food security and sufficient agricultural products, the sustainable production patterns are set to facilitate smallholder farmers on increasing productivities by adopting the environment-friendly agricultural technologies together with traditional farming techniques as well as increase farmers' knowledge on modern technology (MAF, 2010). Thus, the agricultural line agencies have been restructured, reformed and modernized in order to put forward for this sector to be more flexible and having suitable system to ensure food security and promote commercial production in a sustainable way.

Land use planning is also a key issue for the promotion of sustainable agriculture production. In AMP (2011-2015), MAF promotes climate smart land use planning in the context of climate change adaptation for agriculture systems. Climate smart land use planning includes the awareness program on slash and burn cultivation and remote sensing that could provide necessary information to monitor land use practices. Thus, the promotion of climate smart land use planning is a key measure that could contribute to sustainable land use management (MAF, 2010). In addition, research on land use planning under the National Agriculture and Forestry Research Institute (NAFRI) focuses on developing short and medium term conservation management practices for soils, land and forest in order to clarify the importance of carbon-neutral and principle of rural renewable energy.

In order to further support sustainable land use management, the Reducing Emissions from Deforestation and forest Degradation included conservation, sustainable management of forest and enhancement of forest carbon stocks (REDD+) was introduced to Lao PDR' national development agenda in 2007. REDD+ mechanism could be the potential important source of technical and incentive financial support to achieve the goals on afforestation and reforestation in 2020. Through the stimulation from the World Bank's Forest Carbon Partnership and the high attention from the international community, the Lao government has demonstrated interest and established a National REDD+ taskforce in November 2008 to accelerate REDD+ activities (Lestrelin *et al*., 2013).

6. Summary

This chapter investigates how the implementation of the short, medium and long term policies and strategies of agricultural sector contribute to the socioeconomic and environmental development in Lao PDR. Then, it examines a contribution of the agricultural sector in the Lao economy and provides important discussion on socioeconomic perspectives and environmental aspects of sustainability of the Lao farming system.

Since the announcement of the NEM in 1986, a number of productive policy reforms were carried out for socio-economic development. The strategic vision, including the particular Thematic Approach for driving the priority program, had been implemented in order to enhance the dual agricultural development in both lowland and upland areas of Lao PDR. The specific policies for the lowland agriculture have been carried out to increase the productive capacity for cash crop, livestock and fisheries production and strengthen the regional linkages between producers, distributors and consumers. The policies for upland agriculture regions focus on sustainable land use practices toward effective management of community natural resources and diversifying farming systems.

The framework of related strategies and plans, especially the Five Year Agriculture Master Plans (1980-2015), Agricultural Development Strategy (2011-2020), as well as the Agricultural Development Strategy 2025 and Vision 2030, provides significant directions for agricultural development in Lao PDR. The purpose of these strategies is to transfer and apply modern technique and technologies in order to increase productivity for the staple food and industrial cash crops production in the face of limited natural resources. In addition, these strategies also emphasize agricultural production in the context of clean, safe and stable industrialization and modernization of the agricultural sector in order to achieve the goals on food and nutrition security, zero hunger by 2025, commercialized commodity production, better rural livelihoods and poverty alleviation and sustainable development.

After the implementation of the policies and strategies, the agricultural sector has improved in which the subsistence agricultural production was gradually replaced by the commercial production. The agricultural sector growth rate is about 3% during the first half period of 2010s with the significant expansion of cash crop and industrial tree plantation. Rice production steadily increased, coming closer to reaching self-sufficiency status. Several types of crops such as maize, sugarcane, cassava and rubber plantation subjected to intensive agricultural production in term of individual, contract farming and concession investments have seen wide expansion across the country in responding to the high demand from international and regional markets.

After analysis of the agricultural plantations in Lao PDR in this chapter, the following chapters are set to analyze the main objectives and provide empirical evidences and implications regarding the environmental, socioeconomic and technological aspects of sustainability of the Lao farming system.

Chapter 3: Environmental and Economic Valuation of Land Uses: the Incentive REDD$^+$ in Maintaining Forests

The rapid economic growth in Lao PDR over the last two decades has been driven by the natural resource sectors and commercialization in the agriculture sector. Rural landscapes are being transformed over the past decade from land use mosaics of subsistence and smallholder farms to large-scale plantations dominated by a few commercial crops. The capacity of these commercial agriculture plantations to alleviate rural poverty, part of the Government of Lao PDR's national development policy, is increasingly weighed against its long-term impacts on ecosystem services and sustainability of land and forest resources.

The purpose of this Chapter is to discuss on the environmental aspect of sustainability analysis of the Lao farming system. The study used an extended cost-benefit approach (CBA) to integrate certain environmental elements to traditional financial analysis for a comparative look at four land use systems in the northern part of the country. The CBA results demonstrate that commercial agriculture (maize and rubber plantations) does have the potential to support poverty alleviation in the short-run. It, however, exposes the land to serious environmental risks. By comparison, the traditional land uses studied (upland rice farming and non-timber forest products collecting) are largely subsistence activities that are still considered as sustainable, though this is increasingly affected by changing market and population dynamics. The results suggest that longer-term environmental costs can potentially cancel out short-term gains from the commercialization to mono-crop agriculture. Incentives for conserving ecosystem services (such as the Reducing Emissions from Deforestation and Forest Degradation (REDD+) mechanism) may have a potential role in supporting diversification of traditional livelihoods and increasing the competitiveness of maintaining forests.

1. Introduction

Poverty alleviation is the overarching goal in the Lao PDR five-year National Socio Economic Development Plan (NSEDP) for 2011–2015, the country's development blueprint. The country's approach to achieving this goal is to sustain continued high rates of economic growth through use of natural resources financed by domestic and foreign investments. Lao PDR's Gross Domestic Product (GDP) growth is one of the highest in Southeast Asia at 7% between 2001 and 2010 (World Bank, 2010), and the target is set at 8% for 2011–2015 under the NSEDP. This level of economic growth is impressive for the landlocked, least-developed nation. Over the last decade, availability of forests and natural resources has attracted large flows of foreign direct investments into Lao PDR, particularly to the mining, hydropower, and agricultural sectors.

Agriculture and plantation forestry is one of the Lao government's four priority sectors for investment and industrialization (the others being energy, mining, and tourism). In the agricultural sector, maize and rubber are two of the more important commercial crops in terms of land area, and biofuel crops are also expanding rapidly, largely at the expense of forests and smallholder upland rice systems.

In addition to poverty alleviation and sustained high economic growth, the NSEDP also sets the target for "sustainable development by integrating economic development with socio-cultural development and environment protection to the nation's advantage" (MPI, 2011). If Lao PDR is indeed to achieve both poverty alleviation and sustainable development goals of the NSEDP, then a more systematic analysis of the multiple consequences of land use decisions is needed, particularly in the context of rural farming landscapes in vulnerable upland areas of the country where poverty levels are highest. The objective of this paper, thus, is to examine how the development policies that lean towards commercialization of agriculture affect the land and forest resources, farmer livelihoods, and ecosystem services and to ask if such policies are sustainable.

This study looks at the potential role that emerging incentives such as the Reducing Emissions from Deforestation and Forest Degradation (REDD+) mechanism can contribute towards poverty alleviation and sustainable development goals within the Lao context. REDD+ involves payments to forest-rich developing nations for achieving long-term reductions in carbon emissions by reducing the extent of deforestation and forest degradation, thereby protecting and enhancing carbon stocks (United Nations Framework convention on Climate Change -UNFCCC, 2009). The REDD+ framework could also produce co-benefits including maintenance of ecosystem services (e.g., preservation of biodiversity, soil, and water quality) and indigenous livelihoods and cultures (Fox *et al*., 2011 and Mertz, 2009). There are two main approaches to investments in plantations in Lao PDR: large-scale concessions to companies, and smallholder plantations, including those organized through contract farming. We focus on the latter smallholder plantations in this study as it will also examine the household's decision-making relative to availability of REDD+.

2. Land Use and Socio-economic Context of the Study Region

2.1. Socioeconomic Development in Oudomxay Province

Oudomxay province in northern Lao PDR has undergone rapid land use change in recent years as part of the national development boom, with large swaths of its landscapes transformed from forests and upland rice farming systems into commercial mono-crop plantations. During the past five years, the economy of Oudomxay had expanded rapidly with an average growth of 13% per year. The gross domestic income increased from US$ 119.31 million in 2005 to US$ 192.87

million in 2010, and the average income per capital doubled during the same period to US$ 651. Despite this growth, the number of poor households remained high and accounted for 30% of all households in the province (Oudomxay Department of Planning and Investment, 2011), suggesting a highly unequal distribution of income.

Oudomxay remains a highly forested area, official statistics claim that 58% of the province is under forests in 2011 (Natural Resource and Environment information Center-NREIC, 2012) though this is fast changing. The area planted in maize has been growing at an average of 12 percent per year since 2006 to about 28,600 ha in 2010 (NERI, 2012). Although only recently introduced to the region, but rubber plantation areas already covered over 30,000 ha in 2010 (NERI, 2012). Together, maize and rubber covers over 50% of total arable agriculture land in the province. Upland rice farming has declined by almost half since 2006 and covers only around 9,200 ha in 2010 (LSB, 2011), driven by the national policy to "eradicate" upland rice farming (Castella *et al*., 2012). Almost 50% of the expansion in commercial agriculture was from conversion of forests, particularly secondary and old fallow forests. This pattern clearly indicates that Oudomxay is transitioning rapidly along the agricultural development curve from forests and subsistence farms to semi-commercial and commercial plantations.

2.2. Description of the Land Use Practices Considered in this Study

Collection of NTFPs is a traditional practice throughout rural Lao PDR for cash incomes and subsistence needs. Forest use includes harvesting wild products for food and sale at local markets, medicines, fodder, house construction and handicrafts production. Forest food contributes substantively to rural household diets, both in terms of diversity and weight, up to 80% of non-rice food consumption and between 30% - 50% of protein consumption. NTFPs are estimated to have an annual direct use value of between US$ 313–525 per household in Lao PDR

(Emerton, 2005 and the World Conservation Union, 2003). REDD+ incentives could also target upland rice systems in addition to forests, towards lengthening fallow periods and increasing carbon stocks in fallow forests, and also co-benefits of biodiversity and other ecosystem services (Fox et al., 2011 and Podoch and Pinedo, 2010). For simplification and due to lack of detailed information on the economics of rotational upland patterns across the entire landscape, the study assumes that REDD+ incentives are applicable only to forest land use. In this way, we compare the profitability to households in converting forest to the other land uses (upland rice, maize and rubber) *versus* maintaining the forest for REDD+ and NTFPs (see main description on four types of land use in table 3.1).

Upland rice farming is normally practiced on a rotational basis moving from plot to plot within the same landscape after a certain fallow period. While generally considered to be environmentally sustainable, rotational upland rice farming does require extensive land area. This is the predominant traditional farming system in the northern uplands of Lao PDR. Pressures from national policies (NERI, 2012) and expanding maize and rubber plantations are shortening fallow cycles and impacting the productivity, biodiversity and ecosystem services from this land use system (Padoch and Pinedo, 2010 and Emerton, 2005). Communities in the northern uplands actively cultivate in the fallow lands and also depend on the fallow forests for wide variety of forest foods and non-timber products (Fox *et al*., 2011 and Castella *et al*., 2012). In the study region, expanding maize and rubber plantations have generally come at the expense of old fallow and secondary forests.

Maize plantations have dramatically expanded in northern Lao PDR, and Oudomxay province is the second largest producer in the country with much of the crops exported to China. The Provincial Agriculture and Forestry Department has promoted maize amongst local farmers, and expansion of maize farms is largely from conversion of production and fallow forests

(NREIC, 2012). Maize is mostly grown in the mountainous regions and slopes, causing soil erosion in many areas. Maize is also a highly soil-depleting crop and farmers commonly reported that harvests begin to decline drastically after year 5. Local maize farming practice is heavily dependent on chemical herbicides and, typically used unchecked, has led to soil degradation, water contamination, farmer illnesses, and death of livestock and fisheries.

Table 3.1: Description of the land use practices considered in this study

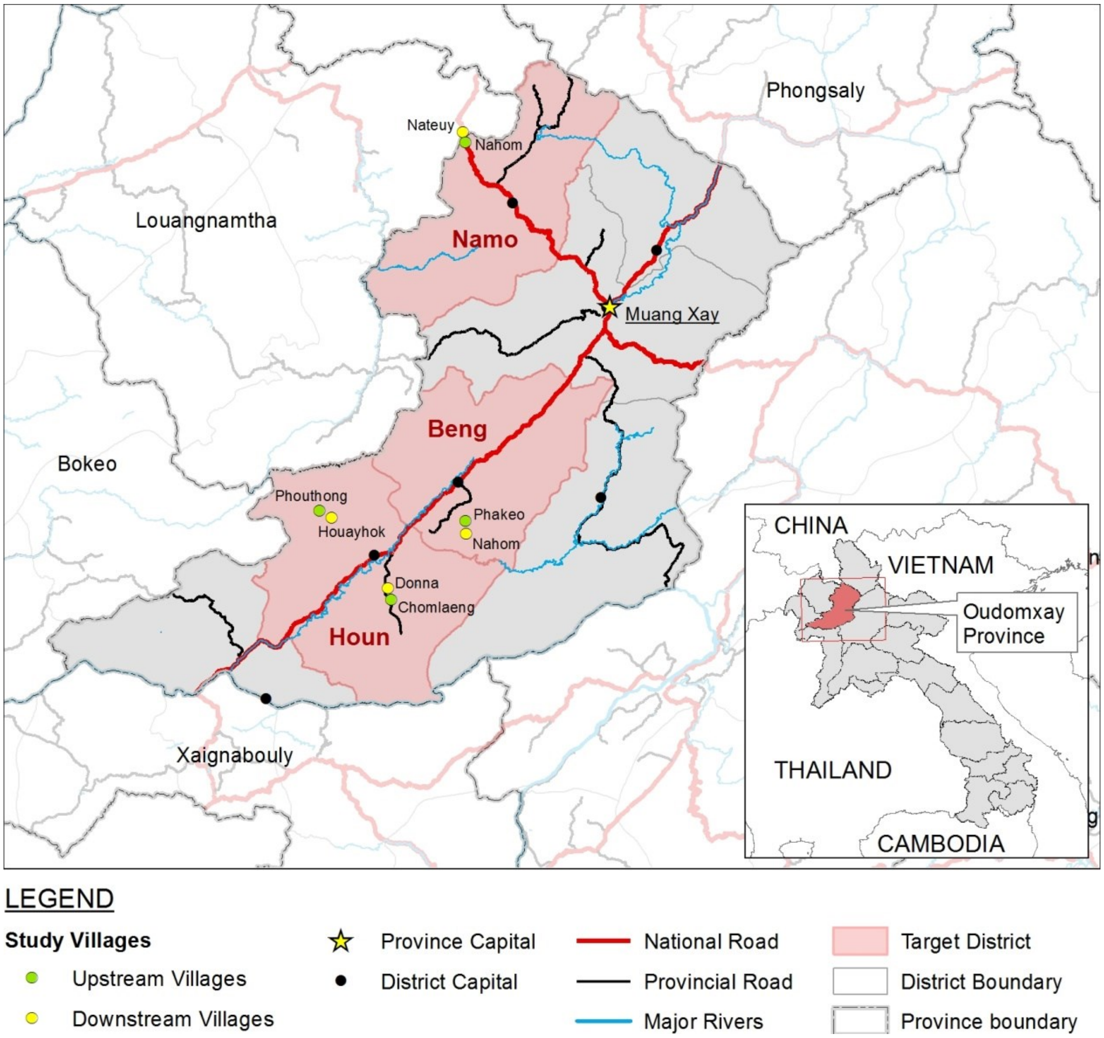
Land Use Practice	Production Cycle	Main Description
Forest/NTFP (with and without REDD+ incentives)	Daily and seasonal activity	• Collection of NTFPs is a traditional practice in rural area for cash incomes and subsistence needs. • Forest use includes harvesting wild products for food and sale at local markets, medicines, fodder, house construction and handicrafts production. • REDD+ incentives could also target upland rice systems in addition to forests, towards lengthening fallow periods and increasing carbon stocks in fallow forests, and also co-benefits of biodiversity and other ecosystem services. • For simplification and due to lack of detailed information on the economics of rotational upland patterns across the entire landscape, the study assumes that REDD+ incentives are applicable only to forest land use.
Upland rice	Rotational annual crops, with fallow periods ranging from 3 to 7 years	• Upland rice farming is normally practiced on a rotational basis moving from plot to plot within the same landscape after a certain fallow period. • Upland rice is the predominant traditional farming system in the northern uplands of Lao PDR. • While generally considered to be environmentally sustainable, rotational upland rice farming does require extensive land area.
Maize	Annual crop	• Maize is mostly grown in the mountainous regions and slopes. • Maize is also a highly soil-depleting crop and farmers commonly reported that harvests begin to decline drastically after year 5. • Local maize farming practice is heavily used chemical herbicides and typically unchecked.
Rubber (self-financed and 2 + 3 contract farming models)	30 year cycle, with production of latex starting at year 7	• The common scenarios of rubber plantation in this region are self-financed and 2+3 contract farming, whereas concessions are limited. • Rubber usually can be tapped when the trees become productive in 7 years. • Rubber plantations have expanded into uplands and hill slopes, increasing soil erosion risks, and use of chemical herbicides have also caused local health issues.

The emergence of rubber is driven by both policy and investor interests. The main arrangement in rubber plantations is through a '2+3' contract model where farmers provide land and labor, and the plantation company provides capital (in the form of seedlings, fertilizer and other equipment), technology and access to markets. When the trees become productive in 7 years, revenues from sale of latex are shared according to conditions set in the initial contract usually 60% to farmers and 40% to the company (NERI, 2012). There are also instances where farmers with relevant knowledge (e.g., villagers located close to borders with China and Thailand and who have worked on rubber farms in these countries), capital and agency (e.g., farmers' groups) can negotiate better arrangements that limit the role of investors or even resist their offers if they have already secured market access (as documented by Castell *et al*., 2008). Both scenarios of a self-financed and 2+3 contract farming rubber land use systems are modeled here. Due to the region's geography, rubber plantations have expanded into uplands and hill slopes, increasing soil erosion risks, and use of chemical herbicides have also caused local health issues.

2.3. Description of the Study Area

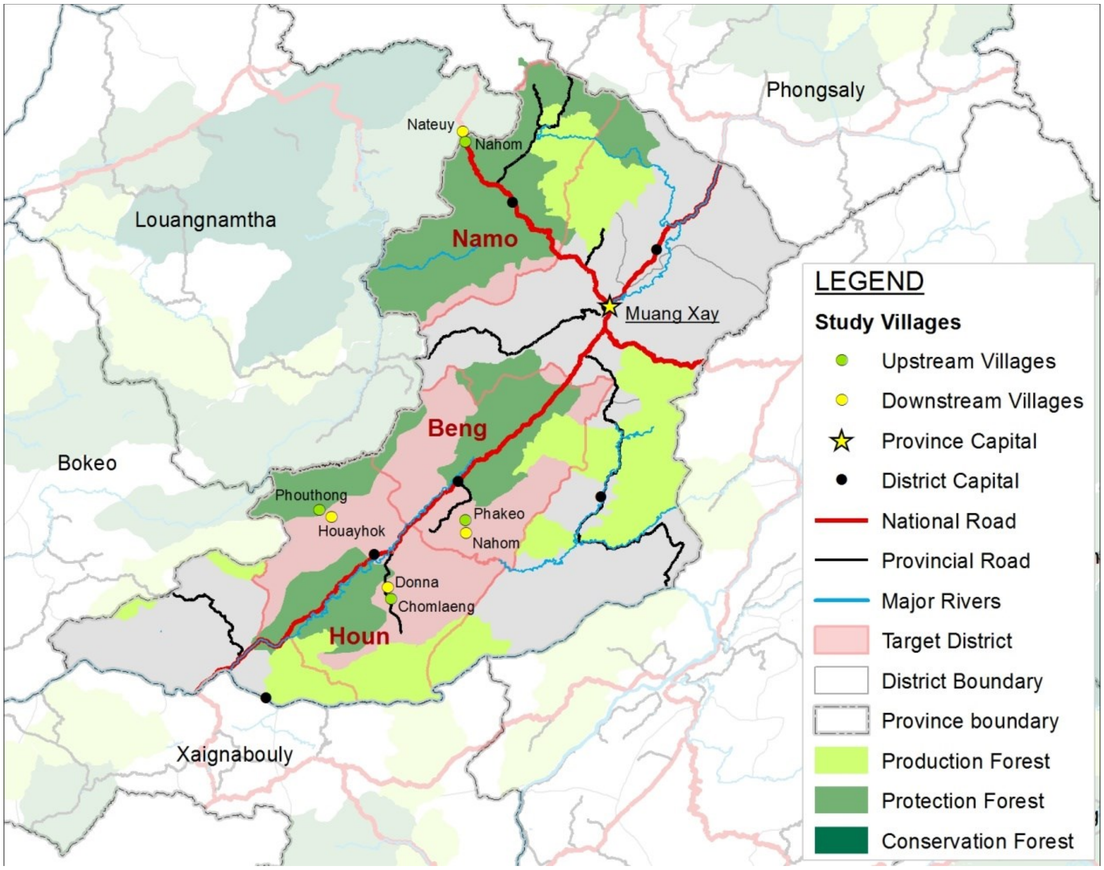
This study carried out household surveys in four research sites in three districts of Oudomxay, where each site represents dominant activity in one of the land use systems being assessed. The total land area in the four research sites is 9,481 ha, of which approximately 3,200 ha (or 34%) is classified as agriculture land. Figure 3.1 captures the location of the four research sites in Oudomxay province, and Figure 3.2 shows the areas under different categories of forest.

Figure 3.1: Location of Oudomxay province and research site



The surveyed households share many similar socio-economic characteristics (see Table 3.2). Households have large number of family members and a fairly even dependency ratio across the different land uses. Majority of household heads and family members have primary school education, and the level of illiteracy is high. Average income per capita range between US$ 104 and 351, depending on the household's dominant land use practice. It should be noted that the rubber incomes are an under estimate as much of the rubber plantations were not yet at production age during the study period.

Figure 3.2: Areas of forests under different classifications in Oudomxay.



The majority of land converted for commercial plantations (rubber and maize) in the study sites were converted from old fallow forests and upland rice fallows. This implies that promotion of maize and rubber plantation will cause a decline in staple crop farming and might put pressure on local food security in the future. There is anecdotal evidence that Houn district, which was previously a surplus rice producer exporting to other cities has now had to import rice from other regions for its domestic consumption (NERI, 2012).

All households practice diversified farming practices with incomes derived from various activities and crops, even for those who have commercial crops as their primary land use. Upland rice farming continues to be practiced by all households, largely as a complementary practice for household food needs. Using the national standard, most household incomes fall below the poverty line and households that predominantly practice NTFP collection and upland rice farming are more likely to be classified as very poor. The rural poverty rate is defined by law (Lao PDR Decree No. 285/PM of 13 October 2009) at 2,160,000 Lao kip (US$ 253) per person per year. The possible exception is households planting maize, whose average gross incomes are relatively higher than the national poverty line. The livelihoods of households practicing rubber plantations are also impacted over the short-term, as rubber replaces annual crops, declines in cash income can be quite serious for households with little savings or capital over the first six years until rubber trees are mature enough to be tapped. At the time of survey, most of the rubber plantations in the region are not yet mature enough for latex production.

Table 3.2: Characteristics of Surveyed Households in the Four Research Villages.

Household Characteristic	Unit	Rubber	Maize	Upland Rice	NTFP
Number of households surveyed	number	37	35	30	36
Average family size	person	8	7.54	6.53	6.67
Dependency ratio	Ratio	0.77	0.82	0.97	0.9
Average income per capita	USD	157	351	104	205
Household head's education					
Illiterate	percent	35	29	17	33
Less than primary school	percent	32	48	30	17
Higher than primary school	percent	33	23	53	50
Average household crop land holding	ha	2.55	1.61	1.71	-
Agriculture land use in study villages are converted from:	ha	92.5	46.3	286.6	-
Secondary forest	ha	10.6	-	26.7	-
Fallow forest	ha	49.2	31.4	259.9	-
Old upland rice farming area	ha	32.7	14.9	-	-

Source: Field survey data (NERI, 2012). See *questionnaire in Annex 3.*

3. Methodology

3.1. Research Question

The first objective of this study is to assess the costs and benefits of different land use systems, as incurred by local farmers who are actively practicing the land use system, including impacts on ecosystem services, to answer the question if the commercialization of agriculture can contribute towards national goals of rural poverty alleviation and sustainable development. A second objective is to assess whether incentives, such as REDD+, could have a viable role in influencing land use behavior within this increasingly market-driven rural economy. To determine how large REDD+ incentives would need to be in order to solicit a positive response from farming households to not convert forests, we first assess the value of the alternative agricultural activities, as opportunity costs to REDD+.

The study is set up to answer the following research questions:

- Is the development of commercial agriculture an effective strategy for reducing rural poverty?
- How are gains and losses of ecosystem services factored in rational decision-making on land use practices?
- Can incentives such as REDD+ be an effective mechanism for supporting sustainable livelihoods and maintaining forests?

Structured surveys were carried out with 136 households in three districts in Oudomxay province in northern Lao PDR to examine the costs and benefits related to four different land use practices: rubber and maize plantations, upland rice farming, and non-timber forest product (NTFP) collection. The gains or losses on ecosystem services were also measured, through environmental health impacts on local farmers (measured as lost labor days and treatment costs) and extrapolated effects of soil degradation on farming productivity. These were assessed through a mix of quantitative and qualitative information gained through participatory assessments and ranking methods.

3.2. Analytical Technique

A simple cost-benefit framework is used to estimate the net revenues from one hectare of land use practice to the individual farming household (rubber and maize plantations, upland rice farming and forest/NTFP collection).

Net present value (NPV) for each land use practice is derived by:

$$NPV_L = \sum_{t=1}^{30} \frac{(TR_{L,t} - TC_{L,t})}{(1+r)^t} \tag{3.1}$$

where NPV_L is the net present value for each land use practice L (US$/ha), $TR_{L,t}$ is total revenue for each land use practice L (US$/ha), $TC_{L,t}$ is total cost for each land use practice L (US$/ha), t is the time frame for the analysis (30 years), and r is the discount rate (12 percent). For the analysis, market prices were assumed to be constant over the 30 year time period. Table 4.2 provides detailed descriptions of the four land use practices.

An extended cost-benefit framework that incorporates potential revenues and costs of managing a forest for REDD incentive into total revenue $TR_{L,t}$ and total cost $TC_{L,t}$ functions for comparison with other land use systems (following Butler *et al.*, 2009 and Sasaki and Yoshimoto, 2010). We assume that only land maintained as forest qualify for REDD incentives. Total revenue from each land use L, $TR_{L,t}$ in Equation (1) is thus:

$$TR_{L,t} = R_L + R_{f,CO_2} \tag{3.2}$$

where R_L is revenues from land use type L (US$/ha). The yield and price information is in Table 3.3. For the NTFP/Forest land use, a total of 29 NTFP products are assessed and detailed information is available (NERI, 2012). We model the impact of soil depletion on crop productivity, and consequently on revenues R_L as a way of capturing the costs of soil degradation and overuse. This is particularly relevant to the case of maize. $R_{f,CO2}$ is carbon revenue to REDD project beneficiaries from land maintained in forest, *f* (US$/ha) and is defined by:

$$R_{f,co_2} = P_{co_2} \times CS_f \tag{3.3}$$

where R_{CO_2} is the price of carbon dioxide, CO_2 (US$/ton/$CO_2$) P_{CO2} vary widely in the literature and practice, ranging from US$ 2 per ton/CO_2 (Sasaki and Yoshimoto, 2010) to US$ 4.80 (average price from 11 cases of avoided deforestation projects, (Hamilton *et al*., 2007)) to US$ 10.30 (€8.03 trading price for European Union Allowances (Point Carbon, www.pointcarbon.com)). A sensitivity analysis is applied using the three different price points. CS_f is the total volume of aboveground and belowground CO_2 stored in each ha of forest. The average stocks of aboveground carbon in the old fallow and secondary forests of northern Lao PDR is estimated at 52 tons of carbon per ha (Hett *et al*., 2011) and belowground carbon is typically 20% of the aboveground content (Gibbs, *et al*., 2007). Thus, total above- and below-ground carbon stock is 62.4 tons carbon per ha. Using the Clark conversion factor (Clark, 1982), CS_f equals 228.63 ton/CO_2/ha. This is well within the range in literature of carbon stocks in similar fallow farming systems in the region (Fox *et al*., 2011 and Takeuchi, 2012). We assume that $R_{f,CO2}$ will be distributed in equal annual payments from year 2 through 30 year, and that $R_{f,CO2}$ will be distributed to the households who are currently involved in the forest/NTFP land use and who will have to incur the opportunity cost of not being able to use the land for another purpose.

Total costs from each land use type L, $TC_{L,t}$ in Equation (1) is:

$$T_{CL,t} = C_{L,Labor} + C_{L,equip} + C_{L,Env} + C_{f,CO_2} \tag{3.4}$$

where $C_{L,Labor}$ is the cost of labor (or in cases where no wages are paid to household labor, the opportunity cost of labor) in the land use *L* (US$/ha), $C_{L,\ equip}$ is the cost of equipment or tools needed (US$/ha) and $C_{L,\ Env}$ is the average cost of health costs caused by environmental degradation (e.g., herbicide contamination), captured in terms of medical costs and days of lost labor due to illness as reported by farmers in the households surveys and translated into US$/ha. The available jobs in the region are typically as plantation or farm workers and the average wage is US$ 2.90 per day. This is used as the opportunity cost of lost work-days due to illness. The costs of hospitalization and medicines attributed to herbicide or pesticide related illness varied widely depending on the location and land use, and the average cost is calculated at US$ 2.80 per hectare. It is assumed that these costs rise by 5% per year after year 5 in the case of rubber plantations when pesticide and herbicide use increase significantly. The positive correlation with health costs is observed from field survey data (NERI, 2012). The ranges of costs and yields in all four land uses are presented in Table 3.3. There is no fixed investment cost as farming practices in this region do not use machinery nor is there value-added production. As much of the land is converted from secondary or fallow forests, we did not include the costs of conversion.

Table 3.3: Costs and production values used in Net Present Value (NPV) analyses

Description	Unit	Upland Rice	Maize	Rubber	NTFP/Forest
Mean total costs	US$/ha	705	544	543	55
(min–max)		(246–1,710)	(129–1,643)	(149–1,021)	
Input costs (seeds and equipment)	US$/ha	33	100	82	9
(min–max)		(11–90)	(47–286)	(60–263)	
Labor costs	US$/ha	672	372	458	46
(min–max)		(229–1,665)	(69–1,003)	(87–946)	
Environmental health costs	US$/ha	0	72	3	0
(min–max)			(1–1,172)	(3–4)	
Average crop yield	Kg/ha	874	4,495	566	*
(min–max)		(500–1,333)	(1,071–17,500)	(319–1,014)	
Crop price	US$/kg	0.35	0.14	1.61	*

Source: Field survey data (NERI, 2012).
*A total of 29 NTFP products are included in the calculations of revenue.

$C_{f,CO2}$ is the cost of implementing a REDD project in forest land, *f* (US$/ha):

$$C_{f,CO_2} = C_{Estab} + C_{Monit} \quad (3.5)$$

where C_{Estab} is the initial one time initial cost of establishing a REDD project to meet the standards of the World Bank's Forest Carbon Partnership Facility (FCPF). C_{Estab} is US$25/ha to cover the project design document, governance and planning, monitoring and measurement, surveying and research, and other costs. C_{Monit} is the annual maintenance costs to cover infrastructure maintenance, information, education, and communication, monitoring, and finance and administration (Butler *et al*., 2009 and Eggleston *et al*., 2006) and is estimated at US$10/ha/year.

Households will thus decide whether or not to convert the fallow and secondary forests from which they depend for NTFPs to another land use (*i.e.*, upland rice, maize or rubber) by balancing the expected profits from the other land uses against the revenues that could be generated from keeping the forests intact with REDD incentives. In this case, we assume that households have the option and the right to choose any of the three alternative land uses. Following the classical optimal utility model, the household's decision to deforest for another land use, *d*, depends on:

$$d_{1,0} = \begin{cases} 0 \;\; for\; NPV_{forest} > NPV_{maize}, NPV_{rice}, NPV_{rubber} \\ 1 \;\; for\; NPV_{forest} \leq NPV_{maize}, NPV_{rice}, NPV_{rubber} \end{cases} \quad (3.6)$$

where if $d = 0$, households will not deforest; and if $d = 1$, households will deforest.

4. Results and Discussion

Two sets of NPVs were calculated; one which includes all on-farm financial costs, and another which also incorporates environmental health and soil degradation costs. The two sets of NPV results essentially represent private and public cost-benefit analyses. Many studies have shown that private decisions that do not take into account ecosystem service values tend to result in overall lower societal benefits (Bateman *et al*., 2013 and Goldstein *et al*., 2012).

There were data gaps with the longer-term crops (*i.e.*, rubber) and particularly with upland rice rotations, NPVs for the four land uses were produced for the extrapolated mean values. Benefit Cost Ratio (BCR) results are also provided in Table 3.4 as an indicator to capture the overall value for money of the land use activity. A higher BCR indicates better value of the land use activity.

The NPVs from the land use options indicate that rubber plantation is the most profitable land use option, with the 2+3 contract farming arrangement generating about one-third of profits gained in the self-financed model (see table 3.4 below). All the other land use systems of upland rice farming, maize plantation and forest/NTFP generated economic losses over the long-term. In these three cases, the opportunity cost of labor is the largest share of incurred costs, but this is not factored into the farmer's rational decision-making process as they largely involve family labor, which is considered to be free. As such, farmers continue with these practices because they are traditional and customary livelihood practices of the region as in the case of upland rice and forest/NTFP. The analyses demonstrate that in the case of maize and rubber, private land use decisions do not consider the costs of environmental impacts.

Table 3.4: Results of the mean NPV and Benefit Cost Ratio (BCR) analyses for all land use options (per ha).

	Upland Rice	**Maize**	**Rubber** (Self-Financed)	**Rubber** (2 + 3 Contract)	**Forest/NTFP**
NPV private (US$)	−4,546	2,229	2,117	686	−96
BCR private	0.35	1.97	1.59	1.24	0.75
NPV public (US$)	−4,546	−4,375	1,980	662	−96
BCR public	0.35	1.02	1.57	1.22	0.75

Source: NERI, 2012.

The highly negative NPV for upland rice is also deceptive due to area of land maintained in fallow. As we had calculated NPV based on overall farm holdings, the fallow area that is not continuously productive tend to bias the results.

In the case of maize plantations, the cash incomes generated are currently the largest cash earnings available in the region by far, but once environmental degradation and environmental health costs were factored into the equation, the NPV was highly negative. These long-term costs are generally not known to local farmers and rarely factor into their decision-making process.

Rubber is the most economically profitable land use option, however it is rather unlikely that the average forest/NTFP or upland rice households will be have the upfront capital needed to convert forests into rubber without external assistance. The 2+3 contract farming system facilitates this conversion and is the most common arrangement amongst rural farmers, but even so, there is increasing evidence that farmers are becoming seriously indebted while waiting seven years for their trees to become productive (Campbell *et al*., 2012 and Arnst, 2010).

$NPV_{rubber} > NPV_{f,\ REDD}$ in all the P_{CO_2} scenarios, indicating the rational farmer will decide to convert forest lands into rubber plantations, based on the higher expected profits from rubber plantations despite availability of REDD+ incentives (see Table 3.5). There are perhaps nuances to a farmer's decision than pure profits. Even at the modest carbon price of P_{CO2} = US$ 4.80, the NPV for forest/NTFP will generate positive returns, indicating that REDD and carbon values can be a viable incentive for conserving forest and maintaining ecosystem services relative to commercial crops such as maize (which has negative NPVs). The benefit-cost ratio (BCR) indicator suggests that forest/NTFP land use with REDD+ incentives of at least US$4.80/ton/$CO_2$ offers competitive returns for the money invested in maintaining forests. A quick analysis demonstrated that a REDD+ incentive would need to be at least US$15/ton/$CO_2$ (generating NPV of US$ 665 and BCR of 2.61) in order to compete with a 2+3 rubber contract farm, and to move closer to a public decision with societal welfare considerations. Whether this is possible given the current carbon market will depend on the global climate negotiations and commitments.

Table 3.5: Results of NPV analyses for Forest/NTFP with Reducing Emissions from Deforestation and forest Degradation (REDD+) options.

	Forest/NTFP (P_{CO2} = 0)	**Forest/NTFP (P_{CO2} = \$2)**	**Forest/NTFP (P_{CO2} = \$4.80)**	**Forest/NTFP (P_{CO2} = \$10.30)**
NPV (US$)	−96	−69	89	399
BCR	0.75	0.88	1.26	1.99
d (0,1)	**1**	**1**	**1**	**1**

Source: Authors' estimation

5. Implications of the Study

5.1. Implications on Land Change for Poverty Reduction

Returning to our first research question if the development of commercial agriculture would be an effective strategy for reducing rural poverty, the indications from a simple NPV analysis suggest that rubber may be a viable option, but not maize. Maize generates fast profits as an annual crop but the longer term environmental degradation and health impacts need to be seriously considered. In the case of rubber, there needs to be further attention to support access to, and availability of, rural capital. This is a rather serious constraint as there is evidence of rural indebtedness forcing smallholding farmers to end up leasing their land to larger farmers or concession companies and only working as laborers on their land (Arnst, 2010, Vientiane times, 2014 and Kemp, 2012). The simple NPV analysis does not, however, capture fluctuating prices and other longer term effects of commercialization on the livelihoods of the rural poor, such as their social networks, diversity of their coping strategies, resiliency to shocks, and food security (Rigg, 2006).

5.2. Implications for Ecosystem Services and Decision Making

Our study results show that ecosystem services and broader societal costs are not factored in rational decision-making of smallholders. For poor smallholders, the immediate need for cash incomes tends to override longer-term environmental costs. It should also be noted that the smallholders do not have real autonomy over land use decision-making in Lao PDR due to government policy and direct intervention. In all three districts where the research sites are located, the stated goals in the district development plan focuses on development of agricultural and forestry sector and value-added production for the market economy, in line with the provincial and national plans (NERI, 2012). Similarly, the development plans also call for the "eradication of slash-and-burn cultivation" (NERI, 2012), a practice considered as environmentally destructive. The conversion of fallows to accommodate rapid expansion of cash crops is evident in our research sites, which is merely a microcosm of the broader landscape across northern Lao PDR (Castella, 2012). Further studies on the impact of the expansion of commercial agriculture on livelihood resilience, risk coping, and food security, and on the role of fallow forests as a provision of ecosystem services and safety net for food are also urgently needed.

5.3. Role of REDD+ as an Incentive for Maintaining Forests

Whether incentives such as REDD+ can be an effective mechanism for supporting sustainable livelihoods and maintaining forests remains to be seen. While the surveyed households generally express concerns over loss of access to ecosystem services and NTFPs (NERI, 2012), and numerous studies have documented the role of NTFPs as a critical component of rural Lao households risk coping strategy (MAF, 2013 and WFP, 2007), it remains uncertain if the environmental incentives can compete with the seemingly lucrative pull of markets for commercial crops, forest and fallow conversion, and intensification of land use. Such incentives would clearly have to be supplemented by alternative development and livelihoods activities. Experience has shown that many of the current REDD+ projects globally have livelihood enhancement activities in place that pre-date REDD+ and which is considered to be an important part of the enabling framework for REDD+ to succeed (Sunderline *et al*., 2014).

6. Summary

This research contributes to a small but growing literature examining the potential impacts of REDD+ on livelihoods and land use (Butler *et al*., 2009, Sasaki and Yoshimoto, 2010, Bluffstone *et al*., 2013, Carlson *et al*., 2012 and Groom and Palmer, 2012). Their findings highlighted the constraints and economics of commercial agriculture and concessions, importance of local ownership, challenges of whether a REDD+ incentive is sufficient for maintaining long-term carbon sinks and livelihoods, and the importance of evaluating policy impacts on income. Our case study of land uses in Oudomxay province has generated similar findings, and provided some illustration on the political-economic linkages between ecosystem services and rural poverty in Lao PDR:

Planting commercial crops of maize and rubber has improved cash incomes for the households and, hence, contributed towards alleviating rural poverty. It has however exposed the area to environmental risks, such as soil depletion and water contamination due to poor soil management practices and improper chemical use, leading to environmental health issues. The costs of these environmental impacts are not fully factored within the households' rational decision-making process as much of this information is not immediately known or well understood at the local level.

Upland rice farming and collection non-timber forest products are currently considered as sustainable practices in our research sites, but these systems are increasingly vulnerable under the pressure of expanding maize and rubber plantations into old fallows and secondary forests. This transition is also precipitated by the Lao government policy, whose rationale is to integrate marginal lands into the global market and lead to the end of upland rice farming, a practice considered as backward, unproductive and environmentally destructive (Fox *et al*., 2009, Fox *et al*., 2011 and Castella *et al*., 2012). The loss of upland rice fields to commercial crop plantations also increases the risks of local food insecurity and loss of a safety net in future as rice production declines and forest fallows are lost.

Environmental incentives such as REDD+ can be an important mechanism to compensate farmers for maintaining important ecosystem services and forgoing alternative agricultural land use. While REDD+ is shown here to have potential to positively impact farmer land use decisions towards forest conservation, it can only be effective if the REDD+ benefits are sufficient, equitably distributed and properly targeted to those households who are incurring the opportunity costs. Whether REDD+ can be sufficient also depends on the markets for carbon credits and how it can compete or interact within other economic and market transformations occurring in rural Lao PDR. At the time of this research, the Lao government does not yet have a national strategy for REDD+ and how it will define the forests or areas eligible for REDD+ and who will have the right to benefit. The national strategy and corresponding policies will shape how REDD+ can be effective, efficient and equitable, and this can be a challenge particularly within the Lao PDR's push towards economic growth and agriculture industrialization.

In certain instances, upland rice agriculture may still be the most rational land use for farmers from economic and environmental perspectives, and for cultural reasons (Padoch and Pinedo, 2010, Fox *et al*., 2009 and Rerkasem *et al*., 2009). REDD+ policies can be directed towards maintaining or rehabilitating traditional upland rice systems with sufficiently long fallow periods to allow for regeneration of mature secondary forests and maintenance of ecosystem services.

In order to further this area of study and to understand the true costs and trade-offs in land use decisions, there is an urgent need for comprehensive assessments of ecosystem services and of local livelihoods in the different land use systems in rural and forested regions of Lao PDR. Evidence on how the expansion of commercial agriculture impacts on livelihood resilience, risk coping, and food security, and on the role of forests and fallows within the local livelihood systems are also needed. There is still little knowledge that can allow for a systematic assessment as demanded by the policy and overall ambition for sustainable development. A baseline of environmental information and rigorous assessments on economic, livelihood and conservation trade-offs are critical to generate consistent evidence that can support informed decision-making beyond political and economic rhetoric.

Chapter 4: Socioeconomic Impact of Cassava Contract Farming on Poverty Alleviation

The Lao government has promoted contract farming as a strategic policy to sustain agricultural farming and improve farmer's income. Cassava plantation under the contract farming has also been rapidly expanded in all parts of the country due to the increasing demand for national and international consumption, in particular the need of raw cassava for producing renewable energy. In terms of socioeconomic aspect of sustainability analysis of the Lao farming system, this study investigates the contract farming arrangement and its impact on poverty in Lao PDR.

The results from this study indicates that although contract farming in the study area appears to be as a better potential option for income generation, but there are several weak points in which the practices of contract farming were somewhat varied from the government policy. Investors provided material inputs, as written in the contract, as loans or credits in kind and more costly than purchase from market. All costs contributed by the investor in Savannakhet province were deducted upfront before payment for products. Technical supports were mentioned in the contract but limited in practices. Hence, only farmers bear the majority of production risk. These demonstrate the serious effect to farmers due to the contract was not transparent or governed improperly in which farmers were in-debt. This is not the case of cassava contract farming in Vientiane province.

Cassava contract farming in Vientiane province was profitable enough covered as much as 75% of the formal poverty line, but the contract farming arrangement in an effort to reduce poverty did not work well with resulting in the negative value of net return per capita of -7%

compared with the alternative crops (upland rice and Job's tears). While cassava contract farming in Savannakhet province was unusual and performed poorly. Farmers had negative return of nearly three million kip. It did not only make profit for farmers, but rather increased poverty level at a double rate (-52%) caused farmers even poorer by one-half of that before. This is due to the improper setting of the system, the exploitation of the investors and the negligence of farmers themselves. The impact of contract farming on poverty was generally moderate, except very special case. Also, if not carefully overseen, contract farming could end up with exploitation of farmers and worsen their income.

1. Introduction

Cassava is important not only for consumption, moreover it is a commercial crop of income generation of rural farmers to alleviate poverty. Cassava can use as raw material for industrial manufacture for goods such as animal food, weaving industry, alcohol, chemical and medicine (Sanni *et al.*, 2008; Adebowale *et al*., 2008). Cassava leaves can be eaten as vegetable where as its root can be used as materials for producing renewable fuel energy (ethanol) which can supply higher carbohydrate and protein (Adegbola *et al*., 1978; smith 1992; Ravindra 1992; Aliba 2002). In Asia, cassava is first planted in The Philippines, India and Indonesia and then expands to Malaysia, Vietnam, China and Thailand. The World Food and Agriculture Organization (FAO) revealed that in 2000 cassava production in Asia trended to increase annually by 3%. Later in 2012, the biggest cassava producer was Indonesia (23,922,075 ton or about 29% of total production in Asia) and the running up was Thailand (22,500,000 ton or about 27%).

Cassava plantation in Lao PDR has rapidly expanded in all parts of the country due to the increasing demand from national and international consumption, in particular the need of raw cassava for producing renewable energy such as Bio-ethanol from China, Thailand and Vietnam as well as the domestic need for cassava flour manufacturing. In parallel with the government policy on commercialized agricultural production for poverty reduction, from 2005-2012 there were 23 national and foreign private companies registered for investing cassava plantation in Lao PDR with total investment of US$ 64.76 million (MAF, 2013). Therefore, the area of cassava plantation has increased from 6,765 hectares in 2005 to 43,975 hectares in 2012 (Table 4.1). This can be said that cassava plantation is an option for promoting commercial agriculture in order to provide more alternatives for rural people to earn income.

Generally, there are 3 major problems influencing small scale cassava plantation in Lao PDR. Firstly, majority small-scale farmers lack of technical and information in production, in which majority plantation technical using are simple, improper land preparation and soil controlling, and having minimal knowledgeable on seedling and less experience. Secondly, rural small scale farmers could not access to financial support to apply proper inputs and production equipment. Lastly, limited cassava market which cause uncertain price and in some area farmers could not sell their products. Therefore, in order to solve the above problem, the introduction of contract farming for cassava plantation might be a better option for rural farmers to reduce their production cost, especially on the transaction market cost and in the meantime farmers can also obtain more information and get better access to production techniques as well as sufficient capital and can mitigate the production risks.

Based on above reasons, there are some concerns on whether contract farming in particular for cassava plantation is a good tool for poverty reduction. Other concern is which model of contract farming arrangement is suitable for the agricultural sector in Lao PDR. Therefore, there are numerous opinions on this issue that contract farming is an assisting tool to solve the problem on public investment and could reduce the transaction cost (Dorward *et al.*, 2004; Poulton *et al*., 2004; Simmons, 2002; Warning and Key, 2002). On the other hands, contract farming practice still face several limitations on maintaining of stable revenue for farmers. Whereas another group suggested that contract farming caused inequity in rural area in particular for smallholders, due to contract farming showed advantages for only the groups that participated the project (Havnevik *et al*., 2007; key and Runsten, 1999). Based on the investigation of Food and Agriculture Organization (FAO) and International Fund for Agricultural Development (IFAD) in 2001, cassava plantation had the impact on environment, particularly land fertility degradation in which the crop absorbs much nutrient. In addition, cassava plantation may also have a long term impact on environment due to land slide if cassava were planted at high slop area. There is, however, not any serious impact evidence on biodiversity.

Therefore, there is a need of effective arrangement for contract farming in order to facilitate the production and selling-buying process and provide better option for farmers to participate in the contract farming system in a manner way. On the other hands, investors could also gain more benefit of their business operation through the supplying of a high quality and quantity product (Eaton and Shepherd, 2001). Thus, the objectives of this study are to investigate the arrangement of the contract farming practices for cassava plantation and analyze the impact of contract farming for cassava plantation on household poverty situation in Phin district, Savannakhet (hereafter called Savannakhet) and Muen districts, Vientiane Provinces (hereafter called Vientiane). In which these two different types of contract farming has been applied and widely expanded in various villages and it is significant for assess the economic impact on poverty. In addition, the research sites are selected also based on the concentration of contract farming practices.

To meet the first objective, this study employs a descriptive approach to review the business practices of contract farming for cassava crops in contrast to four indicators – government policy, norm of business partnership, accountability and monitoring and evaluation. For the second objective, the assessment of the impact of contract farming on poverty situation follows the government's concerns on socio-economic and equity issues. This study estimates the financial net return from contract farming in the year 2012, in comparison to those from the alternative land uses. The differences are the impacts of the crops under contract farming.

2. Cassava Plantation in Lao PDR

Cassava has been planted in Lao PDR for a couple of years, but most of the plantation is for consumption. Through the policy on commercial plantation, farmers favor to plant more of such commercial crop and a lot of agency from public and private sectors also support the plantation. Between 2005 and 2012, there were about 23 registered companies from domestic and international entrepreneurs invested for cassava plantation in Lao PDR with total registered capital of US$ 64.76 million (MAF, 2013). Therefore, production and cassava planted area have been continuously increased. Parallel with this increasing, the productivity of cassava increased from 14.71 tons/ha in 2009 to 23.87 tons/ha in 2011 (MAF, 2011).

Table 4.1: Area and cassava production in Asia countries

Year	Asia Countries that planted cassava*		Lao PDR	
	Harvested Area (Hectares)	Production (Tons)	Harvested Area (Hectares)	Production (Tons)
2005	3,685,568	61,278,467	6,765	51,300
2006	3,920,679	71,497,352	16,880	174,490
2007	4,049,800	76,955,938	11,015	233,420
2008	4,209,445	80,455,090	14,995	261,970
2009	4,300,178	85,851,398	10,375	152,590
2010	4,156,223	79,516,541	19,940	500,090
2011	4,195,740	81,331,060	31,135	743,190
2012	4,254,575	82,182,148	43,975	1,060,880

Source: FAOSTAT, 2013

*Note: *Brunei, Cambodia, China, Taiwan, Indonesia, Lao PDR, Malaysia, Mandrip, Myanmar, Philippines, Silangka, Timoleste and Vietnam.*

There is a widely arrangement for cassava plantation in Lao PDR. The outstanding forms of the cassava plantation are the concession arrangement, a corporation promotion with a contractual agreement and the individual small scale cassava plantation. Although, the contract farming for cassava plantation has been initialed in Lao PDR in late 2010s, cassava is another significant alternative crop that is easy to grow and poor farmers could generate better income.

This due to cassava plantation does not need much of inputs and market for cassava product is also availability. Cassava plantation has been favor and rapidly expanding because there is a high demand from both domestic and international. In addition, cassava plantation has been continually supported by the central and local authorities that lead to increase the domestic and foreign investment during the recent 5 years periods.

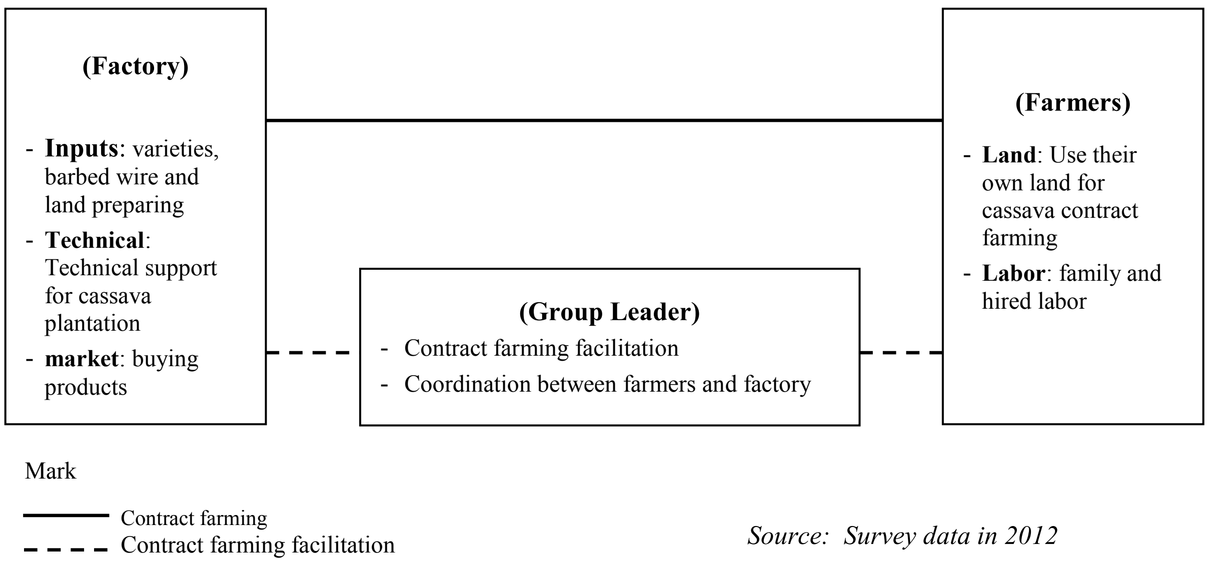
3. Contract Farming for Cassava Plantation

3.1. Contract Farming for Cassava Plantation in Vientiane

During 2006-2010, the plantation of industrial crops and fruit tree for consumption and commercial production in Vientiane Province has been widely expanded. The main crop plantation for supplying market and industrial factories are sweet corn, maize, cassava, small orange, sesame, job's tear, black bean, yellow bean, pineapple, cucumber, watermelon, sweet tamarind and tobacco. Of these, cassava area in the province largely increased from 1,425 hectares in 2010 to 3,130 hectares or covered about 3.03% of total agricultural area of Vientiane Province in 2011 (MAF, 2011). Farmers in this area were encouraged to plant cassava under the contract farming which certified and acknowledged by the local authorities. Therefore, a number of the people convert their land for cassava plantation. This arrangement created opportunity for employment and support the government policy on commercialization.

In order to encourage famers in Vientiane for commercial production particularly on cassava plantation, the central and local government approved to establish the Lao-Vieng Cassava Factory (hereon refered to as factory) in this area in 2007. At the beginning, the factory was authorized to have access to the land concession in a form of land rental from local people of Ban Nakhork and Ban Phasang villages for an area of 300 hectare as a pilot project for cassava plantation in a period of 3-5 years. The factory has capacity in producing flour 100-110 ton per 24 hours with the raw cassava input of 350-360 tons. Thus, the factory and the local authority have continually encouraged local farmers to plant cassava. Then, the number of cassava farmers (planted area) increased from 350 households (with area of 800 ha) in 2009 to 1,250 households (1,600 ha) in 2012. The expansion extended outward into four surrounding districts: Hinherb, Feuang, Muen and Sanakham districts of Vientiane province.

Figure 4.1 :Cassava contract farming arrangement in Vientiane



Source: Survey data in 2012

Contract farming for cassava plantation in Vientiane involves the factory and local farmers. It made a formal written contract for a period of one year which was certified by a village chief and group representative leader. The cassava contract farming follows the 2+3 policy, in which entails that farmers contribute for land and labor, while factory contribute inputs such as: plant varieties; barbed wire and land plowing (the cost of advanced inputs support with the annual interest rate of 8%), technical advice on cassava growing and buying the crop (see figure 4.1). The cost of advanced supply is deducted from the shipment of farmers' cassava yield at the delivery time to the factory. Then, the final net balance is the reimbursement for the crop to the farmers. The contract is individualized process but assigned as part of a group in which a leader serving as monitoring person and serves as a liaison for members and the factory. The group leader receives a stipen of 80,000 Kip/ha per year. The group leader has a duty to dissiminate publications from the factory to inform the people, gathers statistical data on the cassava planted area and number of members, collaborates with factory employee to exchange learned information, booster the moral support and encourage the planting and maintaining cassava crop until harvest.

3.2. Contract Farming for Cassava Plantation in Savannakhet

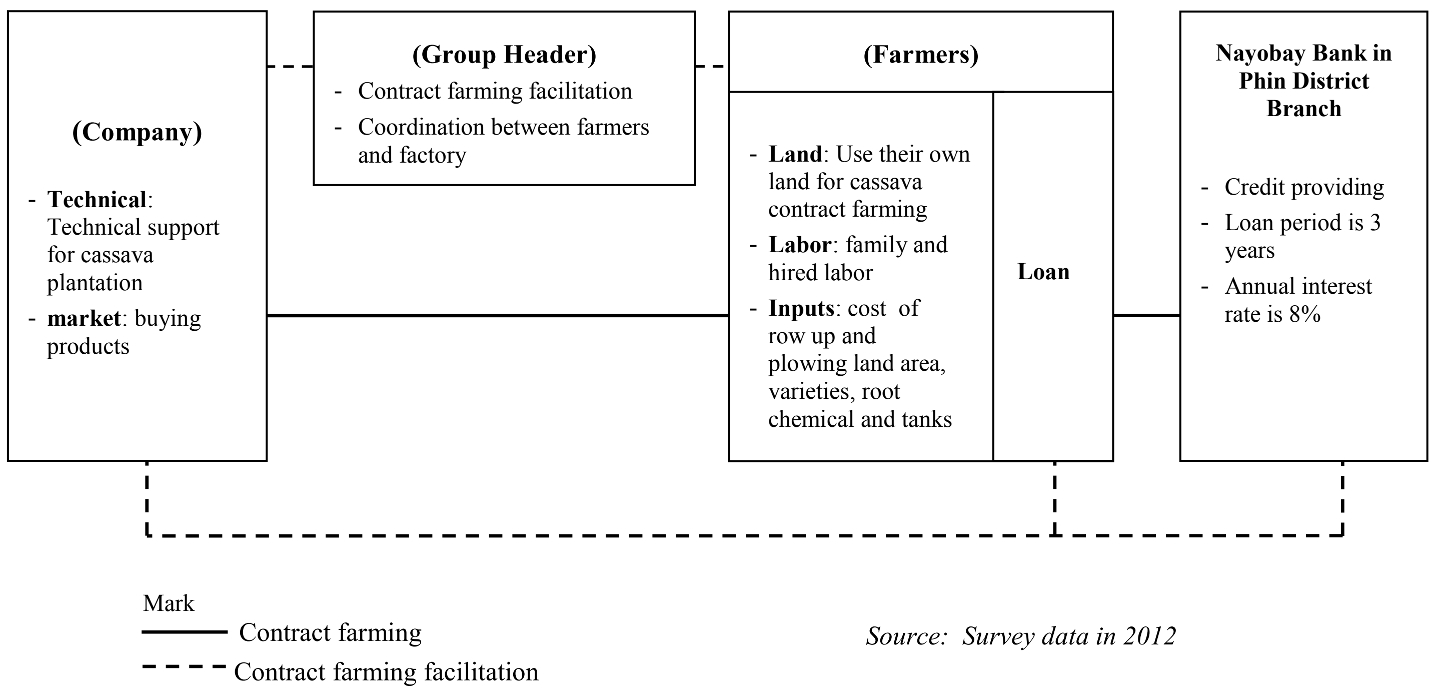
Savannakhet is another important province that has a significantly agricultural development. The province has wide plain area where total agricultural land is 245,365 hectares covering 13.51% of total agricultural area of the country (LSB, 2013). Commercial plantation for consumption and industrial crops has been widely attracting for agribusiness in this province. Most of the plantation was arranged in form of concession with large-scale farming area and promotion for small-scale farmers. Total formal approved concession land is 89,752 hectares where 42,797 hectares has been already used for planting. Besides, the land area for smallholder promoting plantation under the contract farming arrangement in particular for the type of 2+3 model has been expanded about 13,083 hectares. The main consumption crops in Savannakhet province are rice, cucumber, bean and various vegetables, while the industrial crops are sugarcane plantation at Xaybury District, cassava plantation at Phin District and banana plantation in Xepon District (MAF, 2012). Of these, cassava plantation has been expanded continually. In 2011-2012, cassava planting area in Savannakhet reached 3,772 hectares which could produce cassava 80,865 tons, where almost cassava production was supplied for factories to produce cassava flour and about 1,976 tons was exported to Vietnam (MAF, 2012).

In order to encourage local people to grow cassava with the aim of reducing poverty, the local authority of Savannakhet allowed the Duangmala Company (hereafter referred to as company) to operate cassava growing project and support local farmers. At the beginning, the company attempted to grow cassava in Phin district with a total area of 220 ha. As it was proven to be an easy crop to grow and the market available, the company began to introduce the local farmers to grow cassava based on the government endorced 2+3 policy. Since some local farmers lack of capital for cassava plantation, under the guiding of the company they formed in several groups in order to propose for a loan from the local Nayobay Bank to cover the costs for cassava plantation. The total amount of loan that farmers took from the bank was on the average of 15 to 20 million Kip/ha in a 3 years period with the interest rate of 8% per year.

The contract farming arrangement for cassava plantation in this area stipulates that farmers have to contribute their land and labor. In addition, the farmers also use the bank loan to cover the cost of land clearing, land plowing, and buying plant varieties, rooting fertilizer and some other materials from the company. Whereas, the company sale plant varieties, provide technical advice for cassava plantation and buy the crop (see figure 4.2). In buying the cassava crop, the company also guarantees the minimum price setting at 250 Kip/kg, but if the price surging should occur periodically, the adjusted rate could get as high as 600 to 900 Kip/kg.

The group leaders from each village work as the coordinator in order to facilitate and assist the contract process between the company and the people. The land clearing in the first year varies in cost depending on the landscape. If the land is covered with younger fallow, the cost would be around 3,500,000 Kip/ha, but in some older fallow it could run up to two times (7,000,000 Kip/ha). In the first year, plant varieties were provided by the company at the cost of 3,500,000 Kip/ha. Other than the cost of land clearing and plants species, farmers still have to buy the rooting fertilizer with the cost at 250,000 kip. For the cost of land clearing, plant varieties, rooting fertilizer and other materials, the payment is taken upfront at the time the bank issues the loan to farmers. According the data on loan approvals for cassava plantation released by Nayobay bank indicated that cassava growing project has expanded into 14 villages with a total number of 486 household members covering total land area of 530 hectares. Of which, the loan value was about 7.76 billion Kip (Nayobay Bank, 2013).

Figure 4.2 :Cassava contract farming arrangement in Savannakhet



Source: Survey data in 2012

A notable significance of the contract farming between company and people on cassava plantation is that the total expenses for the operation including loan interest are born by the growers. Thus, growers could face risks at three different areas: *Firstly*, farmers were in debt, owing to the bank for both principle amount and interest; the return from the first year selling of the crop to the company was low. *Secondly*, the company deducted the payment upfront for initial investment, making it a lopsided burden on the farmer. *Lastly*, the company does not pay for the crop in lump sum to farmers but pay by increment over time that made it difficult for some farmers to save for continually growing in the following year. Therefore, this method of operation is not inline with policy encouraged by the government to help rural farmers on commercial production in order to reduce the poverty among those living in the region as long as the burden of risk is one sided only.

4. Practices of Cassava Contract Farming

4.1. Practices of Cassava Contract Farming in Vientiane

The pattern of cassava contract farming in Vientiane is a written contract set up between the factory and individual farmer (as a borrower) which is called as a loan contract for cassava plantation. The contract is set up on a yearly basis and has renewed over past 3-4 years. The program is conducted following the government policy 2+3. The farmers involved in this project must contribute land area as specified for cassava growing and the farmers have to provide labor force for growing and maintaining cassava crops until harvest. The factory contributes capital in form of advanced material supply (cash, varieties, land clearing and barbed wire for fences). Moreover, the factory provides training for farmers on technical advice for planting and harvesting and the company has to buy cassava yield according to the plan stipulated in the contract.

In real term contract farming practices, farmers contributed 100% of their land and labor, while factory contribute the other important inputs in the form of advanced credit. Farmers could make their own decision whether to borrow or not from the factory if they are capable of managing and having adequate material supply with their own device for plantation and crop maintenance. In this study, a group of people took material support for production provided by the factory in the form of advanced plant varieties (4% out of total househols), land clearing (12%), and barbed wire for fences (15%). As it turned out, only a small group of people took the offer from the factory because cassava plant is easy to grow. Land owners are able to preserve the stems for next year planting and most farmers tend to plant them in natural setting without soil preparation. Besides, the factory also provides technical support for growing, harvesting and buying the crops from the growers according the contract (see table 4.2). All in all, the contract farming for cassava plantation is within the guideline as set in the policy 2+3 that promoted by the government.

Table 4.2: Contract farming practices for cassava plantation

No	Inputs		Vientiane				Savannakhet			
			Contribution based on contract		Contract farming Practice		Contribution based on contract		Contract farming Practice	
			Farmer	*Factory*	*Farmer*	*Factory*	*Farmer*	*Company*	*Farmer*	*Company*
1	Land		100%	-	100%	-	100%	-	100%	-
2	Labor		100%	-	100%	-	100%	-	100%	-
3	Capital	*Varieties*	-	100%	96%	4%	-	100%	100%	-
		Land preparing	-	100%	24%	12%	-	-	100%	-
		Fertilizer	-	-	-	-	-	-	100%	-
		Barbed wire	-	100%	30%	15%	-	-	-	-
4	Technical	*Plantation and Harvesting*	-	100%	44%	56%	-	100%	17%	83%
		Chemical Using	-	-	-	-	-	100%	16%	84%
5	Market		-	100%	-	95%	-	100%	-	98%

Source: Survey data in 2012

It seems that the stipulations in the contract imposed a lot of liability, an overly binding and retrictive on the farmers for the most parts. In case of farmers failing to carry out and fullfil their obligation they will be penalized to the extent of severe consequences or in some cases farmers could lose their property outright. On the other hand, the liability on the part of the factory (loan provider) is merely a promise to buy the cassava crop from growers at the market price. The contract stipulation mentions no obligation of joint or shared responsibility in case of natural disaster or damage to the crops by disease, and no fine nor consequences of any kind imposed on the factory if buyers do not come around to purchase the products. From the survey, 30% of farmers among a group of growers reported that reimbusement from factory was late even after delivery of their crops. This indicates that the contract terms of agreement are not tightly gripping enough while the farmers largely take heavy risks. Another side of this contract arrangement serves strictly on borrowing by the farmers rather than a strategy to support farmers on cassava plantation in order to serve as a choice to raise revenue towards the aims of poverty reduction.

4.2. Practices of Cassava Contract Farming in Savannakhet

The pattern of cassava contract farming in Savannakhet is diffrent from that in Vientiane. The contract between a company and cassava farmers in this region is called "*An agreement to buy-sell raw and dry cassava crops*". The implementation of most contracts started in 2010 with 3 years term. The price is set annually. The contract stipulated that farmers had to contribute their land and labor force. On the other hand, the company has to provide plant varieties, technical support for growing and has to be the sole buyer of the crops. The minimum pricing is predetermined by the contract at 250,000 Kip/ton. The one hidden issue in this contract stipulating a liability for both parties. If the company does not buy the cassava crops as promised in the contract, then it is liable for all losses incurred. On top of that it has to pay the land owner the labor cost. If the farmers violated by selling crops to another buyer, they will be fined at 100% of the price set in the contract and their membership will be denied and cancelled.

In reality, it varied and was quite different from the contract mandated, mainly in financing the cassava growing operation. The capital was borrowed by the growers from the Nayobay bank, Phin District Branch facilitated by the company. The total portion of capital taken in credit by growers was deducted upfront to pay to the company after receiving the loan from the bank. The capital that growers agreed to pay involves the following: the cost of land clearing at 7,000,000 Kip/hectare, plant varieties at 3,500,000 Kip/hectare, chemical and rooting solution at 250,000 Kip/hectare, and soaking tank at 250,000 Kip/each, totalling at about

11,000,000 Kip/hectare[4]. It was obvious that the capital is too high in comparison to the case study of Vientiane. Inspite of company's technical support and chemical used for rooting, there were 16% of the grower households in this study, at this phase, who were self-taught and work on their own without any support from the company.

4.3. Households' Characteristics

The study conducted the random data collection from 109 and 89 households[5] in Vientiane and Savannakhet, respectively. The cassava farmer samples were interviewed for gathering data in 2012 though the well-constructed questionnaires (see questionnaire in Annex 4). Table 4.3 shows general characteristics of sample household size, level of education, assets, plantation land area and average income in relation to the cassava contract farming in those two areas.

An average household size is large with 6 to 7 members in Vientiane and Savannakhet, respectively. The dependency ratio in Vientiane is lesser than 1 (about 0.79), while it is greater than 1 (1.19) in Savannakhet. The dependency ratio in Savannakhet indicates that the non-labor members are higher than the labor that may cause a lesser opportunity for income earning. Then, per capita income is likely to be low and could possibly be linked to poverty level.

Education level is an important indicator as ability to siphen information, especially in the context of contract farming and other areas of problem solving. The study cited that there is a varying education level of interviewees and their education level is not high; particularly the sample household in Savannakhet where the ratio of household with illiteracy is at 61%, 18% were incomplete primary school, those graduated from primary school and beyonds are at 21%

[4] data from the receipts provided by the people and by the village authority with grower's signature
[5] selected village in Muen district, Vientiane province are B. Phonsaen, Nam Phaed, Nam Horn and Nam Lau. While in Phin district, Savannakhet province included B. Nakanong, Na Phokam and Houay Xay.

only. The ratio of the sample households in Vientiane is in the similarly low ranging. The number of household rate with level below primary education is at 33%, combined cohort among those graduates of primary school and secondary education is at 67%. In comparison, the education level among the sample households in Vientiane is slightly higher than in Savannakhet.

Table 4.3: General characteristics of the households

Household Characteristics	Unit	Vientiane	Savannakhet
Number of samples	HH	109	89
Average family size	person	6.81	7.16
dependency		0.79	1.19
Head of household	%	*80*	*84*
Interviewee's education level			
Illiterate	*%*	*8*	*61*
not completed Primary School	*%*	*25*	*18*
completed Primary School	*%*	*32*	*13*
completed Jiunior High School	*%*	*23*	*6*
completed High School	*%*	*11*	*2*
Average total assets	Kip	45,500,000	14,800,000
Average family-land ownership	hectare	3.99	2.57
Average family-farm-land ownership	hectare	3.63	2.10
Average land area with cassava crop	hectare	1.78	1.32
Land use prior to cassava planting (total area)	hectare	195.41	118.8
Rice farm	hectare	*25.85*	*25*
upland rice farm	hectare	*78.16*	*21.8*
Job's tears	hectare	*36.66*	*0*
Forest	hectare	*0*	*0*
Fallow	hectare	*31.62*	*69*
Undeveloped wilderness	hectare	*8.3*	*2*
Fenced pasture for livestock	hectare	*10.92*	*0*
Other land area	hectare	*3.3*	*1*
Average annual income	Kip	20,200,000	7,857,000
Average income per capita	Kip	3,305,000	1,325,000

Source: Survey data in 2012

Land used for agricultural plantation of these two regions serve as a key mean to generate incomes for households' economy status. The average agricultural land area for each household in Vientiane is 3.63 hectare, while in Savannakhet is at 2.1 hectare, a haft smaller area as compared to Vientiane. Most of farmers in Vientiane converted area for cassava plantation from upland rice farm 78 ha (40% of total land holding), job's tears farm 36 ha (19%), fallow 31 ha (16%) and paddy rice farmland 26 ha (13%). Whereas, people in Savannakhet converted fallow area 69 ha (58%), upland rice farm 21.8 ha (18%) and paddy rice 15 ha (21%) for cassava plantation. Farmers from both regions, however, did not clearing forest for cassava plantation under the contract farming. Farmers used about half of their own available agricultural land area for cassava plantation. The average cassava area in Vientiane is 1.78 hectares covering about 49% of the total household agricultural land area, while the average cassava farm size owned by the farmers in Savannakhet is 1.32 hectares or 63% of total household agricultural land. These figures indicate that there is potential for farmers in both regions to expand land area for cassava plantation in response to demands of cassava product as well as for increasing their revenue and boosting the family economy's status.

4.4. Norm of Contract Farming Participation

Although the intended purpose of the contact is to reassure rightful benefits and sustainability for both parties, but the farmers could not fully participate in the process of contract drafting and stipulating the terms of agreement. From the study, only 50% of the sample among farmers of Vientiane was directly involved in the contract drafting process. From this group only 1% of the total number of farmers had role in the original drafting of documents. Those who took part in the reading, approving and negotiating were only 10% and approximately 39% participated in the certifying and signing of the final contract. It is noticeable that the number of sample households for those only involved in the signing of contract and the people who did not attend in contract drafting process covered 89% of the total sample households (see table 4.4).

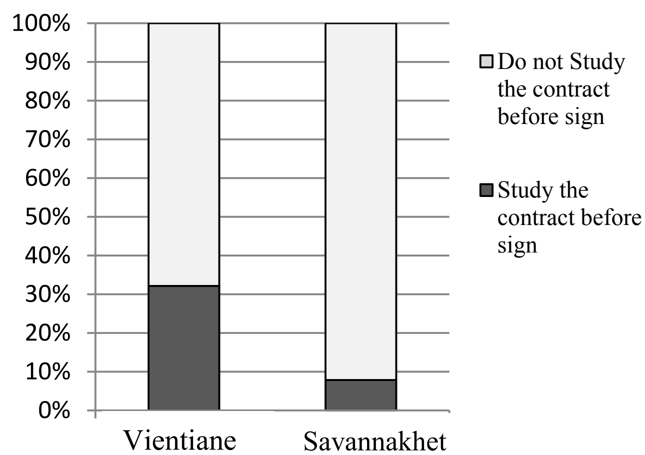
Table 4.4: Participation in cassava contract farming process

Study area	Participation in contract farming process	Registration with Court House	Person filing of the contract
Vientiane	50% of HH do not get involved in the drafting of contract. 11% of HH get involved and negotiate on contract and 39% of HH participate in a certifying and signing on the contract	58% of HH knowing that the contract did not registered in court, while the rest knowing nothing	- 48% of HH answered that contract was kept at the factory, and - 59% of HH said that contract was kept by the group leader
Savannakhet	82% of HH do not get involved in the drafting of contract. 1% of HH involved in the drafting process of contract, 7% of HH participated in the stages of reading, passing and debating on the draft and 10% of HH involved in the certifying and signing of contract.	49% of HH knowing that the contract did not registered in court, while the rest knowing nothing	- 10% of HH said contract was kept with their own - 35% of HH said that contract was kept with company - 37% of HH said that contract was kept by village chief

Source: Survey data in 2012, the percentage shown in the table is the ratio of households

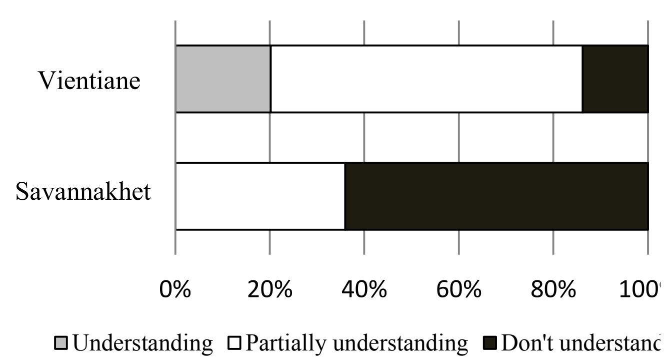
In Savannakhet, it is observed that there was a lack of people's role in the contract process. Most of the sample househols or about 92% of the studied samples do not take part in the contract drafting (see table 4.4). All in all, most of the cassava growers from both regions did not have any involvement in contract drafting process. Consequently, the larger part of the benefits were in the favor of the buyers. The benefits received by growers were only the installment reimbursement after deduction of all credit dues from the sale of cassava products.

Figure 4.3: Learn previous contract before signing



Source: Survey data in 2012

Figure 4.4: Understanding the contract term



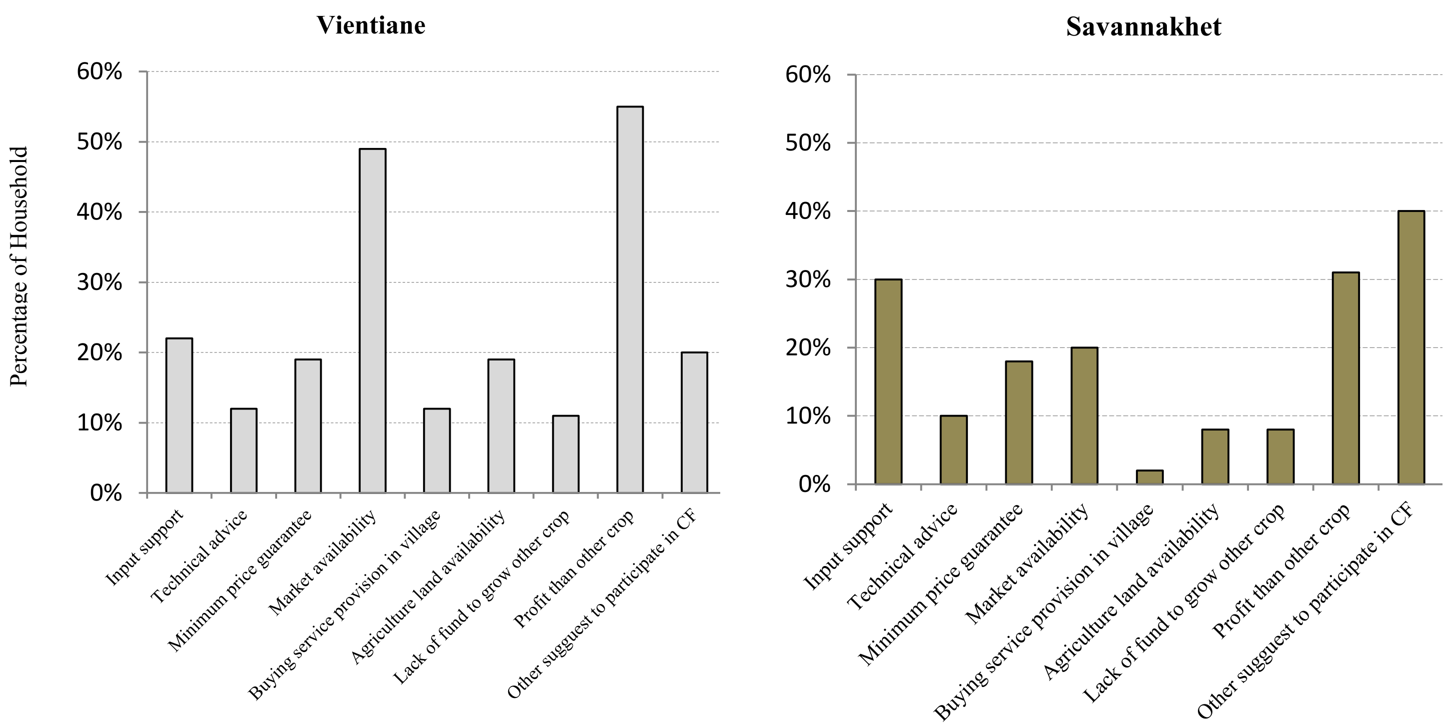
Source: Survey data in 2012

Figure 4.3 shows the knowledge gained from other contract prior to sign for cassava plantation in the two regions. About 68% of the sample households in Vientiane did not have any prior knowledge from other practices before signing the contract with the factory. However, one third of the growers in the sample have had prior contract knowledge before enter into the said contract agreement. 90% of cassava farmers in Savannakhet never had prior knowledge on the contract from other practices.

Considering the level of understanding on the contract terms and its content by the sample households in both regions, there are clear differences on several fronts. Farmers in Vientiane understand contract better than those in Savannakhet. About 20% of the sample farmers in Vientiane have good understanding of the contract signed with the factory interm of the promotion and their responsibility, 66% of farmers knew only some parts of the contract. Nevertheless, 14% of the sample farmers did not understand what so ever (see figure 4.4). Among farmers in Savannakhet, no one understands every detail in the contract that they signed with the company. In addition, about 63% of the sample farmers didn't understanding the contract at all.

Majority of farmers in Vientiane said that they turned to cassava plantation under the contract farming because mostly cassava plantation generate better income than other crop (55% of total sample households), secondly market for cassava crop is availability due to the high demand for raw cassava from the factory that was established in Namphed village, Muen district, Vientiane province. In addition, the factory also provides inputs for cassava plantation and guarantee the minimum price, while most farmers didn't have sufficient capital for other crop plantation (see figure 4.5). Whereas, the farmers in Savannakhet provided some key reasons that about 40% of total sample households got instruction from the other farmers. 31% of the sample households saw that farmers who grew cassava would always generate income more than the other crops. In addition, they turn for cassava plantation because inputs were supported by the company which different from other crop plantation with no any capital support. The market availability and minimum guarantee price were additional important reasons that encouraged the farmers to growing cassava. From these points of view it can be concluded that the farmers in Vientiane made a decision to grow cassava because they considered more on economic point of view that was related to benefit return, while farmers in Savannakhet made a decision for cassava plantation which considered more on the social trend and based on their belief, trust among their own community and also followed the active local leaders.

Figure 4.5: Reasons for decision making to participate in cassava contract farming



Source: Survey data in 2012

4.5. Accountability in Cassava Contract Farming

The contract farming for cassava plantation in these two regions is arranged with assigned responsibility for both parties as the guidelines for implementation and decision making.

The good arrangement of contract farming for cassava plantation is depended on integrity and moral values for personal accountability towards society especially with regard to production, marketing and concern for environment to ensure the sustainability of this industry. It is important to maintain unbiasedness which serves as the measure for poverty reduction among the agricultural farmers.

Regarding to the accountability for production and marketing, cassava farmers in Vientiane proved themselves to be efficient in their operation and following the terms of contract to sell their crops to the factory. The factory in their best effort supplied plant varieties and other inputs in the form of in-kind advanced credit to encourage the farmers to have sufficient inputs at the beginning stage of cassava plantation. In addition, the factory built and maintained the main roads in the village and access roads to their farms in order to facilitate the transportation. The factory employed local people about 135 workers to manufacture cassava flour which brought more opportunity for farmers to earn income during the off-farm season. The farmers in Savannakhet also implemented the contract on growing the crop and delivering to company as stipulated in the agreement. For society in a broader scope, the company has not yet contributed much for the local people on income generation activities rather than just cassava plantation.

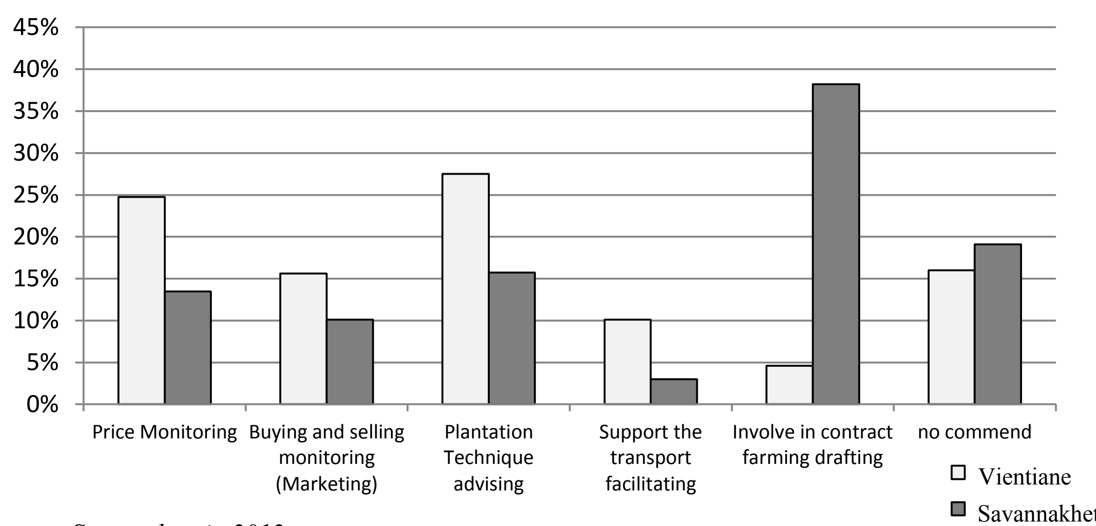
In terms of accountability towards the environment it has been found in this study that farmers in both regions didn't encroachment into the forest or conservation forest for their own cassava practice (see table 4.3). At any rate, the issue of agricultural land controlling has not been considered to stipulate in the contract term either by the farmers or factory/company on maintaining soil fertility which might be depleted of nutrients and productivity due to cassava plantation for several consecutive years. Regarding the environmental protection in the context of cassava flour production in Vientiane, the factory has reported that contaminated water always gets treated (for the washing and rinsing of cassava and residue from the straining apparatus).

The methods involve treating of waste water by the process of turning it into bio-gas which can be used as fuel instead of coal with the efficient rate of 80% (Lao Vieng, 2013). The factory also treated the unpleasant odor coming from cassava flour production. Even though the treatment on the unpleasant odor has been made, but it still exists in this area.

4.6. Monitoring and Evaluation for Cassava Contract Farming

Besides considering the accountability towards the society aspect in the view point of farmers and the factory concerning to the cassava contract farming, the participation of the third party especially the public sector who plays a role in monitoring and evaluation is very important in order to manage the contract farming practices. Delforge (2007) and NGO of Thailand pointed out the impact of the contract farming that small-scale farmers always stay in the disadvantage position and were controlled toward the decision making on contract farming management by the contract counterpart company. Thus, in order to better manage the contract farming practices between the farmers and buyers in a right direction and fairness, the government's role playing for effective monitoring and evaluation is needed.

Figure 4.6: Households' view point on public involvement for cassava contract farming



Source: Survey data in 2012

This study shows that even the governmental authority at both provincial and district levels play an active role in supervising and managing cassava contract farming in the two areas, but the monitoring and evaluation yet could not be effectively put in place. According to the survey, the sample farmers in Vientiane requested the public sector to pay more attention on the monitoring, appropriate price determination, planting technical support to increase the productivity and following up the transaction process in a manner way.

Table 4.5: Summary of main indicators for cassava contract farming arrangement

Region	Business practice	Policy consistency on contract farming practices	Norm of partnership	Accountability	Monitoring and evaluation
Vientiane	The contract between farmers and company is named as loan borrowing contract. It falls to 2+3 characteristics, although input support is regarded as loan provided.	- Yes, follow policy 2+3 - Inputs provided in the form of loan (optional) and deducted prior to payment for products - Purchase at market price - Farmers take own production risk	- 89% of HH did not participate on contract preparation - 70% of HH never studied before signing - 20% of HH fully understand, 66% of HH partially understand the contract	- Factory in the areas generated employment - Followed environmental regulation, although environmental responsibility per contract is unclear - Waste disposal is not appropriate	- No monitoring system on production, chemical application - No public involvement as third-party M&E
Savannakhet	Farmers, through company coordination, directly borrowed loan from the Nayobay Bank. The company also acted as commissionerand facilitated land preparation for the farmers. The company signed contract with farmers to provide technique and purchase the product.	- Do not follow the government policy (contract made with company only on marketing, no inputs or technology supports. Farmers directly borrowed from bank) - Purchase at guaranteed price or higher - Farmers take own production risk - Both sides are subject to penalty if not complied to the marketing contract	- 92% of HH did not participate on contract preparation - More than 90% never studied before signing - 37% partially understand the contract, 63% don't understand	- Environmental responsibility per contract is unclear - Waste disposal is not appropriate	- No monitoring system on production, chemical application - No public involvement as third-party for monitoring and evaluation

Source: Survey data in 2012

While the farmers in Savannakhet request to the public sector to assist on educating farmers to understand the contract term in order to avoid the problem on buying-selling the crop and further support farmers for cassava plantation (see figure 4.6). On the other hand, the company or factory authorized to run their business for promotion the cassava plantation has not yet consecutively follow up the cassava plantation by the farmers who are contract counterpart in order to secure the productivity, sufficiently supply to the demand and share responsibility when problem facing during the growing period (see the summary in table 4.5).

5. The Impact of Contract Farming on Poverty Situation

The second objective of the study is to evaluate the impact of the contract farming on poverty situation. This study uses the method of comparative analysis for farmers with and without contract farming approach. The financial net return from alternative land uses from the two areas are estimated and then compared with the formal poverty line based on the Decree 201/g.o[6]. The difference of net return between with and without contract farming indicates the impact of contract farming on rural poverty.

5.1. Cost and Benefit Analysis for Cassava Contract Farming

Table 4.6 shows that the finance total cost for cassava plantation in Vientiane is 2,181,000 kip/ha, including the largest share of variable cost covered 66%, labor cost accounted for 25%, while the lesser share about 9% is the fixed cost. Regarding to the return from cassava plantation for the farmers in this area, the average production is 18,823 kg/ha. The price of cassava varies depending on travelling distant from the farm to factory and range between 400-500 kip/kg. So that, the average gross income is at 8,354,000 kip/ha, and the net return is about 6,174,000 kip/ha. So that, the financial net return indicates profit and is three time higher than the total cost. The results also presented that the average net return per capita of the cassava plantation under the contract farming is about 134.000 kip/head/month. Even though this figure

[6] Decree on standards on poverty and development during 2012-2015, dated 25 April, 2012

is not exceeding 180,000 kip/head/month, but the earning makes up 75% when compare with the formal poverty line.

The cost and benefit analysis of cassava contract farming in Savannakhet compared with those in Vientiane is totally different. The average finance total cost is 7,358,000 kip/ha which is three times higher than in Vientiane. The largest share cost is the average land clearing and plant variety cost estimated at 6,144,000 kip/ha accounted for 83% of the total cost. The high cost resulted from contract farming arrangement for cassava production. While the fixed and labor cost took up at the rate about 4% and 5% of total cost, respectively. On the other hand, the cassava product was relative low with the average of 10,502 kg/ha which is about 50% lower than the national average product of 23.87 tons/ha (MAF, 2011).

Table 4.6: Finance cost and benefit of cassava contract farming

Indicators	**Vientiane**	**Savannakhet**
Number of households	109	89
Total Fixed Cost (Kip/ha)	**391,621**	**326,638**
Land clearance	56,216	131,205
Erecting fences	90,880	84,211
Equipments	56,242	90,882
Rental land	154,924	0
Land tax payment	33,360	20,340
Total Variable Cost (Kip/ha)	**1,251,224**	**6,684,083**
Cost of land preparation	393,337	3,469,058
Plant species	211,135	2,674,873
Chemical mix	0	113,328
Pesticide	0	23,769
Herbicide	27,224	3,480
Cost of logistics (phone, fuel and transportation)	605,964	244,228
Loan interest	13,563	155,348
Total Labor Cost (Kip/ha)	**538,024**	**347,114**
Hired labor	538,024	347,114
Total Cost (Kip/ha)	**2,180,868**	**7,357,835**
Total Revenue (Kip/ha)	**8,354,532**	**4,472,255**
Avarage yield (Kg/ha)	*18,833*	*10,502*
Profit / Loss (Kip/ha)	**6,173,664**	**-2,885,580**
Net income per capita (Kip/month)	**134,473**	**-43,781**
Percent compared to poverty line (180,000 Kip/month)	**75%**	**-24%**

Source: Survey data in 2012

The average total income is about 4,472,000 kip/ha. When considering the net return it shows that cassava plantation under this contract farming result in a loss at -2,886,000 Kip/ha. Average income per capita is also deficit at -44,000 Kip/month. These figures imply that the cassava plantation under this contract farming is not well practices in order to support the poverty reduction. When compare this result with the formal poverty line, it shows a negative value of -24%. This mean that the return that the farmers get from such cassava plantation under this contract farming is loss, additional worst the farmers take the big burden of being debt one side from the loan that they made from the Nayobay bank.

5.2. The Impact of Cassava Contract Farming on Poverty

In order to estimate the impact of cassava plantation on poverty in the two regions, the approach of this study compares the net return of cassava plantation and the alternative crops. With regard to the alternative crop plantation, the estimation in Vientiane computed from the data collection from 60 households of which 45 households preferred to grow upland rice and 20 households chose to grow job's tears when cassava do not existing. Table 4.6 shows the combination of average net return of upland rice and job's tears production in Vientiane in comparison with the average net return of cassava crop. The results in this table indicated that the average net return of the alternative crops is 6,721,000 kip/ha which is higher than the net return from cassava growing 547,000 Kip/ha. So that, the impact of cassava contract farming on poverty calculated on the difference in average net return per capita per month from cassava and the alternative crops is negative (-12,000 Kip/person/month). Therefore, the percentage of the impact of cassava contract farming as of poverty line is about -7%. These figures show that even though cassava plantation under this contract farming in Vientiane resulted a positive profit, but it is not yet an effective approach for poverty reduction when compared to the alternative crops.

To sum up, although cassava contract farming in Vientiane is not quite capable of helping poverty reduction as its capacbly when compared with other alternative crops, cassava growers are profitting and the contract farming arrangement in this context show better practice evidence on following the government policy. Cassava contract farming practice in the region has a fairly good arrangement because the practices of contract between factory and farmers follow the term stipulated in the contract. Some members understand the term of contract well, hence, realizing the pros and cons in entering into contract agreement. In terms of production, certain numbers of farmers have well learned the planting technique and they become professional in plantation. By the same token, the average quantity of cassava production is at a fairly good level and growers made profit. The cassava flour factory located within the region serves as a market place where farmers can sell their crops, so that the factory come to buy and pick up on schedule.

Table 4.7: The estimation of Impact of contract farming on poverty

Description	Unit	Vientiane	Savannakhet
Alternative Crops		Upland rice* and Job's tears*	Upland rice* and paddy rice**
Net return of Alternative Crops	kip/ha	**6,720,948**	**3,247,997**
Net return of Cassava Contract farming	kip/ha	6,173,664	-2,885,580
Net impact from cassava contract farming	kip/ha	-547,284	-6,133,577
Average cassava land size	ha	1.78	1.32
Average Household size	person	6.81	7.16
Impact of cassava contract farming***	kip/person/month	**-11,920**	**-94,230**
Percent of the impact of cassava contract farming as of poverty line (180,000 kip/person/month)	%	**-7**	**-52**

Source: * Survey data in 2012 upland rice 45 households, Job's tears 20 households
** Setboonsarng *et al.* (2008), net return from paddy field rice is 1,751,000 Kip/hectare
*** the impact of cassava contract farming: the difference of net return of cassava and alternative crop multiple average cassava land size, then divided by the average household size and then divided by 12 (Months) in order to get the impact of contract farming per capita

Cassava plantation under the contract farming in Savannakhet had not been made profitable for the farmers, it also caused worse impoverished condition for growers due to the management and operational system of cassava contract farming practices were full of gaps, leaving growers who never got in debts before became deep in debts over and beyond an ability to pay them off. The fact that growers never had a say in the drafting process of contract then possibly lead them to be victimized and mislead. It is obvious from the start-up funds for entering into the contract that is too high beyond the reality in all other situation. The cassava crop as an average yield was still relative low as compared to the whole region and across the country. Payment received for growers comes in an installment and irregularly (owing over a long period). The net revenue is a negative gain which causes grower to fall short of starter funds for the next year plantation. The consecutive impact of this problem is that farmers with bank loan for start-up funds will be impossible to keep up and pay back. Intesrest payment could not be paid on time to the bank where loans were issued. Consequently, it might have ripple effect on the financial system and the loan issuing by the bank as part of the policy in Phin district in the near future.

6. Summary and Recommendations

6.1. Summary of the Study

The study on the impact of contract farming for cassava plantation in Vientiane and Savannakhet focuse on the two main objectives as mention in the introduction part. *The first objective is to investigate the contract farming arrangement*. The analysis concluded that the practices of the contract farming for cassava plantation in Vientiane overall follow the policy (2+3 modality) as promoted by the government, while the contract farming practices in Savannakhet varied from the promoted policy. The results also reveal additional facts that most farmers in both regions didn't have a role in the process of contract drafting, had no previous learning contract experience from other situation and didn't understand the content of the contract. Cassava growers in Vientiane who decided to participate in the contract farming considered first on the economic reason more than any other factors, while farmers in Savannakhet were leaning toward consideration for social coherence, particularly mutual respect and trust in one another, or just following the leaders whose leadership role in local community carries the messages that they support.

The second objective is to analyze of the impact of contract farming for cassava production on the poverty. The results can be summarized that cassava contract farming in Vientiane is profitable enough covered as much as about 75% of the formal poverty line. But the contract farming arrangement in an effort to reduce poverty in this region is not succesful with resulting in the negative value of net return per capita of -7% compared with the alternative crops (upland rice and Job's tears). Yet, the margin of profit is still there and much more stable than any other crops as it is easy to grow with market availability. On the other hand, cassava contract farming in Savannakhet did not only make profit for farmers, but rather increased poverty level at a double rate (-52%), due to the farmers could not participate in the process of cotract drafting and didn't understand detailed stipulation within the contract terms. Moreover, the operation management system showed several gaps of risks and the practices did not appropriate as needed.

6.2. Recommendations

The contract farming for cassava plantation in Vientiane has more potential to benefit the farmers in producing commodities, while the practices in Savannakhet is not well arrange in order to generate benefit and effectively contribute to the poverty reduction. Therefore, this study offers crucial practical and policy recommendations.

For practical recommendations, it is needed to develop fair and transparent model of cassava contract farming templates. Cassava contract farming in the two regions should be designed a full participatory system, where farmers can involve in the whole process of contract formulation. Cassava contract farming businesses and farmers should be regularly monitor in order to ensure compliance against policies and regulations.

For policy recommendations, it is needed to identify the appropriate public authorities for regulating, monitoring, and enforcing cassava contract farming arrangements. The Lao government should develop a short and concise guideline/handbook outlining the regulations and practice requirements as well as the responsible authorities for contract farming in Lao PDR. The concerned authorities have to develop simple educational materials and deliver mass training to prospective producers on contract farming modalities and terms of contract. Furthermore, the authorities should develop a complaints/dispute resolution center at the district/province level to address issues between the farmer and the investor. Finally, it would be important for the Ministry of Finance and Department of International Cooperation, Ministry of Planning and Investment, Lao PDR to provide sufficient fund and official development assistance (ODA) for research institutions to support further research on contract farming in Lao PDR.

Chapter 5: Economic Analysis of Technical Efficiency in Small-scale Cassava Farming

In the economic aspect of sustainability anslysis of the Lao farming system, the study investigates the return to scale, estimates technical efficiency and identifies the determinant factors on technical efficiency of small-scale cassava farming in Savannakhet and Vientiane provinces, Lao PDR. Cross sectional data of 193 cassava farmers on inputs, output and farming characteristics were collected for this study. The maximum likelihood method is employed to estimate parameters, elasticity and inefficiency scores through the application of the stochastic frontier production function model. This study found that the elasticity of mean value of cassava output is estimated to be an increasing function of farm size, labor cost and variety cost in Vientiane and Savannakhet. The increasing return to scale was found for smallholder cassava farming in Savannakhet. The estimated mean score of technical efficiency are 75% and 72% for Savannakhet and Vientiane, respectively. The significant highlight of the determinant on technical efficiency in Vientiane expressed that planting cassava with good land preparation, suitable time period for plantation and young farmers play a key role in the improvement for technical efficiency of cassava farming.

1. Introduction

The Lao government attempts to achieve the Millennium Development Goal (MDG1) by ensuring food security and improving the livelihoods of rural community through commercialization and modernization of agricultural production (MAF, 2010). The effort has been made with the introduction of programs for the promotion of commercial crop production in order to raise farmers' incomes with the expectation of better livelihoods and sustainable farming. Therefore, a number of favored cash crops have been introduced to Lao farmers, including maize, cassava, rubber, job's tear, banana and sugarcane. Among these, cassava plantation has recently expanded in Lao PDR, due to the high demand for raw cassava for bio-ethanol fuel production in China, Thailand and Vietnam as well as domestic demand for flour production.

Cassava plantations are important not only as food crops but more importantly as a major source of income for rural households. Between 2005 and 2012 there were 12 private domestic and 11 foreign companies registered for cassava plantation within the country with a total registered capital investment of US$64.76 million covered concession land area of 11,428 ha (MAF, 2013a). In 2010/2011, cassava planted area by individual growers were about 18,900 ha (MAF, 2014). Subsequently, cassava plantation areas have expanded over six-fold from 6,765 ha in 2005 to 43,975 ha in 2012 (MAF, 2015). Cassava is fast becoming a key commercial crop that is expected to generate higher farming incomes.

Over the past five years, average cassava farm sizes and productivity have also grown markedly in Lao PDR. Cassava farm sizes increased from 0.1 ha in 1998/99 to about 0.4 ha in 2010/11 (MAF, 2014), while their productivity increased from 17.47 ton/ha in 1998 to 25.08 ton/ha in 2010 (MAF, 2015). In the long term, if farm sizes continue to expand in this manner, it may lead people to believe that large farms are more efficient than small ones. Individual small-scale cassava farmers who are key players in the agriculture sector would be left behind and will eventually be replaced by large scale cassava corporations (Yoav and Willis, 1991). It is also generally recognized that small-scale farmers are poor with low productivity in their agricultural production (Ajibefun, 2002 and Akpan *et al.,* 2012). Improving productivity and efficiency is a key to increasing farmers' income and improving livelihoods which could move them out of poverty (Ajibefun, 2000).

In general, the problems affecting small-scale farmers in cassava plantation in Lao PDR are not different than those for other crops. *Firstly*, a majority of small-scale farmers lack techniques and information on production; they use simple techniques and often have improper land preparation and soil control; as well as little knowledge on seedlings and minimal plantation experience. *Secondly*, rural small-scale farmers do not have access to financial support with which to apply proper inputs and production equipment. *Lastly*, farm size is limited and harvested cassava yield cannot reach the ideal optimum outputs. Therefore, in order to maintain high production in the face of limited land size holding, there is a particular need to improve efficiency of small-scale cassava plantations.

For small-scale farmers to achieve optimum output and production efficiency, limited resources have to be optimally and efficiency utilized. The ability of cassava farmers to adopt new technology and achieve sustainable production depends on their level of production efficiency, mostly determined by variable input factors. Farm specific variables, such as characteristics of the farmers and farm management system, experience of famers and distance from market can influence farm production efficiency (Battese and Coelli, 1995 and Brock, 1994). In order to increase the level of productive efficiency, farmers need to expand the minimal farm plots, learn more innovation technology and maintain soil fertility that might be affected by land use and forest cover change. This is especially true for rural farmers in forest frontier areas. The challenge to improving the level of productive efficiency[7] therefore, is to increase the technical efficiency of cassava plantations.

This study aims to examine the factors that influence technical efficiency of small-scale cassava plantation which would imply that there is a high return to product input factors for cassava plantations in Vientiane and Savannakhet Provinces of Lao PDR, where there is a significant increase in various cassava plantation systems. According to Desli *et al*., (2002), two otherwise identical firms will never produce the same output, and costs and profits are not the same. This difference in output, cost, and profit can be explained in terms of efficiency and unforeseen exogenous shocks.

The specific objectives of this study are to investigate whether there is evidence of increasing or diminishing returns to scale for the cassava plantation under the given outputs and inputs; to estimate cassava farm-level technical efficiency; and to ascertain the determinant factors influencing efficiency levels of cassava plantation in the two areas. In addition, the following assumption and null hypotheses were stated and tested: Stochastic frontier production function is in Cobb-Douglass form; technical inefficiency is absent from the Cobb-Douglass production function model, technical inefficiency effects are absent and farmers' specific determinant factors have no effect on technical inefficiency. Furthermore, the null hypothesis on the constant return to scale is also tested for the Cobb-Douglass stochastic frontier production function.

There is little research on technical efficiency analysis for commercial crop plantation in Lao PDR, some work has been carried out to assess the technical efficiency analysis of maize

[7] The concept of productive efficiency is composed of technical, allocative and economic efficiencies (Farrell, 1957).

farmers in Hauixay district, Bokeo Province (Southavilay *et al*., 2012), and the analysis of technical efficiency of smallholder maize farmers in Paklay district, Sayaboury province (Vanisaveth *et al.,* 2012), but the research on cassava plantation is scant and non-existent. Therefore, this study on technical efficiency analysis for small-scale cassava plantation in Savannakhet and Vientiane Provinces can be considered as pioneering research. The findings from this study will directly feed into various ongoing work and academic series to support policy development for agricultural practices, especially for cassava farming in Lao PDR.

2. Study Area and Data Collection

The study areas for cassava farming are Muen district, Vientiane province and Phin district, Savannakhet province (hereafter the study site refer as Vientiane and Savannakhet, respectively). Vientiane province is located in the northwest part of the country. The province is the largest in terms of land area of 22,554 square kilometers combined with 13 districts with a total population of about 506,881 people (LSB, 2013). Total agricultural land area is 103,960 hectares covering about 4.6% of total provincial land area. The main crop plantations are rice, maize, cassava, small orange, sesame, job's tear, black bean, yellow bean, pineapple, cucumber, watermelon and sweet tamarind. The province is the third largest in terms of cassava plantation area compared to other provinces across the country (MAF, 2011). Cassava areas in the province rapidly increased from 1,425 hectares in 2010 to 3,130 hectares in 2011 covered about 3.03% of total agricultural area of Vientiane Province (see table 5.1).

Savannakhet province, located in the central part of Lao PDR, is known as the land of fertility because of its suitability for agriculture. In terms of land area, Savannakhet province is the second largest one with a total land area of 21,774 km^2 (see table 5.1). It has the highest population of about 937,907 people (LSB, 2013). In terms of agricultural development, Savannakhet province plays an important role as there is a wide plain area where total agricultural land is 245,365 hectares covering 11.26% of total provincial land area (LSB, 2014). The main consumption crops in this province are rice, cucumber, bean and various vegetables, while the industrial crop plantations include sugarcane plantation at Xaybury District, cassava plantation in Phin District and banana planting in Xepon District (MFA, 2013b). Of these, cassava plantation has been continually expanding. In 2012, the cassava planting area in Savannakhet reached 3,772 hectares which could produce cassava 80,865 tons. Most of this cassava production is supplied to factories to produce cassava flour and about 1,976 tons are exported to Vietnam (MAF, 2013b).

Table 5.1: A comparison on provincial information in 2012

Description	Vientiane Province		Savannakhet Province	
	Area (ha)	Product (ton)	Area (ha)	Product (ton)
Population (persons)	506,881		937,907	
Total land area	2,255,400		2,177,400	
Agricultural plantation	103,967		245,365	
Paddy Rice	53,017	230,430	173,117	614,600
Season rice	6,612	28,850	31,286	138,915
Upland rice	7,073	11,570	1,417	2,139
Vegetable	22,570	165,050	11,440	80,240
Maize	6,590	46,530	3,700	35,615
Cassava	3,130	83,040	2,400	65,360
Tobacco	685	3,740	1,200	14,925
Sugarcane	145	1,630	12,140	754,830
Other	4,145		8,665	

Source: Lao Statistics Bureau, 2013.

Field surveys were conducted to gather both primary and secondary data in Savannakhet and Vientiane provinces. The structured questionnaires were used for face-to-face interviews with key informants for primary data from 109 randomly-selected cassava farmers in Vientiane province and 84 cassava farmers in Savannakhet province during the crop season of 2012. In order to empirically investigate and analyze the technical efficiency of cassava farming, the output (cassava yield) and inputs (farm size, labor used and variety cost) for cassava plantation were carefully collected. In addition, the social-economic characteristics of farmers including famers' age, cassava farming experience, farmers' education, cassava planting practices were also collected. Secondary data on related studies as well as statistics, policies and legislation on cassava plantation were also obtained from central and provincial government offices, online sources and journal publication.

3. Theoretical Framework: Stochastic Frontier Analysis

3.1. Stochastic Fronteir Production Function Model

Theoretically, production is an economic conversion process that firms use to transform inputs (such as labor and capital) into outputs (commodity or goods) which can be completely exchanged. The technological possibilities of such a transformation can be estimated through the use of average production function or production frontier,[8] for instance, the ordinary least square (OLS) regression function. The production function is "the mathematical relationship showing how the quantities of the factors of production determine the quantities of goods and services produced" (Mankiw, 2007). The production function (Philip, 1894) is defined as:

$$y_i = f(x_i;\beta) \tag{5.1}$$

Where the subscript *i* denotes the *i*th firm, y_i is the output obtained by a vector of inputs x_i. β is the unknown parameter vector to be estimated. In the case of a competitive market, the OLS measures firms under the assumption that all firms are fully efficient; but in fact firms are commonly inefficient. Therefore, in order to address this issue, a method for measuring the

[8] The two terms can be used interchangeably. The efficiency measurement scholars, however, prefer to use the term *frontier* for emphasizing the situation that the function provides the maximum output that is technologically feasible.

technical efficiency of firms in a homogenous industry through estimating the production frontier is presented (Farrell, 1957). The production frontier indicates the ability of a firm to obtain maximum outputs at each input level. Firms that produce their output on the frontier are classed as having full technical efficiency in their industry, while technical inefficiency represents a firm's operation under the frontier.

The deterministic production frontier method was then introduced to estimate the inefficiency deviated from the production frontier (Aigner and Chu, 1968). In this deterministic model, the specific one-side error (u_i) is considered as the inefficiency and assumed as a non-negative random variable that is mathematically proposed as the following equation:

$$y_i = (x_i;\beta)\exp(-u_i) \qquad (5.2)$$

This work, however, has not been completely successful in linking the gap between theory and empirical studies due to the lack of a tool to measure errors and other sources of noise. To address this issue, the stochastic frontier production function was developed in which the error term composes two components (Aigner *et al.*, 1977 and Meeusen and Broeck, 1977) defined by:

$$y_i = f(x_i;\beta)\exp(v_i - u_i) \qquad (5.3)$$

The Cobb Douglass production function is assumed and input factors are substituted into equation (5.3). By taking the natural logarithm of both sides of equation (5.3), the model of Cobb Douglass stochastic frontier production function is formed as:

$$\ln y_i = \beta_0 + \sum_{j}^{3} \beta_{ij} \ln x_{ij} + v_i - u_i \qquad (5.4)$$

ln denotes a natural logarithm, and subscript *i* represents the *i*th farmers. v_i, referred to as the noise, is a random error and the effects of other random factors (for instance: weather, luck, strikes and so on) that the firm can't control, and is assumed to be the independent and identically distributed normal random variable with zero mean and variance of σ_v^2. u_i represents a non-negative random variable or one-side error term referred to as technical inefficiency in production. This model is needed to set up the assumption that u_i is an independently non-negative truncated normal distribution with mean of μ_i and variance[9] of σ_u^2 (Battese and Coelli, 1995). The truncated normal distribution is a generalization of the haft-normal distribution and it can be estimated on the involvement of the parameters μ in the stochastic frontier model (Stevenson, 1980). v_i and u_i are assumed for independent distribution of each other and expressed as:

$$v_i \sim iidN(0, \sigma_v^2) \tag{5.5}$$

and $$u_i \sim idN^+(\mu_i, \sigma_u^2) \tag{5.6}$$

Two variance parameters[10] of the log likelihood function[11] was presented (Battese and Corra, 1977) and mathematically expressed in the formula bellow:

$$\sigma^2 = \sigma_v^2 + \sigma_u^2 \tag{5.7}$$

and $$\gamma = \sigma_u^2 / \sigma^2 \tag{5.8}$$

γ (gamma) is suggested to be used because it takes a value between zero and one. If $\gamma = 0$, it implies that the deviations from the frontier as a whole is affected by the noise, whereas if its value is equal to one, all deviations from the frontier are entirely due to technical inefficient effect.

[9] It assumes that u_i is independently and identically distributed half-normal random variable with zero mean and variance of σ_u^2 (Aigner *et al.,* 1977).

[10] The parameter $\lambda = \sigma_u^2 / \sigma_v^2$ could be any non-negative value (Aigner *et al.,* 1977).

[11] $\ln(L) = -\frac{N}{2}\ln(\frac{\pi}{2}) - \frac{N}{2}\log(\sigma^2) + \sum_{i=1}^{N}\ln[1-\phi(z_i)] - \frac{1}{2\sigma^2}\sum_{i=1}^{N}(\ln y_i - x_i\beta)^2$

In addition, it further assumes that heteroskedasticity is not present for the two error components, $Var(v) = \sigma_v^2$ and $Var(u) = \sigma_u^2$. It is worth to note that, if $\sigma_v^2 = 0$, model (5.3) collapses to become the deterministic frontier model (5.2). Whereas if the inefficiency component u_i equals zero, the firm fit the assumption that it operates on the frontier and has fully technical efficiency which represents the maximum output obtainable at each input level.

3.2. Graphic Illustration of Stochastic Production Frontier

Figure 5.1 graphically illustrates the significant features of the stochastic frontier production function (Kumbhakar *et al*., 1991 and Reifschneider and Stevenson, 1991). For easily understanding this process, suppose that firms produce output y_i using only one input x_i. The Cobb Douglass stochastic frontier production function is supposed and adds a natural logarithm to both sides of equation (5.3) giving the result below:

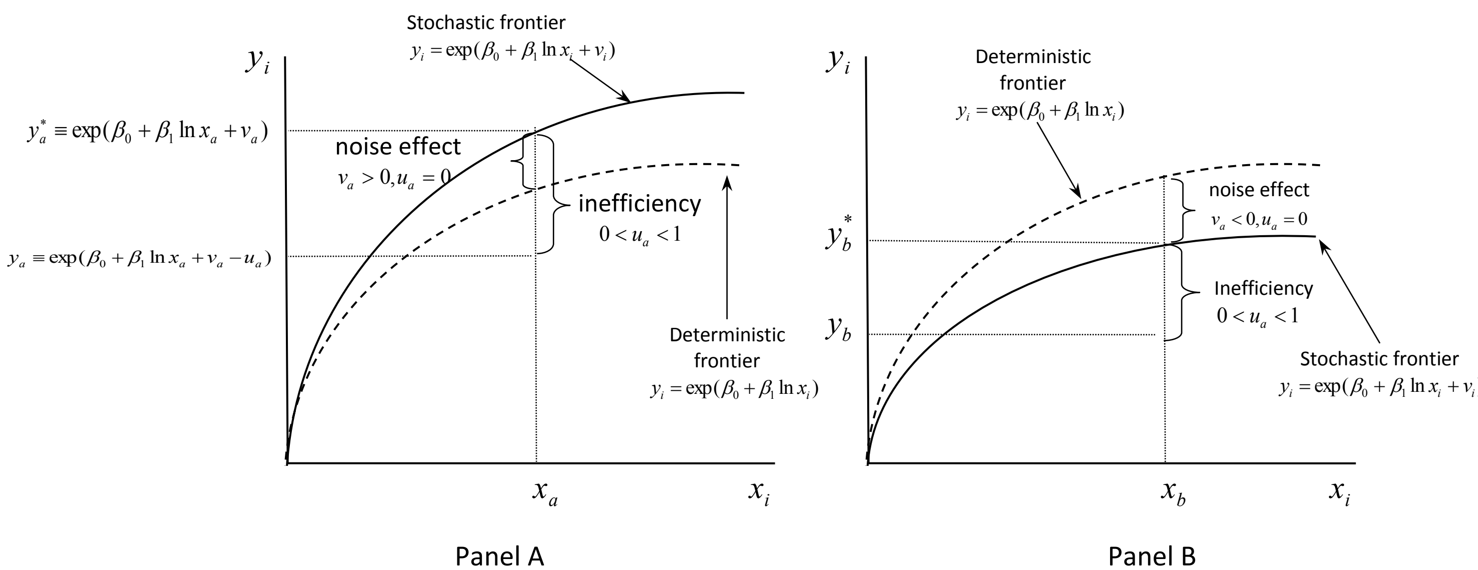
$$\ln y_i = \beta_0 + \beta_1 \ln x_i + v_i - u_i \tag{5.9}$$

or $$y_i = \exp(\beta_0 + \beta_1 \ln x_i).\exp(v_i).\exp(-u_i) \tag{5.10}$$

On the right hand side of equation (5.10), $\exp(\beta_0 + \beta_1 \ln x_i)$, $\exp(v_i)$ and $\exp(-u_i)$ represent the deterministic, noise and inefficiency components respectively. Figure 5.1 shows the inputs and outputs of firms A and B in panel A and panel B, respectively. The diminishing return to scale is represented by deterministic component of the frontier model. The horizontal axis measures the value of input and the vertical axis represents the outputs. Firm A produces output y_a by using input at level x_a, while firm B produces output y_b and uses input x_b. These observed output points are marked by ㊉. If the firm are fully efficiency (e.g. $u_a = 0$ and $u_b = 0$), then the stochastic frontier output would be $y_a^* \equiv \exp(\beta_{0+}\beta_1 \ln x_a + v_a)$ and $y_b^* \equiv \exp(\beta_{0+}\beta_1 \ln x_b + v_b)$ for firm A and B, respectively.

In panel A, the value of the stochastic frontier output (y_a^*) is marked by the point ▲ and stays above the deterministic frontier because the random error (v_a) or noise effect is positive, whereas in panel B the value of output (y_b^*) stays below the deterministic frontier because the random error (v_b) or noise effect is negative. It can be shown that both observed outputs y_a and y_b are lower than the stochastic frontier outputs y_a^* and y_b^*, respectively, because the sum of the noise and inefficiency effects is negative skewed ($v_a - u_a < 0$ and $v_b - u_b < 0$) (Kumbhakar *et al.*, 1991).

Figure 5.1: The stochastic production frontier



Source: This graph is developed from Coelli et al., (2005), Chapter 9: the stochastic frontier analysis

In most research, the stochastic frontier analysis is directed at measurement technical efficiency. Technical efficiency (TE) is the ratio of observed output (y_i) for the *i*th firm relative to potential maximum output (y_i^*) defined by the stochastic production frontier, given vector inputs x_i (Kumbhakar *et al.*, 1991). The measure of technical efficiency takes a value between zero and one and is expressed as:

$$TE_i = \frac{y_i}{y_i^*} = \frac{f(x_i;\beta)\exp(v_i - u_i)}{f(x_i;\beta)\exp(v_i)} = \exp(-u_i) \qquad (5.11)$$

3.3. Determinant of Technical Inefficiency Effect

In practical applications, even though the estimation of technical inefficiency by the stochastic frontier analysis is of wide interest among several scholars, the determinant of possible factors affecting technical inefficiency is also significant. Thus, a two stage method was proposed to measure and determine technical inefficiency. Later, the two stage approaches were integrated into a single-step for simultaneous estimation of the parameters of the stochastic frontier production function model and of the technical inefficiency effect model through applying the maximum likelihood method.

Following the proposed model on determinants of technical inefficiency obtained from the stochastic frontier production function model (Battese and Coelli, 1995), the inefficiency terms " u_i " is constructed to be the dependent variable for the inefficiency determinant specification and is defined to be explicit functions of firm-specific factors (Kumbhakar *et al.*, 1991 and Reifschneider and Stevenson, 1991) which mathematically expressed as following form:

$$u_i = \delta_0 + \sum_j^k \delta_j Z_{ij} + \omega_i \qquad (5.12)$$

where Z_{ij} represents the observable explanatory variables for the ith firm; δ_0 is the constant, δ_j is a vector of unknown parameters to be estimated, ω_i denotes an unobservable random error defined by the truncation of the normal distribution, $\omega_i \sim N(0,\sigma_\omega^2)$. The truncated point at zero is $-(\delta_0 + \sum_j^k \delta_j Z_{ij})$, that is $\omega_i \geq -(\delta_0 + \sum_j^k \delta_j Z_{ij})$. Thus, the parameter β of the stochastic frontier production function in equation (5.3) and the parameters $\delta_0 \,\&\, \delta_j$ of the technical inefficiency effect model expressed in equation (5.12) can be simultaneously estimated in a single process through applying the maximum likelihood method.

3.4. Econometric model

This paper applies the stochastic frontier production function model (Aigner *et al*., 1977 and Meeusen and Broeck, 1977) to estimate technical inefficiency and follows the proposed model (Battese and Coelli, 1995) to determine the impact of farmers' specific factors on technical inefficiency.

A 2012 cross sectional data set of 193 farmers from the field survey Vientiane and Savannakhet is employed for this work. For a set of data in a similar sector, technical inefficiency of each farmer can be estimated by regression of the identical production frontier. The Cobb Douglass production function is assumed and input factors are substituted into equation (5.3). By taking the natural logarithm of both sides of equation (5.3), the econometrics model of Cobb Douglass stochastic frontier production function is formed as:

$$\ln y_i = \beta_0 + \beta_1 \ln Farmsize_i + \beta_2 \ln Labor_i + \beta_3 \ln Variety_i + v_i - u_i \qquad (5.13)$$

The model identified in equation (5.13) basically combines a single output and 3 inputs of each farm. y_i is cassava yield in ton of i-th farm. $Farmsize_i$ is cassava farm size in hectare and $Labor_i$ is value of labor use with the working days in cassava farm including family, exchange and hire labors (man-day). $Variety_i$ is value of variety cost in US$. ln denotes a natural logarithm, and subscript *i* represents the *i*th farmer. $\beta_0, \beta_{1,}, \beta_{2,}$ and β_3 are unknown parameters to be estimated.

To examine the factors effects on inefficiency obtained from the cross section data set mentioned above, inefficiency effect model (5.12) can be expressed in an econometric specific model form as:

$$\mu_i = \delta_0 + \delta_1 Age_i + \delta_2 Age_i^2 + \delta_3 Experience_i + \delta_4 Education_i + \delta_5 Dlandpreparing_i + \delta_6 Farmcareness_i + \delta_7 DPlantperiod_i + \delta_8 DProvince_i + \omega_i \quad (5.14)$$

where subscript i denotes the i-th farmer. μ_i is the technical inefficiency. $\delta_0, \delta_1, \delta_2, \delta_3, \delta_4, \delta_5, \delta_6, \delta_7, \delta_8$ are the unknown parameters to be estimated. Age_i *(Z_1)* denotes the age of farmers in years and the Age_i^2 *(Z_2)* is included in this model with the expectation on non-linear relationship between Age^2 and technical inefficiency. *$Experience_i$ (Z_3)* is year of experience on cassava plantation of farmers, *$Education_i$ (Z_4)* is years of farmers' education in years, $Dlandpreparing_i$ *(Z_5)* is the dummy variable for farm land preparing before cassava plantation, if Z_5=1 then the farm land was prepared before cassava plantation; otherwise it is zero. $Farmcareness_i$ *(Z_6)* is the ratio of the number of working days with labor use for weeding during the time of cassava plantation over the number of working days with total family members. *$DPlantperiod_i$ (Z_7)* denotes the dummy variable for the cassava plantation period, if Z_7 =1 then the time period of cassava plantation is not more than 9 months; otherwise it is zero. *$Dprovince_i$ (Z_8)* defines the dummy province, Z_8=1 refers to Vientiane province; otherwise it is zero. $\omega_i \sim N(0, \sigma_\omega^2)$ denotes unobservable random errors defined by the truncation of the normal distribution with zero mean and variance of σ_ω^2.

3.3. Model Specification Tests

In this study, there are several tests of the null hypotheses pertaining to Cobb-Douglass production function, absence of technical inefficiency, and absence of technical inefficiency effects. The tests carried out by using the generalized likelihood ratio test statistic LR_{stat} (Coelli, *et al.*, 2005) is computed as:

$$LR_{stat} = -2 * [LogL(H_r) - LogL(H_{ur})] \quad (5.15)$$

Where $LogL(H_r)$ is the value of the log likelihood function of a restricted frontier model as specified by the null hypothesis (H_0) and $LogL(H_{ur})$ is the value of log likelihood function of unrestricted frontier model under the alternative (H_1). If the null hypothesis is true, then the test statistic LR_{stat} has appropriately a Chi-square distribution with parameter equal to the number of restrictions identified by (H_0). The test statistic LR_{stat} has a Chi-square (χ^2) or a mixed Chi-square (χ^2) distribution with degree of freedom equal to the different between the parameters involved in the null (H_0) and alternative (H_1) hypothesis, or equals the number of parameters assumed to be zero in the null hypothesis.

3.4. Model Specification Tests for Constant Return to Scale

The return to scale (increasing, diminishing or constant return to scale) can be obtained from the sum of the coefficient parameters (β_k) value on the individual input as specified in equation (3.12). If the value is less (greater) than one, then the production function displays diminishing (increasing) returns to scale. Importantly, the center focus of this test is to analyze whether the Cobb-Douglas stochastic frontier production function applied to this study exhibited a significant diminishing (increasing) return to scale of each input vector (x_{ij}). The study tests whether the sum of the coefficients equals one and therefore whether the null hypothesis on constant return to scale can be rejected as follows:

$$H_0^{CRS}: \beta_1 + \beta_2 + \beta_3 = 1 \qquad \text{Constant return to scale (CRS)}$$

The t-statistic for testing of the constant return to scale for multiple input vectors can be identified as following formula:

$$t = \frac{(\hat{\beta}_1 + \hat{\beta}_2 + \hat{\beta}_3) - 1}{se(\hat{\beta}_1 + \hat{\beta}_2 + \hat{\beta}_3)} \qquad (5.16)$$

In order to find the $se(\hat{\beta}_1 + \hat{\beta}_2 + \hat{\beta}_3)$, we estimate a different model that directly delivers the standard error of interest. It is first by define a new parameter as the sum of β_1, β_2 and β_3 which is $\theta_1 = \beta_1 + \beta_2 + \beta_3$ (Wooldridge, 2009).

Then the test of the null hypothesis is: $H_0^{CRS} : \theta_1 = 1$ (5.17)

So that, the t-statistic is as bellow: $t = \frac{\hat{\theta}_1 - 1}{se\hat{\theta}_1}$ (5.18)

Then we rewrite the $\theta_1 = \beta_1 + \beta_2 + \beta_3$ as $\beta_1 = \theta_1 - \beta_2 - \beta_3$. After that, replace this into the Cobb Douglass stochastic frontier production function (5.13), then we get:

$$\ln y_i = \beta_0 + (\theta_1 - \beta_2 - \beta_3)\ln x_{1i} + \beta_2 \ln x_{2i} + \beta_3 \ln x_{3i} + v_i - u_i \quad (5.19)$$ or

$$\ln y_i = \beta_0 + \theta_1 \ln x_{1i} + \beta_2(\ln x_{2i} - \ln x_{1i}) + \beta_3(\ln x_{3i} - \ln x_{1i}) + v_i - u_i \quad (5.20)$$

4. Empirical Results

This section is divided into 3 parts. The first part analyzes the summary statistic of the output and input variables of a cassava plantation. The second part investigates tests of the stochastic frontier production function and inefficiency effect models and the constant return to scale, and the last part presents results of the measurement and determinants of technical inefficiency. The test of correlation of all variables were done, but not presented in this paper.

4.1. Summary Statistic of Variables

The summary statistics of variables of pooled, Vientiane and Savannakhet data are presented in table 5.2 with the value of mean, standard deviation, minimum and maximum of each variable. In pooled data, the statistic indicates that the mean cassava yield is about 25.67 ton, while its average is about 16.14 ton/ha, which is relative lower than the national mean of 24.12

ton/ha (MAF, 2014). Considering this separated by province, the mean cassava yield of Vientiane is 33.52 ton (averagely18.83 ton/ha) which is relatively higher than Savannakhet of 15.49 ton (averagely 11.47 ton/ha). But these figures in terms of their average are still lower than the national level (24.12 ton/ha). Crop productions in these areas were based on natural practices and used a simple way, which could not take advantage of the resource's optimal potential. Majority of farming are small-scale and poor and most of them were not able to sufficiency access to financial support to purchase for machines and apply innovation technology. In addition, the soil test in the cassava field of two provinces indicated that the intensive and consecutive cassava plantation in the same area lead to soil nutrient depletion. All of these conditions could reduce harvested yield (Soukkhamthat, 2014 and NERI, 2015).

The average cassava farm size of the pool data is about 1.59 ha, while the average cassava farm size of Vientiane is about 1.78 ha which is higher than the farm size in Savannakhet (1.34 ha). These figures are lower than the average land size of agriculture land throughout the country which is 2.11 hectare (Messerli *et al.,* 2008). Most of farmers in the two regions, however, do not use all of their agricultural land for cassava plantation (Soukkhamthat, 2014), which it means that farmers can increase cassava farm size when their plantation provides significant economic return than other land use options.

The average labor use for a cassava plantation is about 193, 246 and 125 man-days for the Pooled, Vientiane and Savannakhet, respectively. The highest value of labor use for cassava plantation is about 767 man-days in Vientiane, while the lowest labor use is 26 man-days in Savannakhet. Farming activities for cassava plantation, viz., planting, weeding and harvesting, consume labors over the planting cycle in a year, due to farmers in these areas do not use machine for cassava plantation except for land clearing at the beginning stage. Therefore such intensive labor use is a key input factor for cassava plantation, particularly farmers in rural area.

Table 5.2: Statistic data for Pooled, Vientiane and Savannakhet

Variable	Units	Obs	Mean	Std. Dev.	Min	Max
Pooled data						
Yield (y)	Ton	193	25,675	20,809	1,500	136,590
Farm size (x_1)	Ha	193	1.59	0.85	0.34	5.50
Labor (x_2)	man-day	193	193.33	145.39	26.00	767.00
Varity cost (x_3)	US$	193	199.70	252.14	0	2,187.50
Age (Z_1)	Year	193	40.01	12.71	19.00	78.00
Experience (Z_3)	Year	193	2.08	0.95	1.00	5.00
Education (Z_4)	Year	193	4.28	3.17	1.00	14.00
Dlandpreparing (Z_5)	1=yes, 0=otherwise	193	0.6010	0.4909	0	1
Farmcareness (Z_6)	Ratio	193	0.4268	0.1924	0.1000	1.0000
Dplantperiod (Z_7)	1=yes, 0=otherwise	193	0.6114	0.4887	0	1
Dprovince (Z_8)	1=yes, 0=otherwise	193	0.5648	0.4971	0	1
Vientiane						
Yield (y)	Ton	109	33,524	21,189	8,900	136,590
Farm size (x_1)	Ha	109	1.78	0.92	0.34	5.50
Labor (x_2)	man-day	109	246.02	159.51	42.00	767.00
Varity cost (x_3)	US$	109	47.01	25.25	10.00	136.50
Age (Z_1)	Year	109	41.00	13.31	19.00	78.00
Experience (Z_3)	Year	109	2.41	1.01	1.00	5.00
Education (Z_4)	Year	109	5.63	3.05	1.00	14.00
Dlandpreparing (Z_5)	1=yes, 0=otherwise	109	0.3761	0.4866	0	1
Farmcareness (Z_6)	Ratio	109	0.4894	0.2079	0.1000	1.0000
Dplantperiod (Z_7)	1=yes, 0=otherwise	109	0.7523	0.4337	0	1
Savannakhet						
Yield (y)	Ton	84	15,491	15,219	1,500	95,000
Farm size (x_1)	Ha	84	1.35	0.70	0.50	5.00
Labor (x_2)	man-day	84	124.96	86.10	26.00	502.00
Varity cost (x_3)	US$	84	397.84	275.48	0	2,187.50
Age (Z_1)	Year	84	38.71	11.85	20.00	72.00
Experience (Z_3)	Year	84	1.64	0.65	1.00	3.00
Education (Z_4)	Year	84	2.54	2.37	1.00	12.00
Dlandpreparing (Z_5)	1=yes, 0=otherwise	84	0.8928	0.3111	0	1
Farmcareness (Z_6)	Ratio	84	0.3456	0.1326	0.1111	0.6667
Dplantperiod (Z_7)	1=yes, 0=otherwise	84	0.4286	0.4978	0	1

Source: estimated results from household survey data in 2012, exchange rate 8,000 kip/$US

The mean cost of varieties for cassava farming in Savannakhet is US$ 398, about 8 times higher than in Vientiane (US$ 47). The variety cost indicates a high value due to their connections to contract farming arrangements for cassava plantation between farmers and an investor, particularly in Savannakhet. The farmers have to pay the high cost of variety for the local investor who made a formal contract with them due to farmers were not able to understand the terms and obligations defined in the contract. In addition, they were also lacking of opportunity and capacity to bargain the cost as comparing with the market price (Soukkhamthat, 2014).

Household characteristic variables of the inefficiency determinant effect model are also shown in table 5.2. The data statistic of the survey households in 3 categories indicate similar mean of age at about 40 years which implies that most cassava farmers are middle active age. Majority of farmers have experience in cassava plantations of about 2 years. Only small amount of farmers in Vientiane have experience for cassava plantation for 5 years, while a minor proportion of farmers in Savannakhet have experience for about 3 years. These results show that farmers in these areas have relatively less experience on cassava farming and it might be difficult for them for copping when facing problems in cassava plantation, unlike farmers with experience more than 5 years are able readily to employ their advantage on cassava plantation (Ogisi, 2013).

The table presents the low level of year in education attainment of those households with an average of not more than 6 years in both areas. This indicated that it might be difficult for farmers to adopt new technology and innovation practice for cassava farming, specifically on the effective technique on input utilization for cassava farming (Ogisi, 2013 and Benjamin *et al.,* 2012). In addition, educational infrastructure and facilities are not available within and nearby to their villages. It takes time and spent high cost on transportation for them to go to the center city for studying. In addition, most of farmers are poor[12] and some of them could not pay the school fee and even some of their children have to drop school in order to support their family as farming labors (Soukkhamthat, 2014). Previous evidence also highlighted that, in 2006 the

[12] In 2009, there were 2,287 poor households or 37.1% in Phin district, the study site, of total poor households (14,286 HH) in Savannakhet province (Provincial Planning and Investment Department of Savannakhet Province, 2009)

proportion of girl and boy who have never been to school in Savannakhet province was estimated at about 14.8% and 12.5%[13] respectively.

The farm care ratio indicated that the labor use for weeding in their cassava field in Vientiane is about 49% which is higher than the labor used in Savannakhet of about 34%. This variable is expected to have a negative effect on technical inefficiency. If the farm is clean and plants are well cared-for, cassava roots will have more opportunity to absorb more nutrients from the soil and cassava yields will increase.

Regarding the dummy variables of land preparation before cassava plantation, only 37% of farmers in the Vientiane area focused on this activity, while the ratio is high in Savannakhet area which was about 89% of total surveyed farmers. Well-prepared loose soil and proper drains area by plow and ridge for clearing of all grass and brush could facilitate better cassava plantation and reduces scramble for soil nutrient absorption by weed (Anthony *et al*., 2008 and Howeler R.H.).

The dummy variables of the planting period showed that about 75% of farmers in Vientiane take 9 months for cassava mature from planting to harvest, while about 42% of the farmers in Savannakhet who take the same periods. From the survey, majority of farmers in Vientiane plant cassava in April-May and harvest in November-December, while the farmers in Savannakhet plant cassava in May-June and harvest in March in the year later. The evidence is also consistence with the works of (Anthony *et al*., 2008 and Howeler R.H.) which explaining that in order to obtain the highest yields, cassava should be planted in early wet season and the highest starch could be generated when plants were harvested in mid of the dry season. In Thailand, cassava was normally planted in May, the beginning period of the rainy season, which

[13] Estimated by research team based on the data provide in Summary of Implementation of Education Development Plan 2005-2006 of Savannakhet province.

could significantly increase the higher yields. All in all, the appropriate time to plant and harvest cassava does not only depend on the seasonal conditions, but it is also based on the marketing conditions at time of expected harvest.

4.2. Test for Stochastic Frontier Production Function and Inefficiency Eeffect Models

The parameters of the stochastic frontier production function and inefficiency effect models can be estimated through the application of the maximum likelihood method by using computer software FRONTIER 4.1 (Coelli, 1996). The generalized likelihood ratio (LR), resulting from such a method, is used to examine whether the Cobb Douglass is not a stochastic frontier, whether there is an absence of technical inefficiency, absence of technical inefficiency effect and to determine the impact of a farmers specific effect (see results in table 5.3).

The first test is the examination on model specifications whether the stochastic frontier is in Cobb-Douglass form. The null hypothesis states that the coefficient parameters of the Cobb Douglass production function are zero. The results in the upper part of table 5.3 clearly shows that the LR statistics are higher than the Chi square critical value at the 5% level of all data sets of Pooled, Vientiane and Savannakhet. Thus, the assumption of the stochastic frontier production function in Cobb-Douglass form is appropriately represented for this technology in the data sets.

The second test is to examine whether the inefficiency presence for this technology in the case of the truncated-normal model. The null hypothesis denotes the absence of inefficiency in equation (5.12). The results shown in table 5.3 indicate that the null hypotheses of the three data sets can be rejected at 5% level significant since the LR statistics are greater than the critical value. These results imply that the average production function, in which all farmers are assumed to be fully technically efficient, is insufficient representation for the case of the three data sets.

The third test is to investigate whether the technical inefficiency effect exists in the inefficiency effect model. The null hypothesis presents that the equation (5.13) has no technical inefficiency effect. Regarding the results shown in table 5.3, the LR statistics of the three data sets are higher than the critical value at 5%. Therefore, the null hypotheses of the three data sets can be rejected. This implies that the technical inefficiency effects represent these data sets.

Table 5.3: Generalized likelihood ratio test of hypotheses involving the parameters of the stochastic frontier and inefficiency model for cassava plantation.

Null Hypothesis	Data	LR. STAT	Degree of freedom	Critical value at 5%	Decision
1. *Test for frontier is not Cobb Douglass form*	Pooled data	209.48	3	7.81	reject H_0
Null: Stochastic frontier is not Cobb Douglass form	Vientiane	130.83	3	7.81	reject H_0
$H_0: \beta_1 = \beta_2 = \beta_3 = 0$	Savannakhet	99.34	3	7.81	reject H_0
2. *Test for absence of technical inefficiency (in the case of the truncated-normal model)*	Pooled data	20.94	2	5.99	Reject H_0
Null: absence of inefficiency	Vientiane	14.35	2	5.99	Reject H_0
$H_0: \mu = \sigma_u^2 = 0$	Savannakhet	16.84	2	5.99	Reject H_0
3. *Test for absence of inefficiency effect.* Null: No technical inefficiency effect					
$H_0: \gamma = \delta_0 = \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = \delta_7 = \delta_8 = 0$	Pooled data	117.60	10	18.31	Reject H_0
$H_0: \gamma = \delta_0 = \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = \delta_7 = 0$	Vientiane	41.45	9	16.92	Reject H_0
$H_0: \gamma = \delta_0 = \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = \delta_7 = 0$	Savannakhet	22.55	9	16.92	Reject H_0
4. *Test for household's characteristic effects.* Null: Determinants have no effect					
$H_0: \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = \delta_7 = \delta_8 = 0$	Pooled data	96.65	8	15.51	Reject H_0
$H_0: \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = \delta_7 = 0$	Vientiane	27.10	7	14.07	Reject H_0
$H_0: \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = \delta_7 = 0$	Savannakhet	4.80	7	14.07	Can't reject H_0

Source: estimated results from household survey data in 2012.

Note: The test statistics are defined by $LR_{stat} = -2*[\log L(H_r) - \log L(H_{ur})]$, where $L(H_0)$ and $L(H_1)$ are the value of the likelihood function of the restrict and unrestricted model, respectively. The LR statistics approximately follow a Chi-squared distribution and the degree of freedom equals the number of parameters assumed to be zero in the null hypothesis. $\gamma = \sigma_u^2 / \sigma^2$ and $\sigma^2 = \sigma_v^2 + \sigma_u^2$. The critical value is drawn from table G.4 Chi-square Distribution, p.829. Wooldridge, 2009.

The fourth test is to ensure whether the determinants of farmers' specific factors present effects on technical inefficiency. The null hypotheses present the coefficients of farmers' specific factors are zero. Likewise, the results shown in the lower part of table 5.3 demonstrates that the

LR statistics of the Pooled and Vientiane data sets are higher than the critical value at 5% and the null hypotheses can be rejected, meanwhile the LR statistic for the Savannakhet data set is lower than the critical value. Therefore, the null hypothesis for the Savannakhet data set cannot be rejected. This indicates that determinants of farmers' specific factors have the effect on the technical inefficiency for the pooled and Vientiane data sets, while Savannakhet has no effect on technical inefficiency with regard to these determinant effect variables.

To sum up, the above testing results support the use of the Cobb Douglass stochastic frontier production function, truncated normal distribution and inefficiency effect specification defined in equations (5.4) and (5.7) for the three data sets are appropriate to represent for the stochastic frontier analysis.

4.3. Results of the Test of Return to Scale

The results of the tests in Table 5.4 indicated that the t-statistic for the pooled (0.7132) and Vientiane (-0.3720) data are lower than the critical value at 5% level. Therefore, the null hypotheses on the constant return to scale cannot be rejected for the Cobb Douglass stochastic Frontier production function. This implies that there is no economy of scale for cassava plantation in Vientiane province. The reason might be that the farmers in Vientiane have been planting cassava for a couple of years and they could optimally utilize the inputs factor well. Therefore, increasing return to scale for cassava farming in Vientiane is not a factor. In addition, they use a simple way for plantation with no innovation of varieties and technology, therefore even they increase the volume of inputs by same characteristic, output will not increase higher or lesser than the proportionally use of inputs. In order words, optimum efficiency of production or the current level of resource use for cassava farming in this area has been attained under the given technology.

On the other hand, the t-statistic of the Savannakhet (5.0034) case is statistically significant at 1% level and higher than the critical value. This indicates that the Cobb Douglass stochastic frontier production function in Savannakhet presents the evidence of the increasing return to scale and was found to be 1.54 as the sum of the coefficient. This indicates that a proportionate increase in all the input factors would result in a more than proportionate increase in the cassava output of the farming.

Table 5.4: Results of the test for constrant return to scale

Variables	Parameters	Pool data			Vientiane			Savannakhet		
		Coeff	Std. Err.		Coeff	Std. Err.		Coeff	Std. Err.	
Constant	β_0	9.7594	0.2700	***	8.3349	0.9587	***	8.7807	0.3387	***
$\ln x_1$	θ_1	1.0308	0.0433	***	0.9828	0.0464	***	1.5379	0.1075	***
$(\ln x_2 - \ln x_1)$	β_2	0.0737	0.0436	*	0.0188	0.0520		0.1174	0.0655	*
$(\ln x_3 - \ln x_1)$	β_3	0.0082	0.0114		0.1445	0.0825	*	0.0060	0.0088	
$\hat{\theta}_1 = \hat{\beta}_1 + \hat{\beta}_2 + \hat{\beta}_3$		1.0308			0.9828			1.5379		
$se\hat{\theta}_1$		0.0433			0.0464			0.1075		
T-statistic		**0.7132**			**-0.3720**			**5.0034**	***	
df (n-k-1)		189			105			80		
Critical Value at 5%		1.980			1.987			2.000		
H_0: Constant return to scale		***Can't reject Ho***			***Can't reject Ho***			***reject Ho***		

Source: estimated results from household survey data in 2012
Note: The dependent variables are yield for the stochastic frontier production function.
****, **, * denote significant level at 1, 5 and 10% respectively.*

The increasing return to scale means that optimum efficiency of production or the current level of resource use for cassava farming in this area has not been attained under the given technology. One thing to note is that while farm size in Savannakhet is only marginally smaller than Vientiane and the yields are significantly much lower as shown in Table 5.2. This could mean that Vientiane is already relatively optimal in production, therefore not a factor. This finding is consistent with the work of (Benjamin *et al.*, 2012). This result suggests that cassava production in Savannakhet can still increase the level of output at the current level of resources by improving technical efficiency. Thus, one implication of this finding is that policies related to agriculture extension service should target improvements in technical efficiency for cassava small-scale farmers in Savannakhet to boost farm outputs.

4.4. Estimates of Stochastic Frontier Function and Technical Efficiency

The maximum likelihood estimate of parameters of the Cobb-Douglas Stochastic Frontier Production function for cassava plantations in Pooled, Vientiane and Savannakhet data are presented in table 5.5. As expected, the input parameters of farm size, labor and seed cost of the three data sets had positive signs which show direct relations with output in terms of cassava yield. In other words, the elasticity of the mean value of cassava output is estimated to be an increasing function of farm size, labor and variety cost.

The results indicate that the input of cassava farm size was found to be the factor with the most influence on production, determining the amount of output. The coefficients are statistically significant at 1% significance for all 3 data sets. The elasticity of different outputs with respect to the mean value of farm size of Pooled, Vientiane and Savannakhet data were estimated to be 0.94, 0.81 and 1.42 respectively. The high elasticity of farm size value of the 3 data sets suggests that expansion in production among the farmers was mainly due to an increase in farm size rather than increase in technical efficiency. This implies that if farmers enlarge their farm land for cassava plantation by 1%, it will lead to an increase in cassava output of 0.94% for the Pooled, 0.81% for Vientiane and 1.42% for Savannakhet, ceteris paribus. Besides land area already used for cassava plantation, several farmers in the two areas, in fact, still have available of agricultural land (Soukkhamthat, 2014) and they could expand the cassava farm size if the plantation generates enough benefit for them. This finding is also inline with the work of (Benjamin *et al*., 2012).

Table 5.5: Maximum likelihood estimation for parameters of the Cobb Douglass stochastic frontier production function

Variables	**Parameters**	**Pooled data**			**Vientiane**			**Savannakhet**		
		Coeff	*t-ratio*		*Coeff*	*t-ratio*		*Coeff*	*t-ratio*	
Constant	β_0	9.7594	34.0180	***	8.3348	8.5926	***	8.7914	26.0969	***
ln (*Farm size*)	β_1	0.9490	18.2242	***	0.8194	9.9198	***	1.4211	12.1940	***
ln (*Labor*)	β_2	0.0737	1.7370	*	0.0188	0.3773		0.1156	1.7667	*
ln (*Seed cost*)	β_3	0.0082	0.5623		0.1445	1.7605	*	0.0058	0.6528	
sigma-squared	σ^2	0.2131	6.0399	***	0.1544	2.6121	**	2.5972	1.1106	
gamma	γ	0.9576	39.9728	***	0.9103	14.4419	***	0.9783	46.208	***
log likelihood function		-68.327			-7.205			-38.683		
Observations		193			109			84		

Source: estimated results from household survey data in 2012
*Note: The dependent variable is yield for the stochastic frontier production function. ***, **, * denote significant level at 1, 5 and 10% respectively.*

Labor used for cassava plantation in this estimation also presented a positive and statistically correlation at 10% significance for Pooled and Savannakhet. This means that an increase of labor by 1% will increase the yield of cassava in Pooled and Savannakhet by 0.07% and 0.11%, respectively. This evidence could indicate that cassava plantations in this area applied a simple and natural based way that is labor intensive for all processes of the plantation. Most farmers do not use any machinery or herbicides for planting, growing, weeding and harvesting. Therefore, the more labor used in the farm, the more output in terms of cassava yield attained. These results are consistence with the previous works (Kasim *et al*., 2014 and Ogunniyi *et al*., 2012).

The other interesting point to mention here is that only the estimated coefficient of variety cost in Vientiane is statistically significant at 10% significance level. This implies that the expenditure for varieties for cassava plantations in Vientiane has an effect on cassava yield. If farmer increase capital in terms of expenditure for variety, they could choose a healthy and free-disease planting material and better root soaking fertilizer. Farmers in those two areas usually soak cassava root by available fertilizers for a few days before planting in order to accelerate and thrive best for cassava plantation for increasing the yields. This finding is in agreement with the work of (Vannisaveth *et al.,* 2012 and Kasun *et al.,* 2014). The result on the effect of variety cost, however, contradicts work on the analysis on technical efficiency of maize farmers in the northern province of Lao PDR (Southavilay *et al*., 2012). The implication of this finding is that policies that provide affordable farm land, planting material and labor would improve farm production.

The minimum, maximum and mean values of technical efficiency for cassava plantations in Pooled, Vientiane and Savannakhet data sets are presented in Table 5.6. The maximum technical efficiency for the 3 data sets was estimated to be higher than 90%. This means that the best practices of cassava farming operate as high as over 90%. Contrarily, the least practice in terms of technical efficiency of cassava plantations in Savannakhet has the minimum score at about 17%, lower than that in Vientiane which has a score of about 33%, while the overall minimum technical efficiency is even lower at about 8%. On average, the mean score of technical efficiency for cassava farmers are 56%, 72% and 75% for Pooled, Vientiane and Savannakhet data sets, respectively. This implies that the technical efficiency could be improved by about 28% for Vientiane and 25% for Savannakhet on the average to the level of the best farming practice with the current set of inputs and the given technology in the study area. In comparison to the technical efficiency reported in previous work in Lao PDR, the mean technical efficiency of this study was found to be higher than that in other studies (Southavilay *et al*., 2012) that assessed the technical efficiency of maize farms in Borkeo province with a mean technical efficiency of 65%. It is, however, lower than work of (Vannisaveth *et al.,* 2012) that analyzed the technical efficiency of maize farms in Sayaboury province that reported a mean technical efficiency of 85%.

Table 5.6: Distribution of the technical efficiency of cassava plantation

Technical Efficiency range	Pooled		Vientiane		Savannakhet	
	Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
0.0 - 0.1	2	1.04%	0	0.00%	0	0.00%
0.1 - 0.2	5	2.59%	0	0.00%	2	2.38%
0.2 - 0.3	15	7.77%	0	0.00%	1	1.19%
0.3 - 0.4	49	25.39%	7	6.42%	1	1.19%
0.4 - 0.5	22	11.40%	10	9.17%	4	4.76%
0.5 - 0.6	10	5.18%	9	8.26%	5	5.95%
0.6 - 0.7	28	14.51%	15	13.76%	10	11.90%
0.7 - 0.8	20	10.36%	27	24.77%	12	14.29%
0.8 - 0.9	27	13.99%	20	18.35%	40	47.62%
0.9 - 1.00	15	7.77%	21	19.27%	9	10.71%
Total	193	100.00%	109	100.00%	84	100.00%
Min Efficiency	0.0818		0.3337		0.1723	
Max Efficiency	0.9678		0.9602		0.9377	
Mean Efficiency	0.5587		0.7196		0.7496	

Source: estimated results from household survey data in 2012

The table also provides the frequency distribution of technical efficiency of these data sets. In Vientiane, approximately 19% of cassava farmers achieved a high level of technical efficiency ranging between 91-100%. About 43% of farmers had technical efficiencies in the range of 71-90%. The proportion of farmers about 22% had technical efficiencies in the range of 51-70%, while the lower technical efficiency range of between 31-50% for Vientiane cassava farmers was about 16%. In comparison of technical efficiencies in Savannakhet, Approximately 11% of farmers achieved a high level of technical efficiency ranging between 91-100%. The majority proportion of about 62% of cassava farmers had technical efficiencies ranging between 71-90%. The proportion of farmers who had technical efficiency ranging between 51-70% is about 18%, while the proportion of farmers with technical efficiency lower than 50% is about 10%.

4.5. Determinant of Technical Efficiency for Cassava Plantation.

Table 5.7 reveals the results of the effect of household characteristics and farming practices on technical inefficiency. The dependent variable is the inefficiency score of each farm estimated from the stochastic frontier production function through the application of the maximum likelihood. The independent variables are age and its square term, education and experience of households, farm care, dummy land preparation, dummy period of cassava plantation and dummy province whether it is Vientiane or not. It is noteworthy that when considering the coefficient of the explanatory variables in the inefficiency effect model, a negative sign for a parameter implies an increase in technical efficiency. In addition, the results of the Savannakhet data set in term of factors effected on technical inefficiency is shown, but they are not suitable for analyses due to the LR statistic test in section 4.2 (Table 5.3) indicate that there is no effect from the given determinant of farmers' specific factors on technical inefficiency. In the meantime, the results of all coefficients of famers' specific factors in Savannakhet, shown in table 5.7, do not indicate any evidence on statistically significant correlation with the technical inefficiency.

The important features of the effect of the explanatory variables on technical inefficiency in this study are the age of household, land preparation and planting period for Vientiane. The coefficient of the dummy variable for land preparation for cassava plantation had a negative sign and is statistically significant at 10% and 1% significance level for Vientiane and the Pooled data sets, respectively. It indicates that cassava farming with good land preparation before planting tends to be more efficient than those who do not to both, with other factors fixed. Cassava can be grown on a wide range of soils but it is more suitable in light deep soils. Land preparation should be deep enough and soil should be ploughed, harrowed, and rowed up and it should be adequate drainage in order to accommodate the effective growth of cassava tubes (Anthony *et al.,* 2008).

Table 5.7: Maximum likelihood estimates of inefficiency effect Determinant

Variables	Parameters	Pooled			Vientiane			Savannakhet	
		Coeff	*t-ratio*		*Coeff*	*t-ratio*		*Coeff*	*t-ratio*
Inefficiency Effect Model									
Constant	δ_0	2.6537	5.1563	***	1.6829	2.4453	*	10.5555	1.0476
Age	δ_1	-0.0566	-2.6989	***	-0.0630	-1.9285	*	-0.7192	-1.0413
Age^2	δ_2	0.0006	2.5121	**	0.0006	1.7718	*	0.0083	1.0335
Experience	δ_3	0.0536	1.0004		0.1082	1.4846		0.3560	0.9343
Education	δ_4	-0.0199	-1.0480		0.0264	0.9857		0.0487	0.4407
Dlandpreparing	δ_5	-0.3687	-2.8447	***	-0.5157	-1.8559	*	-2.4511	-1.0761
Farmcareness	δ_6	-0.1837	-0.6425		-0.2573	-0.7620		-9.5760	-0.9343
Dplantperoid<=9	δ_7	-0.0957	-1.0244		-0.3047	-1.8721	*	2.7550	0.8077
Dprovince	δ_8	-1.0437	-5.7954	***					
Observations		193			109			84	

Source: estimated results from household survey data in 2012
*Note: The dependent variable is inefficiency score for the technical inefficiency effect models, respectively. ***, **, * denote significant level at 1, 5 and 10% respectively.*

The other important parameter that has an effect on the technical efficiency of cassava plantations is the planting period. The coefficient of the dummy variable on planting period of Vientiane had a negative sign and is statistically significant at 10% level. This implies that cassava plantation for 9 months has a greater potential of increased technical efficiency. This means that the longer time taken for cassava growth would not contribute to an increase in technical efficiency. As mention early that farmers in Vientiane prefer to plant cassava in April-May, the beginning of wet season, and harvest in December in the dry season. This evidence is also consistent to the best time plantation as identified in the work of (Anthony *et al.,* 2008 and Howeler R.H). This result confirms that this might be a suitable time period for cassava harvesting to obtain a higher yield which could response to the high demand on raw materials for a cassava processing industry within the area.

Even though the estimated coefficient of farm care in terms of labor used for weeding in the cassava field is not statistically significant, a negative sign is shown in relation to its correlation to technical inefficiency. It was expected to have a positive and significantly impact on technical efficiency, since farmers paid more attention to the care of their cassava plantation and often spends time clearing grass and other unnecessary plants in order to let the cassava tubes obtain maximum fertility from the soil. It might be, however, a better variable or better data to use that could capture the effect on the technical inefficiency for cassava plantation.

The effect of the control variables is observed in that the coefficient of age in Vientiane and pooled data has a negative sign and is statistically significant on technical inefficiency at 1% and 10% significance, respectively. In addition, while its square term shows a positive sign and is statistically at 5% significance for Vientiane and 10% significance for pooled data. The result shows that the parameter age has a U-shaped relationship with technical inefficiency. This implies that technical efficiency tends to increase, ceteris paribus, when younger farmers work for cassava plantation, but as farmers age, technical efficiency seem to decrease. The reason might be that cassava plantations in this area is labor intensive and cassava farming practice needs manpower for growing, weeding and harvesting in order to increase productivity and obtain high yield. Therefore, when young farmers work in a cassava farm, technical efficiency has potential to increase. On the other hand, aging farmers tend to have less energy for farming practices. This suggests that age leads to technical inefficiency in cassava farming practice and this is consistent with the studies of Akhtaruzzaman *et al*., (2010) and Shehu *et al*., (2007).

The estimated coefficients of the experience on farming for pooled and Vientiane are statistically insignificant and have a positive sign for technical inefficiency. This implies that farmers with more or less experience in this area had no effect on the technical efficiency of cassava farming practices. This condition can be explained in that most farmers prefer to practice cassava plantations in a simple way, rain fed without irrigation, and they have just begun to grow cassava in recent years with few lessons learnt on planting, caring and harvesting from external sources. Therefore, farmers' experience did not support improvements in technical efficiency for cassava plantations in this area during the study period.

The estimated coefficient of education is statistically insignificant and implies that the farmer's education did not show any effect on technical efficiency. The result shows a conversely estimated direction from the work of Bravo and Pinherio (1997) and Benjamin *et al.*, (2011) where farmer' education has effect on reducing technical inefficiency level. For this study, most farmers have a low level of education (see Table 5.2). The less educated farmers are also able to grow cassava, but they practice in a traditional farming system-based. Thus, there is possibly insufficient variation in the education variable to capture its effect on technical efficiency.

5. Summary and policy implications.

This study was carried out to investigate whether cassava farming demonstrates returns to scale under the given input factors and available technology, as well as to estimate the level of technical efficiency through the application of the Cobb-Douglass stochastic frontier production function. The study then extends to determine farming performances in terms of technical efficiency from the data of 193 small-scale households farming characteristics in rural areas of Vientiane and Savannakhet provinces, Lao PDR in 2012.

From the analyses, four main significant results were revealed. *Firstly*, the study showed that farm size, labor and variety costs were the key input factors that have the potential to increase output in terms of cassava yield in Vientiane and Savannakhet. But obviously there are constraints to just increasing the farm investment capital, available of labor and land especially for the smallholders. So taking into account these constraints, we could find that there is still room for increasing returns to scale and improvements in technical efficiency. *Secondly*, the existence of an increasing return to scale for smallholder cassava farming in Savannakhet implies that a proportionate increase in all the input factors would result in a more than proportionate increase in cassava outputs. This means that small-scale cassava farming has not optimized use of the current resources available under the given technology. This evidence could not be found in Vientiane which means that cassava farming in this area performs a constant return to scale. *Thirdly*, the estimated mean scores of technical efficiency are 72% and 75% for Vientiane and Savannakhet, respectively. This indicates that the fairly technical efficiency for cassava plantations could be improved by about 28% for Vientiane and 25% for Savannakhet through the better use of the current set of inputs and the given technology. *Finally*, the key determinants of technical efficiency are to plant cassava with good land preparation, to arrange suitable time period for plantation and to have farmers of a young age. This is significant particularly for Vientiane.

The evidence of the study on the economies of scale and technical efficiency indicates the important implications that opportunities still exists to increase cassava output through maximum utilize the given input factors and to improve inefficient farming practice to become better performance. From this point of view, it is recommended that cassava production should be based on the techniques that could support the improvement of optimum use of their resources especially on land, labor and capital in order to ensure that cassava production can reap optimal benefits. In addition, it is requires further comprehensive and careful study on the improvement of technical efficiency for cassava production in order to provide consistent evidence to support cassava farming practice in the right direction under the commercial crop promotion with the expectation to achieve the agricultural development goal on food security, better livelihoods and sustainable farming in Lao PDR.

Chapter 6: Economies of Scale in Smallholder Rubber Farming

The high demand and income potential of rubber plantations in the Lao PDR has resulted in increased public sector interest in plantations since the 1990s. Rubber is a popular crop for agribusiness and attracts large investment from both domestic and foreign enterprises, thereby alleviating rural poverty in Lao PDR by supporting the shift from subsistence agriculture to a more commercialized production system. Over the past 10 years, rubber plantations have been rapidly expanding across the country, whether by large-scale concession, smallholder farmers or individuals. Large-scale rubber plantations with high technology and capital are more efficient in terms of resource utilization than small ones, and tend to eliminate the smallholders whose traditional practices do not take advantage of the land's maximum potential. Rubber plantations generally don't see economic returns during the first 7 years, so they require a large initial capital which creates dependence on outsource capital, particularly for smallholder farmers.

From this point of view, the purpose of this chapter is to analyze the sustainability of the Lao farming system in terms of technological aspect. Particularly, this study investigates the economies of scale through the relationship between the costs of rubber plantation (labor use for land clearing, planting, weeding, herbicide, spraying and tapping; and total labor, plantlet, equipment and total costs) and yield in different 5 year periods and then it further analyze the relationship between the unit costs and years of latex tapping on rubber plantation in Luangnamtha province, Lao PDR. Household data and random face-to-face interviews, collected from 95 rubber farmers with 5 years different data of output, are analyzed using the robust Ordinary Least Square (OLS) on cost function and the study provides significant pioneer results.

The result indicates the existence of economies of scale in rubber plantation as the significant reduction in the costs per unit of output year over year. This implies that rubber plantations in this area could benefit from large-scale farming with the potential capacity to minimize the cost of rubber plantation, while smallholders tend to integrate with the large-scale farming for survival. If there is no support for smallholders, large-scale farming will continue to take advantage and can overrun smallholder farming.

In addition, the result also highlights the increasing returns to scale in cost of rubber farming. The result indicates that at the beginning stage, the initial cost (land clearing and planting costs) for rubber plantation is very important. There is a tendency that larger-scale plantations have better condition and it is concerned that individual small-scale farmers would be replaced by large scale concessions. When rubber plantation operate for year and over year, then the operation cost (labor use for tapping and management cost) will later become essential, due to all of the cost depend on the variable cost and the proportion of variable cost to fixed cost increase. This means that smallholders could compete with the large-scale farming in terms of efficiency of operating cost. All in all, if smallholders overcome such difficult situations by their own competitiveness and governmental support, their management for farming practices will be better improvement.

1. Introduction

Over the past decades, agriculture has been one of the most important sectors for socio-economic development in Lao PDR. The attractive conditions of available land resources, land fertility, abundance of forests and low wages has attracted large flows of domestic and foreign investment into the country. In addition, the government's policy for the agriculture sector, as initially set out in the 6th National Socio-Economic Development Plan (2006-2010), focused on the transition from subsistence agricultural economic activities to a more commercialized production system. Therefore, the production systems are changing and farmers are making more links to the market. Thus, several commercially important crops including rubber, maize, sugarcane and cassava were introduced into the agricultural farming system of Lao PDR.

Rubber is one of the most important crops that could generate income and support economic growth due to increasing demand and price, especially in the Asia region. In 2010, Indonesia had the largest area of rubber plantations (3.45 million hectares). The second largest country in terms of rubber plantation area was Thailand (2.88 million hectares). Malaysia was the third (1.02 million hectares). However, Thailand was the world largest producer and exporter of rubber and supplied 3.072 million tons in 2010, followed by Indonesia[14]. Regarding the demand for rubber, China was the biggest consumer of rubber covering 3.025 million tons or about 38% of the total global rubber demand in 2010 (Natural Rubber Trend and Statistics, 2010).

In the early 2010s, rubber was one of the most popular crops for agribusiness and attracted more interest from the public and private sectors in order to reduce poverty and create permanent jobs for farmers in Lao PDR. Rubber plantations across the country increased rapidly

[14] The Association of Natural Rubber Producing Countries (ANRPC) produced 9.5 million tons of rubber in 2010, covering 85% of global rubber production (http://www.anrpc.org).

from less than 6,000 hectares in 2003 to 147,000 hectares in 2008 and 234,000 hectares in 2010 (NAFRI, 2011). This upward trend continued until the recent review of government policy on rubber plantation indicating that suitable and clear policies, regulations and restrictions to support rubber plantations towards sustainability and contributions to poverty reduction have not been put into place. Rubber plantations in Lao PDR are generally classified into three main patterns: smallholders, contract farming and concessions. Based on this classification, the rubber plantation area in terms of concession patterns covers a large area. Schonweger *et al*., (2012) reported that the approvals of land concession for rubber plantations by foreign investors in Lao PDR covered a total area of 129,614 ha, with an additional 66,500 ha operated by contract farming and smallholder patterns. Although the rubber concessions covered a majority of the area, the government of Lao PDR pays more attention to supporting smallholders and individual rubber farming as a mean to increase farmers' income for poverty reduction and to stabilize the farming system (Manivong and Cramb, 2008a).

In the 2010s, provincial governments across the country supported rubber production and included rubber plantations in the implementation of their provincial socio-economic development plans (Thanthathep *et al.,* 2008). Of these, Luangnamtha province has rapidly changed their previous agricultural approach by shifting from cultivation towards more commercialization, especially in terms of rubber plantations. For example, in Ban Hadyao village rubber plantations increased rapidly from 473 ha in 1994 to 16,534 ha in 2001. This was driven by the Hmong ethnic group from China who had over 15 years of experience in rubber plantations. There was a further increase to 35,085 ha in 2010 due to Chinese investment (NAFRI, 2011 and Manivong and Cramb, 2008b). Rubber plantations in this province are mainly practiced by smallholders and contract farming, whereas concessions are limited in this area.

Rubber plantations in this province, however, have been based on customary and traditional practices that do not take full advantage of the land potential. Smallholders lack the capacity to access credit, information, technology, and plantation and tapping techniques. Rubber plantations generally delay economic returns during the first 7 years and require a large initial capital that creates local farmer dependence on foreign investment (NERI, 2012 and NERI, 2014). Due to this situation, there were concerns that a majority of individual small-scale farmers who are key players in the agricultural sector would be left behind and eventually replaced by large scale corporations or concessions (Yoav and Willis, 1991). This might imply that there are economies of scale in rubber plantations in the agricultural sector of Lao PDR. If increasing returns were appear for this type of production, we may have seen many big factories or corporations dominating the entire agricultural industry instead of small-scale farmers (Yoav and Willis, 1991). Conversely, if diminishing returns to scale occurred in rubber production, small-scale farming may be able to survive in confront with the rapid shifts of the economic situation.

The existence of economies of scale in rubber plantations has been a controversial issue for decades in the agricultural economic development field. Some have indicated that small farms are more efficient than large farms. This idea first appeared in the late 1960s (Srinivansan, 1972 and Robert, 1993). Therefore, the objectives of this study is to examine whether economies of scale exist for smallholder rubber farming, determine the relationship between the costs and output of rubber farming, and investigate the costs per unit of output for smallholder rubber farming in Luangnamtha province, Lao PDR. The remainder of this paper is divided into four sections. Section 2 highlights data and the study site. Section 3 presents the methodology of the study. Section 4 discusses the results and implications of the study, and the conclusion is summarized in Section 5.

2. Study Area and Data Collection

Luangnamtha district, where the main city is located, is in the east of Luangnamtha province. It shares a border with China to the north and is surrounded by Sing, Nalae, Viengphoukha and Long districts of Luangnamtha province, as well as Namor district of Oudomxay province. The district's total land area is 230,400 ha in which 75% is covered by mountains. The district has the potential for international economic integration via road R3 that crosses the district and links with China and Thailand. Over the past ten years (2004-2013), the district's economic development showed great improvement. The agricultural sector's growth rate increased from 6.5% in 2004-2009 to 12.5% in 2011-2013, whereas the growth rate of the industry and service sectors increased from 15% and 18% in 2004-2009 to 25.5% and 34% in 2011-2013, respectively. In terms of agricultural land area, the rice plantation area cover 3,863 ha, upland rice 380 ha, while maize, sugarcane, cucumber, soybean, fruit trees and vegetables cover 3,569 ha. The most popular type of farming, however, is rubber plantations which cover 8,804 ha and is over twice as large as the rice production area (Luangnamtha District Office, 2013).

The study area focused on Luangnamtha district, Luangnamtha province (called Luangnamtha hereafter), which is covered with a large area of rubber plantations and was the first area planted with rubber. In 1994, Ban Hadyao was the first village that planted rubber in the northern part of Lao PDR. It covered a land area of about 473 ha and was cultivated by individual farmers. Since 2004, due to the demand and high interest for rubber products in the region, the province attracted a rapid inflow of Chinese rubber companies. Most of them operated their business through a contract farming system with local farmers (Charlotte *et al.,* 2009). Therefore, rubber plantation areas in the province rapidly increased from 16,534 ha in

2001 to about 35,085 ha in 2010 and ranked as the largest area for rubber plantations across the country (NAFRI, 2011). All in all, the smallholder and contract farming scheme played a key role for rubber plantations in this area, whereas the concession for rubber plantations rarely existed in the province.

The household survey for this study was conducted in 4 villages of Luangnamtha namely Namdengtai, Hua Na, Paknamlueng and Donxay. The data collection involved randomly interviewing 95 rubber farmers through well-constructed questionnaires (it is quite similar to the cassava case in Annex 4). The data details of households consist of output (latex tapping); cost of labor by activities: land clearing, planting, weeding, herbicide spraying and harvesting; cost of equipment and plantlet; and total cost over 5 years of rubber tapping from 2008 to 2012. In addition, the secondary data and related research from previous studies were also gathered from the central and local government offices, online sources and journal publications.

3. Analytical Methodology

3.1. Economies of Scale

Theoretically, economies of scale is a term that refers to the reduction of costs per unit through an increased proportionally in the production volume, while holding all other input prices constant. Economies of scale exist by the significant inverse relationship between the quantity produced and per-unit fixed cost. In other words, the greater the quantity of goods produced, the lower the per unit fixed costs because they share a larger number of inputs to production. Economies of scale may also reduce variable costs per unit because of operational efficiencies and synergies[15].

[15] http://www.investopedia.com/terms/e/economiesofscale.asp access on 18.5.2015. 5:35’

In microeconomics, economies of scale are the cost advantages that enterprises obtain due to size, output, or scale of operation, with cost per unit of output generally decreasing with increasing scale as fixed costs are spread out over more units of output. Chandler (1994) highlighted that economies of scale may be defined as the result of a reduction in the unit cost of production as the size of a single operating unit producing a single product increases.

Economies of scale are theoretically measured by the analysis of industry production costs as a function of output. Therefore, a cost function is applied to describe the technological parameters. Based on Diewert (1982), the producers' cost function is defined as the solution to the problem of minimizing the cost of producing at the least output level, given that the producers face the input price vector. This model is shown as the equation below:

$$C(p, y) = \min_{x \geq 0}\{p.x : f(x) \geq y\} \tag{6.1}$$

Where C is the cost function, $p = (p_1, \dots p_i)$ denotes the positive vector of input prices, $x = (x_1, \dots x_i)$ denotes the non-negative parameter of inputs, and $f(x)$ denotes the production function of the input vector for a single producer that describes the relationship between inputs and maximum output. y is the maximum output produced with the given inputs.

Therefore the cost function expressed in equation (6.1) is the minimum cost that produces a given output level within a given time period, which is defined as a function of input price and output (Chambers, 1988). The cost function has to include the important properties of the non-negative function of input and output, non-decreasing in output and input prices, concave and linear homogeneous in input price. In addition, the cost function should be capable of estimating the zero values of some outputs in order to capture the evidence of economies of scale (Syamak and Hamed, 2013)

3.2. Model Specification for Cost Function

In order to measure the cost function in equation (6.1), the most commonly used model specifications are the translog, polynomial and linear cost functional forms. The studies by Carter and Dean (1961), Binswanger (1974), Paul (1987), Kuroda (1995), Salmon (1999), Koo *et al*., (2001), Emadzadeth *et al*. (2002) applied the translog cost function in agriculture and farm production economics. Bacsi (1997) used the polynomial cost function to analyze the production technology of agricultural producers. Syamak and Hamed (2013) applied the linear, quadratic and cubic functional forms using the ordinary least square (OLS) method to investigate the optimized farm size of barley crops in Tehran Province of Iran and found that the average total cost decreases with an increase in farm size. In this study, the linear functional form is employed to investigate the economies of scale in rubber plantations in Luangnamtha. The total cost and unit cost is separately analyzed for this study, which is divided into two stages. The first stage demonstrates the relationship between the cost and output and mathematically expresses this in the functional forms below:

$$Costs_i = \beta_0 + \beta_1 y_i + \varepsilon \qquad (6.2)$$

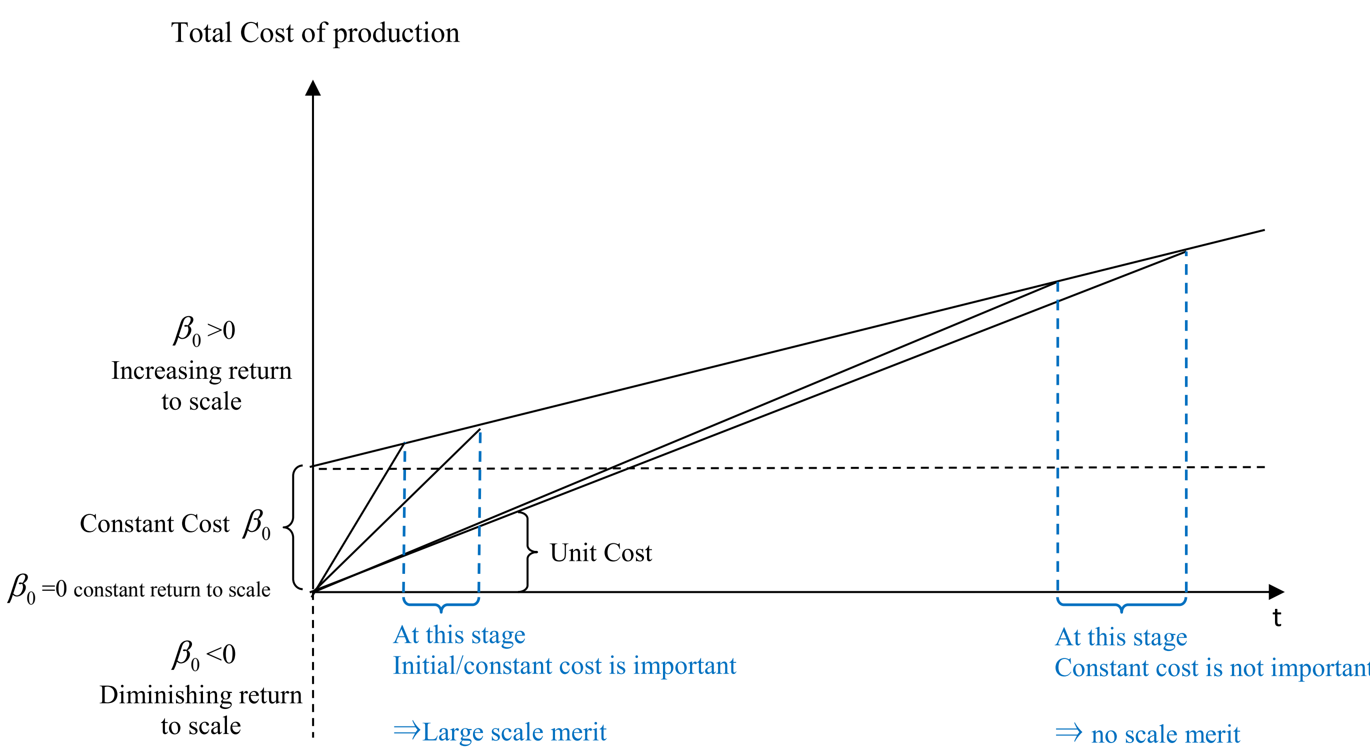
Where: the subscript i denotes the ith farmer. $Costs_i$ are the costs of labor (land clearing, planting, weeding, herbicide spraying, tapping), plantlet, equipment and total cost. y_i is the output of rubber in terms of latex tapping of the ith farmer. β_0 is a constant. If $\beta_0 > 0$, it expresses the evidence of increasing returns to scale, while if $\beta_0 = 0$ and $\beta_0 < 0$, it implies the evidence of constant returns to scale and diminishing returns to scale, respectively (see figure 6.1). β_1 is an unknown parameter to be estimated. ε denotes unobservable random errors.

In the second stage of the analysis, the study shows the relationship between the cost per unit of output and year variable in order to capture the economies of scale year by year (for the first five year tapping periods). It is hypotheses that when planting rubber year over year, the unit cost trend is reduced, which indicates the evidence of the economies of scale on rubber plantations. The unit cost function is shown as below:

$$UnitCosts_i = \delta_0 + \delta_1 year_i + \omega \quad (6.3)$$

Where: $UnitCosts_i$ are the unit costs (costs over yield) of labor (land clearing, planting, weeding, herbicide spraying, tapping), plantlet, equipment and total. $year_i$ denotes the number of years of farmer tapping for latex of the *i*th farmer. δ_0 is a constant and δ_1 is an unknown parameter to be estimated. ω denotes unobservable random errors.

Figure 6.1: The different importance of constant cost



Source: Onishi H., 2015: Marxian economics.

4. Empirical Results

This section is divided into three parts. The first part analyzes the summary statistics of the variables of the cost function and output. The second part presents results of the regression on the costs and output, and the costs per unit output and year variable. The last part discusses the implications of the study.

4.1. Summary Statistics of Variables

As mentioned above, the analysis for this study is divided into two stages. *At the first stage*, the study uses data from 95 surveyed farmers in 2012 and arranges them into 5 year periods based on the years that rubber trees of the farmers were tapped. There were 95 observations in the first year tapping, 92 in the second year tapping, 83 in the third year tapping, 27 in the fourth year tapping and 16 in the fifth year tapping. Table 6.1 presents the mean costs of labor (land clearing, planting, weeding, herbicide spraying, tapping), total labor cost, plantlet, equipment and total input cost and output of the total observation over the 5 year period.

Labor use for land clearing is calculated by multiplying the number of days for land clearing in the first year of rubber plantations by each household and number of family's labor used. The average labor used for land clearing for rubber plantations is about 23 man-days estimated base on tapping for latex (or rubber tapping observations) in the first, second and third years. The labor used as of such estimation in the fourth year is slightly higher at about 29 man-days, while it is double in the fifth year compared to the first and second years. It is important to observe that labor use of the observations is different subject to the year of rubber tapping due to the different volume or number of observations estimated in its mean value.

The labor use for rubber planting is estimated by multiplying labor use and the number of days for rubber plantation in the first year of each household. The average labor use for rubber planting is about 10 man-days for the rubber tapping observations in the first, second and third years, while it is higher by about a half in the fourth year and double in the fifth year.

Table 6.1: Summary statistics of variables in mean for the cost functional form

Variables	**Unit**	First year tapping	Second year tapping	Third year tapping	Fourth year tapping	Fifth year tapping
		Mean				
Land clearing	Man-day	22.34	22.71	23.08	29.22	42.37
Planting	Man-day	10.32	10.41	10.41	15.07	20.44
Weeding	Man-day	33.35	32.66	32.18	30.83	36.13
Herbicide spraying	Man-day	3.61	3.67	3.41	4.54	5.18
Tapping	Man-day	12.23	17.54	49.09	63.09	98.07
Total Labor Use	Man-day	81.85	86.99	118.17	142.76	202.19
Labor cost	1000 Kip	4,593.37	4,856.47	6,322.45	8,141.33	11,099.47
Plantlet cost	1000 Kip	2,662.65	2,698.66	2,719.00	3,079.13	3,912.28
Equipment cost	1000 Kip	186.28	187.58	184.96	316.05	378.43
Total cost	1000 Kip	7,442.31	7,742.71	9,226.41	11,536.51	15,390.18
Yield	kg	552.26	769.87	1,127.75	1,806.18	2,671.75
Observations	*Households*	*95*	*92*	*83*	*27*	*16*

Source: Survey data, 2012

The average labor use for weeding on their rubber farm is estimated from the accumulation of labor use multiplied with the number of days for weeding in a year, from the first year to the fifth year of rubber tapping and divided by the number of years of planting for the period. The estimated mean value of labor use for weeding in rubber farm over the 5 year period for latex tapping is not much different and ranges from 30-36 man-days.

A similar calculation method for the labor use of weeding is applied for the labor use of herbicide spraying. Most farmers were also aware of the impact of using herbicides on health and their farm land (Grace, Darachanthara and Soukkhamthat, 2014). Therefore, there are only a few households using herbicides for clearing unnecessary grass on their rubber farm. The average labor use for herbicide spraying is about 4-5 man-days for over 5 year tapping period.

As mentioned above, rubber trees can be tapped for latex after plantation for at least 7 years. At the initial period of latex tapping, it is need not much of labor in the first year for tapping their rubber tree. This amount of labor and the number of working days increase annually after the year that the rubber trees were tapped for latex. The mean values in table 6.1 also reveal that the labor use of rubber tapping is about 12 man-days for the rubber tapping observations in the first year. It is about 4 times higher in the third year and 8 times higher in the fifth year, compared to the meanvalue of the rubber tapping observations in the first year.

The estimated total cost of running rubber plantations in this study included the cost of labor, plantlet and equipment. Over the 5 year period for rubber tapping, the labor cost covered a large part of the total cost for rubber plantations. For the rubber tapping observations in the first year, the labor cost was about 4.5 million kip or covered about 60% of the total cost (7.4 million kip), while the plantlet and equipment costs were 36% and 4%, respectively. These proportions of cost for rubber plantations are also similar to the rubber tapping observations in the second and third years. The proportion of costs are largely different for the fourth and fifth year, in which the labor cost covered about 70%, while the plantlet and equipment were about 26% and 4% of the total cost, respectively. This implies that rubber plantations in Luangnamtha were labor intensive.

According to table 6.1, the mean value of latex was about 552 kg in the first year, then its mean harvested yield increased to about 770 kg (or about 40%) for the second year. Then, latex could be additional harvested in larger amounts for the third and fourth year at an average of 1,127 kg and 1,806 kg per year, respectively. The highest mean value of latex was in the fifth year at about 2,671 kg per year, or about 5 times higher when compared to the mean value of first year.

In the second stage of the analysis for this study, the data of the estimated variables over the 5 years of rubber tapping observations were pooled together, with a total of 313 observations. Table 6.2 shows the summary statistics in mean, standard deviation, minimum and maximum values of all variables used for the estimated unit cost function of year variable.

The mean unit costs of labor use for land clearing, planting, weeding, herbicide spraying and tapping are 0.10, 0.02, 0.17, 0.01 and 0.07 man-days per kg, respectively. Their standard deviations vary not much from their mean value. Only labor use for land clearing and weeding demonstrates the highest maximum value at 10 and 8.5 man-days per kg, respectively. This implies that these two activities indicate labor intensiveness during the time period. The other interesting point to mention here is that the mean value of the unit cost of total labor use for rubber plantation is 3.28 man-days per kg, while its standard deviation is a bit high at 8.16 man-days per kg. Even though the minimum value is zero, its maximum value is 76 man-days per kg.

Table 6.2: Summary statistics of Variables for the cost functional form of pooled data

Dependent Variables	**Unit**	**Observations**	**Mean**	**Std. Dev.**	**Min**	**Max**
Land clearing	Man-day/kg	313	0.1067	0.5974	0.0000	10.0000
Planting	Man-day/kg	313	0.0276	0.0789	0.0000	1.1429
Weeding	Man-day/kg	313	0.1703	0.7076	0.0000	8.5476
Herbicide spraying	Man-day/kg	313	0.0145	0.0476	0.0000	0.5714
Tapping	Man-day/kg	313	0.0759	0.2351	0.0000	2.7000
Total Labor Use	Man-day/kg	313	3.2844	8.1646	0.0000	76.1000
Labor cost	1000 Kip/kg	313	22.0436	78.8671	0.0000	1,136.7860
Plantlet cost	1000 Kip/kg	313	13.7409	57.0904	0.4250	907.1429
Equipment cost	1000 Kip/kg	313	1.0272	7.0286	0.0011	120.2857
Total cost	1000 Kip/kg	313	36.8116	138.0580	0.5874	2,164.2140
Independent Variable						
Year of tapping	years	313	2.2875	1.1381	1.0000	5.0000

Source: Survey data, 2012

Regarding the unit cost of labor, plantlet and equipment, the mean value of labor costs cover a large proportion of the total cost at about 60% or about 22,000 kip per kg. The mean value of plantlet costs covers about 37% of total unit costs or about 14,000 kip per kg, while a lower amount of unit cost is spent on the equipment and covers only 3% of the total unit cost. Lastly, the year tapping variable has its mean value of 2.28, which implies that most farmers had just begun tapping their rubber farm for about 2 years.

4.2. Results of the Estimated Economies of Scale in Rubber Plantation

This study investigates the economies of scale through estimating the relationship between costs of rubber plantation (labor use for land clearing, planting, weeding, herbicide spraying and tapping; and total labor, plantlet, equipment and total costs) and different set of yield variables of 5 years period. Through applying the robust Ordinary Least Square (OLS) cost function method, fifty different model regressions are shown in table 6.3.

At the first stage of the analysis, the robust estimation results between the costs for rubber plantations and its output are shown in the sub-tables 6.3C1 to 6.3C10. In sub-table 6.3C1, the yield variable does not show any significant relationship with the labor use for land clearing in 5 different models, while the constants are all statistical significantly and indicate positive relations with the labor use for land clearing (except in the 4^{th} year of tapping). The sub-table 6.3C2 shows that the coefficients of yields (0.0060 in the second year and 0.0065 in the fifth year) have a positive sign and are statistically significant, with labor use for rubber planting in the second year and fifth year of tapping, respectively. It is noted that when the yield increases in any proportion, and all other things being equal, the cost of labor use for planting increases less than the proportion of the output increase. This evidence is also consistent with the idea of Massimiliano (2013) that increasing outputs lead to a less than proportional increase in overall costs, with all other things being constant. This implies that economies of scale exist for rubber plantations in the specification model. Furthermore, the constant parameters show positive signs and are statistically significant with labor use for rubber plantation in the first, second and third year of rubber tapping. This also indicates evidence of increasing returns to scale.

The sub-table 6.3C3 also indicates that yield does not show any statistically significant relationship with the labor use for weeding in all 5 estimated models, while all constant parameters are statistically significant and have a positive relationship with the labor use for weeding. The sub-table 6.3C4 shows that rubber's yields do not show any statistically significant relationship with the labor use for herbicide spraying, except for the coefficient parameter (0.0008) of the fifth year of tapping, which shows to be statistically significant and has a positive sign with respect to the labor use for herbicide spraying. This implies that when the yield of rubber increases, the labor use for herbicide spraying to clear grass on rubber farms will also increase by a lesser proportion when other factors are fixed. However, its coefficient is very small. In addition, all of the constant values in five different models have a positive sign and statistically significant relationship with the labor use for herbicide spraying.

The sub-table 6.3C5 shows that only the coefficient of yield in the fifth year of tapping indicates a positive sign and is statistically significant with labor use for tapping at 1% level. This means that when yield increases by one unit, labor use for rubber tapping will increase by 0.017 units (less proportion than of output increase), ceteris paribus. The constant term also show positive sign and statistically significant. These results also provide the evidence of increasing return to scale. The sub-table 6.3C6 presents the rubber yield results for the first year of tapping to the fourth year and does not show any significant relationship with total labor use for rubber plantations. The coefficient (0.0312) of yield for the fifth year of tapping, however, is statistically significant at 1% and has a positive relationship with total labor use for rubber plantations. In addition, the constant parameters are also statistically significant and have a positive relationship with the total labor use. These results also confirm the evidence of the increasing returns to scale in rubber plantations in this area.

This study further estimated the total costs of labor, plantlet, equipment and total cost of rubber plantations in Luangnamtha. The results indicate that yields in different years are statistically significant and have a positive relationship with total labor cost in the fifth year tapping, plantlet cost in the first year tapping, equipment cost in the second and third year tapping and the total cost only in the fifth year tapping (see table 6.3C7-6.3C10). It can be noted that when yields increase in exact proportion, the overall costs will increase less than the proportion of output increase, when all other things being equal. This implies the evidence of economies of scale for rubber plantations. These results also further confirm the fact that in order to obtain more yields for rubber, more cost is also used but in less proportion. This finding is also consistent with the studies of Awotide and Adejobi (2006) and Giroh *et al*., (2010) who described that the reduction in costs were the results of an increase in the technical efficiency of farmers' output. The other important point to mention here is that all of the constant parameters in the sub-tables 6.3C7 to 6.3C10 are statistically significant and have a positive relationship with cost in all models. This also implies that the increasing returns to scale exist for rubber plantations in this study.

To sum up the results on the first stage of the estimation, the findings reveal that when data in each year is treated differently, the results indicate evidence of an increasing return to scale for rubber plantations in Luangnamtha. In addition, the initial cost for rubber plantations, for instance labor use for land clearing and planting and the cost of plantlets, are very important, especially at the beginning stage of establishing rubber plantations. Then after planting year over year, the operational costs for rubber plantations, especially labor use for weeding, tapping and the cost of equipment, becomes more important in order to obtain more latex as well as earn an income from rubber farming.

In order to capture the evidence on economies of scale, the estimation in the second stage between costs per unit of output (labor use for land clearing, planting, weeding, herbicide spraying, tapping and total labor use as well as total labor cost, plantlet cost, equipment cost and total cost) and year variables on rubber tapping are employed by the robust OLS regression method. The results in table 6.4 indicate that year variable in model UC1 to UC10 has an inverse relationship with the cost per unit of output. Furthermore, the year variables, except in model UC1, UC5 and UC9, are also statistically significant with their dependent variables, especially labor use for planting, weeding, herbicide spraying, total labor, labor cost, plantlet cost and total cost with the significant level between 5% and 1%. These results mean that when planting rubber year over year, the unit cost tends to diminish, when other factors are fixed. This implies that economies of scale exist for rubber plantations in the study. The finding is also in line with the work of Massimiliano (2013) who explain that the reduction per unit cost of production is determined by economies of technology, managerial change, and experience or learning.

In summing up, because initial cost is very important at the beginning, there is a tendency that larger-scale plantations play the key role in rubber plantation in this area. However, if small farmers overcome this difficulty through their competitiveness and governmental support, their management will become better year over year. If there is no support for smallholders, rich or large-scale farming investors may continue to take advantage and overrun smallholders.

Table 6.3: Results of the estimation on the cost function of yield on costs

Table C1 **Dependent Variable: Labor Use for Land Clearing**

Independent variables	Model LC1			Model LC2			Model LC3			Model LC4			Model LC5		
	Land clearing, 1st			**Land clearing, 2nd**			**Land clearing, 3rd**			**Land clearing, 4th**			**Land clearing, 5th**		
	Coef.	t		Coef.	t		Coef.	T		Coef.	t		Coef.	t	
Yield	-0.0004	-0.21		0.0010	0.45		-0.0017	-0.54		-0.0043	-0.74		0.0028	0.78	
Constant	22.5555	4.28	***	21.9439	3.76	***	24.9723	3.16	***	36.9368	1.64		34.7724	1.76	*
Observations	95			92			83			27			16		
R-squared	0.0001			0.0002			0.0008			0.0088			0.0055		

Source: Survey data, 2012.

Table C2 **Dependent Variable: Labor Use for Rubber Planting**

Independent variables	Model Pl1			Model Pl2			Model Pl3			Model Pl4			Model Pl5		
	Planting, 1st			**Planting, 2nd**			**Planting, 3rd**			**Planting, 4th**			**Planting, 5th**		
	Coef.	T		Coef.	T		Coef.	T		Coef.	T		Coef.	T	
Yield	0.0021	0.79		0.0060	2.41	**	0.0041	1.43		0.0043	1.37		0.0065	5.56	***
Constant	9.1650	4.90	***	5.7927	2.58	***	5.8301	1.69	*	7.3470	0.91		2.9990	0.52	
Observations	95			92			83			27			16		
R-squared	0.0176			0.0748			0.0451			0.0608			0.2237		

Source: Survey data, 2012.

Table C3 **Dependent Variable: Labor Use for Weeding**

Independent variables	Model w1			Model w2			Model w3			Model w4			Model w5		
	Weeding, 1st			**Weeding, 2nd**			**Weeding, 3rd**			**Weeding, 4th**			**Weeding, 5th**		
	Coef.	t		Coef.	t		Coef.	t		Coef.	t		Coef.	t	
Yield	0.0007	0.43		0.0007	0.15		-0.0005	-0.10		0.0016	0.31		0.0041	1.18	
Constant	32.9451	6.75	***	32.13914	5.69	***	32.6996	4.47	***	27.9210	1.85	*	25.0857	1.78	*
Observations	95			92			83			27			16		
R-squared	0.0003			0.0002			0.0001			0.0027			0.0257		

Source: Survey data, 2012.

Table C4	Dependent Variable: Labor Use for Herbicide Spraying														
	Model HB1			Model HB2			Model HB3			Model HB4			Model HB5		
Independent variables	**herbicide, 1st**			**herbicide, 2nd**			**herbicide, 3rd**			**herbicide, 4th**			**herbicide, 5th**		
	Coef.	t		Coef.	t		Coef.	t		Coef.	t		Coef.	t	
Yield	-0.0001	-0.55		0.0002	0.59		0.0001	0.24		0.0001	0.17		0.0008	1.96	**
Constant	3.6870	6.42	***	3.4835	4.99	***	3.2831	3.52	***	4.3605	1.91	*	3.0207	1.42	
Observations	95			92			83			27			16		
R-squared	0.0008			0.0014			0.0004			0.0004			0.0423		

Source: Survey data, 2012.

Table C5	Dependent Variable: Labor Use for Rubber Tapping														
	Model tap1			Model tap2			Model tap3			Model tap4			Model tap5		
Independent variables	**Tapping, 1st**			**Tapping, 2nd**			**Tapping, 3rd**			**Tapping, 4th**			**Tapping, 5th**		
	Coef.	t		Coef.	t		Coef.	t		Coef.	t		Coef.	t	
Yield	-0.0010	-1.38		-0.0002	-0.09		0.0066	1.50		0.0048	0.85		0.0170	2.71	***
Constant	12.8060	6.00	***	17.7225	5.78	***	41.6814	6.60	***	54.4538	3.52	***	52.7513	2.09	**
Observations	95			92			83			27			16		
R-squared	0.003			0.0001			0.0297			0.0188			0.1949		

Source: Survey data, 2012.

Table C6	Dependent Variable: Total Labor Use for Rubber Plantation														
	Model TL1			Model TL2			Model TL3			Model TL4			Model TL5		
Independent variables	**Total Labor, 1st**			**Total Labor, 2nd**			**Total Labor, 3rd**			**Total Labor, 4th**			**Total Labor, 5th**		
	Coef.	t		Coef.	t		Coef.	t		Coef.	t		Coef.	t	
Yield	0.0012	0.23		0.0076	0.98		0.0086	0.66		0.0065	0.40		0.0312	2.67	***
Constant	81.158	8.11	***	81.081	7.07	***	108.46	5.47	***	131.01	2.59	***	118.62	2.32	**
Observations	95			92			83			27			16		
R-squared	0.0002			0.0042			0.0052			0.6900			0.1013		

Source: Survey data, 2012.

Table C7 Independent variables	Model LC1 **Labor cost, 1st** Coef.	t		Model LC2 **Labor cost, 2nd** Coef.	t		Model LC3 **Labor cost, 3rd** Coef.	t		Model LC4 **Labor cost, 4th** Coef.	t		Model LC5 **Labor cost, 5th** Coef.	t	
Yield	0.1616	0.35		0.8673	1.05		0.8542	0.8		0.9665	0.87		2.1762	2.99	***
Constant	4504.137	8.42	***	4188.726	5.53	***	5359.107	4.09	***	6395.674	2.40	**	5285.266	2.11	**
Observations	95			92			83			27			16		
R-squared	0.0012			0.0186			0.0181			0.0331			0.1906		

Source: Survey data, 2012.

Table C8 Independent variables	Model PC1 **Plantlet cost, 1st** Coef.	t		Model PC2 **Plantlet cost, 2nd** Coef.	t		Model PC3 **Plantlet cost, 3rd** Coef.	t		Model PC4 **Plantlet cost, 4th** Coef.	t		Model PC5 **Plantlet cost, 5th** Coef.	t	
Yield	0.1563	1.67	*	0.1222	0.47		0.0200	0.06		-0.2175	-0.42		-0.3443	-0.61	
Constant	2576.335	9.27	***	2604.59	6.31	***	2696.422	4.75	***	3471.902	2.19	**	4832.074	1.89	*
Observations	95			92			83			27			16		
R-squared	0.0055			0.0017			0.0001			0.0077			0.0283		

Source: Survey data, 2012.

Table C9 Independent variables	Model EC1 **Equipment cost, 1st** Coef.	t		Model EC2 **Equipment cost, 2nd** Coef.	t		Model EC3 **Equipment cost, 3rd** Coef.	t		Model EC4 **Equipment cost, 4th** Coef.	t		Model EC5 **Equipment cost, 5th** Coef.	t	
Yield	0.0160	0.51		0.0768	3.56	***	0.0573	2.50	**	0.0255	0.86		0.0412	1.51	
Constant	177.4482	7.64	***	128.4612	4.96	***	120.3398	3.59	***	269.9349	3.56	***	268.3486	2.27	**
Observations	95			92			83			27			16		
R-squared	0.008			0.0936			0.0679			0.0263			0.1229		

Source: Survey data, 2012.

Table C10 Independent variables	Model TC1 **Total cost, 1st** Coef.	t		Model TC2 **Total cost, 2nd** Coef.	t		Model TC3 **Total cost, 3rd** Coef.	t		Model TC4 **Total cost, 4th** Coef.	t		Model TC5 **Total cost** Coef.	t	
Yield	0.3339	0.68		1.0663	1.16		0.9315	0.76		0.7746	0.58		1.8731	2.06	**
Constant	7,257.921	11.75	***	6,921.777	7.89	***	8,175.87	5.46	***	10,137.51	3.22	***	10,385.69	3.05	***
Observations	95			92			83			27			16		
R-squared	0.0039			0.0216			0.0174			0.0168			0.1226		

Source: Survey data, 2012.

Table 6.4: The results of unit cost estimation for pooled data

	Dependent Variable: Cost/yield (Cost per unit of output)														
	Model UC1			Model UC2			Model UC3			Model UC4			Model UC5		
Independent variables	**Land clearing**			**Planting**			**weeding**			**herbicide**			**Tapping**		
	Coef.	t		Coef.	t		Coef.	t		Coef.	t		Coef.	t	
Year Variable	-0.0528	-1.62		-0.0114	-2.71	***	-0.1036	-2.68	***	-0.0074	-2.90	***	-0.0151	-1.18	
Constant	0.2276	2.13	**	0.0537	3.92	***	0.4074	3.22	***	0.0313	3.81	***	0.1104	2.67	***
Observations	313			313			313			313			313		
R-squared	0.0101			0.0271			0.0278			0.0311			0.0053		

	Model UC6			Model UC7			Model UC8			Model UC9			Model UC10		
Independent variables	**Total labor**			**Total labor cost**			**Plantlet cost**			**Equipment cost**			**Total cost**		
	Coef.	t		Coef.	t		Coef.	t		Coef.	t		Coef.	t	
Year Variable	-1.3435	-3.12	***	-10.5296	-2.46	**	-6.4057	-2.08	**	-0.5309	-1.37		-17.4662	-2.33	**
Constant	6.3578	4.52	***	46.1305	3.30	***	28.3942	2.84	***	2.2415	1.77	*	76.7663	3.13	***
Observations	313			313			313			313			313		
R-squared	0.0351			0.0231			0.0163			0.0074			0.0207		

Source: Survey data, 2012.

5. Policy Implications

5.1. Policy Implication for the Economies of Scale on Rubber Plantation

This study seeks to provide evidence on the economies of scale for rubber plantations through estimating the relationship between the costs and yield and it then further estimates the relationship between the costs per unit of output for rubber plantations and years for latex tapping. The findings indicate that rubber plantations in the study area present evidence of economies of scale since the costs per unit of output tend to diminish when planting rubber year over year. This implies that rubber plantations in this area could benefit from large-scale farming with the potential capacity to minimize the cost of rubber plantation. In fact, even though there are a number of smallholder rubber farmers in Luangnamtha including individual and contract farming with a "2+3" modality, the 2+3 modality often dissolves into a "1+4"[16] model that operate like concessions with large size farming operations. On the other hand, some smallholder farmers integrated with large size contract farming schemes. These conversions create wage disputes, overlapping land designations and unrealistically large contracting areas that leave villagers in worse conditions and create capital conflicts (Shi, 2008). Therefore, the decision to further invested in rubber farming should be carefully identified with sound and quality investment in order to avoid such problems and to reap the benefits for all partners concerned.

5.2. Policy Implications for Smallholder Rubber

Even though large size rubber farming has more advantages than the smaller ones in terms of initial and operating costs as well as output returns, small-scale rubber farming, including the farmers in this study, has to be carefully considered since they cover a large proportion of rubber plantations across the province. In this sense, small-scale rubber farmers

[16] Contract farming 1+4 refers to a farmer that contributes only labor as the input, while the remaining input land, capital, technique and market access are from investor partners.

play a key role in rubber plantations in this area. In efforts to achieve poverty alleviation goals, the provincial government has been paying more attention to stop shifting cultivation and support commercial agricultural production through allocating land for 6,300 households for small-scale rubber farming (Luangnamtha DPI, 2010). In spite of the great efforts have been made so far, small-scale rubber farmers are still facing a difficult situation both in terms of capital and technical practices. Therefore, better competitive conditions for plantation and market access are required for smallholder rubber farmers in Luangnamtha to aid in income generation and sustainability of smallholder farming practices.

5.3. Further Research for Policy Implications

The study provides significant analysis on the yield and time period of tapping year as key factors in costs and costs per unit of output respectively for rubber plantations in Luangnamtha. However, it is need to provide an indication of the farm's characteristics and managerial practices, or technical and economic efficiencies as investigated by Dengle *et al.*, (2011) and Nemgrui *et al.,* (2014) as control factors for the discussion on the economies of scale on rubber plantations. Such control factors might contribute additional significant evidence on the economies of scale for smallholder rubber farming in the Lao context and that should be taken into account in policy decision. Farming characteristics and managerial practices as well as technical and economic efficiency are very complex issues that need to be further discussed, investigated, and analyzed to highlight improvements for rubber plantations in the context of the expansion of commercial agriculture. This would also help in responding to the current policy on commercial crop plantation and sustainable farming practices in Lao PDR.

6. Summary and Recommendation

This study attempts to investigate whether economies of scale on rubber plantations exist among 95 rubber farmers in Luangnamtha through an investigation of the relationship between costs of rubber plantation and yield and the relationship of years for rubber tapping on the costs per unit of output. The study provides significant pioneer results that when data in each year is treated differently, yields and the constant terms show positive significant relationships with labor use for planting, herbicide spraying and tapping and costs of rubber plantations. The results for this study indicate the evidence on the increasing returns to scale on rubber plantations and show that at the beginning stage, initial cost (land clearing and planting costs) is important. This might create a tendency that the commercial plantation in several regions would be occupied by the large-scale farming, where the smallholder one who has less advantage will be replaced by the large-scale concessions. When rubber plantation is well managed year over year, then the operating costs (labor costs, viz., tapping and management) will later become crucial. It seems like the fix cost will be a sank cost and the ratio of variable cost to the fix cost could increase. This implies that smallholders could survive and are be able to compete with large-scale farming in terms of efficiency of operating cost.

Furthermore, the results of this study also show the significant reduction in the costs per unit of output year over year for rubber plantation. The finding implies that rubber plantations in the study area indicate the evidence on economies of scale. This means that the large-scale farming could benefits from rubber plantation than the small-scale one in terms of the capacity to minimize the cost of rubber plantation and that smallholders tend to integrate with the large-scale farming for survival. If there is no support for smallholders, rich or large farming enterprises will continue to take advantage and can overrun smallholder farming. However, if smallholder rubber farmers overcome such difficult situations by their own competitiveness and governmental support, their management for farming practices will be better improvement.

The results of this study suggested since smallholder play a key role in agricultural farming in these areas, it is necessary to encourage them to have better conditions on accession for financial support and farming technique at the beginning stage, particularly the initial costs for rubber plantation. While in the later stage, smallholders are be able to manage and compete with large-scale ones in terms of the efficiency in operating cost. Thus, better competitive conditions for plantations and market access for income generation are required in order to survive and sustain smallholder rubber farming practices. While this study provides important features on the economies of scale through the relationship between the costs per unit of output and yield, further studies on the comparison between large-scale and small-scale farming that emphasizing on farming characteristics and managerial practices as well as technical and economic efficiencies in relation to the economies of scale should be taken into account and it may provide additional important evidence for decision making on improving the rubber farming practices in Lao PDR.

Chapter 7: Conclusion

1. Introduction

Industrialization and modernization in the agriculture and forestry sectors is one of the major priority programs of the Lao government. The purpose of this program is to ensure the sustainability of agricultural farming, food security, improvement in quality of life, as well as poverty reduction for the Lao people. In order to achieve the goals of the program, agricultural effectiveness is needed and natural resources have to be efficiently managed in line with the promotion of sustainable resource utilization.

Agricultural production in many parts of the country is still based on the traditional model, which does not take full advantage of the resource's potential. Decisions on the commercialization of agricultural production have usually been made without considering its benefits and costs, often ignoring the long-term assessment of such decisions. There is less market evaluation for agricultural production and land-use conversion is not consistent with government policies. In addition, small farmers, who cover a large proportion in terms of agricultural stakeholders, lack knowledge on latest production techniques in agriculture, for instance, proper land preparation, soil control, planting technique, and suitable seedling application. They have limited access to credit, agricultural inputs, equipment, and extension services. Furthermore, their farm sizes in rural communities are small and limited. Thus, they are unable to optimize their harvested yields and achieve maximum utilization of the limited available resources in the long run. This study presents a sustainability analysis for Lao's farming system in order to provide significant evidence for addressing policy implications in relation to these issues.

The objective of this study is to analyze the sustainability of Lao farming practices with regard to three aspects: environmental, socioeconomic, and technological. With regard to the environmental aspect, the purpose is to examine how land-use change toward the commercialization of agricultural practice has affected land and forest resources and farmer livelihoods. In addition, the study further estimates how potential incentives in terms of the REDD+ mechanism can contribute to the decision making of smallholders over the land-use change. With respect to the socioeconomic aspect, there are two main objectives. The first objective is to investigate the different types of contract farming and estimate the impact of contract farming on household poverty. The second objective is to investigate the evidence on returns to scale, estimate technical efficiency levels, and determine factors that influence the efficiency scale, particularly for cassava plantations in Savannakhet and Vientiane provinces. Regarding the technological aspect, the objective is to investigate whether economies of scale exist for smallholder rubber farms in Luangnamtha province.

The preceding chapters provide a brief and chronological view on transition from a centrally planned economic system to an open liberalized market-oriented system with the introduction of the New Economic Mechanism reform in 1986. Particularly, the study reviews a number of policies and strategies for agricultural development. It further presents the conceptual, theoretical, and methodological aspects of the research. Data at the household level have been employed and analyzed using both quantitative and qualitative approaches. Results in different chapters have been interpreted and discussed in order to draw policy implications. The main findings, conclusion, policy implications, contribution, and further research directions of the study are presented in the subsequent sections.

2. Main Findings and Policy Implications

There have been controversial issues for decades in the agricultural economic development field. However, very few studies have been conducted in Lao PDR, especially on the sustainability analysis of Lao's farming system. Based on the analysis in this study, the following are the main findings and implications of this study.

The environmental and economic valuation of land use in Oudomxay province provides three main findings on the environment-economic linkages between ecosystem services and rural poverty reduction in Lao PDR. *First*, planting commercial crops such as maize and rubber increased cash incomes for households, but exposed the farming area to environmental risks, viz., soil depletion and water contamination owing to poor soil management practices and improper chemical use. The costs of these environmental impacts are not fully integrated into households' rational decision-making process, since farmers lack of knowledge on this aspect. *Second*, upland rice farming and NTFP gathering are considered as sustainable practices in the research areas; however, these activities are increasingly vulnerable to the pressure of expanding maize and rubber plantations into old fallows and secondary forests. The conversion of upland rice fields to such commercial crop plantations also increases the risks related to food security, rice production, and forest fallows. *Lastly*, the potential incentive in terms of REDD+ can be a significant mechanism to encourage farmers to maintain important ecosystem services and forgo alternative agriculture land use. REDD+ can be an effective tool to influence farmers' decisions toward forest conservation, if its benefits are sufficient, equitably distributed, and properly targeted toward households that are incurring the opportunity costs. Whether REDD+ can be a suitable mechanism also depends on the international markets for carbon credits and how this mechanism could be adopted in the context of rural markets in Lao PDR. Throughout the research period, REDD+ was not yet implemented as a national strategy for Lao PDR.

Furthermore, the forests or areas eligible for REDD+ were not defined and who will have the right to obtain benefits was not specified. It is a great challenge for the Lao government to establish REDD+ as a national strategy and introduce corresponding policies to make REDD+ an effective, efficient, and equitable mechanism to achieve economic growth and commercialization of agriculture.

With respect to the socioeconomic aspect, the analysis of economic impact of cassava contract farming on poverty reduction in Savannakhet and Vientiane provinces provides two significant findings. *First*, many farmers in both regions failed to understand the details of the signed contracts because most of them were less educated and there was little explanation on the details of the contract. The main problem observed was the improper practices of the 2 + 3 model in Savannakhet. Farmers were required to follow the counterpart contractors and provide capital, which disposed them to the risk of indebtedness owing to low price of product, missing plan on product delivery, and installment of cash payment instead of one-time whole reimbusrment. In adverse cases, they did not receive payment for a year after they sold their products. After a few years of implementation, several farmers were not satisfied with the contract farming process. This proved to be most challenging for cassava contract farming. Therefore, intervention from a third party, particularly the public sector and corresponding partners, is necessary to solve these issues. *Second*, the net return from cassava contract farming in Vientiane was sufficient higher than the formal poverty line, but its contribution toward poverty reduction in this region was not significant because the result indicates the negative impact of net return per capita of cassava compared with that of the alternative crops (upland rice and Job's tears). However, the estimation result for Savannakhet suggests that contract farming not only earned profits for farmers, but also rather increased the poverty level twofold. These results imply that contract farming suffers from several weaknesses; if not carefully managed, it could lead to farmer exploitation.

As identified in the socioeconomic aspect of sustainable farming, the empirical analysis on the technical efficiency of small-scale cassava farming in the two provinces also indicates four unique findings. *First*, the key input factors of farm size, labor, and capital indicate significant potential to increase output of cassava plantation in both regions. There are, however, limitations on increasing farm investment, because smallholders often have less labor and small land size. *Second*, the study finds that there is an increasing return to scale for smallholder cassava farming in Savannakhet. This finding implies that a proportionate increase in the input factors would result in a more than proportionate increase in cassava output. This means that small-scale cassava farming fails to optimize the use of current available resources under the given technology. This evidence could not be found for Vientiane, where it performs a constant return to scale. *Third*, the estimated mean score of technical efficiency of cassava production in Vientiane and Savannakhet are 72% and 75%, respectively. This indicates that the fair technical efficiency of cassava plantations could be improved by about 25-28% through better utilization of the current set of inputs and the given technology. *Finally*, the key factors to determine the positive effect of technical efficiency are to plant cassava with good land preparation, fix a suitable period for plantation, and include farmers belonging to a younger age group. This is significant particularly for Vientiane.

Regarding the technological aspect of sustainability of the Lao farming system, the analysis on economies of scale in smallholder rubber farming in Luangnamtha province provides significant pioneer results. The finding indicates the existence of economies of scale in rubber plantation in the form of significant reduction in the costs per unit of output year over year. This implies that rubber plantations in this area could benefit from large-scale farming with the potential capacity to minimize the cost of rubber plantation, and smallholders tend to integrate with the large-scale farming for survival. If there is no support for smallholders, large-scale farmers will continue to take advantage and can overrun smallholder farming. In addition, the result highlights the increasing returns to scale in the cost of rubber farming. In fact, rubber plantation often delays economic returns during the first seven years and requires large initial capital investment, for which smallholders have less capability. This study further indicates that at the early stage, the initial cost (land clearing and planting costs) of rubber plantation is crucial. There is a tendency that large-scale plantations dominated by commercial crops would have better prospects than the smallholder plantations and that a majority of individual small-scale farmers would be left behind and eventually replaced by large-scale corporations or concessions. When rubber plantation operates year over year, then the operating cost (labor costs, viz., tapping and management) will later become essential. Thus, the variable cost and therefore the proportion of variable cost to fixed cost would increase. This means that smallholders would have to compete with large-scale farmers in terms of efficiency of operating cost. Therefore, if smallholders overcome such difficulties by increasing competitiveness and receiving governmental support, their farming management skills will improve significantly.

3. Policy Recommendations and Suggestions

The intention of commercialized agricultural production for poverty reduction in rural areas of Lao PDR is increasingly weighed against its potential impacts on environment, sustainability of land resources, and traditional livelihood systems. The unique analytical results and corresponding discussions in this disseration provide policy recommendations and suggestions as additional options for policymaking on commercialized agricultural production toward sustainable farming.

The introduction of commercial crops like maize and rubber has the potential to reduce poverty in the short run. However, it comes with a tradeoff in the form of loss of ecosystem services and long-term environmental degradation. On the other hand, the traditional practices in terms of upland rice farming and collection of NTFP are considered sustainable land-use options, but they are largely subsistence activities and are not able to contribute toward poverty alleviation of rural households. The results of the study on environmental and economic valuation of land use in Oudomxay province suggest that there is a need to implement comprehensive measures to prevent environmental degradation and minimize risk in maize and rubber plantations, particularly better soil management for maintaining fertility and proper use of chemical herbicide. Value-added options and alternative environment-friendly activities such as multi-cropping and intercropping farming systems should be promoted to support farm households that rely mainly on supplementary activities, particularly upland rice farming or collection of NTFP. Comprehensive economic valuation of different land uses in the north and other regions of Lao PDR should be conducted as a critical baseline to support informed decision making on land-use development. In addition, incentives for preserving ecosystem services, such as the REDD+ mechanism, may serve as a potential measure to support the diversification of traditional livelihoods, increasing the competitiveness of maintaining forests. At the national level, the Lao government ought to establish REDD+ as a national strategy in the context of Lao PDR and define corresponding policies for the REDD+ mechanism to foster economic development, particularly agriculture industrialization.

There is an urgent need to identify the appropriate public authorities for regulating, monitoring, and enforcing contract farming arrangements. The Lao government should develop a short and concise guideline/handbook outlining the regulations and practice requirements as well as the responsible authorities for contract farming in Lao PDR. The authorities must develop a fair and transparent model contract farming template. Furthermore, they must develop simple educational materials and deliver mass training to prospective producers on contract farming modalities and terms of contract. Finally, the authorities should develop a complaints/dispute resolution center at the district/province level to address issues between the farmer and the investor.

The evidence on the analysis in technical efficiency indicates the unique implication that there still exists room to increase cassava output and to improve inefficient farming performance through maximum utilization of the given input factors. From this view point, cassava production ought to be applied as a practice that could support the optimum use of farmers' resources - especially land, labor, and capital - for farmers to reap maximum benefits from cassava plantation.

The results of the analysis on economies of scale in smallholder rubber farming in Luangnamtha suggests that there is a need to support smallholders for improved financial access and farming techniques at the beginning stages for better utilization of the initial cost of rubber plantation. Whereas in the later stage, smallholders can increase their competitiveness against the large-scale ones in terms of efficiency in operating cost. Overall, smallholders should carefully be taken into account, since they cover a large proportion of rubber stakeholders and play a key role in agriculture farming practice in this area. Therefore, better competitive conditions for plantations and market access for income generation are needed in order to ensure profitability and sustainability of smallholder rubber farming practices in this region.

4. Contribution to Existing Literature

This thesis attempts to analyze the sustainability of Lao's farming system through three aspects: environmental, socioeconomic, and technological. The study contributes significantly to the existing literature with regard to economic development, by particularly focusing on the commercialization of agriculture in Lao PDR. The environmental and economic valuation of land use, including the potential incentive in terms of REDD+, provides a unique result regarding farmers' perspective toward decision making on converting their land for commercial production (like maize and rubber plantation). Commercial crop production generates income and reduces poverty in the short run; however, it exposes the land to serious environmental risks in the long run. In contrast, the traditional land-use practices in terms of upland rice farming and NTFP gathering are largely subsistence activities that can be considered as sustainable, but their contribution to poverty reduction is less.

The second important contribution to the literature is the investigation on the cassava contract farming arrangement in Savannakhet and Vientiane provinces. The two different contract-farming modalities vary in terms of their implementation in compliance with the supportive policy. Cassava contract farming in Vientiane followed the common 2 + 3 policy and earned profits for small-scale farmers, while such an operation in Savannakhet was observed as an improper practice and caused losses to farmers, thus leading to farmer indebtedness. The contract farming practice, however, in these two regions could not contribute to poverty reduction subject to the cost and benefit analysis of the net impacts between cassava and alternative crops. These results highlight the facts that cassava contract farming practices are weak and that they need careful management in order to depart small-scale farmers from the disadvantaged conditions.

The third important contribution to the literature is the findings from the analysis on the technical efficiency of cassava smallholder farming in Savannakhet and Vientiane provinces. Studies on this topic are scant. Thus, the study makes a highly original and significant contribution to literature. The evidence on increasing returns to scale in Savannakhet is relevant, while the constant return to scale in Vientiane is also proven in this study, subject to the input factors and given technology under the condition that other factors are held constant. The fair score of technical efficiency is empirically estimated through the well-known stochastic frontier production function analysis. The study elucidates that there still exists an opportunity to increase cassava output and improve the efficiency of farming practices through maximum utilization of the given inputs and determinant factors.

The last unique contribution of this thesis is the proof of the existence of economies of scale and the increasing return to scale in smallholder rubber farming in Luangnamtha province. The results emphasize that at the beginning stage of rubber plantation, the initial cost is important, and it needs huge capital investment to set up the farming operation, while smallholders have less capability in terms of financial management. The large-scale or rich farmers may have more advantages and could benefit over the smallholders. This creates a huge challenge for smallholders to survive. If the smallholders can overcome such difficulties, at the later stage of rubber plantation, they would be able to compete with the large-scale farmers in terms of efficiency in operating cost and their farming practice will better improve over the years.

In sum, the analyses for sustainability of Lao's farming system in all three aspects in this study subject to the quantitative and qualitative approaches adds important unique view points to the accumulation of literatures. In addition, the study aims at providing alternative policy implications to support economic growth, particularly agricultural development in Lao PDR.

5. Conclusion and Future Research Direction

Although the significant and unique results of this thesis contribute to the extant research, it needs further evidence and analysis to provide baseline information that could contribute to policy decision making corresponding to sustainable farming practices in Lao PDR. Therefore, this study throws some light on future research directions.

The environmental and economic valuation of land use that incorporated the potential incentive in terms of REDD+ in confront with the rapid change of agricultural production in this study provide important results in the view of balancing benefits for the local famers and maintaining forests. It is, however, a complex issue and difficult to define all perspectives in the environmental aspect. Thus, future research should analyze a comprehensive economic valuation of ecosystem services, including defining eligible forest areas for REDD+ and local livelihood assessment in different land-use systems in rural and forest areas of Lao PDR. In addition, evidence on the impact of expansion of commercial agriculture on livelihood resilience, risk coping, and food security as well as the role of forest and fallows within the local context should be included in the future investigation.

The main purpose of the analysis on contract farming is to shed some light on its real contribution to poverty reduction compared with the net impact from alternative crops. The study uses both descriptive and statistical approaches. From this point of view, future research should apply the empirical approach in order to identify and determine important factors that influence contract farming practices not only in the context of the two provinces, but also other regions. Therefore, comprehensive evidence and baseline information are necessary for future improvement in contract farming practices in Lao PDR.

Regarding the analysis on technical efficiency of small-scale cassava farming, the generalized likelihood ratio test of hypotheses on the effect of determinant factors in case of Savannakhet showed that the LR statistic of the data set is lower than the critical value, which implies that the study could not statistically estimate the determinant variables of technical inefficiency. Therefore, if additional or a similar household data set is available, future research could apply the Stochastic Frontier Analysis (SFA) or Data Envelopment Analysis (DEA) to re-examine the important factors affecting the technical inefficiency for cassava production in order to provide consistent evidence to support sustainable cassava farming in the right direction.

The study on the economies of scale in rubber farming in Luangnamtha only analyzes the important feature of smallholder rubber farmers, even though the large-scale rubber farming data with similar characteristics are provided. Thus, a comparative analysis between large- and small-scale farming should be included in the estimation in order to capture the competitive evidence in relation to economies of scale. In addition, future research emphasizing on farming characteristics and managerial practices as well as technical and economic efficiencies in relation to the economies of scale is crucial to generate consistent evidence for support policy improvement for rubber plantation in Lao PDR.

In conclusion, the rapid expansion in agribusiness and the development of commercial agriculture production put direct pressure on maintaining forest and food security in Lao PDR. Because of abundant hidden natural resources, Lao PDR is becoming a valuable resource frontier for competitive investments. This creates competition for resource utilization by large-scale plantations over smallholder ones and poses many challenges for long-term availability of land and forest resources. Both large- and small-scale farmers can equally contribute toward social stabilization. There is still little evidence based on a systematic assessment as needed by the policy application for sustainable development. The three aspects - environmental, socioeconomic, and technological - should be rigorously taken in to account in order to promote sustainability of farming system in a right direction and support poverty reduction in Lao PDR.

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Annex 1: Policy Reforms under the New Economic Mechanism Affecting

Farm Family incomes and Agricultural Commercialization

Year	Policies, Instruments and Milestones
1996	4th Plenary Meeting of the Party Central Committee institutes the New Mechanism of Economic Management (NEM), or more generally called the New Economic Mechanism. This creates scope for a market economy
1989	By PM decree No. 49 on interest rate policy issued in 1989, interest rates for loans were to be higher than inflation rates and long-term rates are to be higher than short-term rates.
1990	Contract Law. Specifies basic types of contract, regulates who can enter into contracts, and specifies provisions for enforcement.
1990	Decree 17/PM: Privatization. Specifies procedures for privatization of State enterprises
1991	New Constitution formalizes the market-oriented economy, rights to private property, and an "Open Door Policy" towards foreign investment. The 5th Plenary Meeting of the Party Central Committee reiterates the role of the market economy, identifies the agriculture sector as the "number one battlefield", and confirms the farm household as the main unit of agricultural production.
1991	Guideline No. 333 issued by the central bank, Bank of the Lao PDR (BOL),on 26 September 1991 provided new maximum and minimum interest rate guidelines.
1993	Decree 102 (1993) on the Organization and Management of the Villages identifies rights, duties, and responsibilities of the village community in the use and management of natural resources
1993	Ministerial Decree No.464/KKh (8/12/1993) gives opportunities for all people to enter into retail trade by following established tax and arbitration regulations. This Decree helped liberalize trade, particularly at the retail level
1993/94	Decrees No.169 and 186 support the decentralization of resource and use and management to local authorities and communities
1994	Foreign Investment Law. Details incentives aimed at attracting FDI. Only limited details of investor rights and protection. The 1988 Foreign Investment Code was streamlined and replaced by a new law on the promotion and management of foreign investment in April 1994. The new law provides protection to business investors (against nationalization, allowing repatriation of profits, etc.). Applications for foreign direct investment in business (excluding trading) are to be approved by the Foreign Investment Management Committee (FIMC) under the prime Minister's Office.
1994	A new business law enacted in August 1994 gave the Ministry of Commerce (MOC) the duty to issue all business and trade licenses. As the one-stop agency issuing licenses in Vientiane, MOC adopted regulations and procedures to simplify licensing. Presently, MOC deals only with large import-export companies, and local and foreign investors, while the smaller size local retailers or traders are attended to by MOC's provincial and district trade divisions.

1994	Labor Law. Protects rights of workers, imposes limits on working hours, and specifies minimum wage of labor in business sector. The Labor law enacted in March 1994 contains no restriction on the movement of labor. Travel authorization documents are no longer requires and an identity card is sufficient for domestic travel. Nevertheless, a citizen is still required to inform and register with the local authorities if he intends to stay long in the new area. An impact of this greater labor mobility is that a large number of young farmers leave their village after the rice harvest and go to urban areas or to Thailand to look for new jobs.
1994	Decree No.40 supports the devolution of responsibility for planning and implementation of rural development to provincial and District Authorities
1994	Import taxes on agricultural inputs such as fertilizers, pesticides, agricultural tools, and equipment were lowered in 1994 (Prime Minister Decree No.187) to 3 to 5 percent and valorization and ceased to be Imposed from the beginning of 1999.
1994	ln an effort to reduce the subsidy to the irrigated pumping schemes, Electricity du Lao PDR increased the tariff to KN9/ kilowatt-hour (kWh) in 1994
1995	Tax Law. Provisions on individual and corporate tax. Corporate taxes include: (i) turnover tax (5-10%); (ii) excise tax (5-60%); (iii) profit tax (35%); (iv) minimum tax (at least 1.5% of total income),and (v) service and commission fees (variable). Foreign investors profit tax is only 20% and capital equipment imported at 1% tax under FDI law.
1995	Positive real interest rates were charged for loans in all sectors until 1995. In view of soaring inflation. BOL issued in July 1995 guidelines removing ceiling interest rates for all State-owned commercial banks, except for the Agricultural Promotion Bank (APB), which continued to extend agricultural credit at broadly 10 percent for short-term, 8 percent for medium-term, and 7 percent for long-term loans. Technically, the policy has been reversed for credit extended through APB since 1995 given that the real rates were negative through 1999.
1996	Decree No. 131 supports the devolution of responsibility for management of agricultural and forest land to Provincial and District Authorities, with advisory and technical assistance provided by Central Authorities
1996	Forestry Law
1996	Water Resources Law
1994	In an effort to reduce the subsidy to the irrigated pumping schemes, Electricity du Lao PDR increased the tariff from KN9\kilowatt-hour (kWh) in1994,to KN14\kWh in 1996
1997	In April 1997, the National Assembly enacted the Law giving citizens the right to own, use, and transfer land.
1997	The importation and sale of publications, magazines, and newspapers to promote wider access to market information are permitted under Notice No. 129 of the Ministry of information and Culture.
1998	Agricultural Law
1998	There are no export taxes on agricultural products.PM Decree No.24l dated25 December 1998,however, increased the turnover tax on agricultural products from 3 to 5 percent for products sold locally. Prior to the decree, there were five categories of turnover taxes for various goods, the lowest being 3 percent for agricultural and other low-value products. In compliance with IMF's recommendation to simplify the collection of taxes by reducing the categories of turnover taxes, the Government collapsed the five categories into two of 5 and 10 percent, effectively raising the turnover tax for agricultural produce by default.
1999	Environmental Protection Law
1999	In an effort to reduce the subsidy to the irrigated pumping schemes, Electricity du Lao PDR increased the tariff from KN14\kWh in 1996 to KN50\kWh in January 1999 with a reported schedule of a monthly increase of 3.5 percent for the year.
1999	Agricultural Sector Strategic Vision. Identifies a dual track policy for upland and lowland areas, particularly along the Mekong corridor. Lowland areas should maintain and accelerate the pace of agricultural diversification and intensification with increased land

	productivity, improved value added processing and expanded marketing and sales. For the upland areas emphasis should be on participatory land use zoning and sustainable land use management, along with diversification of farming systems and the development of agroforestry. Extension of new technologies and microcredit facilities. Access to markets through feeder road construction.
1999	Prime Minister's Decree No. II on the management of forestry operations and businesses
2001	Interim Poverty Reduction Strategy Paper
2001	7th Plenary Meeting of the Party Central Committee stressed the need for policies to upgrade the capacity of domestic companies to compete in international markets and to cooperate effectively with foreign companies and general to facilitate beneficial participation in AFTA, AIA and to prepare for WTO membership.
2002	Decision 013/1/CPC. Sets out details on the implementation of the law on the Promotion and Management of Foreign Investment Projects in Lao PDR. Decree includes time limits for Government agencies to process applications.
2002	Decree 46/PM. Decentralizes approval of small FDI projects (USD< =1 million) to the provinces. Vientiane Municipality, Savannakhet, Champasak and Lung Prabang allowed approving projects up to USD 2 million.
2003	Land law (replacing 1997 land law). Includes provisions on types of land use rights that the State grants to citizens (including maximum sizes for different categories of agriculture land), land classification, and land administration (including administrative responsibilities for land management) and to transfer rights to use land. Ongoing initiatives to improve land titling, but counting ambiguity in exercising and transferring property rights to use land.
2003	ASEAN / China tree trade. AFTA-China to be on AFTA terms "Early harvest" provisions enable earlier steps (e.g., Thailand/ China trade in selected agriculture goods); Agreed 2003.Implement by 2012
2003	PM Decision. Establishes National land policy Committee to resolve policy issues related land management, and to develop a comprehensive land policy framework.
2003	Decree 125/PM: Lao National Chamber of Commerce & Industry. Establishes the rights of all business (private, state and foreign) to establish business organization to protect the rights of members.
2004	National Growth and Poverty Eradication Strategy. Private sector identified as "the main engine of growth". Repeated references to the important role of the private sector in promoting growth and development. Identifies macroeconomic stability and a better enabling environment as important policy initiatives promoting private sector investment.
2004	Law on Judgement Enforcement. Specifies measures to enforce court judgements, with a strong focus on measures to enforcement of decisions relating to commercial issues.
2004	Decree 42/PM: SME Development and Promotion. Defines SMEs, institutional arrangements to promote SEM development, and various initiatives (including SME fund) to promote SME development. SME promotion committee established to implement decree.
2004	Order 24/PMO and Instruction 1691. Commands all provincial authorities to implement trade decrees, to establish one-stop trade services, and to abolish import-export licenses (except for gold copper, precious stones, vehicles, spare parts, petroleum and gas, and "other prohibited goods" which require licenses from Ministry of Commerce. Paperwork for import clearance simplified. Import and export and plans only have to be submitted for monitoring purposes. Officials are instructed to apply technical certification for goods in less than 2 days.
2004	Decree 119/PM Domestic & Foreign Investment. Enhancing an enabling business environment to attract domestic and foreign investment. Decree retains some difference in policy treatment between domestic and foreign investors.
2004	Decree 15/PM on trade competition. Specifies key principles for regulating monopolistic practices and promoting fair competition. Specifies responsibilities for ensuring a free market, and for guaranteeing the participation of all sectors in the economy.

2005	Five-Year Plan 2006-2010. Draft emphasizes expanding domestic and foreign market in terms of quality and quantity of product to competition with abroad. Giving priority to expanding of product, attract labor for increasing export. Linking and corporation between domestic investors and investors and investors in abroad. Promoting business of handicraft such as: hand-weaving and furniture.

Source: (PCC 1987; MAF1999; UNDP 2001; Mallon 2005) and (Konishi, 2005).

Annex 2: List of Poor Districts in Lao PDR

No	Districts	Provinces	No. of poor Household	Percentage of poor household
1	Sanxay district	Attapeu	2,558	98.8
2	Kaleum district	Xekong	1,613	96.4
3	Phouvong district	Attapeu	1,688	92.1
4	Vieng thong distrct	Borikhamxay	2,589	89
5	Num nhu Special Region	Bokeo	480	86.8
6	Huameuang district	Houa Phane	3,287	86.7
7	Pakbeng district	Oudomxay	3,335	86.3
8	Nong district	Savannakhet	2,637	86
9	Ta oi district	Saravanh	3,042	83
10	Long district	Luang Numtha	3,557	80.6
11	Samphanh district	Phongsaly	3,306	80
12	Phonxay district	Luang phabang	3,097	79.9
13	Viengkham district	Luang phabang	5,253	79
14	Viengthong district	Houa Phanh	2,823	76.6
15	Sepone district	Savannakhet	5,214	76.4
16	Bolikhanh district	Borikhamxay	3,570	76.2
17	Dakcheung district	Xekong	2,353	74.9
18	Nalae district	Louang Numtha	2,655	69.3
19	Xamtay district	Houa Phane	5,325	66.6
20	Meung district	Bokeo	748	64.9
21	Samuoi district	Saravanh	1,266	64.1
22	Phoukhoune district	Luang phabang	1,964	63.9
23	Khoune district	Xieng Khoang	1,964	63.9
24	Saysomboun district	Xaysomboun	1,379	62.8
25	Viengxay district	Houa Phanh	3,398	61.8
26	Khamkeuth district	Borikhamxay	4,726	61,4
27	Pak xeng district	Luang phabang	2,650	60.9
28	Beng district	Oudomxay	3,697	60.6
29	Xiengkhor district	Houa Phane	2,337	60.5
30	Nga district	Oudomxay	2,356	60.2
31	Hoon district	Oudomxay	5,227	59.1
32	Hom district	Vientiane	544	56.8
33	Pha oudom district	Bokeo	2,994	55.9
34	Viengphoukha district	Louang Numtha	1,706	56
35	Phin district	Savannakhet	3,701	55.7
36	Vilabuly district	Savannakhet	2,425	55.5
37	Thathom district	Xaysomboun	756	55.2
38	Namor district	Oudomxay	2,480	55
39	Nhot Ou distrct	Phongsaly	2,280	54.9

40	Nonghed district	Xieng Khoang	2,823	54,8
41	Phoon district	Xaysomboun	784	53.3
42	Thapangthong district	Savannakhet	2,099	52.7
43	Add district	Houa Phane	2,106	52.6
44	Sopbao district	Houa Phane	2,023	52
45	Meungngeun district	Xayaboury	1,258	49.7
46	Nakai district	Khammouane	1,632	49.3
47	Thaphalanxay district	Savannakhet	2,476	46.6
48	Moonlapamok	Champasak	2,704	46
49	Longxan district	Vientiane	1,110	45.6
50	Xaysetha district	Attapeu	2,015	43.7
51	Khua district	Phongsaly	2,010	40.6
52	Mai district	Phongsaly	1,645	40
53	Xonbuly district	Savannakhet	2,534	39.2
54	Xaybuathong district	Khammouane	1,302	39
55	Mad district	Vientiane	943	3.8.8
56	Xienghonh district	Xayaboury	1,800	38.3
57	La district	Oudomxay	1,193	37.5
58	Nhom malath district	Khammouane	1,786	36.5
59	Toomlarn district	Saravanh	1,175	35.3
60	Paktha district	Bokeo	860	33.1
61	Bualapha district	Khammouane	1,294	32
62	Mahaxay district	Khammouane	1,644	31.3
63	Pek district	Xieng Khoang	3,467	31.2
64	Hongsa district	Xayaboury	1,216	28.4
65	Khop district	Xayaboury	891	28
66	Xayabury district	Xayaboury	2,875	25.3
67	Feuang disitrict	Vientiane	1,593	24.1
68	Sukhuma district	Champasak	1,575	19.6
69	Kham district	Xieng Khoang	974	14.6
70	Bachiangchaleunsook district	Champasak	924	12.5
71	Pathomphone district	Champasak	690	7.9
72	Sangthong district	Vientiane	191	4.4
	Total		160,592	50.4

Source: Government of Lao PDR,National Growth and Poverty Eradication, 2004

Annex 3: Questionnaire for Household Survey on the Economic Valuation on the Land Use Change

Cases of Rubber, maize and upland rice Plantations

I. General Information

1.1. No. of Questionnaire ☐☐☐

1.2. Province: ……………………………………… ☐☐☐

1.3. District: ………………………………………. ☐☐☐

1.4. Village: ………………………………………… ☐☐☐

1.5. House No.: ☐☐☐

Interviewer's Information

1.6. Interviewee Name: ……………………… …………………….

1.7. Age: ………………….. year

1.8. Relation to head of Household 1.❑ Household Head 2. ❑ Member

1.9. Sex: 1.❑ Male 2. ❑ Female

1.10. Telephone No.:……………………..

1.11. Mobile No:………………………….…....….

Quality Control Record

	Date, Month, Year	Response Name
1.12. Data Collection		
1.13. Questionnaire Checking		
1.14. Data Entry		

II. Household Demography

2.1. How many people are there living in your household now?.............. persons,

2.1.1. Members in the labor force by age range (15-60 year old) .... persons,

2.1.2. Members not in labor age (elder with age higher than 60 years and children with age range lower than 15 year) .... person,

Family member detail

No	Name	Sex	Age	Ethnic	Education level	Main occupation	Second Occupation
		1. M 2. F	(year)	1. Lao-Tai 2. Mong-Eemiew 3.Mone Kamaer 4. Chinese-Tibet 5. Other......	1. Kindergarten (lower than 5 year) 2. illiterate 3. uncompleted primary school 4. Completed primary school 5. Completed lower secondary 6. Completed upper secondary 7. primary technical degree 8. medium technical degree 9. Diploma degree 10. university 11. Master degree	1. student 2. farmer 3. government officer 4. repairer 5. handicraft 6. fisheries 7. Trader 8. construction worker 9. General labor 10. Unemployment 11. not in the age of workforce (children or very old person) 12. Other (specify)…..	1. student 2. farmer 3. government officer 4. repairer 5. handicraft 6. fisheries 7. Trader 8. construction worker 9. General labor 10. Unemployment 11. not in the age of workforce (children or very old person) 12. Other (specify)…..
	Q.2.2	Q.2.3	Q.2.4	Q.2.5	Q.2.6	Q.2.7	Q.2.8
1							
2							
3							
4							
5							
6							
7							
8							
9							

Q.2.9. From January to December 2010, what is your income source?

No	Item	2010												
		Jan	Feb	March	April	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Total
	Plantation													
1	Paddy rice													
2	Upland rice													
3	Maize													
4	Rubber													
5	Vegetable													
6	Cash crop													
7	Fruit													
8	other............													
	Livestock													
9	Cow													
10	Buffalo													
11	Goat													
12	Pig													
13	Poultry													
14	Fish													
15	Other............													
	Trade													
16	Retail shop													
17	Whole seller													
18	Sell of NTFPs													
19	Sell of wildlife													
20	other............													
	Other source													
21	Salary													
22	Transporting													
23	wage													
24	Remittance													
25	Other............													
26														
27														
28														

III. Rubber/Maize/Upland Rice Plantation

3.1. How many plots do you have for the crop plantation ....Plots, land area and crop plantation characteristic in the first year?

No	No. Plot	3.1.1	3.1.2	3.1.4	3.1.6	3.1.8	3.1.9		3.1.10
		Beginning year of plantation	Total land area with rubber plantation (ha)	Total product in the first year (kg)	Total product in 2010 (kg)	**What is the land area be before the crop plantation?** 1. Forest 2. Fallow 3. other crop plantation 4. old upland rice 5. Other..................	**What is the surround land area of your rubber filed be?** 1. land area cover with stone 2. grass field 3. Fallow 6. Maize field 4. Forest 7. other.......... 5. Upland rice		**Slope?** 1. 0-15 degree 2. 15-25 degree 3. 25-35 degree 4. 35-45 degree 5. Higher than 45 degree
							1. Area above	2. Area Bellow	
1	Plot 1								
2	Plot 2								
3	Plot 3								
4	Plot 4								
5	Plot 5								
	Total								
			3.1.3	3.1.5	3.1.7				

3.2. Do you make contract farming with a company or an organization for the crop plantation-?

No	No. Plot	3.2.1	3.2.2	3.2.3	Code of 3.2.3	
		1. Without contract 2. With contract 3. get rubber set in first year	write the name of company or organization that you make a contract farming	From which country?		
1	Plot 1		....		1	China
2	Plot 2		....		2	Thai
3	Plot 3		....		3	Vietnam
4	Plot 4		....		4	Lao PDR
5	Plot 5		....		5	Other.......

Remark: if do not make contract farming go to 3.4

3.3. If you make a contract farming

3.3.1. What is the format of Investment?

No	No. Plot	Format of contract farming 1. Contract 2+3 3. Other contract 2. Contract 1+4
1	Plot 1	
2	Plot 2	
3	Plot 3	
4	Plot 4	
5	Plot 5	

3.3.2. How does profit dividing?

1. Land owner get ....percent
2. company get............................percent

3.4. Total cost Using for the crop plantation

3.4.1. Total cost of rubber seed for 6 years ago

No	No. Plot	year 1			year 2			year 3		
		3.4.1.1	3.4.1.2	3.4.1.3	3.4.1.5	3.4.1.6	3.4.1.7	3.4.1.9	3.4.1.10	3.4.1.11
		No. of seeds	Price per seed (kip)	Total cost of seed (kip)	No. of total seeds	Price per seed (kip)	Total cost of seed (kip)	No. of total seeds	Price per seed (kip)	Total cost of seed (kip)
1	Plot 1									
2	Plot 2									
3	Plot 3									
4	Plot 4									
5	Plot 5									
Total			**3.4.1.4**			**3.4.1.8**			**3.4.1.12**	

No	No. Plot	year 4			year 5			year 6		
		3.4.1.13	3.4.1.14	3.4.1.15	3.4.1.17	3.4.1.18	3.4.1.19	3.4.1.21	3.4.1.22	3.4.1.23
		No. of total seeds	Price per seed (kip)	Total cost of seed (kip)	No. of total seeds	Price per seed (kip)	Total cost of seed (kip)	No. of total seeds	Price per seed (kip)	Total cost of seed (kip)
1	Plot 1									
2	Plot 2									
3	Plot 3									
4	Plot 4									
5	Plot 5									
Total			**3.4.1.16**			**3.4.1.20**			**3.4.1.24**	

3.4.2. cost of fertilizer, herbicide and pesticide

No	No. Plot	year 1				year 2				year 3			
		3.4.2.1	3.4.2.2	3.4.2.3	3.4.2.4	3.4.2.6	3.4.2.7	3.4.2.8	3.4.2.9	3.4.2.11	3.4.2.12	3.4.2.13	3.4.2.14
		Cost of fertilizer	Cost of herbicide	Cost of pesticide	Total in 1st year	Cost of fertilizer	Cost of herbicide	Cost of pesticide	Total in 2nd year	Cost of fertilizer	Cost of herbicide	Cost of pesticide	Total in 3rd year
1	Plot 1												
2	Plot 2												
3	Plot 3												
4	Plot 4												
5	Plot 5												
Total		3.4.2.5				3.4.2.10				3.4.2.15			

No	No. Plot	year 4				year 5				year 6			
		3.4.2.16	3.4.2.17	3.4.2.18	3.4.2.19	3.4.2.21	3.4.2.22	3.4.2.23	3.4.2.24	3.4.2.26	3.4.2.27	3.4.2.28	3.4.2.29
		Cost of fertilizer	Cost of herbicide	Cost of pesticide	Total in 4th year	Cost of fertilizer	Cost of herbicide	Cost of pesticide	Total in 5th year	Cost of fertilizer	Cost of herbicide	Cost of pesticide	Total in 6th year
1	Plot 1												
2	Plot 2												
3	Plot 3												
4	Plot 4												
5	Plot 5												
Total		3.4.2.20				3.4.2.25				3.4.2.30			

3.4.3. Labor cost for rubber plantation

Plot 1

No	Description	Year 1				Year 2				Year 3			
		3.4.3.1	3.4.3.2	3.4.3.3	3.4.3.4	3.4.3.6	3.4.3.7	3.4.3.8	3.4.3.9	3.4.3.11	3.4.3.12	3.4.3.13	3.4.3.14
		No. of Labor (person)	Labor cost/ person/day (kip)	No. of day	Total labor cost (kip)	No. of Labor (person)	Labor cost/ person/day (kip)	No. of day	Total labor cost (kip)	No. of Labor (person)	Labor cost/ person/day (kip)	No. of day	Total labor cost (kip)
1	Land preparing												
2	Digging												
3	Planting												
4	Fertilize												
5	Weeding												
6	Herbicide spraying												
7	Tapping												
8	Collecting												
9	Pressing												
10	Transporting												
11	Other...............												
Total		**3.4.3.5**				**3.4.3.10**				**3.4.3.15**			

No	Description	Year 4				Year 5				Year 6			
		3.4.3.16	3.4.3.17	3.4.3.18	3.4.3.19	3.4.3.21	3.4.3.22	3.4.3.23	3.4.3.24	3.4.3.26	3.4.3.27	3.4.3.28	3.4.3.29
		No. of Labor (person)	Labor cost/ person/day (kip)	No. of day	Total labor cost (kip)	No. of Labor (person)	Labor cost/ person/day (kip)	No. of day	Total labor cost (kip)	No. of Labor (person)	Labor cost/ person/day (kip)	No. of day	Total labor cost (kip)
1	Land preparing												
2	Digging												
3	Planting												
4	Fertilize												
5	Weeding												
6	Herbicide spraying												
7	Tapping												
8	Collecting												
9	Pressing												
10	Transporting												
11	Other...............												
Total				**3.4.3.20**				**3.4.3.25**				**3.4.3.30**	

Plot 2

No	Description	Year 1				Year 2				Year 3			
		3.4.3.1	3.4.3.2	3.4.3.3	3.4.3.4	3.4.3.6	3.4.3.7	3.4.3.8	3.4.3.9	3.4.3.11	3.4.3.12	3.4.3.13	3.4.3.14
		No. of Labor (person)	Labor cost/ person/day (kip)	No. of day	Total labor cost (kip)	No. of Labor (person)	Labor cost/ person/day (kip)	No. of day	Total labor cost (kip)	No. of Labor (person)	Labor cost/ person/day (kip)	No. of day	Total labor cost (kip)
1	Land preparing												
2	Digging												
3	Planting												
4	Fertilize												
5	Weeding												
6	Herbicide spraying												
7	Tapping												
8	Collecting												
9	Pressing												
10	Transporting												
11	Other...............												
Total				**3.4.3.5**				**3.4.3.10**				**3.4.3.15**	

No	Description	year 4				year 5				year 6			
		3.4.3.16	3.4.3.17	3.4.3.18	3.4.3.19	3.4.3.21	3.4.3.22	3.4.3.23	3.4.3.24	3.4.3.26	3.4.3.27	3.4.3.28	3.4.3.29
		No. of Labor (person)	Labor cost/ person/day (kip)	No. of day	Total labor cost (kip)	No. of Labor (person)	Labor cost/ person/day (kip)	No. of day	Total labor cost (kip)	No. of Labor (person)	Labor cost/ person/day (kip)	No. of day	Total labor cost (kip)
1	Land preparing												
2	Digging												
3	Planting												
4	Fertilize												
5	Weeding												
6	Herbicide spraying												
7	Tapping												

8	Collecting												
9	Pressing												
10	Transporting												
11	Other...............												
Total				**3.4.3.20**				**3.4.3.25**				**3.4.3.30**	

Plot 3

No	Description	Year 1				Year 2				Year 3			
		3.4.3.1	3.4.3.2	3.4.3.3	3.4.3.4	3.4.3.6	3.4.3.7	3.4.3.8	3.4.3.9	3.4.3.11	3.4.3.12	3.4.3.13	3.4.3.14
		No. of Labor (person)	Labor cost/ person/day (kip)	No. of day	Total labor cost (kip)	No. of Labor (person)	Labor cost/ person/day (kip)	No. of day	Total labor cost (kip)	No. of Labor (person)	Labor cost/ person/day (kip)	No. of day	Total labor cost (kip)
1	Land preparing												
2	Digging												
3	Planting												
4	Fertilize												
5	Weeding												
6	Herbicide spraying												
7	Tapping												
8	Collecting												
9	Pressing												
10	Transporting												
11	Other...............												
Total				**3.4.3.5**				**3.4.3.10**				**3.4.3.15**	

No	Description	year 4				year 5				year 6			
		3.4.3.16	3.4.3.17	3.4.3.18	3.4.3.19	3.4.3.21	3.4.3.22	3.4.3.23	3.4.3.24	3.4.3.26	3.4.3.27	3.4.3.28	3.4.3.29
		No. of Labor (person)	Labor cost/ person/day (kip)	No. of day	Total labor cost (kip)	No. of Labor (person)	Labor cost/ person/day (kip)	No. of day	Total labor cost (kip)	No. of Labor (person)	Labor cost/ person/day (kip)	No. of day	Total labor cost (kip)
1	Land preparing												
2	Digging												
3	Planting												
4	Fertilize												
5	Weeding												
6	Herbicide spraying												
7	Tapping												
8	Collecting												
9	Pressing												
10	Transporting												
11	Other...............												
Total				**3.4.3.20**				**3.4.3.25**				**3.4.3.30**	

Plot 4

No	Description	Year 1				Year 2				Year 3			
		3.4.3.1	3.4.3.2	3.4.3.3	3.4.3.4	3.4.3.6	3.4.3.7	3.4.3.8	3.4.3.9	3.4.3.11	3.4.3.12	3.4.3.13	3.4.3.14
		No. of Labor (person)	Labor cost/ person/day (kip)	No. of day	Total labor cost (kip)	No. of Labor (person)	Labor cost/ person/day (kip)	No. of day	Total labor cost (kip)	No. of Labor (person)	Labor cost/ person/day (kip)	No. of day	Total labor cost (kip)
1	Land preparing												
2	Digging												
3	Planting												
4	Fertilize												
5	Weeding												
6	Herbicide spraying												
7	Tapping												
8	Collecting												
9	Pressing												
10	Transporting												
11	Other...............												
Total				**3.4.3.5**				**3.4.3.10**				**3.4.3.15**	

No	Description	year 4				year 5				year 6			
		3.4.3.16	3.4.3.17	3.4.3.18	3.4.3.19	3.4.3.21	3.4.3.22	3.4.3.23	3.4.3.24	3.4.3.26	3.4.3.27	3.4.3.28	3.4.3.29
		No. of Labor (person)	Labor cost/ person/day (kip)	No. of day	Total labor cost (kip)	No. of Labor (person)	Labor cost/ person/day (kip)	No. of day	Total labor cost (kip)	No. of Labor (person)	Labor cost/ person/day (kip)	No. of day	Total labor cost (kip)
1	Land preparing												
2	Digging												
3	Planting												
4	Fertilize												
5	Weeding												
6	Herbicide spraying												
7	Tapping												
8	Collecting												
9	Pressing												
10	Transporting												
11	Other...............												
Total				**3.4.3.20**				**3.4.3.25**				**3.4.3.30**	

Plot 5

No	Description	Year 1				Year 2				Year 3			
		3.4.3.1	3.4.3.2	3.4.3.3	3.4.3.4	3.4.3.6	3.4.3.7	3.4.3.8	3.4.3.9	3.4.3.11	3.4.3.12	3.4.3.13	3.4.3.14
		No. of Labor (person)	Labor cost/ person/day (kip)	No. of day	Total labor cost (kip)	No. of Labor (person)	Labor cost/ person/day (kip)	No. of day	Total labor cost (kip)	No. of Labor (person)	Labor cost/ person/day (kip)	No. of day	Total labor cost (kip)
1	Land preparing												
2	Digging												
3	Planting												
4	Fertilize												
5	Weeding												
6	Herbicide spraying												

7	Tapping												
8	Collecting												
9	Pressing												
10	Transporting												
11	Other...............												
Total				**3.4.3.5**				**3.4.3.10**				**3.4.3.15**	

No	Description	year 4				year 5				year 6			
		3.4.3.16	3.4.3.17	3.4.3.18	3.4.3.19	3.4.3.21	3.4.3.22	3.4.3.23	3.4.3.24	3.4.3.26	3.4.3.27	3.4.3.28	3.4.3.29
		No. of Labor (person)	Labor cost/ person/day (kip)	No. of day	Total labor cost (kip)	No. of Labor (person)	Labor cost/ person/day (kip)	No. of day	Total labor cost (kip)	No. of Labor (person)	Labor cost/ person/day (kip)	No. of day	Total labor cost (kip)
1	Land preparing												
2	Digging												
3	Planting												
4	Fertilize												
5	Weeding												
6	Herbicide spraying												
7	Tapping												
8	Collecting												
9	Pressing												
10	Transporting												
11	Other...............												
Total				**3.4.3.20**				**3.4.3.25**				**3.4.3.30**	

3.4.4. Equipment cost (Equipment that buy and use for rubber plantation)

No	Description	3.4.4.1	3.4.4.2	3.4.4.3	3.4.4.5
		No	Cost per unit (kip)	Total (kip)	Years of using (year)
1	Land preparing equipment (hoe, spade)				
2	Tractor				
3	Weeding machine				
4	Spraying tool				
5	Tapping knife				
6	Cup				
7	Gutter				
8	Hook				
9	Bucket for collecting latex				
10	Plastic for latex collection				
11	lamp, battery, torch				
12	Boot				
13	Other.......				
Total			**3.4.4.4**		

3.5. If herbicide using, how many people get sick from herbicide spraying? ....persons

- If there is no one get sick, go to 3.6 **(if yes**, please provide detail bellow)

3.5.1. Person 1

No	3.5.1.1	3.5.1.2	3.5.1.3	3.5.1.4	3.5.1.5	3.5.1.6	3.5.1.7	3.5.1.8
	Sick Characteristic	Absence from work (days)	Inpatient (kip)	Transport cost (kip)	Self-treatment by buying medicine (kip)	Opportunity cost for caring for sick person (kip) *(person/day x labor cost per day)*	Other (kip)	Total health cost (kip)
1								
2								
3								

Remark: 3.6.1.8 = 3.6.1.3 + 3.6.1.4 + 3.6.1.5 + 3.6.1.6+3.6.1.7

3.5.2. Person 2

No	3.5.2.1	3.5.2.2	3.5.2.3	3.5.2.4	3.5.2.5	3.5.2.6	3.5.2.7	3.5.2.8
	Sick Characteristic	absence from work (days)	Inpatient (kip)	Transport cost (kip)	Self-treatment by buying medicine (kip)	Opportunity cost for caring for sick person (kip) *(person/day x labor cost per day)*	Other (kip)	Total health cost (kip)
1								
2								
3								

Remark: 3.6.2.8 = 3.6.2.3 + 3.6.2.4 + 3.6.2.5 + 3.6.2.6 + 3.6.2.7

3.5.3. Person 3

No	3.5.3.1	3.5.3.2	3.5.3.3	3.5.3.4	3.5.3.5	3.5.3.6	3.5.3.7	3.5.3.8
	Sick Characteristic	absence from work (days)	Inpatient (kip)	Transport cost (kip)	Self-treatment by buying medicine (kip)	Opportunity cost for caring for sick person (kip) *(person/day x labor cost per day)*	Other (kip)	Total health cost (kip)
1								
2								
3								

Remark: 3.6.3.8 = 3.6.3.3 + 3.6.3.4 + 3.6.3.5 + 3.6.3.6+3.6.3.7

3.6. Have you tapped for latex from your rubber tree?

❑ 1. Yes ❑ 2. Not yet - If Not yet go to 3.8

3.7. Yield cultivation

Rubber Plot	No	3.7.1 Year of tapping	3.7.2 Product per year (kg)	3.7.3 Price of rubber (kip/kg)	3.7.4 Total return from rubber	3.7.5 Who is the customer? (Multiple choice)
Plot 1	1	Year..........				1. ☐China 2. ☐Thailand 3. ☐Vietnam 4. ☐Lao PDR 5. ☐Other......
	2	Year..........				1. ☐China 2. ☐Thailand 3. ☐Vietnam 4. ☐Lao PDR 5. ☐Other......
	3	Year..........				1. ☐China 2. ☐Thailand 3. ☐Vietnam 4. ☐Lao PDR 5. ☐Other......
Plot 2	1	Year..........				1. ☐China 2. ☐Thailand 3. ☐Vietnam 4. ☐Lao PDR 5. ☐Other......
	2	Year..........				1. ☐China 2. ☐Thailand 3. ☐Vietnam 4. ☐Lao PDR 5. ☐Other......
	3	Year..........				1. ☐China 2. ☐Thailand 3. ☐Vietnam 4. ☐Lao PDR 5. ☐Other......
Plot 3	1	Year..........				1. ☐China 2. ☐Thailand 3. ☐Vietnam 4. ☐Lao PDR 5. ☐Other......
	2	Year..........				1. ☐China 2. ☐Thailand 3. ☐Vietnam 4. ☐Lao PDR 5. ☐Other......
	3	Year..........				1. ☐China 2. ☐Thailand 3. ☐Vietnam 4. ☐Lao PDR 5. ☐Other......
Plot 4	1	Year..........				1. ☐China 2. ☐Thailand 3. ☐Vietnam 4. ☐Lao PDR 5. ☐Other......
	2	Year..........				1. ☐China 2. ☐Thailand 3. ☐Vietnam 4. ☐Lao PDR 5. ☐Other......
	3	Year..........				1. ☐China 2. ☐Thailand 3. ☐Vietnam 4. ☐Lao PDR 5. ☐Other......
Plot 5	1	Year..........				1. ☐China 2. ☐Thailand 3. ☐Vietnam 4. ☐Lao PDR 5. ☐Other......
	2	Year..........				1. ☐China 2. ☐Thailand 3. ☐Vietnam 4. ☐Lao PDR 5. ☐Other......
	3	Year..........				1. ☐China 2. ☐Thailand 3. ☐Vietnam 4. ☐Lao PDR 5. ☐Other......

3.8. Do you have any intercropping plantation in your rubber field? ❑ Yes ❑ No

3.8.1. How many years that you plant an intercropping?.............................year

3.8.2. What do you plant?

Plot	3.8.2.1 1st Year	3.8.2.2 2nd Year	3.8.2.3 3rd Year
Plot 1	1. ☐Rice 2. ☐Pie apple 3. ☐cassava 4. ☐Maize 5. ☐Job tear 6. ☐other....	1. ☐Rice 2. ☐Pie apple 3. ☐cassava 4. ☐Maize 5. ☐Job tear 6. ☐other....	1. ☐Rice 2. ☐Pie apple 3. ☐cassava 4. ☐Maize 5. ☐Job tear 6. ☐other....
Plot 2	1. ☐Rice 2. ☐Pie apple 3. ☐cassava 4. ☐Maize 5. ☐Job tear 6. ☐other....	1. ☐Rice 2. ☐Pie apple 3. ☐cassava 4. ☐Maize 5. ☐Job tear 6. ☐other....	1. ☐Rice 2. ☐Pie apple 3. ☐cassava 4. ☐Maize 5. ☐Job tear 6. ☐other....
Plot 3	1. ☐Rice 2. ☐Pie apple 3. ☐cassava 4. ☐Maize 5. ☐Job tear 6. ☐other....	1. ☐Rice 2. ☐Pie apple 3. ☐cassava 4. ☐Maize 5. ☐Job tear 6. ☐other....	1. ☐Rice 2. ☐Pie apple 3. ☐cassava 4. ☐Maize 5. ☐Job tear 6. ☐other....
Plot 4	1. ☐Rice 2. ☐Pie apple 3. ☐cassava 4. ☐Maize 5. ☐Job tear 6. ☐other....	1. ☐Rice 2. ☐Pie apple 3. ☐cassava 4. ☐Maize 5. ☐Job tear 6. ☐other....	1. ☐Rice 2. ☐Pie apple 3. ☐cassava 4. ☐Maize 5. ☐Job tear 6. ☐other....
Plot 5	1. ☐Rice 2. ☐Pie apple 3. ☐cassava 4. ☐Maize 5. ☐Job tear 6. ☐other....	1. ☐Rice 2. ☐Pie apple 3. ☐cassava 4. ☐Maize 5. ☐Job tear 6. ☐other....	1. ☐Rice 2. ☐Pie apple 3. ☐cassava 4. ☐Maize 5. ☐Job tear 6. ☐other....

Plot	3.8.2.4 4th Year	3.8.2.5 5th Year	3.8.2.6 6th year
Plot 1	1. ☐Rice 2. ☐Pie apple 3. ☐cassava 4. ☐Maize 5. ☐Job tear 6. ☐other....	1. ☐Rice 2. ☐Pie apple 3. ☐cassava 4. ☐Maize 5. ☐Job tear 6. ☐other....	1. ☐Rice 2. ☐Pie apple 3. ☐cassava 4. ☐Maize 5. ☐Job tear 6. ☐other....
Plot 2	1. ☐Rice 2. ☐Pie apple 3. ☐cassava 4. ☐Maize 5. ☐Job tear 6. ☐other....	1. ☐Rice 2. ☐Pie apple 3. ☐cassava 4. ☐Maize 5. ☐Job tear 6. ☐other....	1. ☐Rice 2. ☐Pie apple 3. ☐cassava 4. ☐Maize 5. ☐Job tear 6. ☐other....
Plot 3	1. ☐Rice 2. ☐Pie apple 3. ☐cassava 4. ☐Maize 5. ☐Job tear 6. ☐other....	1. ☐Rice 2. ☐Pie apple 3. ☐cassava 4. ☐Maize 5. ☐Job tear 6. ☐other....	1. ☐Rice 2. ☐Pie apple 3. ☐cassava 4. ☐Maize 5. ☐Job tear 6. ☐other....
Plot 4	1. ☐Rice 2. ☐Pie apple 3. ☐cassava 4. ☐Maize 5. ☐Job tear 6. ☐other....	1. ☐Rice 2. ☐Pie apple 3. ☐cassava 4. ☐Maize 5. ☐Job tear 6. ☐other....	1. ☐Rice 2. ☐Pie apple 3. ☐cassava 4. ☐Maize 5. ☐Job tear 6. ☐other....
Plot 5	1. ☐Rice 2. ☐Pie apple 3. ☐cassava 4. ☐Maize 5. ☐Job tear 6. ☐other....	1. ☐Rice 2. ☐Pie apple 3. ☐cassava 4. ☐Maize 5. ☐Job tear 6. ☐other....	1. ☐Rice 2. ☐Pie apple 3. ☐cassava 4. ☐Maize 5. ☐Job tear 6. ☐other....

3.9. Cost of intercropping

No.	Plot	1st Year					2nd Year				
		3.9.1	3.9.2	3.9.3	3.9.4	3.9.5	3.9.6	3.9.7	3.9.8	3.9.9	3.9.10
		Total cost of seed (kip)	Labor cost (kip)	Cost of fertilizer (kip)	Cost of Herbicide (Kip)	Total cost (kip)	Total cost of seed (kip)	Labor cost (kip)	Cost of fertilizer (kip)	Cost of Herbicide (Kip)	Total cost (kip)
1	Plot 1										
2	Plot 2										
3	Plot 3										
4	Plot 4										
5	Plot 5										

No.	Plot	3rd Year					4th Year				
		3.9.11	3.9.12	3.9.13	3.9.14	3.9.15	3.9.16	3.9.17	3.9.18	3.9.19	3.9.20
		Total cost of seed (kip)	Labor cost (kip)	Cost of fertilizer (kip)	Cost of Herbicide (Kip)	Total cost (kip)	Total cost of seed (kip)	Labor cost (kip)	Cost of fertilizer (kip)	Cost of Herbicide (Kip)	Total cost (kip)
1	Plot 1										
2	Plot 2										
3	Plot 3										
4	Plot 4										
5	Plot 5										

No.	Plot	5th Year					6th Year				
		3.9.21	3.9.22	3.9.23	3.9.24	3.9.25	3.9.26	3.9.27	3.9.28	3.9.29	3.9.30
		Total cost of seed (kip)	Labor cost (kip)	Cost of fertilizer (kip)	Cost of Herbicide (Kip)	Total cost (kip)	Total cost of seed (kip)	Labor cost (kip)	Cost of fertilizer (kip)	Cost of Herbicide (Kip)	Total cost (kip)
1	Plot 1										
2	Plot 2										
3	Plot 3										
4	Plot 4										
5	Plot 5										

3.9.1. Return from intercropping (Unit: Kip)

No.	Plot	3.9.31.1 1st Year	3.9.31.2 2nd Year	3.9.31.3 3rd Year	3.9.31.4 4th Year	3.9.31.5 5th Year	3.9.31.6 6th Year
1	Plot 1						
2	Plot 2						
3	Plot 3						
4	Plot 4						
5	Plot 5						

3.10. Are there any impact from rubber plantation for the past 5 year?

No	***3.10.1. Positive impact for your household***	Agree	Disagree	Don't know	Reason
3.10.1.1	Is it a main income source for your household?				
3.10.1.2	Does it provide Job opportunity?				
3.10.1.3	Can you save money from rubber plantation?				
3.10.1.4	Can you plant an intercropping?				
3.10.1.5	Does your household's status getting better?				
3.10.1.6	Can you improve you skill on rubber plantation?				
3.10.1.7	Other................................				
Positive impact for your village in overall					
3.10.1.8	Does the livelihood of people in the village getting better than in the past?				
3.10.1.9	Does the socio problems (steal, rob, and other) within your village reduce?				
3.10.1.10	Does the rubber plantation is the main source of income within your village?				
3.10.1.11	Does the migration problem reduce?				
3.10.1.12	Other...				
	3.10.2. Negative impact to your household				
3.10.2.1	Does the other plantation area reduce?				
3.10.2.2	Does the soil fertility reduce after rubber plantation?				
3.10.2.3	Are there more stone and sand within the rubber field? (land slight or soil erosion)				
3.10.2.4	Do you increase fertilize using for rubber plantation in every year-?				
3.10.2.5	Do you children drop school for rubber plantation?				
3.10.2.6	NTFPs collection reduce				
3.10.2.7	Aquatic animal reduce				
3.10.2.8	Wildlife animal reduce				
3.10.2.9	Other problem..				
Negative impact for your village in overall					
3.10.2.12	Are there some households be debt due to borrowing money for rubber plantation?				
3.10.2.13	Do the new decease occurring or more serious?				
3.10.2.14	Do the animal fields within the village reduce?				
3.10.2.15	Does it became drought or climate change?				
3.10.2.16	There is not enough water use than before?				
3.10.2.17	People dare not use and drink water in the river due to chemical integration				
3.10.2.18	Land slight and soil erosion				
3.10.2.19	Biodiversity reduce				
3.10.2.20	Flooding				
3.10.2.21	Other problem (specify)................................				

3.11. Why do you plant rubber in this area?

....

....

3.12. Do the rubber plantation make livelihood of your and other people in the village getting better for the past 5 years?

....

....

3.13. Do you have any comments for solving the mention problem?

....

....

Annex 4: Questionnaire for the Study on the Impact of Cassava Contract Farming on Poverty

Section I: Overview

1.1 Questionnaire Code.. ☐☐☐

1.2 Province....................................... Code ☐☐☐

1.3 District.. Code ☐☐☐

1.4 Village.. Code ☐☐☐

1.5 Interviewee.. ☐☐☐

(Interviewee has to be a main decision maker for the household)

1.5.1 Sex: ❑1.Male ❑2. Female

1.5.2 Relationship with household head: ❑1.Household head ❑2. Member

1.5.3 Age...years

1.5.4 Telephone/Mobile …………………………….

1.5.5. <u>The highest completed education</u>	1.5.6. Main occupation of interviewee	1.5.7. the main income generation activities for the household
❑1. Kindergarten ❑2. Illiterate ❑3. Not completed primary school ❑4. Completed primary school ❑5. Lower secondary school ❑6. Upper secondary school ❑7. Lower diploma ❑8. Middle diploma ❑9. Higher diploma ❑10. Bachelor degree ❑11. Master degree ❑12. PhD	❑1. Farmer ❑2. Government employee ❑3. Private/project employee ❑4. Mechanic ❑5. Craftsperson ❑6. Fisher ❑7. Merchant ❑8. Laborer ❑9. Unemployed ❑10. Other…………...	❑1. Cassava farming ❑2. Paddy rice farming ❑3. Upland rice farming ❑4. Banana farming ❑5. Maize farming ❑6. Fruit tree farming ❑7. Bean growing ❑8. Other cash crop planting ❑9. General labor worker ❑10. Trade ❑11. Others........

1.5.8. Questionnaire for ❑1. Contract farming ❑2. Non-contract farming

1.6. Questionnaire Quality Check

List	(A) Date	(B) Person in Charge
1.6.1. Data Collection		
1.6.2. Questionnaire Inspection		
1.6.3. Data Entry		

Section II: Household overview

2.1 Household Demographic Composition:

Code	Household Labor	Number	Code	Female
2.1.1	Total members		2.1.2	
2.1.3	Working age members (aged between15-64 years old except disabled members)		2.1.4	
2.1.5	Supplementary labor (aged below 15 years old)		2.1.6	
2.1.7	Supplementary labor (aged above 60 years old)		2.1.8	
2.1.9	Total supplementary labor		2.1.10	

2.2. Household Asset Possessions in 2012:

2.2.1	Resident house	❑1. Made from bricks only ❑2. Made from bricks and wood ❑3. Made from wood only		
Code	List	(A) Amount	(B) Total Value (Kip)	(C) Remarks
2.2.2	Saving	X		
2.2.3	Buffaloes			
2.2.4	Cattles			
2.2.5	Pigs			
2.2.6	Goats			
2.2.7	Poultry (Chickens/Ducks)			
2.2.8	Fishes	X		
2.2.9	Cars			
2.2.10	Trucks			
2.2.11	Motorcycles			
2.2.12	Tractors			
2.2.13	Rice harvesters			
2.2.14	Automatic seeding machines			
2.2.15	Mills			
2.2.16	Maize milling machines			
2.2.17	Boats			
2.2.18	Water pumping machines			
2.2.19	Televisions/Satellite dishes			
2.2.20	Electronic keyboard			
2.2.21	CD, VCD, DVD players			
2.2.22	Radios			
2.2.23	Electric pans			
2.2.24	Fans			
2.2.25	Telephones(Landline & Mobile)			

2.3 Household land holdings.

Code	Land Types	(A) Number	(B) Area (Hectares)	(C) Have Title Deed
2.2.1	Total		(m^2)	❑1. Yes ❑ 2. No
2.2.2	Construction land		(ha)	❑1. Yes ❑ 2. No
2.2.3	Agricultural land		(ha)	❑1. Yes ❑ 2. No
2.2.4	Vacant land		(ha)	❑1. Yes ❑ 2. No
2.2.5	Others		(ha)	❑1. Yes ❑ 2. No

2.4 Sources of Household Cash Income in 2012: (Unit: Kip)

Code	List	(A) Total Value in the Year	(B) Total Value Received in Cash
2.4.1	***Total Income from Agriculture***		
2.4.1.1	Maize		
2.4.1.2	Rice farming		
2.4.1.3	Banana		
2.4.1.4	Cassava		
2.4.1.5	Job's tears		
2.4.1.6	Sugar canes		
2.4.1.7	Rubber		
2.4.1.8	Other fruits		
2.4.1.9	Taros		
2.4.1.10	Vegetables		
2.4.1.11	Others (specify)...		
2.4.2	***Total Income from Animal Husbandry***		
2.4.2.1	Cattles		
2.4.2.2	Buffaloes		
2.4.2.3	Pigs		
2.4.2.4	Goats		
2.4.2.5	Poultry (Chickens/Ducks)		
2.4.2.6	Fishes		
2.4.2.7	Others……		
2.4.3	***Total Income from Commercial Activities***		
2.4.3.1	Whole sales	X	
2.4.3.2	Retails	X	
2.4.3.3	Sales of NTFP gathered		
2.4.3.4	Sales of wildlife caught		
2.4.3.5	Sales of aquatic animal caught		
2.4.3.6	Others……		
2.4.4	***Total Income from Other Sources***		
2.4.4.1	Salaries	X	
2.4.4.2	Wage	X	
2.4.4.3	Remittance	X	
2.4.4.4	Rent	X	
2.4.4.5	Handicraft	X	

2.4.4.6	Restaurant service		
2.4.4.7	Maintenance service		
2.4.4.8	Guesthouse service		
2.4.4.9	Interest		
2.4.4.10	Others…		
2.4.5	***Grand Total for the Year***		

Section III: Information on Contract Arrangement

3.1. Overview of Contract Arrangement

3.1.1. When did your household start growing cassava under contract? Year 20**……………**

3.1.2. At present, how many pieces of land do you have for cassava plantation? (A)………plot, total area (B)………………..ha.

3.1.3. Before growing cassava under contract, did your household ever grow other crops on your pieces of land?

❑1. Yes, on all pieces ❑**2.** Yes, on some pieces ❑3. No (Skip to *3.1.**3**.2*)

3.1.3.1. If yes, what kind of crops were they? *(could choose multiple answers)*

Crop	Area	Crop	Area
❑1. Paddy rice	**…………**ha	❑5. Traditional maize	**…………**ha
❑2. Upland rice	**…………**ha	❑6. Beans	**…………**ha
❑3. Banana	**…………**ha	❑7. Fruits	**…………**ha
❑4. Maize	**…………**ha	❑8. Other annual crops	**…………**ha

3.1.3.2. What is the area that has just been developed for the current cassava? (A)……….plots, farming (B)................hectares? And what type of land is it (C)?

❑C1. Forests.............................hectares ❑C2. Old fallow...........hectares
❑C3. Dipterocarp forest...........hectares ❑C4. Other…………… hectares

3.1.4. Why did you decide to grow cassava under contract? *(Multiple answers)*

❑1. Receive production factors
❑2. Guaranteed market
❑3. Guaranteed price
❑4. Receive training on production technique from the contracting partner or public sector
❑5. Receive cash for initial investment from the contracting partner
❑6. Have spare pieces of land
❑7. Have spare labor
❑8. Lack support on capital
❑**9.** Receive transporting services from the contracting partner
❑10**.** Receive assistance or welfare benefits from the contracting partner
❑11. Made a loss from growing other crops before or
❑12. Receive higher income (profit) than growing other crops
❑13. There is no market for other crops
❑14. Land is not suitable for growing other crop
❑15. Was convinced to join by others
❑16. Others (specify)...

3.1.5. Who is your contracting partner?

❑**1.** Chinese company
❑**2.** Vietnamese company
❑**3.** Thai company
❑**4.** Domestic company
❑5. Chinese trader
❑**6.** Vietnamese trader
❑**7.** Thai trader
❑**8.** Domestic trader
❑**9.** Others (specify)……..

3.1.6. Who introduced you to this contract farming project? *(Multiple answers)*

❑1. Representatives from production group
❑2. Relatives/friends
❑3. Village/district authorities
❑4. Chinese trader
❑5. Vietnamese trader
❑6. Thai trader
❑7. Domestic trader
❑8. Representatives from domestic companies
❑9. Media (Radio, television)
❑10. Others (specify).............

3.1.7. What form does the contract take?

❑1. Verbal (*explain then skip to 3.1.8*)..
❑2. Written
❑3. Others…………………….

3.1.7.1. For written contract, who were signed and certified the contract ? *(multiple answers)*

❑1. Production group
❑2. Village authority
❑3. District Agriculture and Forestry Office
❑4. District Industry-Commerce Office
❑5. Others (specify).............
❑6. Others (specify).............
❑7. Don't know

3.1.8. Were you involved in contract drafting process?

❑1.Yes ❑2. No *(If No, skip to 3.1.8.2)*

3.1.8.1. If Yes, at what stage?

❑1. Writing up stage
❑2. Review and comment stage
❑3. Approving stage

3.1.8.2. If No, who draft the contract for you? *(multiple answers)*

❑1. District authority
❑2. Village authority
❑3. Representative from production group
❑4. Others (specify)..................

3.1.9. Before signing the contract, did you study previous contracts from other sources?

❑1. Yes ❑2. No

3.1.10. Before signing the contract, how much did you understand details of the contract?

❑1. Yes, everything ❑2. Yes, some part ❑3. Not at all

3.1.11. Was the contract registered with court registration office?

❑1. Yes ❑2. No ❑3. Don't know

3.1.12. Who got to keep a copy of the contract? *(multiple answers)*

❑1. Yourself
❑2. Contracting company
❑3. Production group
❑4. Contracting trader
❑5. Village head
❑6. Involved government office (specify).......

3.2. Model and Details of Contract Arrangement

3.2.1. What is the length of the contract:…………… years

3.2.2. After signed the contract, can you cancel the contract or not?

❑1. Yes, (please explain..
❑2. No (move to 3.2.3)

3.2.2.1. If yes, how many due dates that the contract can be canceled………………….days

3.2.3 Contribution

Code	Inputs of contribution		(A) Contributor	(B)Means of contribution	(C) Actual Implementation	(D) Reasons for Breaking Contract
3.2.3.1	Land		❑1. You ❑2. Contracting partner ❑3. Not specified	*(How did you contribute your land ?)* ❑1. Rented to the contracting partner ❑2. Provided as a contribution ❑3. Contributed into production, then split the plantation ❑4. Others (specify)………………………	❑1. Completely adhered to that contract ❑2. Adhered to the contract to some extent ❑3. Did not adhere to the contract	
3.2. 3.2	Labor		❑1. You ❑2. Contracting partner ❑3. Not specified		❑1. Completely adhered to that contract ❑2. Adhered to the contract to some extent ❑3. Did not adhere to the contract	
3.2. 3.3	Capital	❑1. Preparation costs	❑1. You ❑2. Contracting partner ❑3. Not specified	❑1. You paid for ❑2. The contracting partner provided for free ❑3. The contracting partner provided first, then deducted from the sales ❑4. Other (specify)………………………	❑1. Completely adhered to that contract ❑2. Adhered to the contract to some extent ❑3. Did not adhere to the contract	
		❑2. Seeds	❑1. You ❑2. Contracting partner ❑3. Not specified	❑1. You were able to buy from any source ❑2. You needed to buy from the contracting partner ❑3. The contracting partner provided for free ❑4. The contracting partner provided first, then deducted from the sales ❑5. Others (specify)………………………	❑1. Completely adhered to that contract ❑2. Adhered to the contract to some extent ❑3. Did not adhere to the contract	
		❑3. Fertilizer	❑1. You ❑2. Contracting partner ❑3. Not specified	❑1. You were able to buy from any source ❑2. You needed to buy from the contracting partner ❑3. The contracting partner provided for free ❑4. The contracting partner provided first, then deducted from the sales ❑5. Others (specify)………………………	❑1. Completely adhered to that contract ❑2. Adhered to the contract to some extent ❑3. Did not adhere to the contract	
		❑4. Herbicide	❑1. You ❑2. Contracting partner ❑3. Not specified	❑1. You were able to buy from any source ❑2. You needed to buy from the contracting partner ❑3. The contracting partner provided for free ❑4. The contracting partner provided first, then deducted from the sales ❑5. Others (specify)………………………	❑1. Completely adhered to that contract ❑2. Adhered to the contract to some extent ❑3. Did not adhere to the contract	

		❑5. Pesticide	❑1. You ❑2. Contracting partner ❑3. Not specified	❑1. You were able to buy from any source ❑2. You needed to buy from the contracting partner ❑3. The contracting partner provided for free ❑4. The contracting partner provided first, then deducted from the sales ❑5. Others (specify)………………………	❑1. Completely adhered to that contract ❑2. Adhered to the contract to some extent ❑3. Did not adhere to the contract	
		❑6. Production tools	❑1. You ❑2. Contracting partner ❑3. Not specified	❑1. You were able to buy from any source ❑2. You needed to buy from the contracting partner ❑3. The contracting partner provided for free ❑4. The contracting partner provided first, then deducted from the sales ❑5. Others (specify)………………………	❑1. Completely adhered to that contract ❑2. Adhered to the contract to some extent ❑3. Did not adhere to the contract	
3.2. 3.4	Technique	❑1. Production	❑1. You ❑2. The contracting partner ❑3. Public sector ❑4. Not specified	❑1. You did it your own ❑2. The contracting partner provided a training ❑3. Public sector provided a training ❑4. Others.................................	❑1. Completely adhered to that contract ❑2. Adhered to the contract to some extent ❑3. Did not adhere to the contract	
		❑2. Chemical Use	❑1. You ❑2. The contracting partner ❑3. Public sector ❑4. Not specified	❑1. You did it your own ❑2. The contracting partner provided a training ❑3. Public sector provided a training ❑4. Others.................................	❑1. Completely adhered to that contract ❑2. Adhered to the contract to some extent ❑3. Did not adhere to the contract	
3.2. 3.5	Market		❑1. You ❑2. The contracting partner ❑3. Not specified	❑1. The contracting partner promised to buy all ❑2. The contracting partner promised to buy at quantity specified in the contract ❑3. The contracting partner promised to buy according to quality standard (grades) specified in the contract	❑1. Completely adhered to that contract ❑2. Adhered to the contract to some extent ❑3. The company did not buy at all ❑4. You sold to other companies/traders	

3.2.4. If you received seed from contracting partners, what type of seed and where is it from?

(A) Type of seeds (specified)…………………………………………………………………….

(B) Where is it from? (specified)…………………………………………………………………

3.2.5. If you receive the training on planting technique provided by the contracting partner, what are they?

❑1. Land preparing ❑2. Planting
❑3. Fertilizing ❑4. Harvesting
❑5. Drying yield ❑6. Other (specified)…………

3.2.6. If you receive the training on chemical using techniques provided by the contracting partner, what are they?

❑1. Chemical mixing ❑2. Spraying of chemical
❑3. Protecting when spraying ❑4. Keeping of chemical
❑5. Other (specified)…………

3.2.7. Did you use the techniques from the training for real farming practice or not?

❑1. Yes ❑2. No (*(If No, skip to 3.2.8)*

3.2.7.1**.** If you use the techniques from the training, what are they? *(Multiple answer)*

❑1. Land preparing ❑2. Planting
❑3. Fertilizing ❑4. Harvesting
❑5. Yield drying ❑6. Chemical mixing
❑7. Spraying of chemical ❑8. Protecting when spraying
❑9. Keeping of chemical ❑10. Other (specified)…………

3.2.7.2. What techniques that you think are useful? *(Multiple answer)*

❑1. Land preparing ❑2. Planting
❑3. Fertilizing ❑4. Harvesting
❑5. Drying yield ❑6. Chemical mixing
❑7. Spraying of chemical ❑8. Protecting when spraying
❑9. Keeping of chemical ❑10. Other (specified)…………

3.2.8. Was the buying price defined in the contract or not?

❑1. Defined based on market price, but there is no the minimum price guarantee
❑2. Defined based on market price, with the lowest price guarantee
❑3. Constant price
❑4. Define the price based on the product's grade
❑5. No price defining
❑6. Other (specified)…………

3.2.8.1. If there was the minimum price guarantee, how much was it………………….kip/kg

3.2.8.2. If price was defined as constant, how much was it………………….kip/kg

3.2.8.3. If the price defined based on the grade, did you know details about grade-based pricing mechanism?

❑1. If know (please explain)……………………………………………………
❑2. Don't know *(If No, skip to 3.2.9)*

3.2.9. After delivering products, are there a timeframe for payment specified in the contract?

❑1. Yes ❑2. No *(If No skip to 3.2.10)* ❑3. Receive in cash

3.2.9.1 If Yes, how many days?...................days

3.2.10. Was there any additional assistance specified in the contract?

❑1. Yes ❑2. No *(If No skip to Section IV)*

- If Yes, what are they?

Code	Detail	1=Specified 2=Not specified	1=Received 2=Not received	Reason for not receiving
		(A)	(B)	(C)
3.2.10.1	Compensate all of your investment in the event of natural disasters			
3.2. 10.2	Compensate some of your investment in the event of natural disasters			
3.2. 10.3	Provide seeds and defer debt in the event of natural disasters			
3.2. 10.4	Provide emergency loans			
3.2. 10.5	Others......................................			

Section IV: Process, Costs of and Income from the crop cultivation

4.1 Process of Cultivation

Code	Activities	Month *(Please tick 1 in the box with the specified activity)*											
		1	2	3	4	5	6	7	8	9	10	11	12
4.1.1	Slashing												
4.1.2	Burning												
4.1.3	Clearing farm area												
4.1.4	Ploughing												
4.1.5	growing (Planting)												
4.1.6	Weeding												
4.1.7	Spraying herbicide												
4.1.8	Harvesting/drying												
4.1.9	Milling												
4.1.10	Transporting												
4.1.11	Storing												
4.1.12	Selling												

4.2. Costs of cassava plantation in 2012

4.2.1. Fixed costs in 2012

Code	List	Lifespan (Years)	Responsible person 1. Farmer 2. Company	Value (Kip)	1. Own capital 2. Loan 3. Own and loan capital 4. Company
		(A)	(B)	(C)	(D) Source of fund
4.2.1.1	Preparation costs				
4.2.1.2	Fencing costs				
4.2.1.3	Building barn				
4.2.1.4	Spraying tube/machine				
4.2.1.5	Seed dropping machine				
4.2.1.6	Protection equipment				
4.2.1.7	Spades				
4.2.1.8	Shovels				
4.2.1.9	Hoes				
4.2.1.10	Harvest equipment				
4.2.1.11	Storage				
4.2.1.12	Other………				
4.2.1.13	**Total**				

4.2.2. Variable costs in 2012

Code	List	Responsible person 1. Farmer 2. Company	Value (Kip)	1. Own capital 2. Loan 3. Own and loan capital 4. Company
		(A)	(B)	(C) Source of fund
4.2.2.1	Plowing			
4.2.2.2	Seeds			
4.2.2.3	Chemical fertilizer			
4.2.2.4	Organic fertilizer			
4.2.2.5	Insecticide			
4.2.2.6	Herbicide			
4.2.2.7	Interest on loans			
4.2.2.8	Water bills			
4.2.2.9	Land rent			
4.2.2.10	Electricity bills			
4.2.2.11	Transportation costs			
4.2.2.12	Seed dropping costs			
4.2.2.13	Spraying costs			
4.2.2.14	Petrol (for machine and travel to farm)			
4.2.2.15	Telephone costs (estimated)			
4.2.2.16	Tax on farmland			
4.2.2.17	Others….......			
4.2.2.18	**Total**			

4.2.3. Local daily wage rate

(A) For labor with age between 15-64 years..Kip/day

(B) For labor with age less than 15 years..Kip/day

4.2.4. Labor use for cassava plantation in 2012

	Activities	Family Labor				Exchange Labor				Hired Labor			
		No. of days	No (head)			No. Of days	No (head)			No. Of days	No (head)		
			Total labor	Labor <15 year			Total labor	Labor <15 year			Total labor	Labor <15 year	
				Total labor <15 years	No. of student labor			Total labor <15 years	No. of student labor			Total labor <15 years	No. of student labor
		A	B	C	D	E	F	G	H	I	J	K	L
1	Slashing												
2	Burning												
3	Clearing the area												
4	Ploughing												
5	Planting												
6	Weeding												
7	Spraying herbicide												
8	Fertilizing												
9	Spraying pesticide												
10	Harvesting/ drying												
11	Milling												
12	Transporting												
13	Storing												
14	Others..........												

4.3. Did you borrow money for cassava plantation under the contract farming or not?

Source of fund	Amount of Loan (kip)	Interest rate per year (%)	Outstanding loan in late 2012 (kip)	Loan repayment 1. Cash repayment one time for both principle and interest 2. Installment repayment 3. Installment of interest, but one time principle repayment 4. Repayment by deducted from crop selling 5. Other………………………
	(A)	(B)	(C)	(D)
4.3.1 Bank				
4.3.2 Company/ contract partner				
4.3.3 Village fund				
4.3.4 Relative/local person				
4.3.5 Total		X		X

4.4. Sale of Products

Year	Quantity (Kilogram)	Selling Price (Kip/Kilogram)	Total Income (Kip)	**Ways of Receiving Money** 1. Receive all at once 2. Receive a stream of payments under the define date 3. Not yet receive the money 4. Others (specify)
	4.4.1	4.4.2	4.4.3	4.4.4
2012				
2011				
2010				
2009				

4.5. When selling products, how the company deduct your income?......................................

Section V: Impact of Cassava Plantation under the Contract Farming

5.1. After joining the contract farming, how has your household's economic situation changed?
❑1. Improved considerably ❑2.Improved ❑3. Not changed ❑4. Worsened ❑5. Worsen considerably
5.1.1. Explain:..

5.2. After joining the contract farming, how has the employment opportunity for household members changed?
❑1. Increased ❑2.Not changed ❑3. Decreased

5.3 Have you ever breached the contract?
❑1. Yes ❑2. No *(If No skip to 5.4)*

5.3.1 If yes, in what case?
❑1. Did not meet quality specification ❑2. Did not meet quantity specification
❑3. Did not sell to the contracting partner ❑4. Other (specify)..........................

5.3.2. In case you breach the contract, what was the punishment mechanism from the contracting partner? *(Multiple answers)*
❑1. Mediated between both parties ❑4. Asked to leave the project
❑2. Notified only ❑5. Fine
❑3. Arbitrated by authority ❑6. Others (specify)..........

5.4. Has the contracting partner ever breached the contract?
❑1. Yes ❑2. No (*if No skip to* 5.5)

5.4.1 If Yes, in what case? *(Multiple answers)*

No.	List	Solutions/Recommendations
1	❑Delay in payment	
2	❑Pay in small amounts	
3	❑Non transparent grading mechanism	
4	❑Others.......................................	

5.5. Have you been indebted as a result of making a loss from cassava farming under contract?
❑1. Yes ❑2. No *(if No skip to 5.6)*

5.5.1. If yes, who were you indebted to?
❑1. Bank(s) ❑2.Contracting partner ❑3.Village fund ❑4. Relatives ❑5. Informal lenders

5.5.2. If you were indebted, how did you repay the loan to the contracting partner? *(Multiple answers)*
❑1. Sold land ❑2. Sold house ❑3. Sold vehicles ❑4. Sold livestock
❑5. Borrowed from others ❑6. Worked for free ❑7. Repaid with future harvest
❑8. Others.........

5.5.3. Are you currently indebted?
❑1. Yes ❑2. No *(if No skip to 5.6)*

5.5.4. If yes, what is the amount owed?...Kip

5.6. Was a production group created for contract farming?

❑1. Yes ❑2. No *(If No skip to 5.7)*

5.6.1. If yes, what benefits did you receive from joining the production group? *(Multiple answers)*
❑1. Increased bargaining power
❑2. Information source for production technique
❑3. A source of information related to maize contract farming
❑4. Provide assistance in the event of emergency
❑5. Assist in mediating with the contracting partner
❑6. Others...................................

5.7. In your opinion, what are the pros of growing cassava under contract arrangement?

....

5.8. In your opinion, what are the cons of growing cassava under contract arrangement?

....

5.9. In your opinion, how the most suitable model of contract farming should be in maximizing benefits for both parties and minimizing environmental risks?

....

5.10. How satisfied are you with the contract farming project (in terms of income and employment)?
❑1. Very satisfied ❑2. Satisfied
❑3. Somewhat satisfied ❑4. Not satisfied

5.11. Having known about all pros and cons of growing crop under contract, would you decide to continue growing cassava under this contract farming after the current contract expired?
❑1. Yes ❑2. No

5.12 Why or Why not? Explain

....

....

Thank You Very Much