Expansion of Rubber Tree Plantation in Northern Laos: Economic and Environmental Consequences

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Abstract

Rubber trees have been planted in the Northern Province of Laos since the mid-1990s, with tapping beginning in early 2000s. Consequently, livelihoods in the upland of northern Laos have rapidly moved away from subsistence shifting cultivation to rubber tree plantations. As a result, the total area of rubber tree plantations in Laos has drastically increased from 342 ha in the early 1990s to more than 25,000 ha in 2009. This paper reviews the factors that accelerated that rapid expansion of rubber tree plantation in northern Laos and its economic and environmental consequences and identifies key issues for future studies. The Land and Forest Allocation (LFA) program played a direct role in shaping the rubber landscape in northern Laos, but increased demand for natural rubber from China in response to stagnation of Chinese domestic supply was the most important factor behind the rapid expansion of rubber tree plantations in Northern Laos. Therefore, under current and likely future market conditions, investment in smallholder rubber production in Northern Laos appears financially profitable. However, this study found that the economic gains from rubber tree plantations came with losses in food production, soil quality degradation, and deforestation. Therefore, it is necessary to thoroughly analyze the behaviors of smallholder rubber production in Northern Laos to understand their labor allocation decisions for different livelihood activities, including forest extractions along the tract, to achieve the goal of promoting rubber tree plantations as a key strategy to alleviate poverty and as an instrument to eliminate shifting cultivation to conserve natural forests.

1. Introduction

Shifting cultivation or slash-and-burn agriculture[1] plays an important role in rural livelihoods in the uplands of the Laos, where hills and mountains made up more than 80% of the total land area. Rice is a major crop produced by shifting cultivation, mainly to supply staple needs for household consumption. In addition to rice, other crops such as maize, chili, cucumbers, egg-plants, and vegetables are usually intercropped or grown adjacent to the upland rice plots (Gansberghe, 2005a). In addition, these upland farmers also engage in livestock production and non-timber forest products (NTFPs). Livestock are produced to supply meat for home consumption and ceremonial needs; however, several upland households keep livestock as a source of savings to be sold when cash is needed and to make long-term investments in farming and livelihoods, e.g., planting fruit trees, purchasing a two-wheel tractor, micro rice mill, and sending children to higher levels of education (Gansberghe, 2005b). Different types of NTFPs are widely collected by the upland farmers. Edible NTFPs, namely bamboo shoots, rattan shoots, mushrooms, cardamom, wild vegetables, and wild fruits form a large share of the diet of upland households, and they are usually eaten in greater amounts as filling foods during the periods of rice shortage (Krahn, 2005). Non-edible NTFPs, such as broom grass and paper mulberry, are also sold for cash to purchase other commercial goods and rice during the periods of shortage. The shifting cultivation system is practiced through use of the traditional tenure system. Under such a system, tenure was conventionally obtained through the

cultivation of land that has not been claimed by others, but a clear ownership of the occupied plots was not officially given to the households. The ownership rights of the land remained during the fallow rotations between cultivation, but it was possible to hand over cultivation rights to others with the permission of the previous owner (Sodarak, 2005). The Lao government views shifting cultivation as an outdated and destructive agricultural production and as a less efficient use of land resources, whereas permanent or intensive farming would generate greater production (MAF, 1999). In the early 1990s, the Land and Forest Allocation (LFA) program was introduced as an instrument to increase land tenure security in order to encourage famer involvement in intensive farming and to eliminate shifting cultivation to protect natural forests (Thongphanh, 2004; and Ducourtieux et al., 2005). Two forms of land allocation have been implemented in the process of LFA. The first demarcated the villages' boundaries for forest and agricultural lands. Then, a more detailed classification of land-use types was created[2], and land was allocated to households accordingly. LFA was undertaken with a goal of preserving traditional tenure system or land used in the past. The size of the allocation is based on each household's available labor and capital. In principle, an active worker could be allocated up to 22 hectares[3]. To retain land tenure, the land has to be under cultivation or intensively developed within three years. If there is no agricultural activity or intensive use of the land, the allocated areas would be returned to the state[4] (Thongphanh, 2004).

In response to the LFA program, the provincial government of LuangNamTha (Northern Province of Laos) introduced rubber trees as a permanent crop to replace the shifting cultivation practice, with the goals of reducing poverty and promoting more the efficient use of land resources. A pilot project was undertaken from 1994 to 1996, during which a designated group of six minority villages in the LuangNamTha district of LuangNamTha province were encouraged to grow rubber trees in plots that used to grow upland rice (Shi, 2008). Those trees planted during that time have since matured and have been tapped since 2003 (Alton et al., 2005). Latex sales after rubber tapping at that time were finically profitable (Manivong and Cramb, 2008). As a result, LuangNamTha Province (Hadyao village in particular) became known as the first place for rubber cultivation in Northern Laos (Alton et al., 2005; Manivong, 2007; and Shi, 2008). That successful story of rubber tree cultivation has inspired and attracted the villagers, and domestic and foreign investors to venture into this business. The total area of rubber tree cultivation in LuangNamTha Province have drastically increased from 342 hectares in the first period (1994-1996) to more than 25,000 hectares in 2009 (PAFO, 2010). This paper reviews the factors that have accelerated the expansion of rubber tree plantation in northern Laos and its economic and environmental consequences in order to provide a foundation for future studies. The second section reviews the rubber plantation development in northern Laos and the driving factors behind its rapid expansion. The following section discusses the economic consequences of smallholder rubber production in northern Laos. Ecological and environmental consequences are discussed in the fourth section. Due to lack of studies on ecological and environmental impacts of rubber tree plantation in Laos, this section discusses cases of Laos and others countries where rubber tree plantation has been adopted. The last section concludes and discusses prime issues that need to be thoroughly investigated to achieve the goal of promoting rubber tree plantations as a key strategy for the alleviation of poverty and as an instrument to eliminate shifting cultivation to conserve natural forests.

2. Demand for natural rubber from China

Rubber is one of China's four main industrial materials, along with coal, iron, and petroleum. China's domestic supply for natural rubber has stagnated and has even shown signs of decline after 2005 when a severe typhoon hit Hainan, one of China's three main rubber producing provinces, and destroyed a substantial area of rubber forests (Shi, 2008). At the same time, China's total consumption of natural rubber continued increasing; averaging 11.5 percent growth per year from 862 thousand tons in 1999 to 1,504 thousand tons in 2005 at an average rate of 11.5% (Figure 1). Therefore, increasing rubber imports is one of China's main efforts to meet domestic demand of natural rubber (NR). In fact, China's NR imports exceeded the United States' making it the world's largest importer from 2003 to 2005 (Figure 2). In addition to increasing imports, China also made other efforts to stabilize the domestic supply of natural rubber; however, high land prices in China made this strategy prohibitive. Thus the Chinese government actively encouraged domestic investors to invest in foreign rubber producers. Hainan and Guangdong state-owned farms expanded their investment as far as to Malaysia, while Yunnan state farms have been seeking investment outlets in northern Laos since 2004. Narcotics control efforts have been officially integrated into the Chinese economic agenda in order to create a favorable environment for Chinese investors to invest in rubber tree plantations. Under this narcotics control strategy, the China subsidized the development of opium replacement plantations in northern Laos and aggressively promoted commercialization of trees and cash crops to eradicate opium cultivation. Officials in Xishuangbanna (Chinese Southwest province bordering Laos) reported that over 40 Chinese companies, among them rubber companies, are currently operating in northern Laos under the provision of opium replacement program (Shi, 2008). World market prices for natural rubber increased from approximately US$542.27 in 2001 to its highest price of approximately US$1,907.31 in 2006. Changes in the world market price of natural rubber

from 1990 to 2006 are presented in Figure 3. As the world's largest consumer of natural rubber since early 2000, China's increasing demand for natural rubber along with the stagnation of the domestic supply may be one factor driving up natural rubber prices in that time.

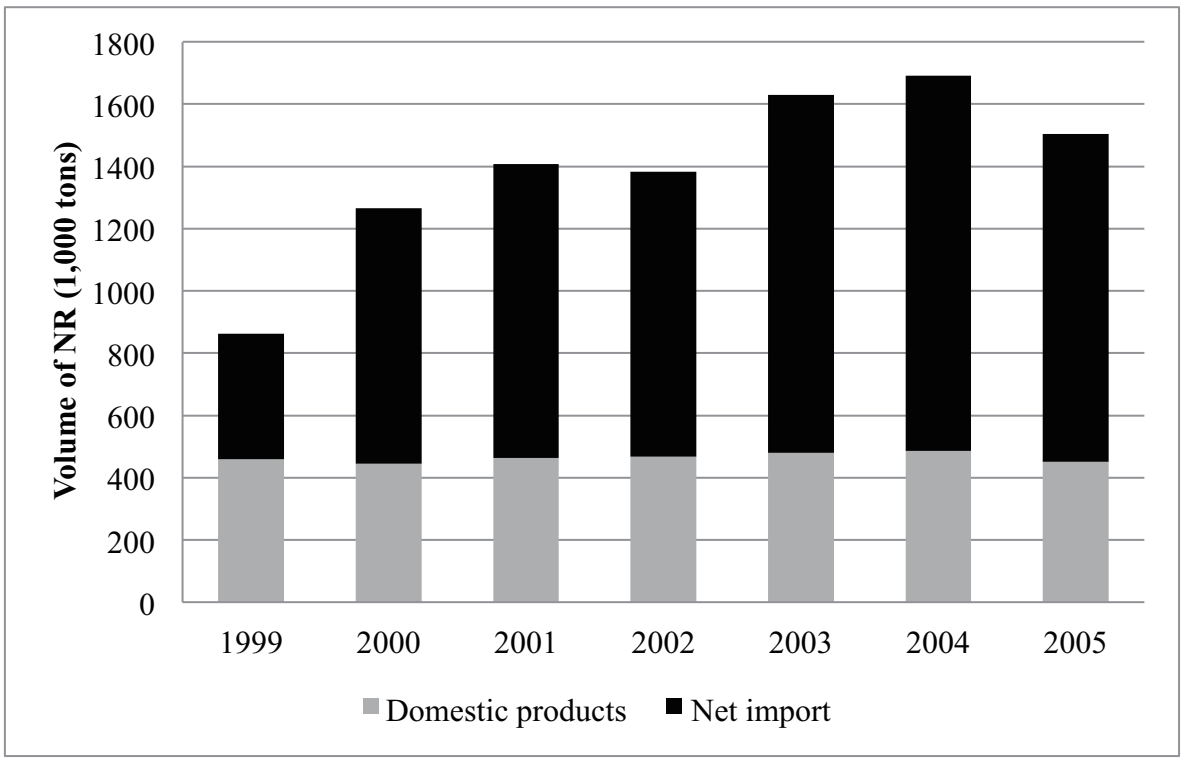

Figure 1. Total consumption of natural rubber for China from 1999-2005
Source: Tavarolit, 2006

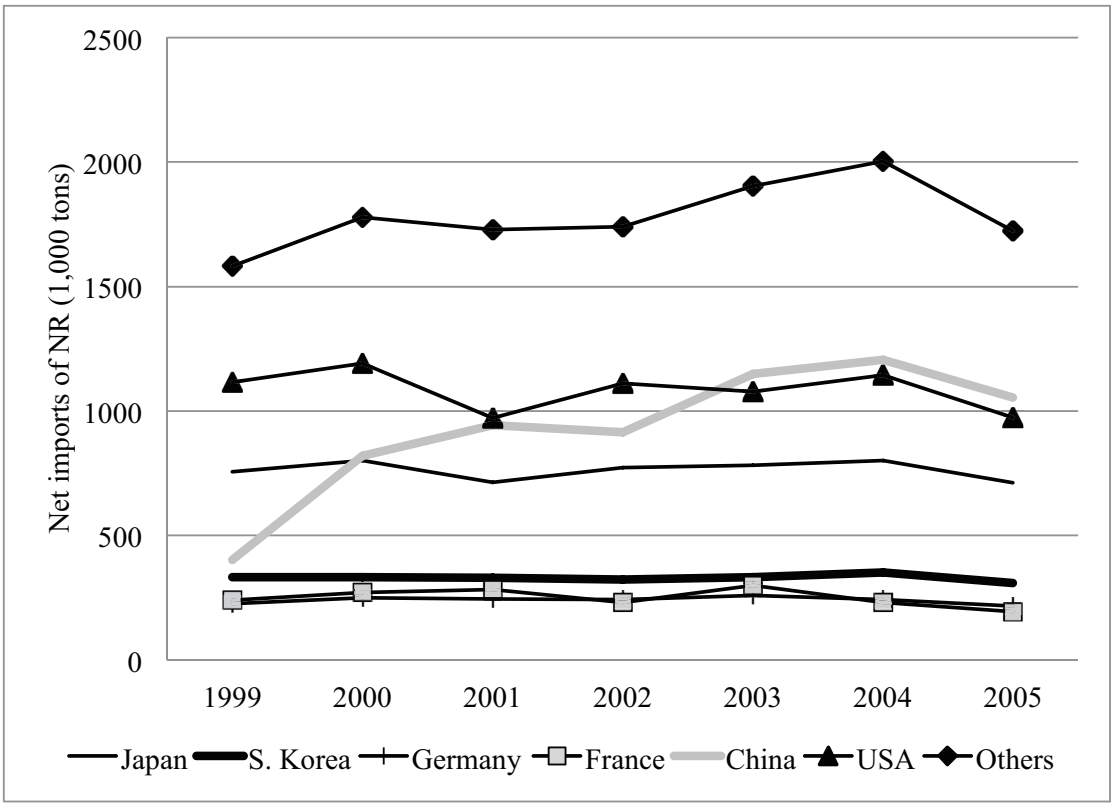

Figure 2. Net import of natural rubber (NR) by major countries from 1999-2005
Source: Tavarolit, 2006

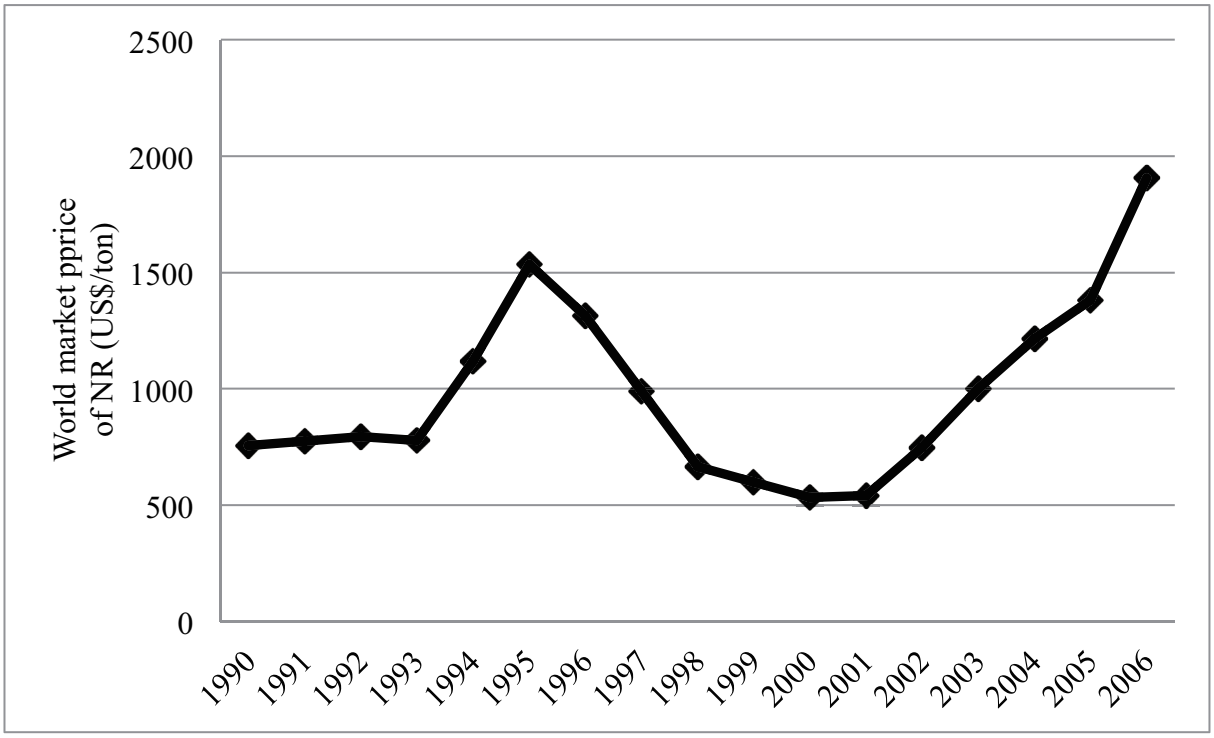

Figure 3. World market price of natural rubber from 1990 to 2006 ($/ton)
Source: Khin et al., 2008

3. Expansion of rubber tree plantations in Northern Laos

Rubber trees were first planted in Northern Laos in 1994. In the next two years, approximately 154,000 rubber trees were planted on about 342 hectares in Hadyao village in the district and province of LuangNamTha. Unfortunately, in December 1999 heavy frost killed approximately 34,000 trees or an equivalent of 75.5 hectares. The surviving trees matured and their tapping began in the early 2000s (Alton et al., 2005). Cash income received from consequent latex sales demonstrated the financial profitability of rubber plantations and Hadyao village become known as the first major rubber cultivating village in Northern Laos. Shi (2008) revealed that Hadyao, in fact, was a village contained in a group of six minority villages encouraged by the provincial government to plant rubber trees in the mid-1990s. Before Hadyao's success, there was a number of repatriated Akha refugees from the American War emigrated from China to the Sing district of LuangNamTha Province, bringing with them skills in rubber cultivation developed in China. These immigrants were the first to plant rubber trees in that area and served as models and a crucial source of knowledge for local villagers. However, the first well-known wide-spread successful rubber cultivation was Hadyao village (Alton et al., 2005; Manivong, 2007; and Shi, 2008).

Two main factors that contributed to Hadyao's success were key groups and individuals (the farmers that worked on the plantations) and strong leadership. Alton et al (2005) noted that Hadyao village had Hmong who came from China and moved to Laos to be with friends and families. Some of this group arrived in the late 1980s after having worked over 14 years on rubber tree plantations in Xishuangbanna, Yunnan province. After settling in Hadyao, the newly arrived Hmong recommended rubber tree plantation as a commercial alternative to friends and relatives who had been practicing shifting cultivation. Hearing of their experiences of rubber tree cultivation in China, Hadyao village authorities went to Xishuangbanna, China to learn more about various alternatives to shifting cultivation, such as fruit tree and vegetable cultivation, animal husbandry, aquaculture and rubber tree plantation. They concluded that the newcomers' experiences made rubber production the most promising option. Thus, these resettled Hmong were the first group of important people, followed by Hadyao village authorities that help to promote rubber tree plantations in Northern Laos. The most important figure in Northern Laos' rubber cultivation story was the Vice Governor of LuangNamTha province that was also part of the Hmong ethnic minority of Laos. He encouraged and supported the Hmong community in their decision-making process, and in particular through the provision of provincial funds to subsidized loans for rubber tree cultivation. In fact, in 1994, the villagers received their first loan of 12.9 million kip with an interest rate of 2 percent and a 7-year payment period[5]. The next year the Provincial Agriculture and Forestry Office (PAFO) also advanced 10 million kip with the same interest rate and repayment period (Manivong, 2007). During the early stage of rubber tree cultivation, the village

authorities often went to Xishuangbanna to obtain technical advice, purchase inputs, and, after tapping, to look for sales opportunities. In addition to in-house learning-by-doing, authorities also led several study tours, showing village elders and some heads of household farm level rubber tree cultivation and processing factories (Alton at al., 2005). The experience of rubber tree cultivation in Hadyao village was a special case because of its key people, provision of low interest rate loan with long payback periods accompanied by increasing world price of natural rubber, all helped to create favorable conditions that supported the village's success. Despite the unique combination of conditions Hadyao village had, farmers and investors from other areas started looking to rubber cultivation. As a consequence, the area with rubber tree cultivation doubled from 354 hectares from 2002 to 671 hectares in 2003 (Figure 4).

Manivong (2008) confirmed Hadyao's rubber tree cultivation success and further estimated that under current and likely future market conditions, investment in smallholder rubber cultivation in the uplands of Northern Laos would be financially profitable, emphasizing that the Laos government is on the right track in promoting rubber tree cultivation as the key environment friendly strategy for alleviating poverty. Rubber tree cultivation is now promoted in a larger scale. The provincial government is encouraging more villages to grow rubber trees while providing incentives and programs to attract domestic and foreign investors[6]. The first broad-scale regulations on rubber plantation investment came in 2003. These regulations prescribed the general modes of rubber investments, provided specific procedures associated each mode, and delineated the investment scenarios for both domestic and foreign companies through either concession or contract farming[7]. In 2006, the government set an ambitious goal to cultivate 20,000 hectares of rubber. To realize that target, at a micro level, the provincial government gave a hectare of land and seedlings to families without paddy rice crops in 12 targeted villages in the LuangNamTha district. Funds for the project were borrowed from the Mengla County government in Xishuangbanna and distributed to the villagers through the Agricultural Promotion Bank as a subsidized loan. At the macro-level, the government provided tax exemptions[8]. Rubber trees typically mature after 7 to 8 years before they can be tapped, thus the tax exemptions allowed for producers to receive exemptions from tax on profit for the first 14 to 15 years of investment in rubber tree cultivation. At the national level, the government also offered land concession granted property rights to people who planted trees and distributed free seedlings to farmers and organizations (Shi, 2008). The LFA program introduced by the government also played an indirect part in shaping the rubber landscape in LuangNamTha Province because the villagers faced pressure to adopt permanent crops or return their allocated land to the State if the allocated plots were abandoned or undeveloped for three years. Thus rubber tree cultivation became a way for people to gain exclusive land rights on land, regardless of the ambiguous legal status of land ownership (Thongmanivong et al., 2009).

LuangNamTha Province shares a 140-km-long border with China to the north and is a center for commerce between Laos, China, and Myanmar. China is its main trade partner. Trade between Laos and China is mainly conducted through the Borten international check point (DOPI, 2009). GDP growth of LuangNamTha province was 7.87 percent in 2008, and approximately 70 percent of GDP came from the agricultural sector, whereas industrial and handicraft; and commerce and services accounted for approximately 15.20 and 16.17 percent, respectively. LuangNamTha province is well-known as an eco-tourism destination in Northern Laos, offering abundant nature life because of Nam Ha nationally protected areas and home stays with various ethnic groups. The main industrial sectors are hydro power plant and mineral extraction mainly coal and copper. The manufacturing sector was not present in the Provincial Social and Economic report (DOIP, 2009). Therefore, total products of natural rubber latex produced within the LuangNamTha Province are exported to China in the form of tub-lump. During rubber tapping season, usually from April to November, Chinese traders come to LuangNamTha once a month to buy tub-lump rubber at the villages. Villagers would be given the price of tub-lump rubber by the Chinese trader at the time of purchase. This was the only source of price information. Over time, the price increased in line with world rubber prices (Manivong, 2007). Figure 5 show quantity of tub-lump rubber exported to China from 2006 to 2009. The export of tub-lump rubber declined from 587 tons in 2006 to 444 tons in 2007, due to unstable in latex given by the rubber trees themselves (rubber supply) but increased continuously after 2007. This section presented the China and Laos relationship in regards to rubber tree cultivation and trade. China is the main market for rubber in Northern Laos but it is a substantial market with large demand for natural rubber because of its own inadequate domestic Chinese supply. In summary, rubber tree cultivation promoted by Lao government brought financial profits to smallholder farmers because of huge demand from China. Rubber tree plantations have rapidly expanded in the province (Figure 4).

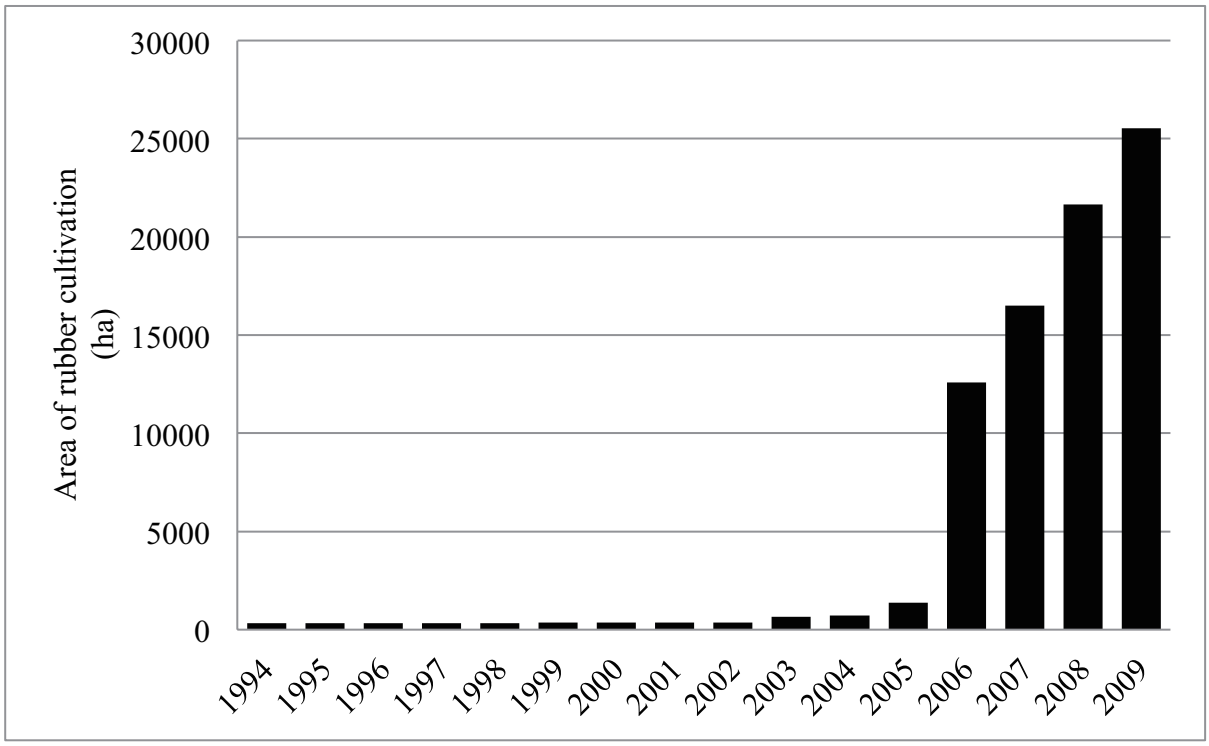

Figure 4. Total area (hectare) of rubber cultivation in LuangNamTha Province
Source: Manivong, 2007; Shi, 2008; Department of Planning and Investment of LuangNamTha Province (DOPI), 2008; and Department of Agriculture and Forestry of LuangNamTha Province (PAFO), 2010

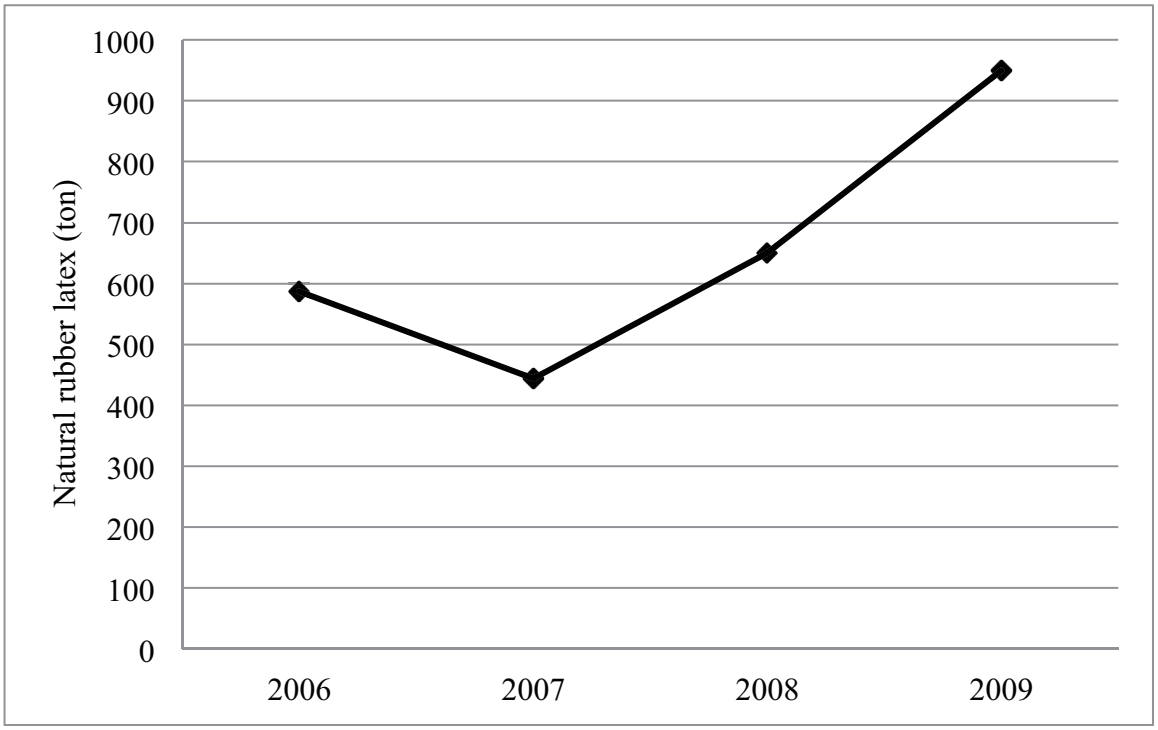

Figure 5. Total quantity of tub-lump rubber exported to China from 2006 to 2009
Source: Department of Industry and Trade of LuangNamTha Province, Laos (2010)

4. Economic Perspective of Rubber Tree Plantation

Changing from subsistence-based shifting cultivation to a commercially dominated plantation system of primarily rubber tree plantations appeared to be financially profitable. Fu et al., (2009) found that, in Xishuangbanna, returns from rubber tree cultivation have significantly increased the per capita income of smallholders from US$128.30 in 1998 to US$561.70 in 2004, of which income from rubber alone increased from US$75.80 in 1998 to US$451.40 in 2004. Investment in smallholder rubber production in the uplands of Northern Laos was also found to be financially profitable under the current and likely future market conditions (Manivong and Cramb, 2008). Moreover, rubber trees that are intercropped with other crops or that are combined with animal husbandry at either immature or mature stages increase land value (Tajuddin 1986; Jusoff, 1988; Rodrigo et al, 2001; Pathiratna and Perera, 2006; and Guo et al, 2006).

Table 1. Results of DFC analysis of smallholder rubber in Hadyao village, LuangNamTha Province, Northern Laos (2005 prices)

Rubber price (Kip/kg)	NPV (Kip/ha) and BCR at selected discount rates			IRR (%)
	5%	8%	13%	
5,460	-4,958,000 (0.94:1)	-9,361,000 (0.84:1)	-10,847,000 (0.71:1)	3.4
7,800	23,038,000 (1.27:1)	7,048,000 (1.12:1)	-3,347,000 (0.91:1)	10.7
10,140	51,034,000 (1.61:1)	23,463,000 (1.40:1)	4,153,000 (1.11:1)	15.4

Source: Manivong and Cramb, 2008[9].

Manivong and Cramb (2008) performed a Discounted Cash Flow Analysis (DCF) in the Northern Province of LuangNamTha, Laos. Three price scenarios of tub-lump rubber and three different discount rates were used (Table 1). A discount rate of 8% and tub-lump price of 7,800 Kip/kg were used as a baseline scenario. The prices of tub-lump rubber varied from a low of 5,460 Kip/kg to a high of 10,140 Kip/kg, which 30% below and above the baseline scenario, respectively. Different discount rates of 5%, 8%, and 13% were applied to evaluate the sensitivity of the results. The results of the DCF analysis of the baseline scenario revealed that investment in smallholder rubber tree plantation was clearly worthwhile. If the price decreased by 30% compared to 2005, new investment in smallholder rubber production was no longer worthwhile. However, if the rubber price increased by 30% relative to 2005, this investment would generate a NPV of over 23 million Kip/ha (US$2,235/ha) and a rate of return of approximately 15%.

Intercropping during the unproductive immature stage of rubber provided a method to reduce the gap in income suffered by smallholders after replanting or new planting of rubber. A financial appraisal revealed that there was a potential to raise profits by more than 350% if the planting density of banana was increased threefold over the current practice of the Sri Lankan smallholders. The density of banana cultivation was increased from a single row of 500 banana clumps per 500 rubber plants per hectare to three rows of 500 banana clumps per 500 rubber plants per hectare. However, the authors emphasized that the yields expected in the third year, fertilizer costs, labor costs, and market value of banana were four major factors that governed the profitability of the intercropping (Rodrigo et al, 2001). Rubber-tea intercropping generated a higher Land Expectation Value (LEV) than rubber and tea monocultures. In Hainan province, China, rubber-tea intercropping generated the highest LEV, while tea monoculture had the lowest under current market conditions. The rubber-tea intercropping had an optimal rotation age of 26years with LEV of 50,717 CNY/ha, and the optimal rotation year of rubber monoculture was 29 years with 39,286 CNY/ha. Tea monoculture had no optimal rotation age with maximum NPV (Guo et al., 2006). Rearing animals under rubber tree plantation not only increased the economic value but also reduced costs of weeding and fertilizing. In Malaysia, sheep rearing under rubber plantations also appeared to be very attractive and practical, as apart from selling meats, it also served as a biological weed control measure. The cost of controlling weeds could be reduced by approximately 21% over the usual method by using sheep grazing or weed control. In addition, the Internal Rate of Return (IRR) from sheep rearing could be as high as 44% (Tajuddin, 1986). Sheep grazing was also found to improved soil fertility, which resulted in increased nutrient uptake and growth by rubber trees (Jusoff, 1988). In considering the topographical conditions of northern Laos, instead of sheep, goat rearing in rubber plantations would be a promising option to increase land values.

5. Expansion of rubber tree plantation and ecological services

5.1 Upland rice cultivation

In general, the total areas of upland rice cultivation in northern Laos have declined mainly because of the direct policy of the government to reduce shifting cultivation. Similar to other northern provinces, upland rice cultivated areas in LuangNamTha Province have been in decline since the mid-1980s (Figure 6). However, it was found that the decreasing rate was relatively faster after the introduction of rubber tree cultivation. Before rubber tree plantation, a reduction in areas of shifting cultivation was directly influenced by the central governmental policy to liberalize trade and markets to promote private-sector activities. The normalization of trade relationships with Thailand and China boosted economic growth in Laos during the early 1990s; cash crop production increased in particular (Fujita, 2006; and Thongmanivong and Fujita, 2009). Then, from the mid-1990s to the mid-2000s, the expansion rubber tree cultivation was considered a major cause for the further reduction in shifting cultivation. This decrease was especially noticeable after the rapid expansion of rubber tree cultivation (the rubber boom) began in 2006 when target areas for rubber cultivation had been chosen and several policies had been implemented to realize the goal (as described in the previous section). The long-term decline of upland rice cultivated areas as a result of the rapid expansion of rubber tree cultivation was not surprising because evidence in both in Laos and in Yunnan province, China, has demonstrated that an expansion of rubber tree plantation occurred at the expense of forestlands and upland agricultural production, mainly shifting cultivation (Thongmanivong and Fujita, 2006; and Liu et al., 2006). Thongmanivong and Fujita (2006) assessed land use changes from 1993 to 2000 in four northern provinces of the Lao PDR, including LuangNamTha Province. They found that the agro-ecological landscape of the upland areas in those four northern provinces is undergoing a rapid transformation from subsistence and swidden-based landscapes towards a more commercial and multifunctional use of uplands. In particular, upland agricultural land decreased significantly from 1993 to 2000, from more than 1.5 million hectares to 625,429 hectares. In Xishuangbanna, China, swidden fields decreased from 20.4 ha in 1998 to 12.7 ha in 2004, while the number of cultivated upland rice varieties decreased from 7 varieties in 2001 to 1 variety in 2004 because of a sharp increase in the price of rubber after 2002 (Fu et al., 2009 and 2010). These studies suggested that the expansion of rubber tree cultivation resulted in the deforestation of tropical forests, a loss of biodiversity, and a decrease in food crop production (Liu et al., 2006; and Li et al., 2007).

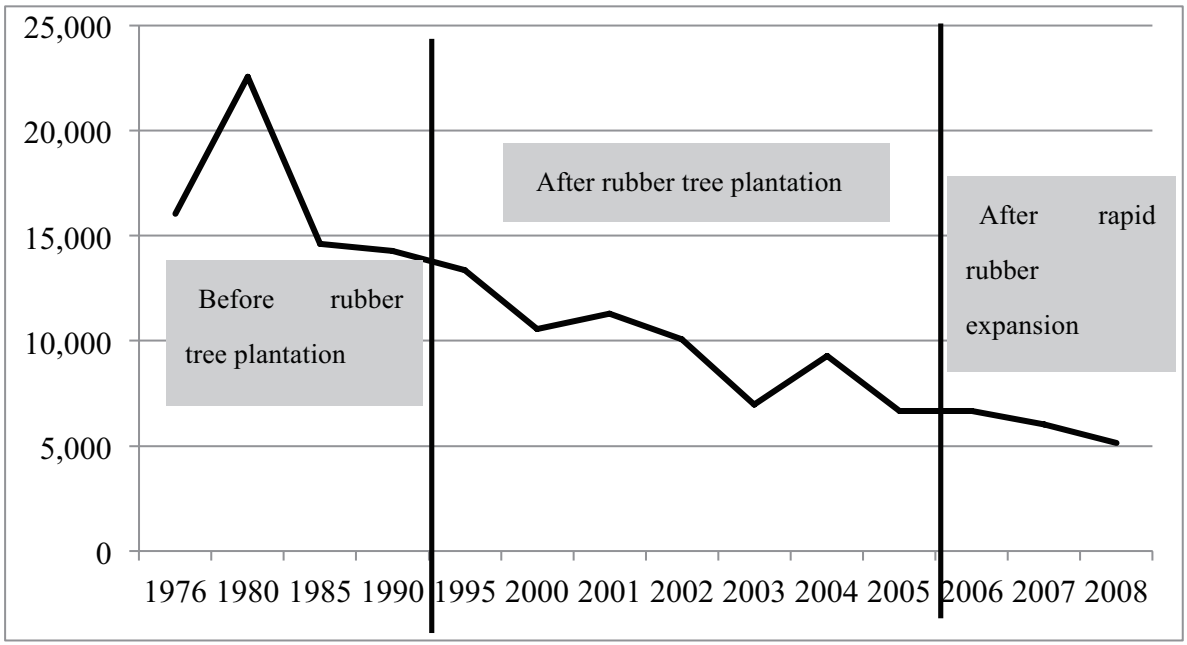

Figure 6. Upland rice cultivated areas in LuangNamTha Province (hectare)
Source: Agriculture Statistics 30 Years of Laos (1976-2006)

5.2 Forest cover changes

The rapid expansion of rubber tree cultivation has led to widespread land conversion; for example, upland cultivated plots and fallow forests have been cleared and converted into rubber tree plantations. The forest cover in northern Laos has declined continuously for three decades (Figure 7). In 1982, forest cover was 38.1% of total area in 1982; in 1992, it was approximately 36.3%, and, in 2002, it remained approximately 27.9% of total area. This shown a rapid decrease from 1992 to 2002 of

approximately 8.4%, while this decrease was only approximately 2.2% from 1982 to 1992 (Vongsiharath, 2009). The main external factor that contributed to land conversion in the northern region of Laos was the continued increasing demand for natural rubber from China accompanied by its stagnation in domestic supply (as described in section two). Whereas internal factors included shifting cultivation practices and forest fires, the unsustainable use and management of forest resources, the conversion of forest lands into permanent agricultural land and infrastructure, and the dissemination of laws and regulations among concerned agencies, have not been fully effective and are not strictly enforced (Vongsiharath, 2009). Although there is no clear evidence that supports the claim that the rapid expansion of rubber tree plantation was the main cause of forest cover changes in northern Laos, but upland cultivated plots for shifting cultivation and fallow forests have been converted to rubber tree plantation for either the benefits from foreign exchange as a result of a continued increasing demand for natural rubber from China or for acquisition of exclusive land use rights, regardless of ambiguous legal status of land ownership (Thongmanivong et al., 2009).

Rubber is one of China's four main industrial materials, along with coal, iron, and petroleum, and China's demand for natural rubber has increased continuously since 1999. In addition to ensuring the stable supply of natural rubber by importing, the Chinese government also devoted efforts to maintaining the domestic supply of natural rubber. From 1988 to 2003, rubber tree plantation increased by 324%, while forest cover decreased by 60%. Fallow lands for upland rice and other crops cultivations decreased by 95% (Liu et al., 2006). The most obvious change was the decrease in forest cover and increase in rubber tree plantations. A total area of 139,576 hectares of tropical seasonal rain forest was lost because of increased rubber tree plantation below 800 m and shifted agricultural activities to the higher elevations. The tropical rain forest of southwest China has the richest flora and fauna of China, and losing substantial parts of this forest type has increased the loss of biodiversity (Li et al., 2007)

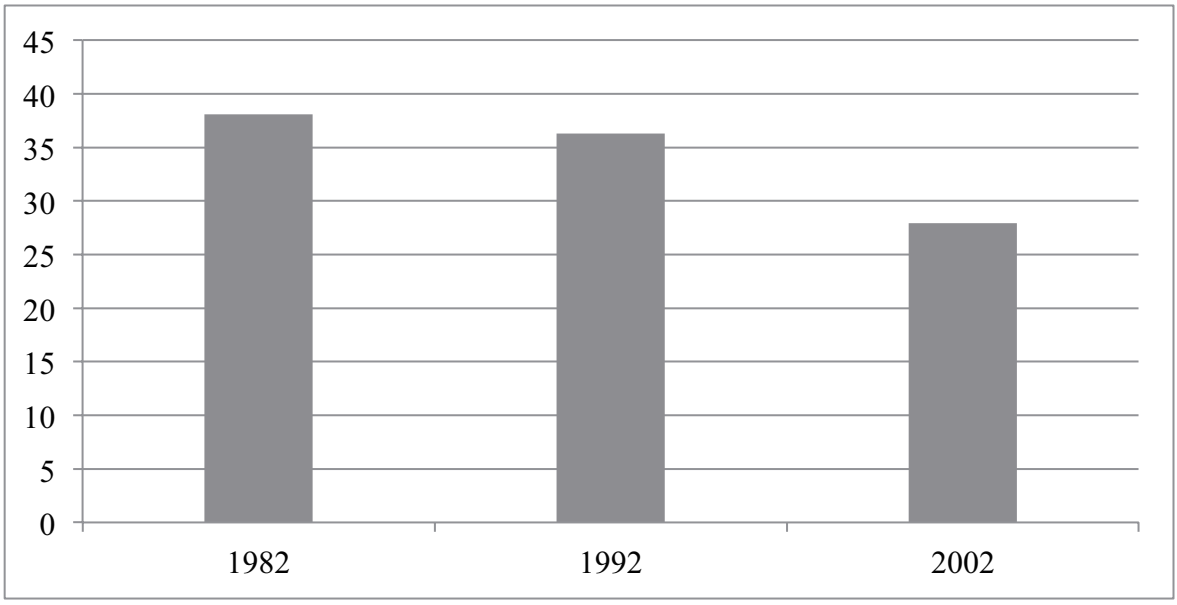

Figure 7. Forest cover change in northern Laos in three decades
Source: Vongsiharath, 2009

5.3 Soil quality

The impacts of planting rubber trees on soil quality have been widely recognized (Aweto, 1987; Zhang et al., 2005, 2007; and Zhang et al., 2007). Aweto (1987) observed that in southwestern Nigeria, changes in soil bulk density and total porosity during the first 18 years of rubber plantation establishment were slight. However, most of the observed decline in soil mineral-nutrients occurred during the first 11 years following rubber tree plantation. The work of Aweto has been supported by a number of current studies conducted in Yunnan and Hainan Provinces of China. In Hainan, there was strong evidence that long-term rubber farming caused soil acidification, soil compaction, and depletion of organic matter and nutrients (Zhang et al., 2005). Two years later, the authors found that rubber cultivation had resulted in a significant decline in soil organic Carbon (C) and microbial biomass carbon (C) and that adopting rubber-intercropping could not decelerate soil degradation (Zhang et al., 2007). In addition, they found that total organic carbon (TOC) increased significantly in the tea-row soils of tea-rubber intercropping, but remained low in the rubber-row soils of rubber plantations and tea-rubber intercropping in the age 40 year stand. Other scholars suggested that adopting animal husbandry under rubber tree plantation would improve soil quality. For instance, sheep grazing under rubber tree plantation in

Malaysia was found to improve soil fertility through the additional nutrients, which resulted in increased nutrient uptake and growth by rubber trees (Jusoff, 1988). In line with a number of advantages of rubber intercropping and combining animal husbandry, Guo et al. (2006) stated that there were some barriers that must be taken into consideration. (1) Rubber intercropping was more labor intensive than a monoculture system, so the labor sources and wages were two factors affecting its adoption. (2) Intercropping could not be adopted by all smallholders because intercropping was more technically demanding. Intercropping may generate lower LEV than a monoculture if management was not applied properly. (3) Finally, intercropping was not suitable for high altitudes because rubber trees would be destroyed by cold temperatures.

6. Conclusion and Discussion

Farmers in the uplands of the northern province of Laos have been rapidly moving away from shifting cultivation towards rubber tree plantations in response to government policies encouraging rubber tree cultivation as a strategy to alleviate poverty and conserve remaining forest land. This paper reviewed the factors that contributed to the rapid expansion of rubber tree cultivation and identified its economic and environmental issues related to rubber cultivation providing venue for future studies. The evidence reviewed in this research showed that China's increasing demand for natural rubber and stagnating of Chinese domestic supply (Figure 1), and the lasting increase in world natural rubber prices (Figure 3) would be the two main external factors contributed to the rapid expansion of rubber tree plantation in Northern Laos; whereas, direct and indirect incentives and policies provided by the Lao government also helped to nurture the expansion of rubber tree plantations as shown in section 2 and 3.

The reviewed researches suggest that under current and likely future market conditions, investment in smallholder rubber production in northern Laos as well as in the Yunnan and Hainan provinces of China will continue to be financially profitable (Manivong and Cramb, 2008; and Fu et al., 2009). Furthermore, combining rubber tree plantation with other crops and animals provided the methods to reduced income gap at the first planting and re-planting stages, increased land values, reduced weeding costs, and maintained soil quality (Rodrigo et al., 2001; Tajuddin 1986; Jusoff, 1988; Rodrigo et al., 2001; Pathiratna and Perera, 2006; and Guo et al., 2006). Along with economic benefits, the rapid expansion of rubber tree cultivation led to a drastic reduction of areas for upland rice production, diminishing rice varieties, and exacerbating deforestation (Fu et al., 2009; Li et al., 2007; and Vongsiharath, 2009). The reviewed evidence also found negatively relationship between soil quality and the number of years of rubber tree cultivation (Aweto, 1987; Zhang et al., 2005; and Zhang et al., 2007).

In conclusion, the evidence reviewed in this study supports the claim that, despite economic incentives, large-scale rubber tree cultivation will reduced areas for upland rice cultivation and may led to the extinction of upland rice varieties as well as loss of tropical rain forests. Most households in the uplands of northern Laos rely on upland rice cultivation for household consumption rather than for income. Therefore, the decrease of areas for upland rice cultivation in the region may affect food security. At the same time, because rubber trees are perceived as a long-term crop, planting rubber is often a direct way to acquire exclusive rights to land regardless of ambiguous legal land ownership (Thongmanivong et al., 2009). Do rubber tree plantations serve as an instrument for forest resource conservation? Or do rubber tree plantations induce more forest destruction? The first question calls for the careful analysis of the effects of rubber tree plantations on food security. While forests can be vital for rural households in developing countries, the forest activities to support livelihoods vary considerably. Thus, understanding how different households utilize the forest is necessary to gain information for both conserving forest and alleviating poverty. However, in many cases of rural poverty, households have limited choices with labor often being the only input that they can choose to utilize, e.g. to clear surrounding forest and convert into agricultural land or participate as unskilled labor in the labor market (Barbier, 2010). Cases from the Philippines and Malawi studied Shively and Fisher (2004); and Fisher et al (2005), show strong positive own-wage effects and negative cross-wage effects in labor-allocation decisions, meaning that households that obtain higher returns from that activity allocate a greater share of household labor into it and vice versa. The authors suggest that labor can be drawn away from the forest through price incentives in the off-farm sector, provision of tenure security, access to credits, and through improving education levels. Higher levels of education provide households with more opportunities for employment. However, Harris (2004) found that although deforestation and production decision among Brazilian agricultural household were largely influenced by access to credits, wealth level, farm size, and products markets, more sustainable production methods are unlikely to be adopted by the majority of the households. They found, under current conditions that households with access to credits enlarge their investment in crop production, while households receiving increased incomes from milk expanded their investment in cattle production, both two activities increase deforestation due to necessary land clearing and competition for land use and resources (Harris, 2004). These studies suggest that understanding household labor allocation for different activities would further elucidate how forests were utilized, and consequently the time allocation decisions of smallholder rubber producers could be the key to the answers for the second and third questions.

Endnotes

[1] Shifting cultivation is also known as slash-and-burn agriculture. In general, shifting cultivation involves cutting natural vegetation, leaving it to dry, and then burning so that a temporary crop can be planted. An important principle of shifting cultivation is the regeneration of the soil fertility through plant re-growth after harvest. To maintain the system of shifting cultivation, rural households that practice shifting cultivation own a number of plots, and after growing crops on a shifting cultivation plot, farmers abandon that plot and let the vegetation regenerate for a number of years. This is called 'fallow rotation.' In the meantime, they grow crops on other new plots. In principle, the longer the fallow rotation is, the better the crop is (Gansberghe, 2005a).

[2] These categories are agricultural land, conservation forest, protection forest, production forest, cemeteries, and residential areas (DPIO, 2010).

[3] Including 1 ha of upland rice, 15 hectares of pasture, 3 ha of cash crops, and 3 ha of orchard (Thongphanh, 2004).

[4] According to the law, land and forest resources are owned by the state on behalf of the national community and may be allocated to individuals, villages, or organizations to use sustainably (GoL, 2003).

[5] The funds were distributed to the households in the form of rubber seedlings and barbed wire for fencing at the value of 1-3 million kip for each household (Manivong, 2007).

[6] Contract farming and smallholder types of rubber arrangements are strongly supported the provincial government due to they are considered to provide the villagers more secure access to their land and a stronger sense of ownership in the plantations compared to the concession.

[7] Land concessions refer to the situation where land was leased to foreign individuals or their organizations by the state government of Laos. The periods of land lease or grant of concession from the State to foreign individuals or their organizations are based on the characteristics, size, and conditions of the intended operations on the land. The maximum periods cannot exceed thirty years but may be extended on a case by case basis in accordance with the approval of the government (GoL, 2003). Contract farming refers to joint investment in rubber tree plantation between the villagers and domestic or foreign investors. 2+3 contract farming was the most common mode in LuangNamTha Province. Under this mode, productive inputs were divided into five categories: land, labor, capital (including seedlings, fertilizers, and equipment), techniques, and marketing. The villagers supplied the first two factors, the other three components were ensured by the companies. The benefit sharing was 70/30; 70% of revenues went to the villagers, and 30% went to the joined-companies. The government felt that this arrangement, compared to concession, would provide villagers more secure access to their land and a stronger sense of ownership toward the plantation (Shi, 2008).

[8] LuangNamTha Province was classified as a Zone 1 in the "Law on the promotion of foreign investment in Article 18 on Incentives related to duties and taxes," which means it will profit from a profit tax exemption for 7 years and, thereafter, shall be subject to a profit tax at the rate of 10% (GoL, 2004). Accessed through the online Vientiane Times newspapers on August 22, 2012 at 19:10 pm on http://www.vientianetimes.org.la/Con_titution/Constitution_foreigninvestLaw.htm

[9] Note: US$1= Kip 10,500, August 2005; family labor valued at 17,000 Kip/day

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