Economics of Smallholder Rubber Production in Northern Laos

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Abstract

In response to demand from China, rubber smallholdings are being established by shifting cultivators in Northern Laos, encouraged by government land-use policy. We examine the economics of smallholder rubber production in an established rubber-growing village and model the likely expansion of smallholder rubber in Northern Laos. Data were obtained from key informants, group interviews, direct observation, and a farm-household survey. Latex yields were estimated using the Bioeconomic Rubber Agroforestry Support System (BRASS). A financial model was developed to estimate the net present value for a representative rubber smallholding. This model was then combined with spatial data in a Geographical Information System (GIS) to predict the likely expansion of rubber based on resource quality and accessibility.

Keywords: smallholder rubber, Laos, commercialisation, bioeconomic modelling, land-use change

Introduction

In recent decades the uplands of Southeast Asia have experienced major changes due to economic growth in the region. In Northern Laos there is a transition underway from subsistence production based on shifting cultivation to commercial production. This change is a result both of increasing integration with the regional economies of Southeast Asia, particularly southern China, and of government policies directed towards upland development (Thongmanivong and Fujita, 2006). Most of the change in agriculture has been driven by market forces and foreign investors, particularly from China. The government policy of stabilising shifting cultivation and improving road access has helped drive the change.

The most extensive and rapid change in the uplands of Northern Laos is the expansion of smallholder rubber. This has been made possible due to robust global demand for rubber, especially from China, and the interest of foreign investors from China, Vietnam, and Thailand. While rubber provides an attractive investment opportunity for foreign investors, the Government of Laos envisages it as a way of stabilising shifting cultivation and generating income for upland farmers. However, with a relatively small area having been planted with rubber and an even smaller area in production, there is little information currently available on the potential economic returns to smallholder producers that can be used as a basis for the promotion of the crop by the government (Manivong et al, 2003).

In this paper we examine the economics of smallholder rubber production in Luangnamtha Province. The paper draws on thesis research on the economic potential of smallholder rubber production in Northern Laos. The specific objectives of the research are to appraise the economics of smallholder rubber production in the established rubber-growing village of Hadyao in Namtha District of Luangnamtha Province, and to use this as a basis for modelling the economic potential of smallholder rubber production in a variety of settings to indicate the likely expansion of rubber in other areas within Luangnamtha Province.

Background

Laos is one of the poorest nations, with a GDP per capita in 2002 of US$330 and a ranking of 135 out of 175 countries in UNDP's Human Development Index (ICEM, 2003; UNDP, 2003). Laos is a predominantly rural country with approximately 83 per cent of the population living in rural areas, of whom 66 per cent rely on subsistence agriculture. The national economy is overwhelmingly dependent on agriculture, which accounts for around 47 per cent of GDP and absorbs approximately 80 per cent of the labour force (NSC, 2005a). Based on the total area of 236,800 km^2 and the population of 5.6 million, Laos is the least densely populated country in Asia at only 24 persons per km^2 (NSC, 2005b).

Rubber was first introduced into Laos in 1930, with the first rubber plantation established in Champasack Province by French planters during the colonial era. Then in 1995 rubber was again planted in Bachiangchalernsouk District of Champasack Province over an area of 50 hectares by the Development of Agriculture, Forestry and Industry (DAFI) state company. Between 1994 and 1996, the Hmong village of Hadyao in Laungnamtha Province established rubber over 342 hectares in the form of

smallholdings. Since then, the rubber area in Laos has increased steadily, but at a more rapid pace since 2003 as many individuals, private sector entities (both domestic and foreign), and state sector entities have responded to high rubber prices and the growth in demand from China (Alton et al., 2005; FRC, 2005).

Luangnamtha Province is located in the Northern Region of Laos, lying between 20°30' and 21°30' north and 100°30' and 102°00' east (Fig. 1). It shares a border of 140 km with China in the north, 130 km with Myanmar in the west, 230 km with Oudomxay Province in the east and 100 km with Bokeo Province in the southwest. The province is divided into five administrative districts, namely Namtha, Sing, Long, Viengphoukha, and Nalae (PPCO, 2005). Luangnamtha Province is a centre for commerce between China, Laos, and Thailand.
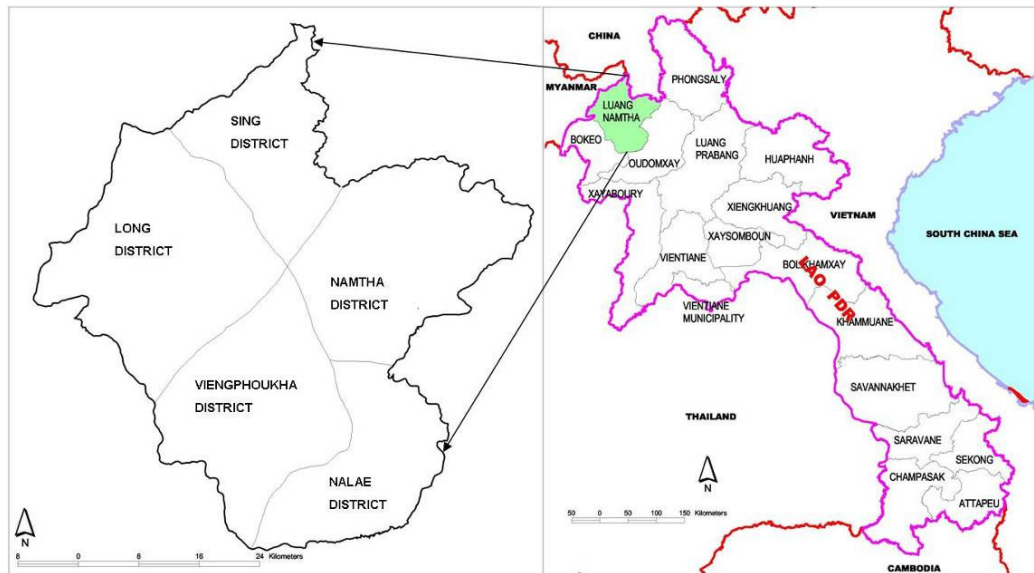

Figure 1: Location map of Luangnamtha Province

In order to evaluate the economics of smallholder rubber production, the village of Hadyao in Namtha District of Luangnamtha Province was selected for in-depth study as Hadyao was the first village in Northern Laos to plant rubber. Hadyao is a Hmong village located around two km from the district centre and near the main road to the Chinese border via the Boten international checkpoint in Sing District. The village is located on acid upland soils in mountainous terrain at a latitude of 21°00' N and an elevation of about 900 m. Rainfall averages 1,500 mm and is concentrated in May-October. Rubber was introduced in the 1990s by Hmong migrants from China and was planted on sloping land by individual smallholders. In the first phase (1994-96) 341 hectares were planted but trees on about 75 hectares were killed by a heavy frost in 1999. In the second phase (2003-05) a further 296 hectares were planted. Tapping of 266 hectares commenced in 2002, making Hadyao the first rubber-producing village in Laos.

Methods

Discounted cash flow analysis

Discounted cash flow (DCF) analysis was used as the framework for assessing the returns from the investment of household resources in smallholder rubber production, with the usual investment criteria of net present value (NPV), internal rate of return (IRR), and benefit-cost ratio (BCR) (Campbell and Brown, 2003). Within this framework, consideration was given to the appropriate valuation of unpaid household labour and of the appropriate discount rate to use in calculating present values, given that farmers are only partially engaged in both labour and capital markets.

Investment analysis of rubber production required data on costs and benefits of smallholder rubber production, which were collected through key informants interviews, group interviews, direct observation, and a questionnaire survey of 95 farm-households conducted in August 2005. Most of the interviews were carried out in the respondent's house as this also provided a chance to observe living conditions; however, farm visits were also undertaken.

In addition, since rubber is a long term investment, estimates of the yield of latex over the life of the investment were required. Annual latex yields were estimated using the Bioeconomic Rubber Agroforestry Support System (BRASS), which is the best available tool for modelling smallholder rubber production (Grist et al., 1998; Cacho, 2001). BRASS has a biophysical and an economic component, of which only the former was used in this study (Fig. 2). The biophysical module incorporates many variables in order to estimate the intercrop yields during the intercropping period, the stream of latex yields over the life of the plantation, and the volume of harvestable timber at the end of the production period. These variables are grouped into climate, topography and soil, rubber management, and intercrop management. Climate variables were based on an eleven-year data set (1994-2004) for Luangnamtha Province obtained from the Meteorology Station of Luangnamtha Province. Topography and soil variables were based on soil properties in Luangnamtha Province as recorded by the Soil Survey and Land Classification Centre (SSLCC) of the National Agriculture and Forestry Research Institute (NAFRI). Variables of rubber and intercrop management were based as far as possible on the actual practices of rubber farmers in the study village obtained during the fieldwork.
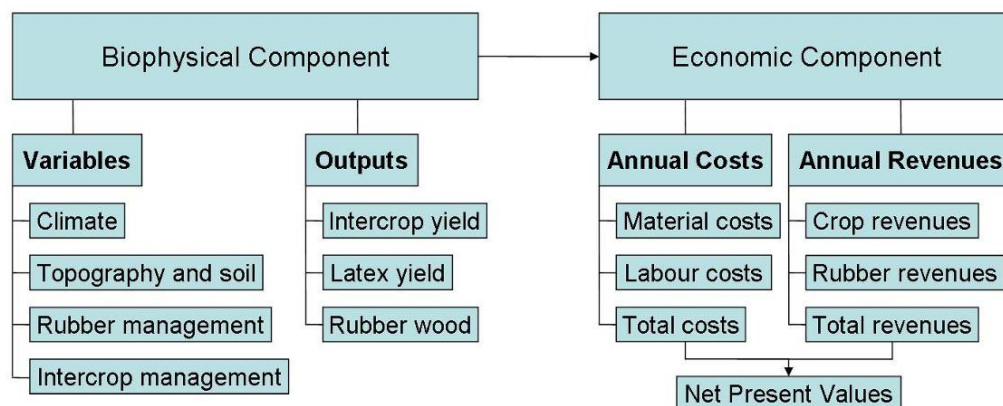

Figure 2: Variables in the biophysical and economic components of BRASS

Spatial analysis

As well as considering economic returns over time, the study considered the spatial potential of rubber, drawing on the concept of land use-capacity in land resource economics. Land use-capacity has two major components – resource quality and accessibility (Barlowe, 1986). Resource quality involves the relative ability of the land resource to produce desired products, returns, or satisfactions. With agricultural lands, quality is usually viewed in terms of native fertility or fertility in combination with the ability to respond to fertilizer inputs. Quality may reflect climatic advantage – favourable temperature and precipitation, low wind velocity, or infrequency of storms. Accessibility involves the convenience, time, and transport cost saving associated with specific locations with respect to markets, transport facilities, and other resources. Areas near the road, city, or market have more advantage than those located at greater distance. The extent of this advantage corresponds with differences in transportation costs; fields located at greater distances from market naturally have higher transportation costs and thus receive a lower price for products and incur a higher price for inputs.

The areas with the highest land use-capacity ordinarily have the greatest production potential and yield the highest return. In this study, resource quality was based primarily on the soil properties affecting latex yield in the BRASS model and accessibility was based on the distance from the main road and the corresponding mode of transporting rubber to the point of sale. The data on soil properties for Luangnamtha Province were obtained from the Soil Survey and Land Classification Centre of NAFRI. Road data and village locations were obtained from the GIS Unit of NAFRI. These dimensions were mapped using ArcView GIS 3.2a, resulting in a map of the economic suitability of rubber in the study area.

Results

DCF analysis for Hadyao village

The costs and benefits associated with the production of smallholder rubber over the life of a typical one-hectare plantation in Hadyao village were identified and quantified using constant 2005 prices. The costs included material costs and labour costs. The benefits included the output from intercropping upland rice in the first three years, tub-lump rubber (the main form in which rubber was sold), and rubber wood harvested at the end of the plantation's productive life.

Survey data were used to obtain the cost of materials used in each phase of rubber production. The output of rice was estimated from the average rice yields reported in the survey, valued at the 2005 price of 3,500 Kip/kg.[i] The output of rubber from Years 9 to 35 was estimated using BRASS (Fig. 3) and valued at the 2005 price of tub-lump rubber of 7,800 Kip/kg. The output of rubber wood was also estimated using BRASS. Since there is no existing market for rubber wood in Laos, the price of rubber wood in Yunnan Province was used, adjusted to reflect the actual price which is likely to be offered by Chinese traders. The 2005 price of rubber wood in Yunnan was 360

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[i] 1US$ = 10,500 Kip (August 2005)

Yuan/m^3 (Alton et al, 2005).[ii] The farm gate price in Laos was assumed to be about 280 Yuan/m^3 or 364,000 Kip/m^3.
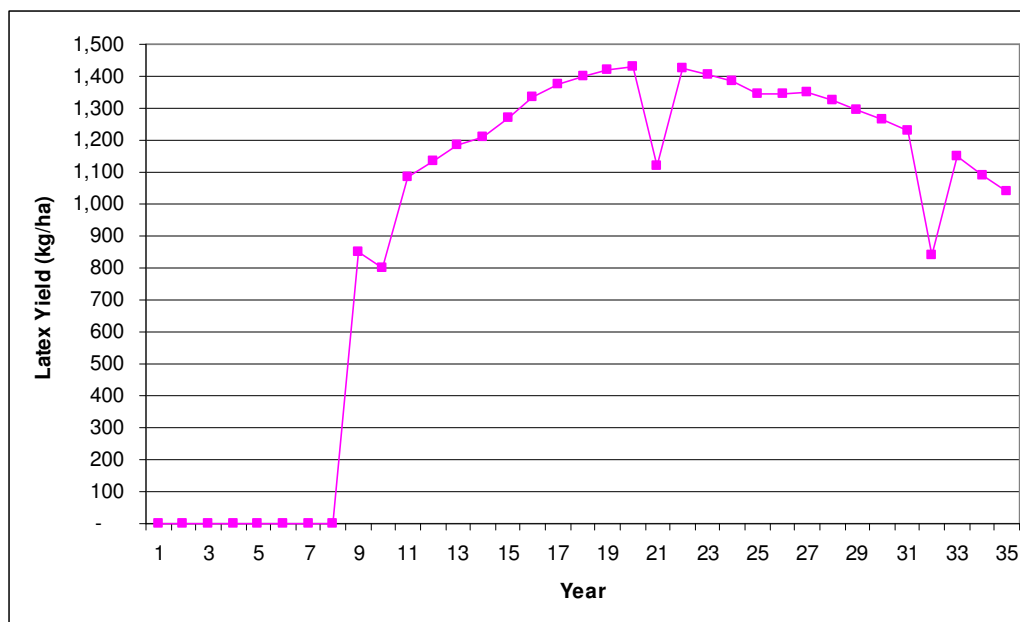

Figure 3: Predicted latex yield in Hadyao over 35 years using BRASS

The labour costs were valued by calculating the labour requirements for rubber establishment and production over the life of the plantation and estimating the opportunity cost of labour or wage rate. The current wage rate for agricultural work in Hadyao village is 20,000-25,000 Kip/person-day, depending on the type of work (light or heavy), while the wage rate in Luangnamtha town is 25,000 Kip/person-day. These rates apply to an adult male or female working for eight hours in a day. In the study village, rubber production was undertaken by male and female labour, but school-children also helped. In many cases school-children assisted by tapping before they went to school or collecting latex during the weekend. Also, it cannot be assumed that all adult household members had the alternative of off-farm employment, particularly in town. Therefore, it was decided to use some fraction of the market wage rate to estimate the opportunity cost of labour. The problem was deciding what fraction to use as there is no standard way to measure this. Hence it was assumed that the opportunity cost of labour was about two thirds of the maximum market wage rate of 25,000 Kip/person-day, that is, around 17,000 Kip/person-day. Both the market wage rate and the estimated opportunity wage rate were used in the DCF analysis.

Fig. 4 shows the estimated undiscounted annual net returns for a hectare of rubber over 35 years in Hadyao village, using wage rates of 17,000 and 25,000 Kip/person-day. It can be seen that in the immature phase of the plantation net returns are only positive in Years 2 and 3, when development costs are minimal and a crop of upland rice is harvested. Net returns become positive from Year 10 when tapping begins and from that point follow the yield profile as shown in Fig. 3. At the end of the

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[ii] 1 Yuan = 1,300 Kip (August 2005)

productive life of the rubber in Year 35 there is an additional return from rubber
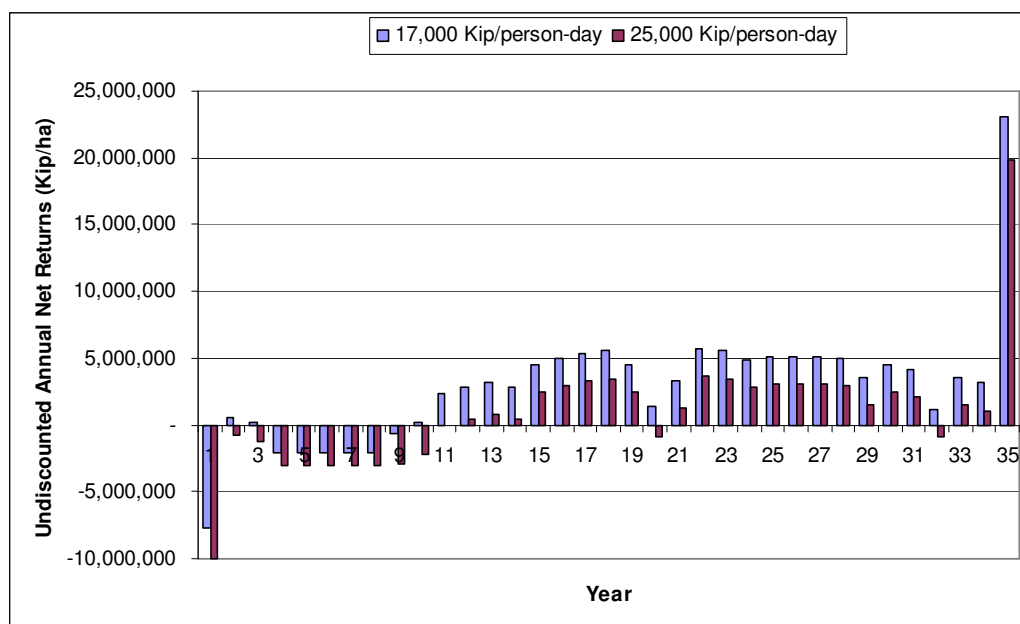wood.

**Figure 4: Undiscounted annual net returns using wage rates of 17,000 Kip/person-day
and 25,000 Kip/person-day**

The selection of a discount rate was also crucial in determining the result of the DCF
analysis. Following Perkins (1994), the market borrowing rate or interest rate was
adopted as most Lao farmers lack the capital to invest in agricultural production
without obtaining credit, particularly in the early stages of transition to commercial
agriculture as in the case study area. Since the interest rate varies with different
sources of funds, the important issue was which interest rate to use. In the case of
borrowing from the Agricultural Promotion Bank (APB) the interest rate was 12%,
from commercial banks, 15%, and from money lenders, 20%. Allowing for the 2005
inflation rate of 7% (BOL, 2006), these three rates were used in the DCF analysis, i.e.,
5%, 8% and 13%.

Table 1 shows the results of the DCF analysis for a typical hectare of rubber in
Hadyao, using the three discount rates and two wage rates. At the maximum wage rate
the investment in rubber was unprofitable at all discount rates. At the lower wage rate
the investment was profitable at the lower and middle discount rates, shading into the
unprofitable zone at a discount rate of 13%.

Table 1: Results of DCF analysis for smallholder rubber in Hadyao (2005 prices)

| Wage rate | NPV (Kip/ha) and BCR at selected discount rates | | | IRR |
(Kip/person-day)	5%	8%	13%	(%)
17,000	23,411,487 (1.28:1)	7,516,940 (1.13:1)	-2,915,015 (0.92:1)	10.93
25,000	-6,727,684 (0.94:1)	-13,102,185 (0.83:1)	-15,632,226 (0.68:1)	3.44

However, the conventional investment criteria may not be entirely applicable in the case of semi-commercial smallholder agriculture, in which the markets for land and labour are incomplete. It can be argued that the relevant criterion is the net return to the family's own resources of labour and land, sometimes termed farm family income. Without costing family labour, and using a discount rate of 8%, the NPV per person-day is around 29,000 Kip. This is slightly higher than the off-farm wage of 25,000 Kip/person-day, reflecting the farmers' calculation that rubber is a worthwhile use of family resources.

Another criterion which a semi-commercial smallholding farmer would consider is the short-term cash flow, taking borrowings and repayments into account. Farmers could not afford to have a negative cash flow and would want to ensure they had the capability to service their loans. Hadyao rubber farmers received loans with a 2% interest rate and a 7-year repayment period in 1994-95 and then in 2003 they received loans with a 7% interest rate and a 10 year repayment period. In both cases interest charges were accumulated and paid at the end of the loan period. To check the capacity of farmers to pay back their loans and not suffer a cash flow problem, cash flow budgets were developed for the first eleven years of a one-hectare rubber enterprise (thus including three years of tapping), using both current prices and constant 2005 prices. In both cases, farmers had no problem with cash flow and could comfortably pay back the loans, due to the favourable terms provided. It is likely that farmers could afford to pay somewhat higher interest rates but would still need the grace period during the establishment phase if they were planting for the first time. Similar support has been given to rubber smallholders in the past in the major producing countries, such as Thailand and Malaysia (Barlow, 1997).

Spatial analysis for Luangnamtha Province

The previous section presented a DCF analysis for smallholder rubber production in the study village, showing that, at the current market conditions and subsidized credit supports with low interest rate, investment in rubber is worthwhile. That is the reason for the expansion of rubber planting in Hadyao and other villages in the study area. The purpose of this section is to assess the scope for further expansion of smallholder rubber within Luangnamtha Province. The approach was first to define representative scenarios in spatial terms, then to estimate the economic suitability of those scenarios for rubber planting.

Different scenarios can be defined in many ways, depending on the criteria used. For this study, the scenarios were based on the concept of use-capacity, which is a function of two major attributes – resource quality and accessibility. In general the potential yield is the best summary measure of resource quality because it reflects all the different biophysical dimensions in a given location. Hence resource quality categories were based on the aggregate yields over the life of a rubber plantation for various locations within Luangnamtha Province. Data on soils, topography and climate for these locations, represented by 116 five km by five km mapping units, were fed into the biophysical component of the BRASS model to generate latex yields for each mapping unit.

This measure of resource quality was classified into three levels – high (yields greater than 1,200 kg/ha), moderate (yields between 900 and 1,200 kg/ha), and low (yields

less than 900 kg/ha). By integrating these three levels in a GIS, a resource quality map for smallholder rubber in Luangnamtha Province was produced (Fig. 5). It can be seen that the majority of the area in Luangnamtha Province is at the moderate level of resource quality, with only a small proportion at the high level. The main differences between these three levels are that the areas of low resource quality are predominantly Eutric Cambisols that are shallow, rocky, of poor nutrient status, and steeply sloping topography, while the areas of moderate resource quality are predominantly Haplic Acrisols and Dystric Cambisols that are limited by moderate levels of soil nutrients, soil pH, drainage and steeply sloping topography. The areas of high resource quality are predominantly Haplic Acrisols that have good soil depth, texture, and drainage and relatively flat topography.
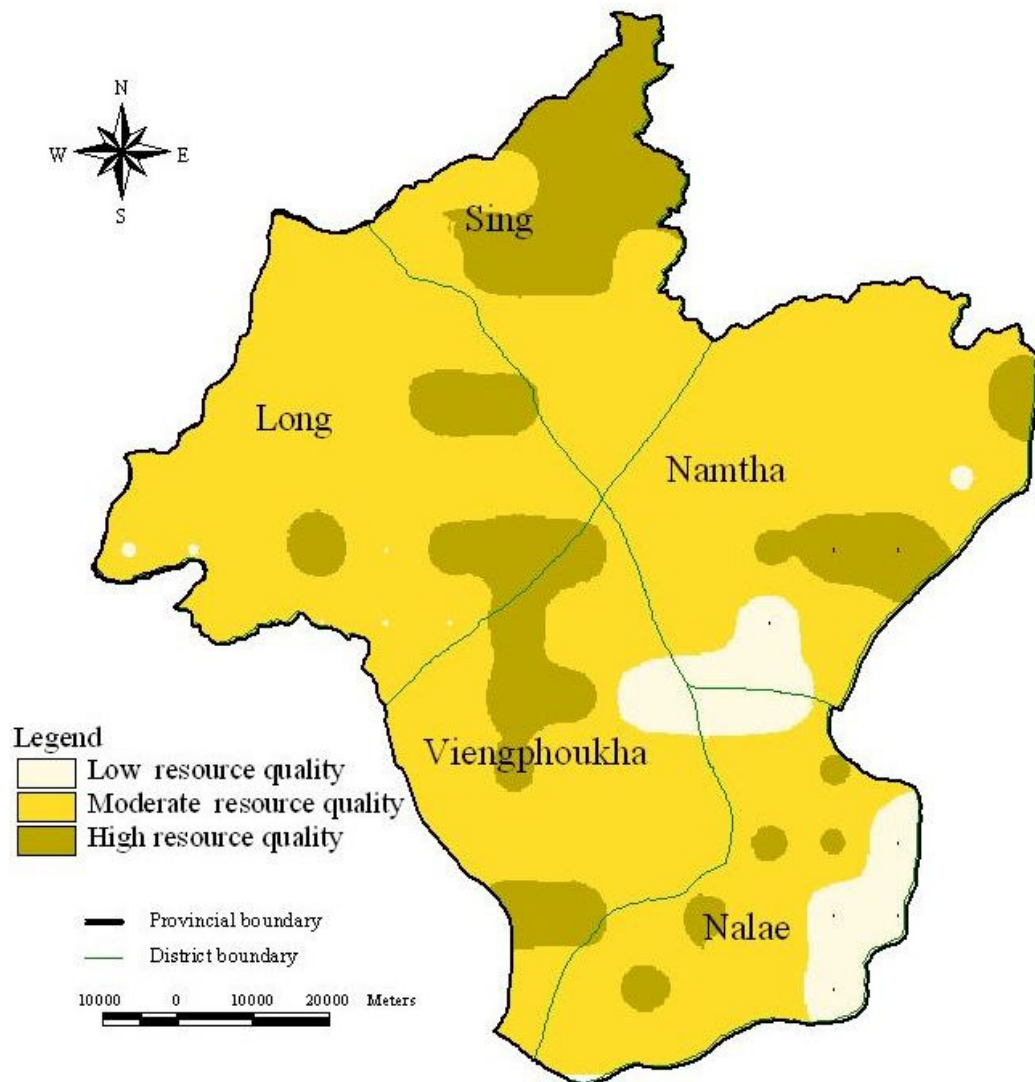

Figure 5: Resource quality map for smallholder rubber in Luangnamtha Province

The accessibility attribute was also divided into three levels – good, moderate, and poor accessibility – based on the distance from a main road. Areas less than 0.5 km from a main road were defined as good accessibility, from 0.5 to 3.5 km as moderate accessibility, and more than 3.5 km as poor accessibility. Villages with good accessibility are located along or very close to the main road, hence agricultural produce such as rubber can be collected directly by traders or transported by truck to the market. Most villages with moderate accessibility are located in gently sloping areas and can access the main road by cart-tracks, though some may only have footpaths. Agricultural produce from this zone is normally transported by human-drawn carts to the side of the main road and then collected by traders or transported to the market. Most villages with poor accessibility are located in hilly areas reachable only by footpaths. Agricultural produce is normally back-loaded to the main road.

Obviously the time spent in transporting produce to the roadside increases as accessibility declines due to the greater distance, poorer condition of the road, and more difficult mode of transportation, resulting in higher unit cost of transportation. It should be noted that, according to provincial agricultural officials, some villages in the more accessible parts of the poor accessibility zone had already started planting rubber, with the intention to upgrade their footpaths to cart-tracks when they started tapping.

By integrating these three levels of accessibility in a GIS, an accessibility map for Luangnamtha Province was produced (Fig. 6).

After the levels of resource quality and accessibility had been defined, these dimensions were combined to form scenarios. Three levels of resource quality and three levels of accessibility gave nine scenarios (Table 2). For example, Scenario A combined a high level of resource quality and a high level of accessibility, while Scenario I combined a low level of resource quality and a low level of accessibility. Each of these scenarios were spatially referenced to the 116 mapping units referred to above.
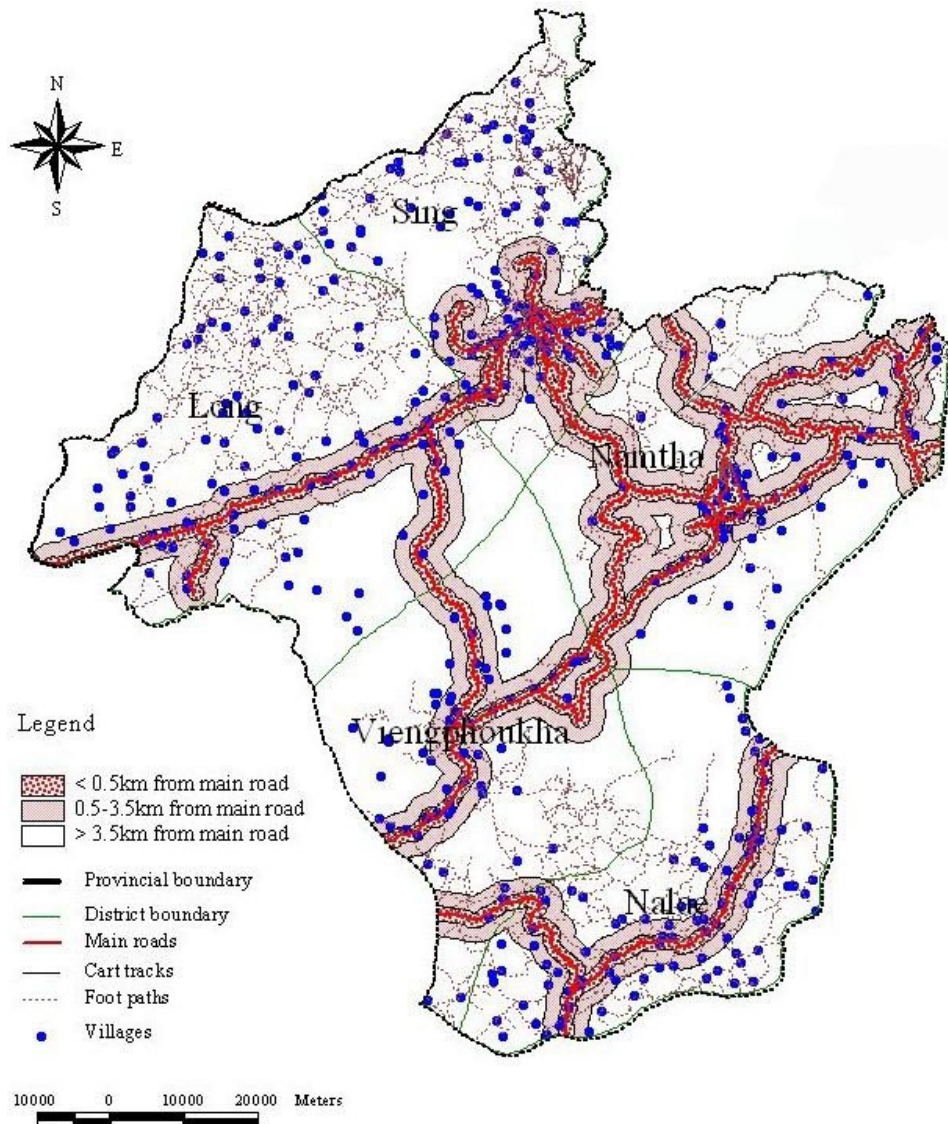
Figure 6: Accessibility map in Luangnamtha Province

Table 2: The levels of accessibility and resource quality in each scenario

Resource quality	Accessibility		
	Good	Moderate	Poor
High	Scenario A	Scenario D	Scenario G
Moderate	Scenario B	Scenario E	Scenario H
Low	Scenario C	Scenario F	Scenario I

In order to define the economic suitability of these scenarios, hence of the spatial units they described, a DCF analysis was undertaken for each scenario. The DCF model for Hadyao (using the lower value for farm labour) was modified by developing new yield profiles from the BRASS model for each level of resource quality and adjusting prices and costs based on the estimated unit transport costs for each level of accessibility. This entailed a 3% and 60% increase in material costs for the moderate and poor accessibility zones, respectively, and a 3% and 60% decrease in output prices and wage rates for the same zones, relative to the roadside zone.

The DCF analysis for each scenario was performed using a real discount rate of 8%. The results in terms of NPV, IRR, and BCR are shown in Table 3. It can be seen that the investment in rubber is clearly worthwhile in Scenarios A and D, and marginal so in Scenarios B and E, but not in scenarios C, F, G, H, and I. Hence low resource quality and poor accessibility combined to make rubber unattractive.

Table 3: Results of DCF analysis for each scenario

Scenario	NPV (Kip)	IRR (%)	BCR
A	14,443,000	14.2	1.25
B	3,120,000	9.7	1.05
C	-15,230,000	-	0.74
D	13,156,000	13.7	1.23
E	2,173,000	9.2	1.04
F	-15,627,000	-	0.73
G	-11,293,000	-0.1	0.72
H	-15,823,000	-10.5	0.61
I	-23,163,000	-	0.43

The nine scenarios were then ranked according to NPV per hectare to give a measure of economic suitability (or land-use capacity) for smallholder rubber in Luangnamtha Province (Table 4). By integrating these nine categories of economic suitability in a GIS, an economic suitability map for rubber in Luangnamtha Province was produced (Fig. 7). Given that the categories 1 to 4 were associated with a positive value for NPV per hectare, approximately 239,600 hectares (or 26 per cent of the total provincial area) were considered as economically suitable for smallholder rubber plantations, of which only 1 per cent (categories 1 and 2) as highly suitable and 25 per cent (categories 3 and 4) as marginally suitable. These areas were concentrated along the main road, indicating that road access is likely to be the key factor, but moderate to high resource quality was also important.

Table 4: Ranking of economic suitability for rubber

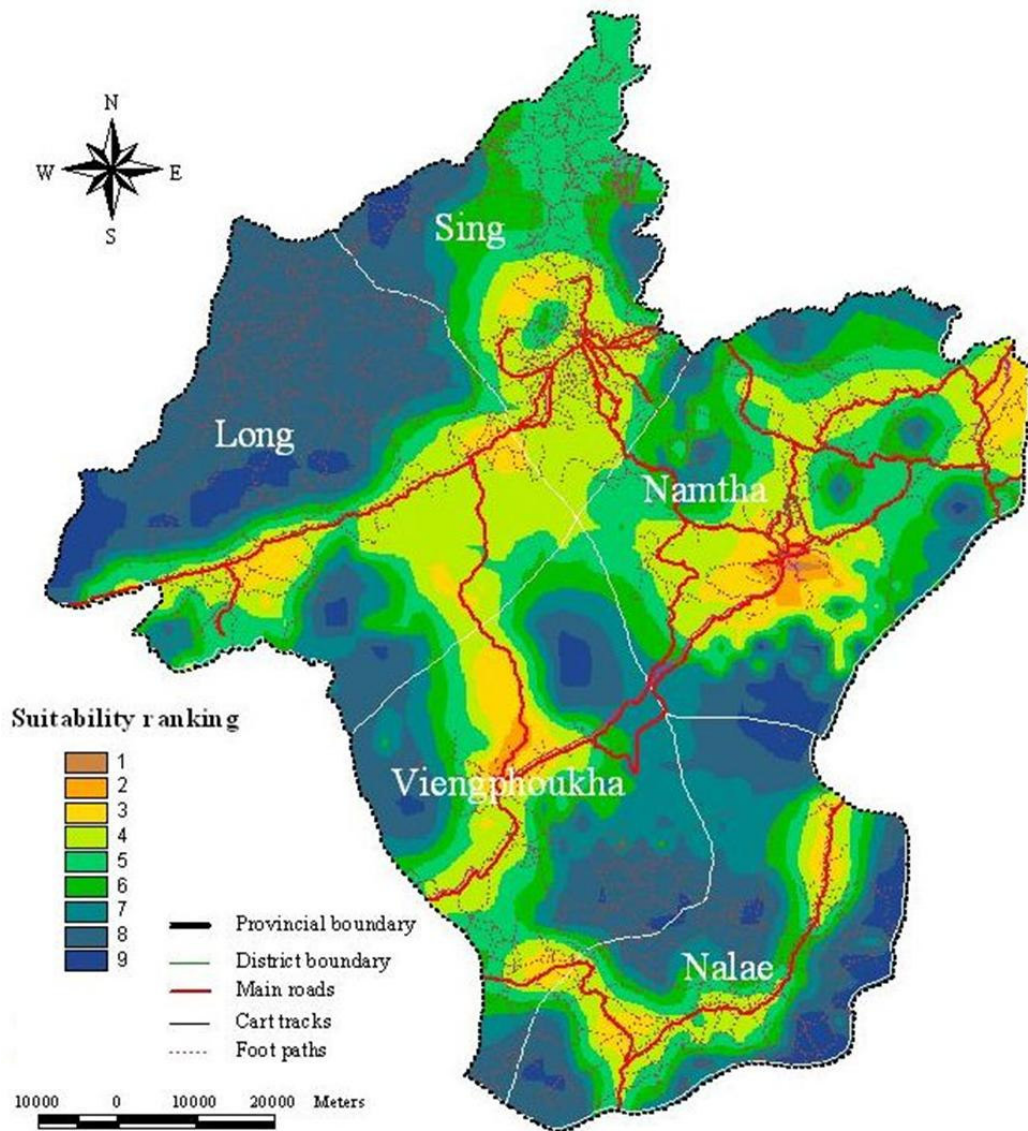| Ranking	Scenario
1	A
2	D
3	B
4	E
5	G
6	C
7	F
8	H
9	I

Figure 7: Economic suitability map for rubber in Luangnamtha Province

Conclusion

These results show that, given current market conditions and subsidized credit supports with low interest rate, investment in smallholder rubber production in the uplands of Northern Laos can be profitable. The results from the DCF analysis for the study village show that the expansion of rubber planting in that village is based on good economic returns. Therefore, rubber can be considered as one of potential alternatives for poor upland farmers, in line with the government policy of stabilising shifting cultivation and supporting new livelihood options for poverty reduction. The spatial analysis indicates that the potential for rubber in the study village is not an isolated case; there are also other areas in Luangnamtha Province that appears to be economically suitable for rubber. It is important to note that the maps presented are very rough approximations and should not be used for the government's land-use planning and allocation process, or for pushing rubber onto smallholders in situations where they are uncertain about reducing their dependence on shifting cultivation. The

role for government, as in other countries where smallholder rubber has played a significant role in rural development, is to ensure the provision of good quality planting material, to assist financially during the long investment period when no income is generated, and to invest in roads and marketing infrastructure. In particular, maintaining secure access to the China market will be crucial for the sustainability of smallholder rubber in Northern Laos.

Acknowledgements

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