Rubber Plantation Development in Cambodia: At What Cost?

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LIST OF ABBREVIATIONS

ADB	Asian Development Bank
AFD	Agence Française de Développement
BCR	Benefit-Cost Ratio
CBA	Cost Benefit Analysis
CDRI	Cambodia Development Resource Institute
EEPSEA	Economy and Environment Program for South-East Asia
ELC	Economic Land Concession
GDRP	General Directorate of Rubber Plantation
HH	Household
IRR	Internal Rate of Return
MAFF	Ministry of Agriculture, Forestry and Fishery
NPV	Net present value
NRE	Natural Resource and Environment
NTFP	Non-Timber Forest Products
PHF	Smallholder rubber plantation project funded by the AFD
PV	Present value
RDB	Rural Development Bank
RGC	Royal Government of Cambodia
RP	Rubber Plantation
RRA	Rapid Rural Appraisal
SDR	Standard of Dried Rubber
SOE	State Owned Enterprise
USD	United States Dollars
WB	World Bank

mm	Millimeter
kg	Kilogram
ha	Hectare
m^3	Cubic meter
y	Year
t	Ton

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EXECUTIVE SUMMARY

The government of Cambodia has implemented several new policy instruments established under the 2001 Land Law, especially Social Land Concessions (distribution of state private lands to the poor) and Economic Land Concessions (long-term contracts for plantation-type developments on state private lands). The latter relates especially to forest-covered areas of the State asset. For this study, surveys were conducted in Chamkar Andong, Krek and Tumring rubber plantations to assess the livelihood of local populations and the impacts of different forms of land conversion. The results show significant changes in people's livelihoods from forest dependence to sell their labor.

The study makes use of secondary data and the results of the field surveys to conduct a cost-benefit analysis of two land conversion schemes. First, is the conversion of forestland to large-scale rubber plantations in Tumring commune, Sandan district, Kampong Thom province. Second, is the conversion of crop production (cassava, soybean, maize and cashew) to smallholder rubber plantations in several districts of Kampong Cham province. The study offers several suggestions to the government as the basis for determining its strategic approach to land and agricultural development.

The present value of the net benefits of forest conservation was estimated at USD 14,575 per ha over a 25-year period assuming a 10% discount rate. The net benefits of large-scale and smallholder rubber plantations were estimated at USD 15,690 and USD 7,661 respectively over the same period. The net benefits of other orchard crops were much lower at USD 1,416; USD 785; USD 584; USD 2,270 for cassava, soybean, maize and cashew respectively.

The cost-benefit analysis considered the following five options to estimate the incremental net benefit of each conversion scheme. The incremental net benefits of the five conversion schemes were then ranked to identify the one with the highest incremental net benefit. There was no assessment of the monetary value of the change in people's livelihood.

- Option 1: Conversion from forest land to large-scale rubber plantation
- Option 2: Conversion from cassava production to smallholder rubber plantation
- Option 3: Conversion from soybean production to smallholder rubber plantation
- Option 4: Conversion from maize production to smallholder rubber plantation
- Option 5: Conversion from cashew production to smallholder rubber plantation

The result of the cost-benefit analysis showed clearly that the conversion from crop production (maize, soybean, cassava, and cashew) to smallholder rubber plantation provides the largest benefit to farmers involved in those conversion schemes. The conversion of forestland into large-scale rubber plantation ranks last in economic terms.

Four sensitivity analyses were undertaken which demonstrated that despite varying key basic assumptions, the ranking of all crops and forest conversion schemes remained unchanged. The study clearly reveals that smallholder rubber plantations represents the most desirable land use from an economic viewpoint, compared with other forms of crop production (cassava, soybean, maize and cashew).

1.0 INTRODUCTION

1.1 Description of the problems

Deforestation is currently one of the most important global environmental issues. The development of rubber plantations is generally considered one of the major causes of deforestation in developing countries (Liu et al., 2006). Gradual increases in the area under rubber plantation are to be seen in many countries in the region. In Vietnam, for example, the total area under rubber cultivation has increased from approximately 77,000 ha in 1976 to about 465,000 ha in 2005. Vietnam's target for rubber development is 700,000 ha (Phuc, 2006). In Lao PDR, rubber plantation currently covers approximately 11,000 ha; and it is planned that this area will increase to 180,000 ha by 2010 (Sounthone *et al.*, 2006). In Thailand, it has been reported that about 160,000 ha of land in the northern and eastern regions of the country are planned for new rubber plantations (MAFF, 2006). The increasing demand for natural rubber and the high price of latex have been the main driving forces of the expansion of land for rubber that is currently observed in the region.

In Cambodia, rubber plantations can be divided into three categories of ownership: state, household-owned, and private-industrial plantations. In 1985, the total area of rubber plantations covered more than 51,000 ha, and this area was gradually increased to about 63,000 ha by 2006 (Table 1-1). The state-owned plantations are mainly located in Kampong Cham Province, comprising over 63 percent of the total rubber plantation land, and are controlled by seven state companies (Khun, 2006). In 2001, one of these-Chup Rubber Plantation- was granted permission by the Royal Government of Cambodia (RGC) to expand its plantation into Kampong Thom Province (Tumring Commune) clearing over 6,000 ha of forests. The NGO Forum (2005) conducted a study on the impacts of this development in Tumring Commune and argued that the plantation had caused economic, social, and environmental problems within the commune and the surrounding areas.

Table 1.1 Areas under rubber plantation in Cambodia (2005)

Type of Rubber Plantation	Number of holders	Total area (ha)	Percen-tage	Status	Source
State-owned plantation	7	39,900	63	In progress	GDRP, 2006
Household-owned plantation	5,843	18,600	30	In progress	GDRP, 2006
Private-industrial plantation	2	4,600	7	In progress	GDRP, 2006
Private-industrial plantation under ELC*	13	119,000	-	Unknown	MAFF, 2006

Note: * MAFF (2006) provides only data mainly related to areas and duration of contract. No report is available on the status of those land concessions.

Household-owned plantations - or to use another term, “smallholder rubber plantations” - commenced in 1990 (AFD, 2006). In August 2000, the government announced a policy of promoting family-scale rubber plantations with the aim of ensuring livelihood security and land tenure and increasing rubber development (RGC, 2000). In addition, the rectangular strategy of the RGC also stressed the importance of promoting smallholder rubber development to assist in poverty alleviation and economic development (RGC, 2004). Following this announcement and encouragement, areas under smallholder plantation have also increased rapidly, from 10,000 ha in 1995 to 18,600 ha in 2006 (MAFF, 2006). The AFD (2006) projected that areas under smallholder rubber plantations will have increased to 35,000 ha by year 2010. Although no detailed report on land use types before the establishment of rubber plantations is available, it is believed that rapid expansion of such plantations has been and will continue to be one of a number of threats to natural forestland.

Currently, in addition to existing private-industrial plantations, more privately owned plantations are granted under the Economic Land Concession (ELC) scheme, initiated by the RGC in 1992. Such concessions comprise agro-industrial plantations, including cash crops (palm oil, cashew nuts, cassava, bean, sugar cane, rice and corn), fast-growing trees (acacia, eucalyptus, pine), and other valuable trees such as rubber and teak. Since then, about 907,000 ha of land have been approved for development under 50 concessions (MAFF, 2006). Of the total land area, about 13 percent (approximately 120,000 ha) was granted for partly growing rubber trees. Such plantation development seems to be one of the main crops currently planned to be cultivated. In fact, between January 2005 and July 2006, 10 out of the 25 land concessions signed by the MAFF planned to establish rubber on their land (MAFF, 2006). However, only a limited number of plantations are actually in progress; while for others, it remains unknown whether rubber trees has been planted or not (Table 1-1). Based on MAFF (2006), large parts of many concessions fall within areas covered by natural forest - as has been found by tracking the coordinates of concessions provided in the agreement contracts using the digital land use map produced by the Forestry Administration in 1997 - meaning that these forests are subject to clearance for the purposes of establishing rubber plantations. Such development is seen as one of the major threats to the natural forests of Cambodia. In addition, it has induced critical issues regarding land use changes, and raised serious questions about the economic costs and benefits, as well as the social and environmental impacts of such changes.

Until recently, the RGC has expressed its strong commitment to promoting economic land concessions and rubber development. Such large-scale agro-industrial concessions have been used as tools for generating income for the state, stimulating private enterprises, and creating jobs for rural communities; thus argued to contribute to poverty alleviation objectives. However, in the case of rubber development in Tumring Commune, there is little evidence that the development objectives have been achieved so far. In fact, the situation is quite the contrary: it has been reported that the livelihood of the commune is generally worse off and the environment within or surrounding the concession areas has been adversely affected (NGO Forum, 2005). Thorough research on the costs and benefits of land conversion to rubber plantation is, therefore, crucial.

1.2 Significance of the study

Although many land concessions have been granted so far, in only about a dozen cases have plans actually been implemented. During the implementation process, many conflicts have emerged between concessionaires and local communities. This is because the concessions were approved at the central level, without proper consultation with local communities and completion of social or environmental impact assessments. Pheapimex's concession, for example, was granted in 2000 over an area of 315,028 ha in Pursat and Kampong Chhnang Provinces. Since then, the company has initiated many attempts to clear forests for pulp wood plantations of acacia and eucalyptus. However, the plans were halted by local opposition (Ironside *et al.*, 2004).

In 2004, Wuzhishan L.S. Group received permission in principle to establish a 199,999 ha pine tree plantation in Mondolkiri Province. The company, however, has also experienced many conflicts with local people. If all 50 concessionaire companies implement their investment plans over areas of about one million ha, large areas of forests may be cleared for agro-industrial plantations and it is possible, even likely, that there will be further conflicts with local communities.

Relevant government agencies such as the General Directorate of Rubber Plantations, the Rubber Research Institute of Cambodia, and the Forestry Administration have declined involvement in the issues and never conducted any thorough assessment on the impacts of the economic concessions and rubber development on local people. So far, only a few studies have looked into these issues. However, most of them are qualitative studies, mainly focused on social issues and policies in relation to land reforms. Only one study conducted by NGO Forum in 2005 focused on the impacts and emerging issues of rubber plantations on local communities and rural livelihoods. However, the plantation covered by the latter study is relatively young in terms of age (about five years) and limited to one specific area (Tumring Commune).

Taking into account current policies on land concessions and the limitations of previous studies, the present study takes a closer look at the economic aspects of land conversion to rubber plantations by analyzing the economic costs and benefits of conversion scenarios at different locations. In addition, a value flow model developed by the NRE Unit (CDRI) in 2006 (Hansen and Top, 2006) is used to carry out parts of the above analysis. Results from this study will provide useful information and indicators for policy makers on the economic costs and benefits related to rubber development and economic land concessions. Furthermore, they will contribute to policy discussion on the potential role of rubber development in poverty alleviation and economic development in Cambodia.

Table 1-2: State owned rubber plantations in Cambodia (2003)

Company	Size (ha)	Production of dried rubber (ton)
State owned company		
Chup	6,892	10,044
Peam Chang	2,795	3,200
Krek	4,289	4,394
Memot	4,485	4,524
Snuol	3,119	2,472
Chamcar Andong	3,945	4,414
Boeng Ket	3,292	4,644
Tumring	4,359	N/A
IRCC[1]	662	483
Smallholders*	17,024	10,900
Private owned*	4,644	500
Total	55,506	45,576

Source: Hansen and Top, 2006, except * Khun 2006.

2.0 RESEARCH METHODOLOGY

2.1 Research objectives

The general objective of this study has been to analyze trade-offs related to rubber plantation development in Cambodia based on a cost-benefit analysis (CBA) framework. More specifically, the study compares the direct and indirect values of existing land uses with those of rubber plantations based on estimated returns from established rubber plantations of different ages, in Kampong Cham and Kampong Thom provinces. In addition, current policy on economic land concessions is discussed, considering whether promoting such policy on natural forest conversion is economically desirable.

The specific objectives of the study have been to:

- Investigate at what rate natural forest and other land uses have been converted to rubber, and how such conversions have taken place;
- Conduct a cost-benefit analysis of land conversion to rubber plantations;
- Identify and evaluate different functions and services provided by rubber plantations, including socio-economic and environmental functions;
- Assess people's perceptions of land use changes and the impacts of land conversion to rubber plantations on the local people;
- Explore alternative cropping systems to mono-cultural rubber plantations in order to support local livelihoods in, for example, agro-forestry systems;
- Examine the distribution of benefits originating from mono-cultural and mixed rubber plantation systems; and

- Analyze future scenarios for the price of latex and rubber plantation development in Cambodia over the period of a project cycle of 25 years.

The study aims to provide information on the general perceptions of local people towards land development being promoted by the government, and the various impacts of the conversion of forestland to rubber plantation on local communities. In addition, it provides results on the economic value of different types of land use, the cost-benefit of land use changes and future scenarios regarding latex price, rubber plantations, and forestland. The results should provide important messages for policy makers in decisions concerning the expansion of rubber plantations. Further, the findings should contribute to policy discussions regarding the issue of whether economic land concessions and other kinds of rubber plantation development can make a significant contribution to poverty alleviation and economic development of the country.

2.2 Research questions

The study seeks to answer the following questions:

- What are the impacts of forestland conversion into rubber plantation and crops production on local populations, especially their livelihoods and social environment?
- What is the perception of local populations on the establishment of large-scale rubber plantations?
- What are the main costs and benefits of forestland in term of biodiversity conservation and other environmental gains for the local population?
- What are the main costs and benefits accruing in alternative uses of forestland especially the conversion into rubber plantations and crop production?
- How can we expect to improve the social accountability of the agricultural uses of forestland?
- What is the most acceptable mechanism for minimizing the negative impact of establishing large-scale rubber plantations on local populations?
- What are the major benefits and constraints of conversion from orchard crops (cassava, soybean, maize and cashew) into smallholder rubber plantations?

2.3 Literature review

A literature review was conducted to derive various kinds of information from secondary sources. Indirect economic values were drawn from existing studies. The benefit-transfer method was used to value watershed protection and soil erosion control functions. Uncertainties inherent in the analysis were addressed by means of sensitivity analysis.

Rubber plantations and alternative land uses such as forests play an important role in the global carbon cycle, by capturing carbon from the atmosphere through photosynthesis, converting that carbon dioxide to forest biomass. Management of carbon stocks has received more attention since the signing of the Kyoto Protocol, as carbon credits could be gained from activities in developing countries related to planting activities (including reforestation, afforestation, and rubber plantations) under the Clean Development Mechanism (CDM) of the Kyoto Protocol.

The present study examines the amount of carbon that rubber plantations and alternative land uses can sequester per year from the atmosphere using the results of

Hansen and Top (2006) and Khun (2006), respectively. A large amount of research has revealed that approximately 50 percent of dry biomass is the relevant carbon ratio or carbon content. The amount of carbon stored in a tree (or forest), therefore, can be calculated if the amount of biomass of living plant tissues is known. Detailed methods for calculating standing biomass and annual biomass increments in rubber plantations and alternative land uses are available in Hansen and Top (2006) and Khun (2006).

2.4 Field Survey in 2007

Information related to economic land concessions, forestland, rubber plantations, and other relevant documents was collected as part of the initial research phase. Sources of information included literature review, communication with relevant institutions, and personal discussions with key people involved in the research area. Examples of the key relevant institutions consulted were the General Directorate of Rubber Plantation, the Rubber Research Institute of Cambodia, the Forestry Administration, and the National Institute of Statistics.

Field investigation was conducted to collect data related to, for example, the history of rubber development, cost-benefit of rubber plantations and pre-rubber land uses, people's perceptions of land use changes, alternative cropping systems to mono-cultural rubber plantations, impacts of land conversion on local livelihoods, costs of establishment and maintenance of rubber plantations, etc.

The fieldwork comprised three phases. Phase I covered the selection of sites, general observation, and positioning of the selected plantations using GPS, etc. This kind of information was used in identifying the actual location of plantations and previous types of land use before the arrival of plantations, using the land use map of 1998 produced by the Forestry Administration in 1999 and ArcView 8.3 (ESRI, Inc.) software application. Apart from natural forests, additional baseline land uses were defined. Phase II involved construction and pre-testing of a questionnaire. Finally, Phase III was carried out, including the selection of respondents, conducting surveys of households and plantation owners, key informant interviews, and Rapid Rural Appraisal (RRA).

Since the duration of the project was short (one year), it was not possible to measure a number of variables of rubber plantations and baseline land uses directly, such as standing stock, timber productivity, non-timber forest products (NTFPs), yield of latex, rubber wood, etc. Accordingly, results from existing studies (e.g., Hansen and Top, 2006; Khun, 2006) and key informant interviews were used for the assessments. Other data, such as latex price and the environmental functions of forests and rubber plantations, including carbon sequestration, soil erosion control, and watershed protection were valued using results from existing literature (e.g., Yamashita et al., 1999; Balsiger *et al*., 2000; Hansen and Top, 2006; Khun, 2006).

2.4.1 Household survey

The household survey was conducted via face-to-face interviews using a semi-structured questionnaire. The questionnaire was pre-tested to evaluate its user-friendliness and effectiveness. Feedback from the pre-test was used to revise and further develop the questionnaire. The survey enumerators or interviewers were given suitable training before going into the field. They comprised staff from CDRI or students from the Royal University of Agriculture whose backgrounds are compatible with the research areas.

Information was collected in the interviews on changes in the livelihoods of people in the communes before and after the establishment of rubber plantations. The information gathered includes the income generated from natural forests and rubber, the contribution of rubber plantations in improving livelihoods, the direct and indirect values of rubber plantations, reasons why local people decided whether or not to plant rubber, and past and current price of latex. Information on people's perceptions of land use changes and the impacts of land conversion on local livelihoods was also collected. Three villages located within and/or surrounding selected plantations were chosen for the survey. Approximately 10 percent of the total households within each village were randomly selected for interview.

2.4.2 Plantation holder interviews

The plantation holder interviews were conducted in parallel to the household survey. Plantation holders included owners of both small- and large-scale plantations. Around 20 small- and 4 large-scale plantations located in different places were selected for the study. Large-scale plantations comprised 2 plantations, each selected from industrial and state-owned plantations.

The information collected included the history of rubber development, costs of establishment and maintenance of rubber plantations, expected income from production of latex and timber over a production cycle, distribution of income originating from rubber plantations, location of rubber plantations in relation to preferred soil type, or originality of land use type (e.g., forest or barren land).

2.4.3 Key informant interviews

Key informant interviews were conducted in parallel to the household and plantation holder surveys. Key informants, including chiefs of villages or communes and officials or workers at the plantations were targeted for discussion and interview. Additional relevant stakeholders working within the communes and nearby areas were also consulted or interviewed where appropriate.

2.4.4 Rapid rural appraisal and focus group discussion

Rapid Rural Appraisal (RRA) was used for focus group interviews locally. RRA was applied to supplement the data from household interviews, key informant interviews, and discussion with relevant parties. In addition, it included direct observations, physical measurements, and semi-structured interviews. Interviews were conducted with key informants and selected informants and households drawn from representative samples of participants in the selected villages.

3.0 OVERVIEW OF RUBBER PLANTATIONS

3.1 Rubber tree in brief

The Pará rubber tree (Hevea brasiliensis Müll.Arg.), simply called rubber tree, originated as a wild plant in the Amazon Rainforest, Brazil. It is belongs to the family Euphorbiaceae and the most economically important member of the genus Hevea (Wikipedia, 2007). Its latex was discovered by an American scientist and later became of major economic importance (Balsiger *et al.*, 2000). The tree has soft wood, high, branching limbs, and a large area of bark. Fresh rubber wood is white to creamy in color, sometimes with a pinkish tinge, and has a straight grain. It turns yellowish after seasoning. Heartwood and sapwood are not distinguishable. Fresh rubber wood, moreover, has an initial moisture content of 60 to 80 percent and contains 1 to 2.3 percent free sugars and 7.5 to 10.2 percent starch (Killmann and Hong, 2000).

As a tropical tree, Hevea brasiliensis grows best under conditions of temperatures between 20-28°C, well-balanced annual rainfall of 1,800-2,000 mm and protection from high winds. It develops reasonably well up to 600 meters above sea level (but is capable of growing to at least 1000 meters near the Equator) and will perform on most adequately drained soils. Its prime growing area is between 10° latitude on either side of the equator, although it also found further north, as in China. At least once a year the leaves of the tree die and fall off in winter (Balsiger *et al.*, 2000). The tree can reach a height of over 30 m. Once the trees reach 5-6 years old, tapping for latex can begin. Tapping is carried out orthogonally to the latex vessels and the sap is collected in small buckets (Balsiger *et al.*, 2000). Older trees yield more latex, but production decreases significantly from the age of about 25-30 years. Normally, the tree is cut down and re-planted when production decreases. On average, in Cambodia rubber trees produce 1100 kg/ha of latex per year, compared with about 1400kg/ha per year in Thailand, Indonesia, and Malaysia (Khun, 2006). The standing stock of rubber wood can reach 100-200 m^3/ha by the age of 25-35 years old (Balsiger *et al.*, 2000). Khun (2006) conducted a study on rubber plantations in Cambodia which indicated that the quantity of carbon dioxide (CO_2) absorbed from the atmosphere by rubber trees at the common ration age of 25 years was about 525 Mt/ha per year.

An attempt was made in 1873 to grow rubber outside Brazil with no success, but by 1898 a rubber plantation had been established in Malaya (Wikipedia, 2007). Today most rubber tree plantations are found in Southeast Asia and some in tropical Africa. The current area under rubber plantation is about 9 million ha globally, of which 75% is located in Indonesia, Thailand, and Malaysia (Balsiger *et al.*, 2000).

So far, rubber wood has been used as a cheap source of fuel wood in most of the countries where rubber plantations are abundant. It has been used industrially for brick burning and tobacco curing. In addition, it has been used as timber for general utility purposes in timber-scarce countries such as India and Sri Lanka. It has a number of advantages over conventional timbers from the natural forest (Killmann and Hong, 2000). In Japan, for example, rubber wood has been increasingly used to replace the traditional timbers in a wide variety of applications such as furniture. Sixty-one different products, moreover, are made from rubber wood (Killmann and Hong, 2000). Its most important uses are in furniture (manufacturing high-end furniture) and furniture parts, parquetry, paneling, wood-based panels (particleboard, cement- and gypsum-bonded panels, medium-density fiberboard), kitchen and novelty items, general utility sawn timber and fuel (Killmann and Hong, 2000).

3.1.1 Area under rubber plantations

The surface area under rubber plantations throughout the world shows an increasing trend from year to year. In East Asia, rubber plantation areas had increased from 50 ha in 1900 to 10,000 ha in 1910. This figure reached to 40,000 ha in 1920 and continued to increase from 115,000 ha in 1960 to 156,000 ha in 1996 (Wikipedia, 2007). Between 1999 and 2003, moreover, though Malaysia (one of the world largest rubber producing countries) reduced the cultivated area of rubber plantation (1.40 million ha in 1999 to 1.18 million ha in 2003), the total rubber plantation area in the world increased from 7.52 million ha in 1999 to 8.18 million ha in 2003 (see Table 2-1). This is because the area under plantations for rubber producing countries has increased significantly, especially in Thailand (+21%), Indonesia (+16%), India (+12%), Cambodia (+10%), Vietnam (+11%) and other countries (+17%) from 1999 to 2003 (SOFRECO, CEDAC, 2005).

Rubber plantations in many producing countries continue to increase their areas gradually. In Cambodia, for example, rubber plantations increased from 51,000 ha in 1985 to 63,000 ha in 2006 and is expected to continue expanding in the future (Khun, 2006). Presently, the current global area under rubber plantations is about 9 million ha of which 95% located in Asia. About 75% of total areas are located in Indonesia, Thailand, and Malaysia and 18% are in China, India, Vietnam, and Sri Lanka (Balsiger *et al.*, 2000).

Table 2-1: The global trend of area under rubber plantation

Year	**1981**	**1991**	**1999**	**2000**	**2001**	**2002**	**2003**
Thailand	1,269	1,420	1,548	1,563	1,576	1,593	1,880
Indonesia	1,564	1,878	2,300	2,400	2,599	2,635	2,675
Malaysia	1,620	1,610	1,400	1,250	1,220	1,183	1,183
India	194	306	387	395	400	401	435
China	n/a	420	418	421	417	429	420
Vietnam	85	221	395	412	416	429	437
Ivory Coast	17	42	67	67	70	70	70
Nigeria	73	268	298	330	333	330	330
Liberia	0	20	100	105	110	115	115
Brazil	n/a	50	75	94	95	102	103
Sri Lanka	230	198	158	158	157	115	115
Philippines	54	87	91	81	78	80	82
Guatemala	16	15	35	41	41	44	44
Cambodia	10	35	40	34	34	30	44
Cameroon	28	41	40	40	40	40	38
Myanmar	47	39	47	52	62	63	62
Mexico	n/a	n/a	12	12	13	13	13
Other	16	65	112	104	133	131	131
Total	**5,314**	**6,650**	**7,523**	**7,559**	**7,793**	**7,802**	**8,176**

Notes: All values are in 1,000 ha. Source: FAO, 2003.

Rubber consumption is one of the major reasons for rubber plantation areas in the world increasing. Increased consumption of natural rubber is important in China, Taiwan, India and Japan (SOFRECO, CEDAC, 2005). Consumption-led rubber producing countries, especially the major producing countries in Asia, have expanded their plantation areas from year to year in response to demand. In India, for example, consumption has always exceeded production. In year 2001-2002, their production was 7,000 MT less than consumption. World rubber consumption has increased by 2.3% from 21.0 million tons in 2001 to 21.5 million tons in 2006 while production amounted to only 6.86 million tons in 2001 and 8.66 million tons in 2006. The projected excess of consumption of natural rubber over production in 2011-2012 is 229,000MT.

Currently, global rubber consumption consists of 48% natural rubber, 20% solid SBR, 14% latex SB, 12% polybutadiene, 5% EPDM, 2% polychloroprene, 2% nitrile and 7% other synthetics. The demand for elastomers both for synthetic rubber as well as natural rubber is still continually increasing at a rate of 3% to 4% per year (FAO, 2003).

3.1.2 Trend in rubber prices

For a long time, the price of rubber has been in decline, from over USD 2,500 per ton in 1960 to just over USD 600 per ton in 1990. Judged by this, countries relying on rubber production are worse off than ever, with prices following a continuous downward trend over the past forty years. Natural rubber latex prices also fluctuate from period to period. Prices increased by 67%, for example, over the past three years and in year 2003 alone, price rose 13%. A similar increase occurred in 1995-1997, after a significant price fall (SOFRECO, CEDAC, 2005). In 2001, Thai RSS 3 fell by the biggest margin while Indonesia TSR 20 fell by the smallest margin. The same year, SS1 annual average prices in New York and London stood at a low point, with the average London price in 2001 of 469.8 £/ton and the New York price at USD 746 per ton. Up to year 2000, New York rubber prices were at their lowest levels for about thirty years (FAO, 2003).

Price fluctuations are caused by many factors. Demand and supply, and hence stocks, are the fundamental factors influencing natural rubber prices. After 2001, for example, the rubber price rose after the International Tripartite Rubber Organization (ITRO), covering 70% of world production, cut exports 10% in January 2002 and cut output 4% in 2002 and 2003.

Natural rubber prices have been on a declining trend since 1995 as result of global stocks rising. The long-run rise in rubber stocks led to a continuous fall in rubber prices during 1995-99. Then, when stocks were about to reach the peak towards the end of 1999, prices rose again. The decline in stocks in 1993-94 led to a rise in rubber prices. However, the puzzling period has been 2000-01 when the decline in world stocks has not led to a rise but rather a fall in prices (FAO, 2003).

Currency movements can affect direct or indirectly the natural rubber price through the effects of changes in exchange rates. A direct effect occurs when natural rubber is purchased from one country in a given currency for use or resale in another country with a different currency. Any change in exchange rates can affect the price in the purchasing country without any change in prices in producing countries taking place. Second, an indirect effect can come from arbitrage activity and speculative demand, which can be either commodity speculative or foreign exchange speculative.

For example, in the short-run, a 10% decline in £/Ringgit or £/USD leads to a rise of 2% in London price, while a 10% rise in the USD/Ringgit leads to fall less than half a percentage in the New York price, and a 10% appreciation of the USD to SDR leads to a rise of 2.5% in the average of rubber prices. Over the longer term, a 10% appreciation of the USD/SDR rate has resulted in a decline of more than 30% in the average prices in New York, London and Kuala Lumpur.

Depreciation of the USD has led to a sharp improvement in the rubber price and vice versa from 1995 to the present (FAO, 2003). The 20% appreciation of the SDR, on the other hand, since the peak of rubber prices in early 1995 has led to a decline of almost 60% in the rubber price. A strong dollar also makes rubber more expensive in the dollar-denominated export market and normally leads to higher prices in consuming countries' currencies, e.g. the yen. If the dollar does fall, the long-term consequence for the rubber price would be the opposite from any increase in rubber prices.

Market intervention is another factor. Aimed at stabilizing the natural rubber price, one form of intervention is a reduction in output, thereby reducing global stocks and exerting a positive effect on rubber prices. On 11 December 2001, for example, following a meeting of the ITRO, held in Bali, Indonesia, a decision was made to cut or withdraw rubber output and exports from the rubber market by 181,000 tons (4%) and about 374 000 tons (10%), respectively at the beginning 1 January 2002. This can be compared with more than 900,000 tons of rubber purchased by the Thai government during their intervention program (1992 - present) and over 700,000 tons purchased by International Natural Rubber Agreements (INRO) since October 1980.

Price intervention, on the other hand, can be conducted by selling from the stockpile. In 2001, for instance, the REO (Rubber Estate Organization) of Thailand released an estimated 130,000 tons of rubber (50,000 tons negotiated) sold under a government-to-government deal with the People's Republic of China (FAO, 2003).

Other factors affect the rubber price, including technological innovation, economic development, weather, futures markets activities etc (FAO, 2003).

3.2 Rubber plantations in Cambodia

3.2.1 Basaltic red soil in Cambodia

The available land for rubber plantation in Cambodia is located in Kampong Cham, Kratie, Kampong Thom, Rattanakiri, Mondulkiri, Battambang, Preah Vihear and Pailin provinces. It covers around 900,000 ha where more than 700,000 ha is basaltic red soil (MAFF, 2006). Of the total area of basaltic red soil in Cambodia, 186,600 ha is located in Lower Mekong including Kampong Cham and Kratie province, 520,000 ha in the North East plateau including Rattanakiri province (180,000 ha), Mondulkiri (320,000 ha), and Kratie (20,000 ha), and 10,000 ha in mountain areas. A realistic estimate of the potential area for rubber cultivation in Cambodia for the North and East area of the country is around 330,000 ha.

The soils have a distinctive red color and uniform deep profile. The surface of the soil has a crumb structure with a high degree of aggregate stability and usually friable. The soil texture is clayey throughout the profile. The surface gives the impression of being sandier because of the stable microstructure of the mainly kaolinitic clays, iron and aluminium oxides and hydroxides. The soil is very sticky and slippery when wet. The subsoil is clayey. It usually has a deeper red color than the topsoil and usually friable with a crumb structure. The red soils are pluvial lands and do not occur in the flooded valleys. They occur on sides of hills and mountains that were once ancient volcanoes. The soils have evolved from the underlying basalt rock. These soils occupy the freely draining parts of the topo-sequence.

Large areas of basaltic red soils have very good water holding capacity. Cambodia has a tropical monsoonal climate with a pronounced wet and dry season. In the long dry season, November to April, the high available moisture-holding capacity of the soil permits a high yield potential for rubber, comparable with that of the best rubber producing countries. Rains occur mainly in May-June and around September-October. The central plains and eastern parts of the country have precipitation ranging from 1,000 to 2,800 mm/yr thus becoming a major location for rubber plantations in Cambodia.

Although there are large areas of basaltic red soil and very good climate conditions, the area under rubber plantations covered only 70,000ha by 2007. Therefore, large areas of red soil remain, compared to the total available area.

3.2.2 History of rubber development in Cambodia

The first rubber seeds were brought and planted in Cambodia in Veal Rinh district in 1910 by a French person, Mr. Bouillard. After a couple of years of successful trial, the first rubber plantation was established over an area of 150 ha in 1914. Later in the 1920s, French companies set up a number of large-scale plantations on basaltic red soil in Chup and Chamkar Leu plateau, Kampong Cham Province. Since then, the area under rubber plantation has increased gradually from 28,000 ha in 1940 to 70,000 ha in 1969 with a total production of 52,000 tons of rubber per year. During the 1970s, the plantation plan was halted and parts of the plantations were destroyed by war and chemical defoliant used by the US army. As of 1979, the remaining plantation area under latex cultivation was only 50,000 ha (MAFF, 2006).

Up to 2006, the area under rubber plantation increased to 63,000 ha. The plantations can be divided into three categories of ownership: state, household-owned, and private-industrial plantations. The state-owned plantations are mainly located in Kampong Cham Province, comprising over 63 percent of the total rubber plantation land, and are controlled by seven state companies, i.e., Chup, Peam Cheang, Krek, Memot, Snuol, Chamcar Andong, and Beung Ket Rubber Plantations while privately owned plantation covered around 17 percent (Khun, 2006). Household-owned plantations - or to use another term, “smallholder rubber plantations” - commenced in 1990 (AFD, 2006). The areas under smallholder plantation have increased rapidly, from 10,000 ha in 1995 to 18,600 ha in 2006 (GDRP, 2006). The AFD (2006) projected that areas under smallholder rubber plantations will have increased to 35,000 ha by year 2010.

Currently, in addition to existing private-industrial plantations, more privately owned plantations are granted under the Economic Land Concession (ELC) scheme, initiated by the Royal Government of Cambodia (RGC) in 1992. Such concessions comprise agro-industrial plantations, including cash crops (palm oil, cashew nuts, cassava, bean, sugar cane, rice and corn), fast-growing trees (acacia, eucalyptus, pine), and other valuable trees such as rubber and teak. Since then, about 907,000 ha of land have been approved for development under 50 concessions. Of the total land area, about 13 percent (approximately 120,000 ha) was granted for partly growing rubber trees. Such plantation development seems to be one of the main crops currently planned to be cultivated. However, only a limited number of plantations are actually in progress; while for others, it remains unknown whether rubber trees have been planted or not (MAFF, 2006).

Most rubber plantation area in Cambodia has been converted from forestland. Large areas of forestland have been cleared to develop rubber plantations. In 2001, for example, the royal government of Cambodia cancelled 6,200 hectares of forest concessions of three logging companies in Tumring commune, Kampong Thom province. Of the total cancelled area 912 hectares were given to local people, 929 hectares were reserved for smallholder rubber production, and 4,359 hectares were given to Chup Rubber Plantations for rubber development. Chup Rubber Plantation, moreover, also hired the adjacent forest concessionaires to log 1,200 hectares to develop rubber plantations.

3.2.3 Contribution of rubber to the national economy

The Cambodian economy, until recently, remained strongly dependent on the agricultural sector though it is an undeveloped sector. From 1994 to 2003, agriculture was the major sector of the economy, contributing an average 41% of GDP (USD 4.6

billion) while services accounted for 34% and industry 19% (Dourng and Sok, 2005). In 2005, agriculture remained the main sector contributing 34% to GDP, employing 70% of the labor force.

Industrial crops especially rubber, cassava, soybean, maize, cashew, sesame, sugarcane, tobacco and jute are an important part of the role played by the agricultural sector in the national economy. For a long time, rubber has been a major source of foreign exchange, government revenues and employment opportunities, alleviation of poverty among smallholders, stimulation of agro-industrial development, conservation of the environment and fostering of regional development (Dourng and Sok, 2005). According to SOFRECO & CEDAC (2005), the 7 state owned rubber companies in 2002 employed about 15,000 people, 66% of whom were on plantations (rubber tapped), 22% office workers and 12% factory workers. Rubber, moreover, is the country's major agricultural export. On average, 45,000 tons are exported annually. Its export value accounted for USD 32 million in 2005, representing 54% of total agricultural exports (Dourng and Sok, 2005).

Rubber plantations play an important role similar to natural forests. Their functions have been extensively studied, in terms of rainfall, water run off, evaporation and transpiration, and soil moisture (Jiang and Wang, 2003). Their study has shown that annual rainfall, which is intercepted by plantations, accounted for 11% and 63% for evaporation and transpiration (water returned to the atmosphere from plant cells, soil moisture). Two interconnected functions of plantations are a decrease in soil erosion reducing rainwater runoff; and decreasing sedimentation (Jiang and Wang 2003). Hence, plantations play a very important role in protecting watersheds.

Another indirect benefit of rubber plantations is carbon sequestration. According to Jiang and Wang (2003) the function of rubber plantations is similar to tropical forest though it is not a natural form of vegetation. According to one study conducted by Khun (2006) regarding the amount of carbon sequestration by rubber, the result has shown that at the age of 25 it can absorb 525 tons per hectare.

3.2.4 Government policy toward rubber development

State-owned rubber plantation

Rubber plantations used to be owned by the State of Cambodia during its socialist regime in the 1980s and 1990s. The socialist regime managed rubber plantations according to State Plans but not market competition throughout the country. Because of this system, the majority of the rubber plantation staff were inactive and less committed unless instructed by their supervisors. Therefore, like many other national economic sectors, the rubber plantation sector had contributed little profit to the national economy. After the political regime changed and free market systems were introduced and opened to the public in Cambodia in 1993, the Royal Government of Cambodia (RGC) released State-operated businesses to non-government owners including self-managed rubber plantation enterprises, rubber plantation associations, family-scale rubber plantations, and other divestment strategies.

Working toward privatization of the rubber plantation, the RGC has issued regulations and policies, which are encouraging private sectors and, more recently, family-scale rubber plantations. Rubber plantations are included in the RGC's rectangular strategy, which is clearly stated to enhance and extend a high-potential agricultural and agro-industrial sector.

Existing laws and regulations

The law on forestry was promulgated in August 2002. The law's objectives are to frame the management, harvest, use, development, and conservation of the forests in Cambodia (Article 1). Conversion Forestlands for other development purposes are idle land, comprised mainly of secondary vegetation. Areas not yet designated for use by any sector are classified as Permanent Forest Reserves until the Royal Government decides to use and develop the lands for another purpose (Article 10). Nevertheless, the RGC shall consider the priorities of public interests before declassifying permanent forests for other purposes, only under condition that the present demand would be greater than the previous one (Article 12).

Sub-Decrees on Procedure Establishment Classification and Registration of Permanent Forest Estate define procedures for establishment, classification and registration of permanent forest estate in order to organize and manage sustainable forest lands and forest resources in line with the policy and national forest management plan. The Minister for Agriculture, Forestry and Fisheries is authorized to chair the National Committee that has roles and tasks to conduct surveys, propose forest estate demarcations, and submit final maps of permanent forest estates to the RGC for final approval (Article 5 & 6). The Forestry Administration (FA) is the permanent secretary to the MAFF responsible for all technical tasks related to forest classification and demarcation on map and on the ground.

Sub-Decrees on Community Forestry Management were adopted in 2003. The sub-decree shall be officially countrywide implemented and aimed at determining rules for the establishment, management and use of community forests (Article 1). It is also stated that Community Forest is state public property (Article 3). A Community Forestry could be established by local communities or the Forestry Administration with the involvement of local authorities or Commune Councils (Article 6 & 7).

Sub-Decrees on Economic Land Concession in 2005 aim to determine the criteria, procedures, mechanisms and institutional arrangements for initiating and granting new economic land concessions; for monitoring the performance of all economic land concession contracts; and for reviewing economic land concessions entered into prior to the effective date of this sub decree for compliance with the Land Law of 2001. Article 4 of the ELC requires any proposal to meet the following conditions before approval:

- An economic land concession may be granted only on land that meets all of the following five criteria: (1) increase in agricultural and industrial-agricultural production by using modern technology; (2) creation of increasing employment; (3) promotion of living standards of the people; (4) perpetual environmental protection and natural resources management; (5) avoidance or minimizing of adverse social impacts and (6) any linkages and mutual support between social land concessions and economic land concessions.
- The land has been registered and classified as state private land in accordance with the Sub decree on State Land Management and the Sub decree on Procedures for Establishing Cadastral Maps and Land Register or the Sub decree on Sporadic Registration.
- Land use plan for the land has been adopted by the Provincial-Municipal State Land Management Committee and the land use is consistent with the plan.

- Environmental and social impact assessments have been completed with respect to the land use and development plan for economic land concession projects.
- Land that has solutions for resettlement issues, in accordance with the existing legal framework and procedures. The Contracting Authority shall ensure that there will not be involuntary resettlement by lawful land holders and that access to private land shall be respected.
- Land for which there have been public consultations, with regard to economic land concession projects or proposals, with territorial authorities and residents of the locality.

By 2006, ELC areas amounted to approximately 6% of the total country surface (Figure 3-1). A large percentage of land (20%) is under suspended forest concessions and are not well managed by legitimated concessionaires. Almost all forest concessionaires walked away from or were very reluctant owners of the forest areas (Hansen and Top, 2006).

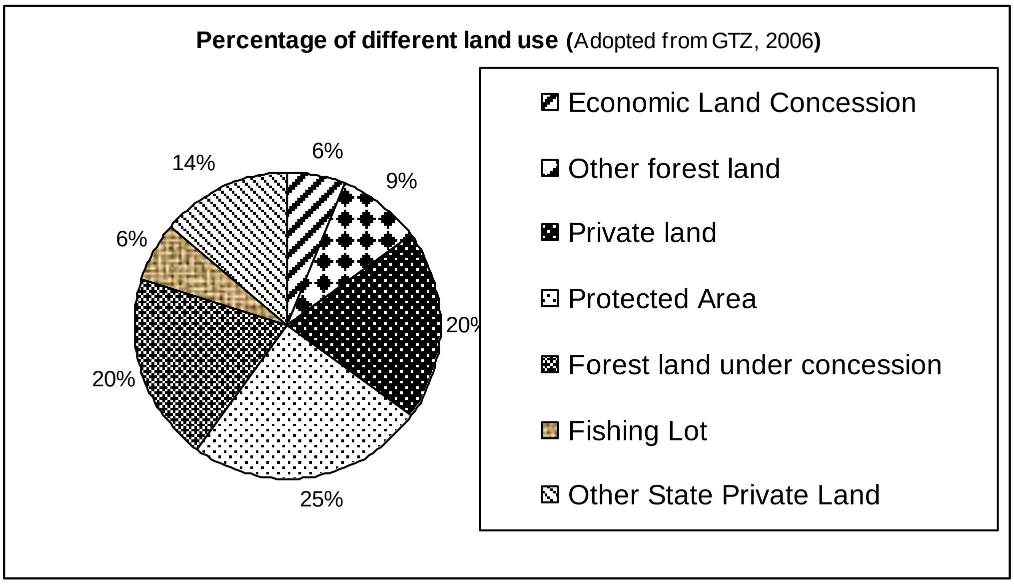

Figure 3-1: Land use distribution in Cambodia

Policy on Household Rubber Plantations

The government declaration No. 03 Rbk dated 08/08/00 encourages farmers to plant rubbers on their small-scale plantation with proper credit, land tenure providing policy. The policy is aimed to push rubber development as agro-industry not only on farmers' lands, but also on private lands especially small-scale rubber plantation. The Policy emphasized that government ensures and encourages farmers through providing:

- Land tenure and family-lines inherit of their RPs,
- Enhance cheap creditability,
- Provide training and services of RP and latex markets,
- Provide free markets for rubber sale,
- Provide rights of creating RP association (Natural Rubber Bulletin, 2005),

The specific goal of the farmer-scale rubber plantation is to:

- Speed up development of rubber plantations in the Kingdom of Cambodia;

- Granting rights of possession, use of farming land, succession, transferring tenure rights to another person, and guarantee not to nationalize;
- Facilitating in borrowing credits from rural development bank under the terms/conditions and available methods;
- Providing training and technical services in planting, maintenance, harvesting and give information about rubber markets;
- Granting the rights to receive products of their plantation, processing, and freely sale rubber products; and
- Farmers are entitled to organize Association of Rubber Farmers to protect interests of each member.

Following the farmer-scale rubber plantation policy, suitable soils including previous or existing croplands and natural forestlands have been extensively converted and supported by the government by adopting a policy on household rubber development to encourage farmers to boost rubber plantation production on their farmlands.

It is important to remember that a similar strategy of farmer-scale rubber plantation was introduced to Cambodia in the 1950s and early 1970s by the past government. The development was mainly near industrial-scale concessions in the traditional red-earth area of Kampong Cham province. At the end of 1969, the areas planted with Hevea amounted to 70,000 ha, two-thirds of which were under agro-industrial companies and one-quarter for private and smallholder's plantations. In 1969 production amounted to 52,000 tons of rubber, all of it exported. This total consisted of balanced proportions of concentrated latex, smoked sheets and specified granules. (SOFRECO, CEDAC, 2005)

Smallholder rubber plantations

About 80% of the rubber plantations have been state-owned for the last ten years. Since 2000 following the RGC policy on farmer-scale rubber plantation, there has been increasing implementation of the policy. With the fund from Agence Française de Développement (AFD), smallholder rubber plantations were established. Micro credit with a low interest rate was offered to farmers involved in this project. In 2007 the General Direction of Rubber Plantation (GDRP) shows that private rubber plantations represent 30,000 ha, which is about 43% of the available rubber plantation lands. Up to 2007, 1,200 households were involved in household-scale rubber plantations on a total area of 3,800 ha.

Privatization of state-owned plantations

The RGC, with advice from the ADB, has started to privatize, through a public bidding process, three of seven, state-owned rubber plantation enterprises (Chamka Andong, Beung Ket and Memot). Because of the new policy, Chup Company was granted the Tumring rubber plantation with areas of about 4,359 ha. Similar to Chup Company, Krek Company has been seeking new rubber plantation areas in Svay Leu district, Siem Reap province. Family-scale rubber plantations and companies have been seeking opportunities in many other places such as Rattanakiri province where available red soils make it possible. Foreign companies started to search for rubber plantation opportunities even on non-red soils such as in Chhlong district, Kratie province.

3.3 State-owned rubber plantation firms

3.3.1 Krek rubber plantation

Krek rubber plantation is located in Ponhear Krek district in Kampong Cham province, Cambodia, established in 1928 by Terou Company from France. (see Figure 3-2.) After the collapse of the Khmer rouge regime, the company was re-established in 1980 under the name of Chub Rubber Plantation. In 1991, Krek plantation was separated from Chup Company. In mid-2007, Krek was awarded by the government an area of 9,104 ha in Svay Leu Commune, Siem Reap Province for developing rubber plantations.

The plantations could contribute to the economic growth in the country by generating employment opportunities and tax revenue. For employment generation, a 3 ha area of rubber plantation requires the labor of one worker who generally receives a wage of USD 2 per day. In 2007, the company provided jobs to 1,167 workers who are mostly from Kampong Cham. With the newly expanded areas, one plantation in Siem Reap not only was able to expand employment opportunities, but also contribute about USD 273,000 to government tax revenue.

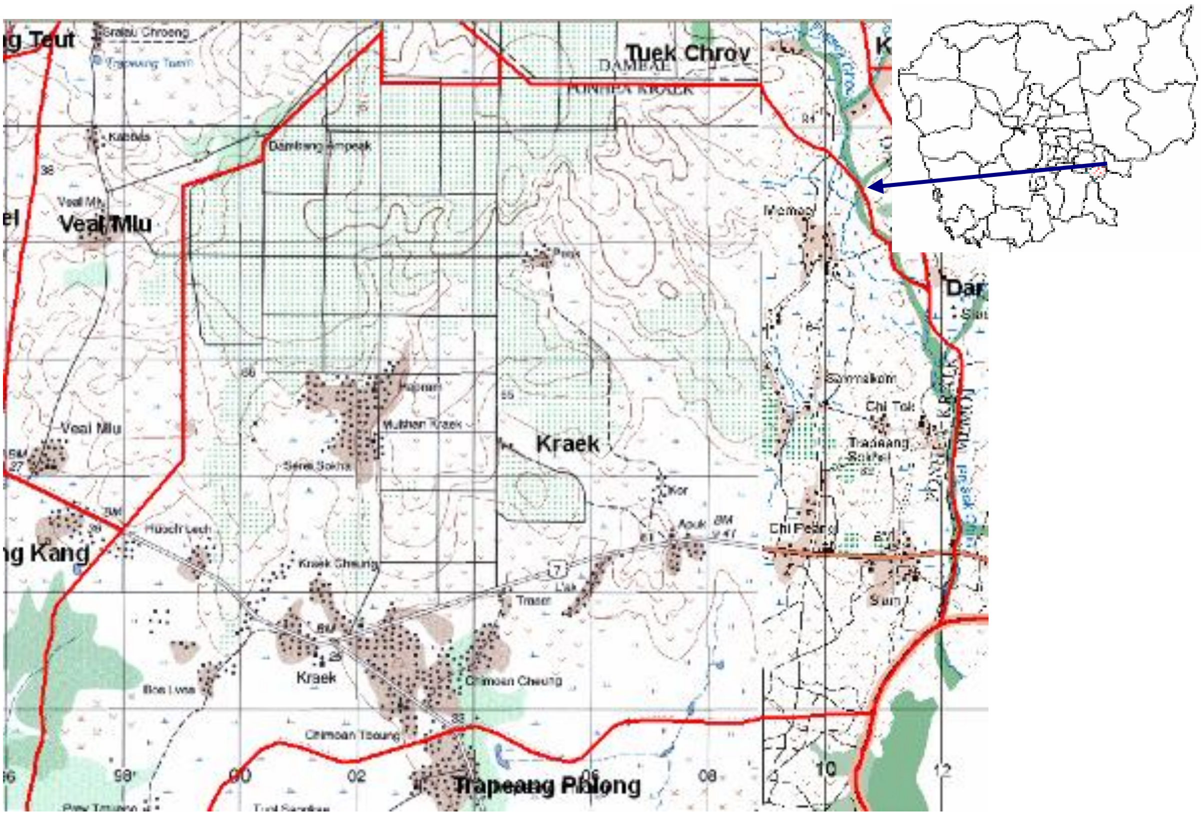

Figure 3-2: Geographic situation of Krek rubber plantation

With the support of AFD, some villages in Ponhear Krek district have been selected for planting rubber with a special incentive program that allows villagers to borrow money as their capital at a low interest rate of 7 percent per year. The number of households to plant the rubber has been increasing because people have begun to understand the benefits of rubber plantations. The yield of rubber is increasing yearly from smallholders surrounding the Krek plantation and there are prospects for five corporations to buy latex in the locality.

3.3.2 Chamcar Andong rubber plantation

The Chamcar Andong rubber plantation was created since 1927 covering an area of 20,976 ha. It is located in Chamkar Leu districts of Kampong Cham province (see Figure 3-3). During 1980s, this plantation has been shared with local population; the total area of this RP is reduced to 6,956 ha in 2008. The privatization is undergoing.

Chamkar Andong rubber plantation employs 1,629 people including a few government officials. The salary for all the workers is about USD 107,250 per month. Mostly the workers are from Kampong Cham, Takeo, Kampot, Kampong Thom, Kampong Speu, Prey Veng and Svay Rieng provinces. In addition to the salary, the workers in the plantation can get benefits by planting supplementary crops such as soybean and mung bean between the rubber rows without charge during the first three years of new plantings.

The company sells the latex to Vietnam which then re-exports it to Singapore and Malaysia. The price has increased from USD 557 per ton in 2000 to USD 1,792 per ton in 2007. However, the prices can fluctuate within each year, and sometimes it pushes the highest price of up to USD 2,500 per ton in Malaysia. The price peak often occurs in February and March.

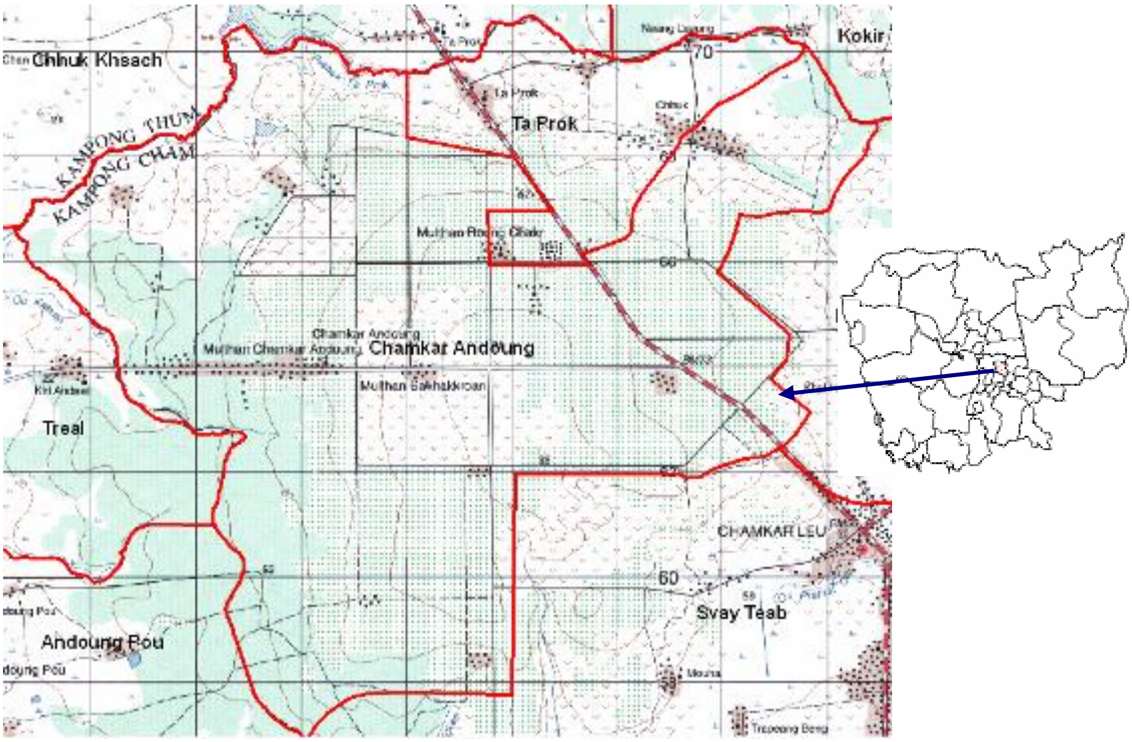

Figure 3-3: Geographic situation of Chamkar Andong rubber plantation

3.3.3 Tumring rubber plantation

After the Khmer Rouge regime, the Cambodian economy experienced hardly any growth. However, after the first election in 1993, the political situation in the country became stable with the help of donors, who assisted the government in stimulating economic growth through privatization of the agro-industrial sector. In 1997, AFD conducted a study on financing the rubber sector in Cambodia in order to restructure the management of this sector. The study proposed a program of renewal of rubber plantations of 2,700 hectare per year, which meant expanding the potential land for plantations. Red soil in Kampong Thom province represented a potential rubber plantation development. The areas were converted from parts of forest concession (GAT, COLEXIM and Mean Ly Heng), after having seen unsatisfactory incomes from timber exploitation compared to rubber plantation elsewhere and with the pressures of donor communities (NGO Forum, 2005).

In August 2001, the government allocated a 6,200 hectares concession in Tumring commune, Kampong Thom province, to the Chup Company to develop the rubber plantation. (see Figure 3-4.) However, the total land for rubber plantations in Tumring is only 4,359 ha. The company had to meet two purposes objectives: first to develop the area and establish an agro-industrial rubber production unit; and second the company has had to allocate some 1,841 hectares of land for setting up operations with smallholders in the form of compensation to local people, who had lived there before 2000. In addition to the land sharing, the company has a policy to provide the plants and technical assistant free of charge to the local people, as they had no experience in planting rubber.

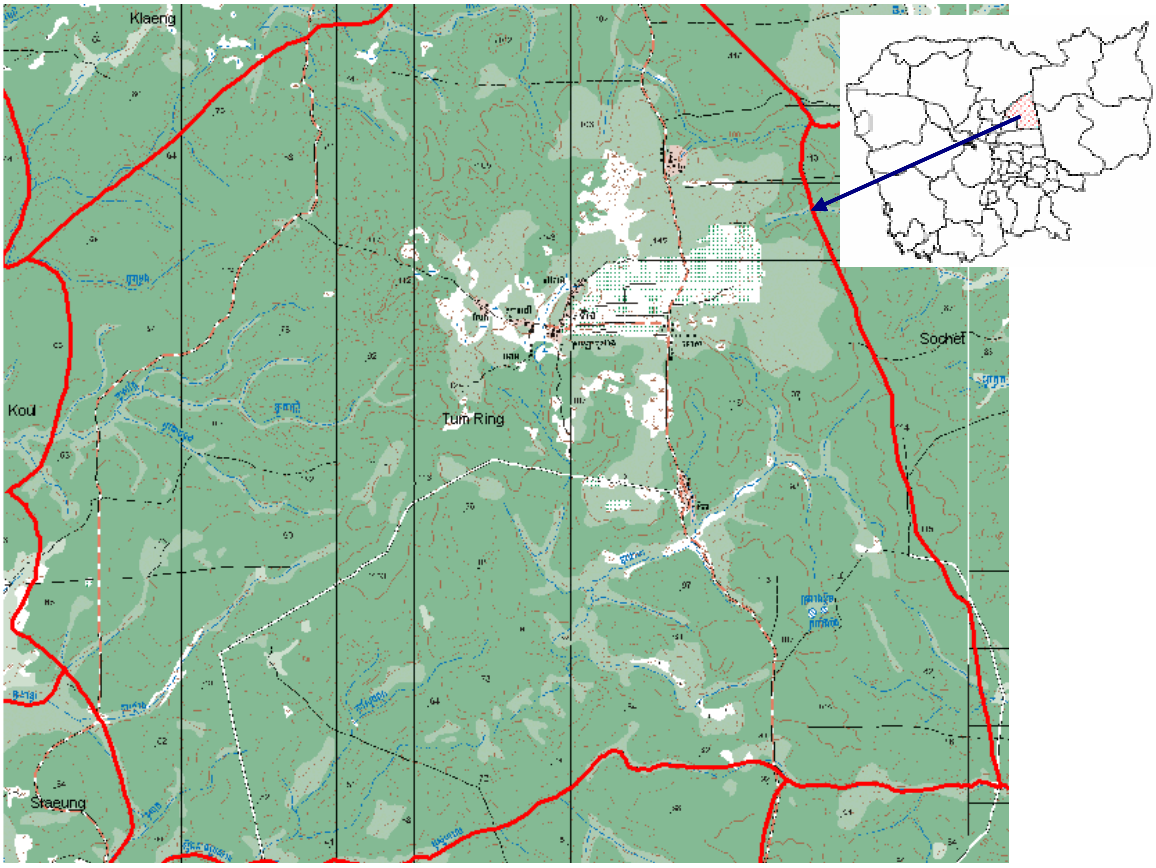

Figure 3-4: Geographic situation of Tumring commune

The conversion of forestland into rubber plantation is controversial. Establishing a new rubber plantation would generate income for national economic growth, but it has to be ensured that farm-household level economic benefits could be gained from it as well. The forest area of 6,200 hectares in Tumring commune that the government awarded to the Chup Company was classified as degraded forest by the developer. In contrast, NGO Forum (2005) argued that the area was covered by dense highly valued forest and a large number of wild animals. This 6,200 ha of forestland is located in the large pristine forest in Kampong Thom province. Furthermore, the local people used to rely on non-timber forest products (NTFPs) for their subsistence.

The developer argued that the establishment of the rubber plantation would generate a huge number of employment opportunities for the local people. But few local people were recruited to work on the rubber plantation due to a lack of skills. Most of the employment was given to workers from other areas such as Kampong Cham province as they had more experience with rubber plantations. In addition, the relationship between the owner and local people seemed to deteriorate.

The developer was obliged by the government to provide technical assistance to the local population in establishing the family-owned rubber plantations on the land the people received. The developer accused local people of lack of willingness to accept the new practices, of undermining the benefits of the rubber plantation and lack of cooperation during the training sessions for rubber planting techniques. In contrast, the local population blamed the developer of not properly handling the rubber planting technique training sessions; and by only providing young rubber trees to them. Moreover, as rubber plantations provide benefits only after 6 years of planting, the local population was forced to live without income for at least 5 years.

4.0 CHARACTERISTICS OF HOUSEHOLDS

This section reports the results of the information obtained from households with plans of land conversion to rubber plantations. Among the three sites where surveys were undertaken for the study - Tumring, Chamkar Andong, and Krek - households have a very different background of involvement with rubber plantations. Some households have been traditionally used their lands for agricultural purposes (shifting cultivation and permanent rice fields) whereas others had in-migrated, taking advantage of red soil areas for their cash crops or for rubber plantations. Given the price of rubber latex, some of those households converted more of their croplands to rubber plantations.

4.1. Tumring Rubber Plantation

Tumring is newest state-owned rubber plantation in Cambodia. The local people have inhabited the area, practicing slash and burn agriculture for generations. During the late 1970s, some of those areas were used as cotton plantations. As a condition of the conversion scheme, the government promised to allocate 3 ha of land for the local population for developing family-owned rubber plantations, with technical assistance from the Chup Company. Those families were promised full property rights.

After the first one or two years following their agreement, the Chup Company assisted those families with land preparation and rubber seedlings. Nevertheless, after the third year, the Chup Company was reluctant to help them, as people began to question the benefit of rubber plantations compared with other annual cash crops. With inexperience in rubber plantation practice, some families decided to sell their land and move to other places where agricultural lands were available or to work for the Chup Company to develop rubber plantations.

Given the lack of skill in rubber planting techniques by the local population, the Chup Company tended to hire qualified workers at the Tumring rubber plantation, especially those originating from Kampong Cham province. This created unprecedented immigration as the local population sold off land and moved to other places. During the survey, a few of the better off and newcomer families could afford to run their own rubber plantation with the land bought from local families. It is essential to recognize that no family had planned by themselves to convert their croplands into rubber plantations before and after the establishment of Chup Company.

4.2 Chamkar Andong Rubber Plantation

Before 1999, the population in Chamkar Andong used their land for banana, pineapple, soybean, cassava, and cashew tree plantations. The majority of families had their own agricultural lands, and knowledge and skills gained from their previous experience. In 1999, smallholder plantations were established under a project of "smallholder rubber plantation development (PHF)" funded by Agence Française de Développement (AFD). Under this project, AFD provided credit funds to the Rural Development Bank (RDB) to fund the smallholder rubber planters via long-term loans with technical support from the Project. RDB signed a loan contract with farmers for 20 years cycle in local currency with an interest rate of 7% per year and with an 8-year grace period. Farmers involved in this project were also provided technical support on rubber planting techniques. At the first year, the project planted only 25 ha, but this increased to 70 ha in the second year (2000). The local population was reluctant to take part in this project for several reasons, especially uncertainty over ownership, limited market outlets for selling the rubber latex and a non-attractive latex price.

With a higher latex price, the area of rubber plantations involved in the PHF project increased to 3,000 ha (900 families) in 2006 and for autonomous plantations increased to more than 6,900 ha in the same year (AFD, 2006). Under this project, farmers make payments of 20-30% of their rubber annual income over 12 years[1] (AFD, 2006).

More rubber plantation holders recognized that rubber provides larger incomes compared to orchard crops such as cashew, soybean, corn, cassava, and sesame. Holders stated that though they changed to plant rubber they still practiced intercropping (during the first three years rubber age) including soybean, mung bean and sesame. Most plantation holders became better off.

The survey interviews conducted for the study demonstrated that workers of the Chamkar Andong rubber plantation had no problem with their employers. The interviewed workers strongly declared that their were happy with their job and their livelihoods were getting more support from the employers, including free electricity use, water supply, and housing settlement. Their children were provided free schooling within the Chamkar Andong RP campus.

4.3 Krek Rubber Plantation

Households in the surrounding area cultivate rice and other crops such as soybean, durian, jackfruit etc. This area was also part of the project of "family-owned rubber plantation development (PHF)" funded by AFD from 2001. Smallholder plantations started to expand their area and convert their croplands to rubber plantations. Some people have more than 100 ha of rubber plantations. Besides that, 'outsider' rich people originating from Phnom Penh and Kampong Cham towns have purchased croplands and converted them to rubber plantations. Some of them have more than 1,000 ha of rubber plantations.

The rubber plantation workers were classified into villages. The head of each village was assigned to assist in any challenge that occurred with his or her villagers.

[1] This estimation is based on international rubber price of USD 1,000 per ton.

With little fee owing to the Krek rubber plantation, some of those villagers were allowed to grow annual crops under or in between rubber rows when they were less than 3-years old. All workers were provided with accommodation, electricity, potable water supply, and school. Main and busy roads were paved by the Krek rubber plantation.

5.0 IMPACTS OF FOREST LAND CONVERSION ON LOCAL PEOPLE: THE CASE OF TUMRING

5.1 Development of land conversion

Tumring Rubber Plantation is located in Tumring commune, Sandan district, Kampong Thom province, about 230 km north of Phnom Penh. There are eight villages in Tumring commune: Tum Ar, Roneam, Ronteah, Samrong, Sror Lao Srong, Khaos, Leng, and Kbal Demrei with a population of around 3,721 inhabitants (795 households) in 2005. The commune is located in the middle of one of Cambodia's remaining largest pristine forest areas with a large number of wild animals. However, the forest was under logging by concessionaire companies (Colexim, Mien Ly Heng and GAT). According to NGO Forum (2005), traditionally, the local people were dependent on forest resources, lowland rice and shifting cultivation. Additionally, they tap resin trees and collect other NTFPs such as rattan, vine and wild fruits from the surrounding forest. These activities of Tumring villagers kept going until the last day of forest conversion to rubber plantation.

The area was initially cleared for a very small area of land (2 ha) for agriculture by an immigrant who discovered the potential of red soils in the early 1990s (Yet Hun, pers.com.) and who gradually introduced rubber plantations on his land. The situation changed, however. By the late 1990s security of the areas was better after the last Khmer Rouge defection in 1998. Then, roads were improved by forest concession companies (Colexim, Mien Ly Heng and GAT) and many more people could access the areas and see the opportunity of red soils for either agricultural crops or rubber plantations.

In early 2000, the government decided to award Chup Company about 6,200 ha of basaltic red soil to develop rubber plantations in the area. In November 2000, a study conducted by the Kampong Thom Provincial Department of Agriculture stated that the forestland assigned to Chup was degraded to the point that it had no commercially valuable trees. In 2001 the government issued a sub-decree to withdraw the red land from the forest concessions and allocated around 6,200 ha to Chup Company for developing industrial-scale rubber plantations, in which 1,841 ha were offered to local people to develop family-scale rubber plantation.

According to NGO Forum (2005), mature forests in Tumring commune have been cleared without regard for local people whose livelihoods traditionally depended on products collected from the forest. While the valuable forests were cleared and converted to rubber plantations, the biodiversity inside and outside the area, including forest resources and wildlife habitats, decreased drastically. The rubber company, moreover, used a top-down approach to implement the project without taking seriously consultation with or participation by the local people. People were deprived of forest resources and their lands to develop rubber plantations under the project with uncertain returns from their long-term investment. Moreover, the company did not provide any training on rubber planting techniques or land titles to people under the project. There was no formal or written agreement between the rubber company and the local people on family-scale rubber plantations. In 2007, Chup Rubber Plantation claimed that their areas for Rubber Plantation at Tumring were around 4,359 ha of basaltic red soil in the locality.

Compensation has been the major problem for people who lost their land to rubber plantations. Tumring Rubber Company failed to honor their engagement with the local population regarding compensation to affected families of USD 125 per ha of land. In fact, Tumring Rubber Company compensated affected families only between USD 12 and USD 75 per ha. Moreover, about 20 to 30 families did not receive any compensation. Some people in Tumring commune did not receive 3 ha land as in the conversion scheme, for reasons that are unclear. These findings corroborate the results of the study conducted by NGO Forum in 2005.

5.2 Livelihood before and after arrival of plantation

With the rich fertile soil and water resources, villagers in the area live on cultivation of shifting agriculture and NTFP collection. At the time prior to the rubber plantations, surveyed households depended mainly on forest products collection, wet rice and other cash crop cultivation. Nearly 31% of respondents put wet season rice production as the main source of income. About 28% of respondents stated that forest products are the main source of income (Figure 5-1 left). They tapped resin trees, hunted, collected fuel wood, and other NTFPs including vine, rattan and other wild fruits to support their subsistence. Additionally, some people in Tumring commune depend on small business, livestock and selling labor at daily basis.

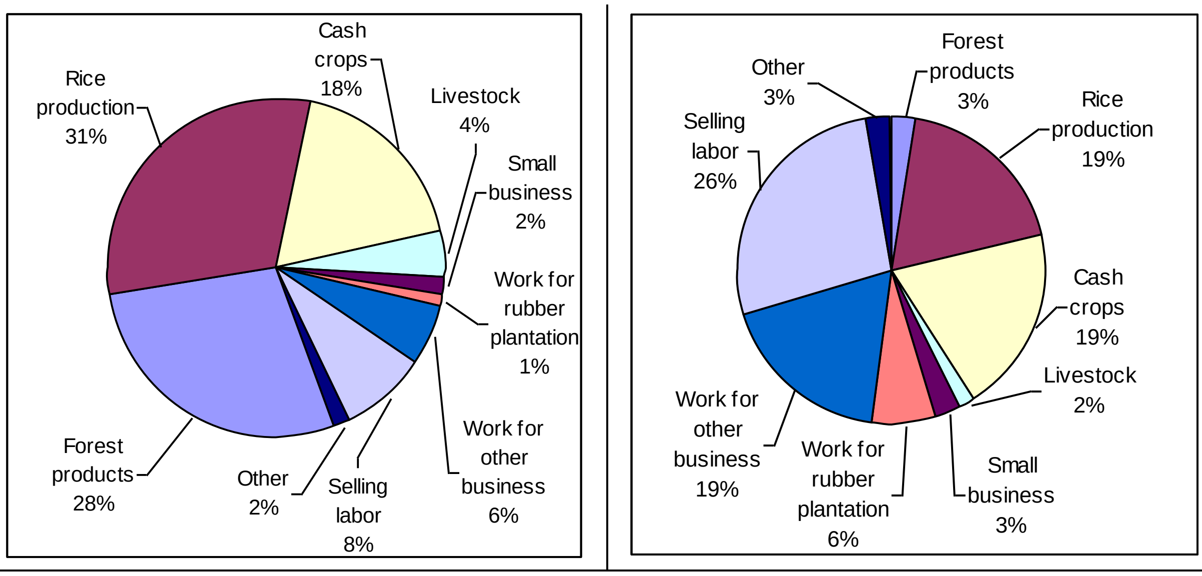

Figure 5-1: Source of incomes before (left) and after (right) RP establishment

After the establishment of rubber plantations, people's livelihoods in the area have changed rapidly. As the forest area has been converted into rubber plantations only 3% of respondents relied on forest products as the main source of income compared to 28% before the conversion scheme. Only 19% relied on rice production, as part of their farmland was expropriated. Some of them did not receive the 3 ha of land distribution under the conversion scheme. (See Figure 5-1.)

According to NGO Forum (2005), the average rice yield after the establishment of rubber plantation dropped from 864 kg/ha to 696 kg/ha. Moreover, the Chup Rubber Company did not allow farmers to grow any other crops and stopped all activities on their own land until the lands were converted to rubber plantations. Some affected farmers started to sell their livestock as result of a USD 75 penalty imposed by the Chup Rubber Company if their cattle entered the rubber farms, as occurred in Rantas village. Table 5-1 shows that 77% of the surveyed people stated that their income was not enough for living after the establishment of the rubber plantation. Again, this finding corroborates the result of the study conducted by NGO Forum in 2005.

Table 5-1: Status of family income after the establishment of rubber plantation

Number of households with lack of income	50	77%
Number of household with enough income	15	23%
Total sample responded	65	100%

Many of respondents claimed that most benefits from rubber plantation went to the Tumring Rubber Company. The Company claimed that benefits from the rubber plantation accrued to laborers, local administration, government tax, and the national economy. The Company emphasized that since the introduction of the rubber plantation, social security and traffic safety have been improved in the communes. School and health care centre facilities are financially supported by the Company.

5.3 People's perception of land conversion

The survey conducted in 2007 showed that 66% of respondents were not satisfied with rubber plantation establishment, while only 22% supported the rubber activities. It is interesting to note the fairly high score for no opinion. (See Figure 5-2.)

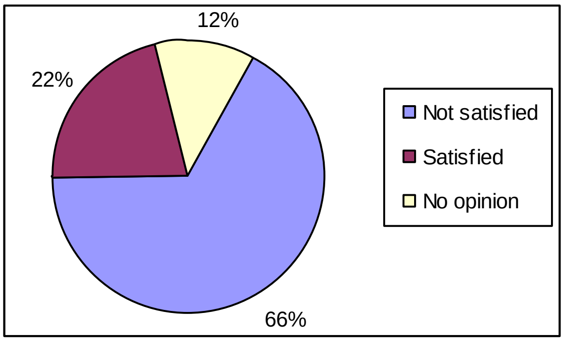

Figure 5-2: Respondent satisfaction of rubber plantation activity

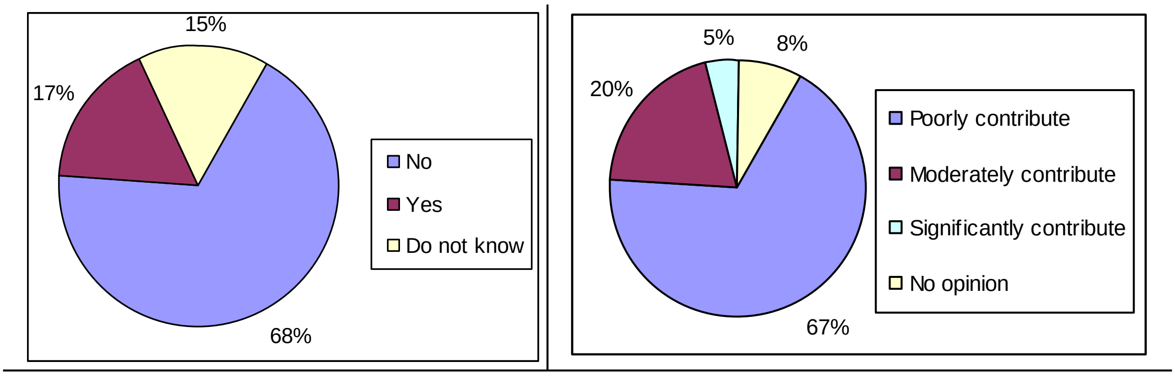

Figure 5-3: Role of plantation owner in livelihood improvement (left) and its contribution to poverty alleviation (right)

Figure 5-3 left above shows that majority of respondents (68%) stated that the owners of plantation did not play any role in improving local livelihood against only 17% of respondents who said that their livelihood had been improved by the establishment of rubber plantations. They did not have a direct connection to the rubber plantation but they observed that since the introduction of rubber plantation, new houses were erected in the areas. Figure 5-3 right show that only 5% of respondents stated that rubber plantations contribute significantly to poverty alleviation in the area while the large majority of respondents (67%) stated that the plantation contributes poorly to poverty reduction.

Figure 5-4 left below shows respondents' perception of the establishment of the rubber plantation in their communes. The most frequently expressed kind of negative impact is lost of agricultural land followed by depletion of the forest resource. Degradation of livelihood associated with lost income ranks third as a negative impact, followed by the economic migration in and out of the Tumring commune.

Figure 5-4 right below shows that respondents rank first the decrease in malaria infection as the major benefit of the establishment of rubber plantation followed by the employment opportunity, intercropping practice benefit and livelihood improvement.

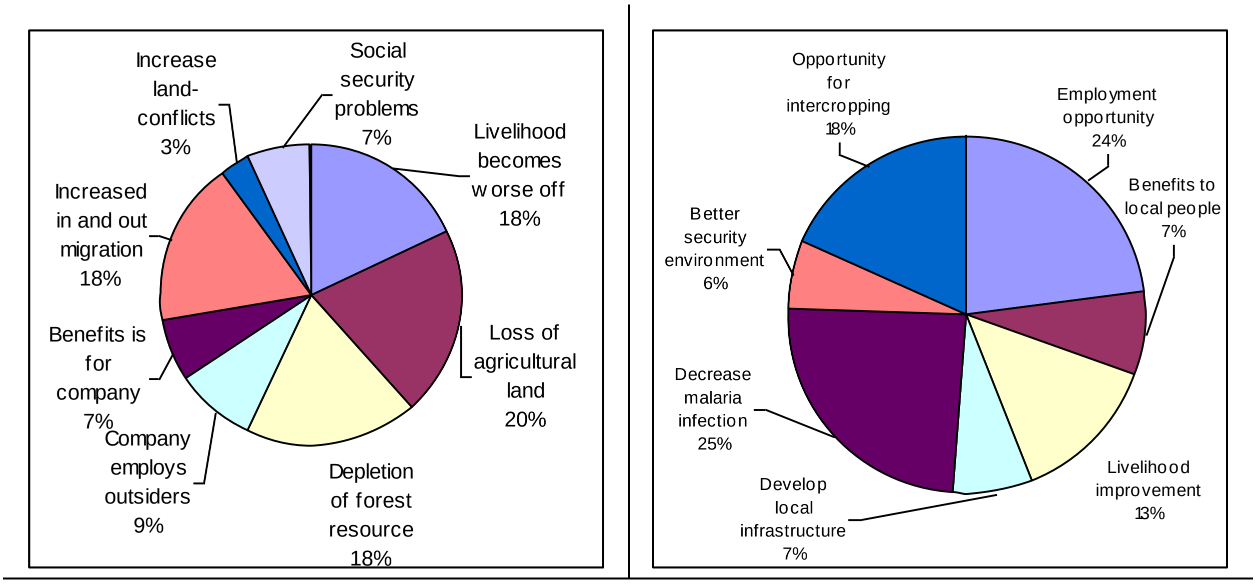

Figure 5-4: People's perception of negative (left) & positive (right) of RP establishment

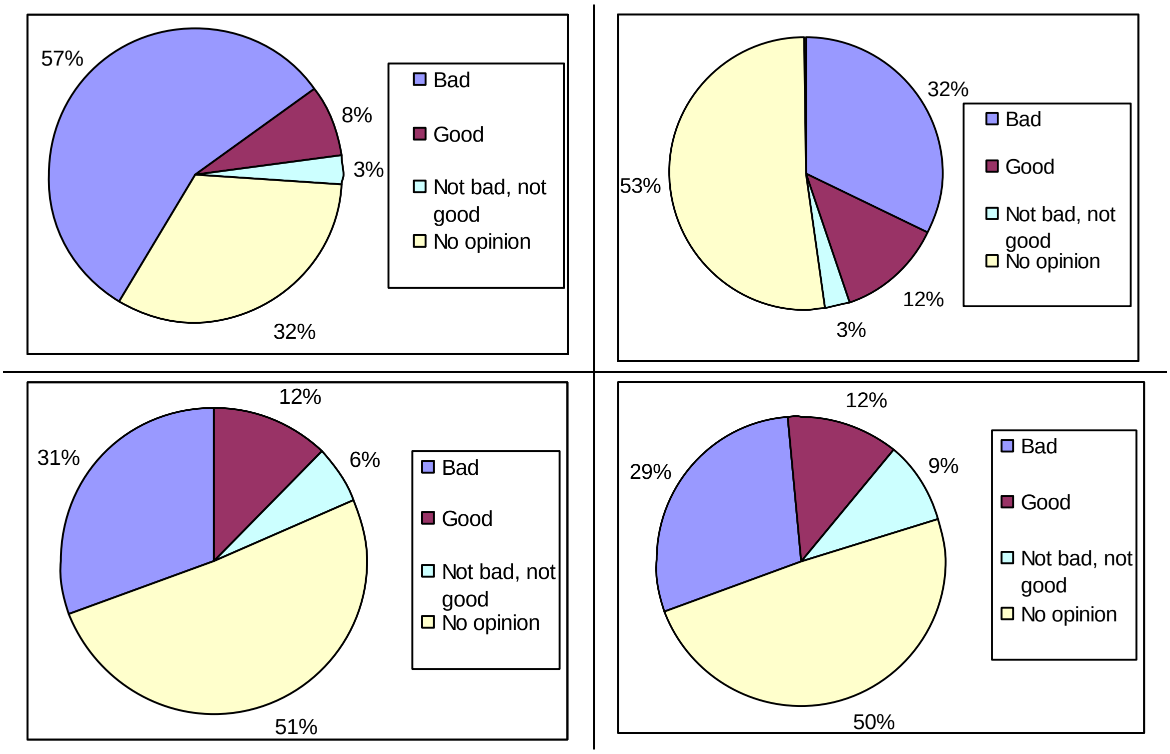

Figure 5-5: Respondent's perception of conversion of evergreen forest (top left) and mixed forest (top right), deciduous forest (bottom left) and re-growth forest (bottom right) into rubber plantation

As Tumring commune is one of the most pristine forest areas, people in the area are happily with their traditional living style. They have depended and currently depend on forest resources collection and cultivation of rice and other crops. Most people in the area generate incomes only for subsistence. People knew that the rubber development project could change their livelihood and lifestyle. The were to receive 3 ha of red soil land in compensation for the establishment of Tumring rubber plantation. In the deal, the Chup Company had to train them to develop a family-scale rubber plantation. Some families did not receive any compensation and lost their agricultural lands.

Without a proper supporting program in a land conversion scheme, loss of agricultural land and lower income source for daily need, many households have insufficient ability and capital to develop rubber plantations that will generate income only in 6 years after planting. Those people had been looking for short-term benefits from year to year. Their income was generated from annual crops that they could plant during the first 3 years of establishment of the rubber plantation. Most households were reluctant to convert their cropland into rubber plantation, quoting the uncertainty of future income from rubber plantations, lack of experience and technique in this practice. Therefore most households in Tumring opposed the forest conversion scheme.

The 2007 survey showed that 57% of respondents believed that the conversion of evergreen forest area into rubber plantation is bad idea (Figure 5-5 top left). This figure falls to less than 32% for the conversion of other types of forest into rubber plantation (Figure 5-5 top and bottom right). The chart reveals that respondents are reluctant to change their livelihood. Evergreen forest provides more benefits for them including construction materials, vegetable, fruits, and meat to local people. Evergreen forest supports a rich biological diversity of both fauna and flora species.

Figure 5-6 below shows that the conversion of orchard crops production into rubber plantations is considered a good idea by 18% to 26% of all respondents. Regardless, the respondents that have no opinion comprise up to 53% of the total. The high score for a good perception of the crop conversion scheme relates to the possibility of intercropping in the rubber plantation, with similar yields to those achieved before the establishment of the rubber plantation.

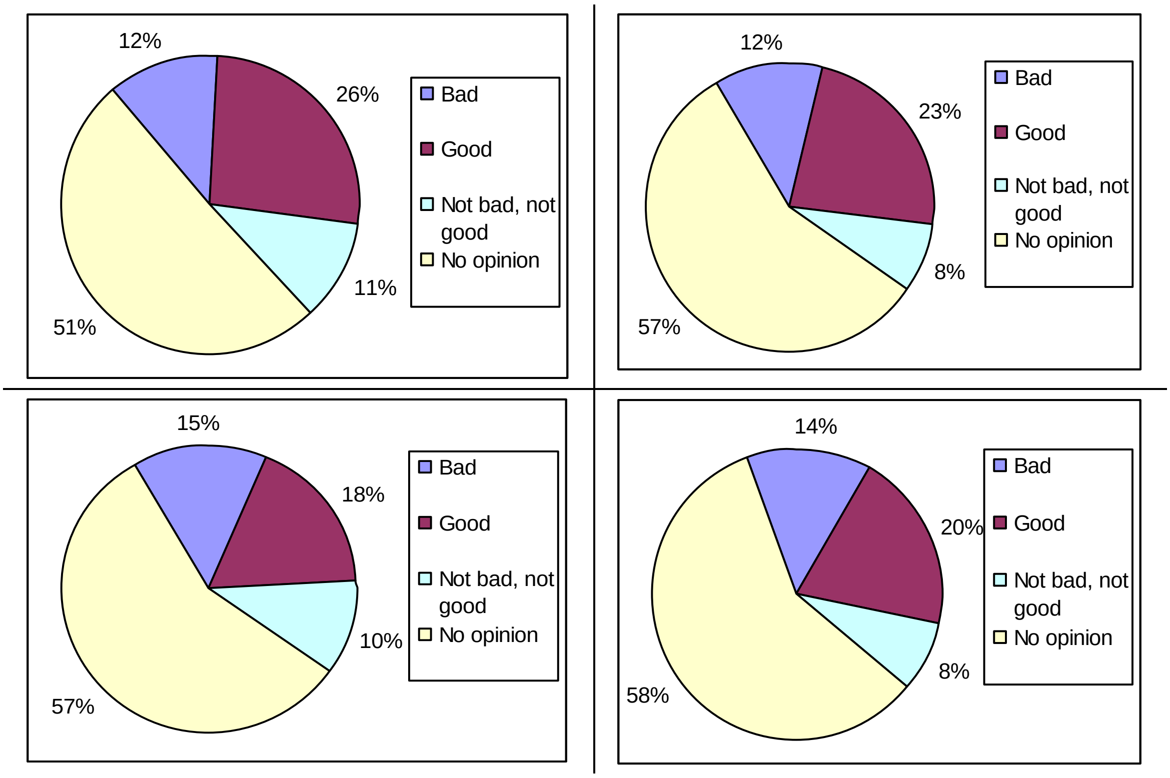

Figure 5-6: Respondent's perception of conversion of soybean (top left), cassava (top right), maize (bottom left) and cashew (bottom right) into rubber plantation

5.4 Discussion

The development of the rubber plantation in Tumring commune caused many problems to local population, as assessment of the social aspects of the conversion scheme was not properly carried out. The valuable forests in the area were cleared without seriously considering the people who traditionally depend mainly on forest products. Some people lost their orchard cropland without adequate compensation (from USD 12 to USD 75 per ha of land compared to the official compensation rate of USD 125 per ha). The promise of a 3 ha land distribution scheme also failed to be met, for all affected people. Up to 30 families lost their orchard lands.

After the establishment of rubber plantation in Tumring commune, people's livelihoods have changed rapidly. People lost the main source of their income as they were not able to collect the timber and NTFPs as they had done in the past. Crops lands were lost and rice yield in the area decreased after the establishment of the rubber plantation. The restrictions not only limited people's movement, but livestock belonging to the local population was banned from grassland located within the plantation area, with the imposition of a large penalty. About 77% of respondents stated that they lacked sufficient income to support their family after establishment of the rubber plantation. Social infrastructure was, however, established by the rubber company, especially roads, school and hospital.

Because forest was the source of potential income, people in Tumring did not want the company to clear forest for the purpose of establishing rubber plantations. People recognized that forests, especially evergreen forests, are the most valuable natural resources that should be under conservation practices. People stated that rubber could not compare with natural forest both as a source of income and for the environment. They stated that rubber plantations should be developed in other areas with no valuable forest and not in Tumring commune.

In Tumring commune, people's livelihoods were worse off than before the time of the rubber plantation because the forest resources were damaged by the rubber plantation company. People in Tumring commune, moreover, stated that rubber could generate a higher income only to the plantation owner and some people who have enough ability to plant it. So most of people in the area who mainly depend on forest products would be made worse off after forest was cleared. Meanwhile, people in Tumring commune recognized that rubber really produced much more benefits than other crops including cashew, cassava, soybean, etc. They stated that if they had stable livelihoods they would want to convert their croplands to develop rubber, expecting to get better economically after rubber trees reached the maturity for tapping. People knew that rubber needs 5-6 years to reach tapping maturity, but farmers also needed to practice intercropping in the plantation within the first to third year in the initial stage of rubber plantation establishment. Farmers would then need to wait only 2 or 3 years to collect a yield from their plantations. People stated that rubber could help the plantation owners become better off as soon as tapping started.

Rubber plantations could generate higher benefits than forests on economic grounds. But this may not take environmental services and biodiversity richness into consideration. From the environmental and sustainable forest management viewpoint, forests could generate more and better benefits, last longer than rubber, and create additional incomes from recreation and eco-tourism. Some parts of evergreen forests and other types of forests should be preserved while introducing rubber plantations into the area. Having done, so, a balance of economic development, socio-cultural, and biodiversity conservation could be reached. The high score for "no opinion" by respondents regarding the relative advantages and inconvenience of converting forest and orchard crops into rubber plantation may simply reflect the limited knowledge of respondents about rubber plantation management and benefits.

6.0 ECONOMIC ANALYSIS OF CROP CONVERSION SCHEMES

6.1 Forest conservation

In terms of human wellbeing, forests fulfill various functions, including production (economic), protective (the ability to protect other components of the environment, particularly soil), and spatial. Nevertheless, laws and regulations in Cambodia define functions of forests as productive, protective, and preservative for cultural purposes. The productive forests are classified as forest concession, non-forest concession, forest rehabilitation, forest plantation, regeneration forest, and community forestry (Article 10). The protective forests include reserve forest for special ecosystems, water resources regulation, watershed protection, recreation, and botanical purposes. The preservative forests include cultural and minority religious.

Although forest plays many other roles, three main components of forest are discussed in terms of economic value in the present context: timber, non-timber forest products, and biodiversity. Forest resources provide use and non-use values as shown in Figure 6-1 below.

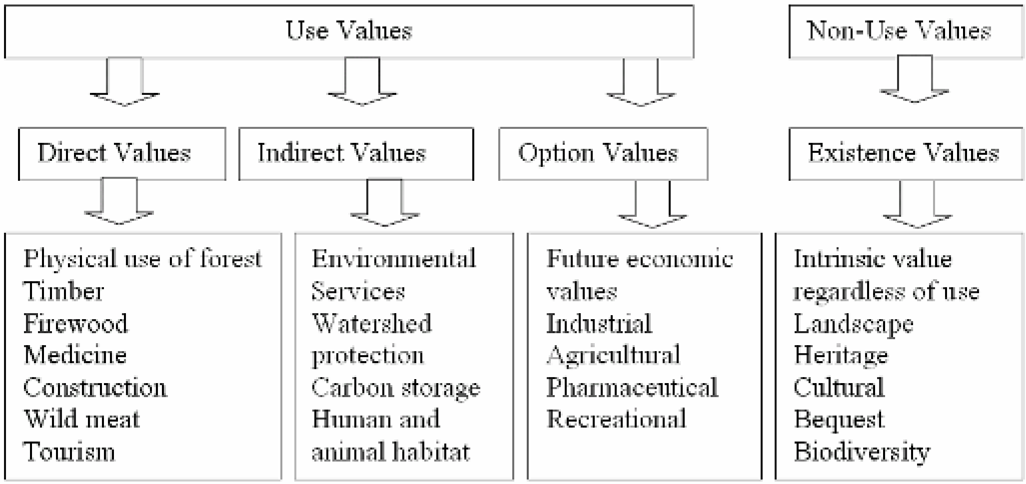

Figure 6-1: Total economic value of natural forest

A recent study on degraded and re-growth dry dipterocarp forest in Kampong Chhnang province (Lic and Shima, 2005) shows that timber could be extracted at a rate of at least 2.39 m^3 per hectare annually if proper silviculture were practiced.

Non-timber forest products (NTFP) are defined as all biological materials/products other than timber that are extracted from forests for human use. The NTFPs include: foods, medicine, spices, essential oils, resin, gums, latexes, tannins, dyes, ornamental plants, wildlife (products and live animals), fuel wood and raw materials, notably rattan, bamboo, small wood and fibers.

Hansen and Top (2006) provide very detailed calculations of NTFP benefits to rural Cambodian people. Their study found that at different provincial villages local poor households gain between USD 167 and USD 424 per household per year from NTFPs; and within all dependent family-livelihoods 30 - 42% of their incomes come from forests annually. Cheap (2007) emphasized that NTFPs play a significant role as regards fuelwood energy. Approximately 70% of national energy consumed is fuelwood and around 7 million m^3 fuelwood is estimated to be collected annually, half of that from forest areas.

While timber and non-timber forest products are important to human lives, biodiversity is another component of forests that is vitally important indirectly to humans and the environment. More importantly, forests provide fundamental watershed protection or significant biodiversity and/or recreational values that should be protected (Hansen and Top, 2006). Conversion of natural forests must affect the full range of biodiversity, species and ecosystems.

McKenney *et al.*, (2004) studied livelihoods and management of high value forest in three provinces of Cambodia, one of those study sites being Kampong Thom. Ethnic minorities account for a high proportion in the high value forest area of Cambodia. Khmer ethnic groups are dominant in Kampong Thom province. Agricultural production and forest products collection are the main source of income followed by livestock raising, fishing and wage labor.

Cambodian people, especially rural, have a long history of using forest and non-forest timber products for their shelters. Different species of rattan are used for making baskets, mats, furniture, cordage, house-building material, thatch, hunting and fishing utensils and traps. Bamboo is another example of shelter material derived from forests.

Many Cambodian people use bamboo for house construction materials, fences, and a great variety of agricultural equipment and implements. Nowadays, although plastic and metal construction materials are increasingly easy to find, rural people, especially ethnic groups, still very much depend on bamboo, rattan and leaves derived from non-timber forest products for their shelters.

One of the most important roles of non-use values of forest is watershed protection and regulation. Forests reduce the speed of water runoff after rains and may retain some amount of rainwater in catchments for use by vegetation at a later stage. Although there has not yet been a study of watershed protection roles of forest in Cambodia, it may be useful to take results of studies in similar cases from neighboring countries into account. A study by Thé (2001) on soil erosion caused by various crop plantations in Central Vietnam showed that fruit tree based agro-forestry systems are the least erosive and most financially profitable. On the other hand, the on-site cost of soil erosion under upland rice-based and eucalyptus-based systems are USD 62 and USD 61 per ha per year, respectively.

The role of forest in carbon sequestration is of increasing concern among environmentalists around the world. There are many different arguments among forest experts regarding the roles of forest in carbon sequestration. Some argue that plantations of forest and rubber are economically viable whereas others support the role of natural forest of all types. Hansen and Top (2006) applied a Value Flow Model to estimate the quantity of carbon off-take from the atmosphere, and found that forests, of all types, significantly sequestered carbon obtained from the atmosphere.

Under forest conservation land use, it is assumed that no changes are made to the current forest cover. Logging is banned, and the local population is freely allowed to collect NTFPs. The major category of net benefits comprises net returns associated with environmental benefits, especially biodiversity conservation and carbon sequestration. No attempt was made in the present study to estimate directly in monetary terms the value of people’s livelihood, conservation, timber product collection, wildlife trade and other crop production, under this land use. Instead, the values were taken from existing studies. The present value of net economic benefits of forest conservation were estimated over a time period of 25 years, at a 10% discount rate.

6.1.1 Benefits of forest conservation

The benefits of forest conservation is divided into two categories:

- Direct revenue from NTFPs: the study did not assess this benefit. Instead, the value of NTFPs of USD 375 per ha per year was extracted from Hansen and Top (2006).
- Environmental benefits: the study did not assess this benefit. These values were extracted from previous studies especially: (1) Hansen and Top (2006) value of water conservation of USD 70 per ha per year; value of soil conservation of USD 60 per ha per year; value of carbon sequestration of USD 759 per ha per year with an increment of 2% per year; and (2) Bann (1997) values of biodiversity conservation of USD 300/ha and per year.

Table 6-1: Estimation of benefits accruing from the forest conservation

Year	PV	Yr1	Yr2	Yr3	Yr4	Yr5	…	Yr24	Yr25
Value of NTFPs products	3,404	375	375	375	375	375	…	375	375
Value of timber products	0	0	0	0	0	0	…	0	0
Value of water conservation	635	70	70	70	70	70	…	70	70
Value of soil conservation	545	60	60	60	60	60	…	60	60
Value of biodiversity *	2,723	300	300	300	300	300	…	300	300
Carbon sequestration value	8,379	759	781	803	825	847	…	1,265	1,287
Total Benefits	15,686	1,564	1,586	1,608	1,630	1,652	…	2,070	2,092

Notes: All values are in USD per ha. Source Hansen and Top, 2006 except (*): Bann, 1997.

6.1.2 Costs of forest conservation

The cost of forest conservation was divided into the following items:

- Cost of protection and silviculture: the study did not assess this cost. The value of forest area protection and silviculture was extracted from a previous study of USD 25 per ha and per year (Hansen and Top, 2006).
- Capital investment for NTFPs collection: the study did not assess this cost. It was extracted from an existing report (CBNRM-LI, 2008). These costs involve the purchasing of materials used for timber and non-timber collection especially ox, oxcart, knife, axe, line, shoe cloth and mosquito net. The costs would be incurred only once, in year one. It was assumed that the ox and oxcart would last for the whole project period of 25 years. The knife, axe, line, shoe cloth and mosquito net would be replaced every two years. The costs of timber and non-timber product collection are included in the costs of purchasing food as well as the cost to cover medical expenses to treat illness incurring the stay in the forest for NTFP collection.

Table 6-2: Estimation of costs incurred in the forest conservation

Year	PV	Yr1	Yr2	Yr3	Yr4	Yr5	…	Yr23	Yr24	Yr25
Protection and silviculture (1)	227	25	25	25	25	25	…	25	25	25
Cost of NTFPs collection (2)	702	460	30	40	30	40	…	40	30	40
Total Costs	929	485	55	65	55	65	…	65	55	65

Notes: All values are in USD per ha. Source (1): Hansen and Top, 2006, (2): CBNRM-LI, 2008.

6.2 Large-scale rubber plantation

The result of the field survey in 2007 did not provide reliable data for estimating the costs and benefits accruing in the large-scale rubber plantation scheme. The study makes use of existing data for estimating the costs and benefits (Hansen and Top, 2006). In the large-scale rubber plantation scheme, it is assumed that the current forest cover area will be cleared and transformed into large-scale rubber plantations. The benefit accrues only in the sixth year after planting the rubber tree. The present value of net economic benefits in the rubber plantation is calculated using a time period of 25 years and a 10% discount rate. There has been no attempt to estimate the economic value of the change in people's livelihood, timber products when cut, wildlife trade, environmental damages and all indirect benefits that could accrue especially social infrastructure (road, school, hospital), or credits from the Clean Development Mechanism.

6.2.1 Benefits of large-scale rubber plantation

The benefits accruing from large-scale rubber plantations are generated from selling dried rubber products, its by-products, old rubber trees at 25th year and the indirect value of carbon sequestration. (see Table 6-3.) There is also the possibility of obtaining revenue from renting the lands for intercrop production during the first 3 years, but the study does not take into account this benefit, as it is problematic. Some large-scale rubber plantation owners encourage their workers to undertake orchard crop production on the land available without charge, as a bonus for them.

The price of dried rubber products at international market (SMR-L) varies monthly and represents USD 3,290 a ton on June 2008. The study takes into account the average rate in 2007 of USD 2,331 a ton for the economic calculations. In line with the results of the field survey conducted in 2007, the study assumes that the price of dried rubber products at farm gate is equal to 85% of the rate in the international market, equivalent to USD 1,982 a ton. Dried rubber production varies from 0.72 ton per ha in the 6th year to a peak of 1.80 ton per ha in the 16th year and drops to 0.79 ton per ha in the 25th year. The rubber by-products represent 0.2% of total dried rubber. The revenue from selling the old rubber tree is estimated at USD 3,300 per ha.

Table 6-3: Estimation of benefits accruing from the large-scale rubber plantation

Year	PV	Yr1	…	Yr6	Yr7	Yr8	…	Yr23	Yr24	Yr25
Value of dried rubber	11,686	0	…	0	396	991	…	3,964	3,964	3,964
Value of rubber by-product	23	0	…	0	1	2	…	8	8	8
Value of rubber tree	923	0	…	0	0	0	…	0	0	10,000
Carbon sequestration value	7,153	0	…	659	766	872	…	2,472	2,579	2,685
Total Benefits	19,785	0	…	659	1,163	1,865	…	6,443	6,550	16,657

Notes: PV: Present value. All values are in USD per ha. Source: Hansen and Top, 2006.

6.2.2 Costs of large-scale rubber plantation

Table 6-4 below shows detailed costs incurred in large-scale rubber plantation schemes. Those costs are divided into six components comprising: (1) maintenance of rubber trees, (2) tapping and harvesting, (3) material and equipment, (4) manufacturing and coagulating, (5) taxes and (6) overhead expenses. The average annual total cost for rubber plantations is USD 628 per ha with minimum cost of USD 226 per ha in the second year and maximum of USD 809 per ha at the 11th year.

Table 6-4: Costs description incurred in the large-scale rubber plantation

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Maintenance of rubber trees																									
Land clearing	74	7	4	4	3	4	2	3	4	5	5	9	5	6	6	6	7	4	5	5	9	5	6	6	6
Planting	103	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maintenance	107	105	107	61	55	55	41	51	46	50	47	43	46	43	45	45	44	46	50	47	43	46	43	45	45
Fertilizing	63	63	101	133	172	210	0	0	0	0	0	0	2	1	1	1	1	0	0	0	0	2	1	1	1
Maladies treatment	0	0	0	11	11	17	10	22	20	12	10	14	15	15	14	14	14	20	12	10	14	15	15	14	14
Subtotal	**347**	**185**	**211**	**208**	**242**	**285**	**53**	**76**	**70**	**67**	**62**	**66**	**67**	**65**	**67**	**66**	**66**	**70**	**67**	**62**	**66**	**67**	**65**	**67**	**66**
Tapping and Harvesting																									
Tapping wages	0	0	0	0	0	0	83	85	87	114	113	115	114	112	113	112	114	87	114	113	115	114	112	113	112
Tapping bonus	0	0	0	0	0	0	96	98	83	77	80	69	66	65	66	63	62	83	77	80	69	66	65	66	63
Chemical using	0	0	0	0	0	0	33	33	44	47	49	54	54	50	48	48	46	44	47	49	54	54	50	48	48
Transport of latex	0	0	0	0	0	0	15	16	19	21	24	24	25	26	27	25	26	19	21	24	24	25	26	27	25
Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**226**	**231**	**233**	**260**	**266**	**261**	**258**	**254**	**254**	**249**	**248**	**233**	**260**	**266**	**261**	**258**	**254**	**254**	**249**
Material/Equipments																									
Material for tappers	0	0	0	0	0	0	7	7	7	4	4	4	4	4	4	4	4	7	4	4	4	4	4	4	4
Material for rubber trees	0	0	0	0	0	0	13	13	15	18	16	15	15	14	15	18	18	15	18	16	15	15	14	15	18
Tanks/harvested equipments	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	1	1	0	1	0	0	0
Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**21**	**20**	**22**	**23**	**21**	**19**	**19**	**19**	**20**	**22**	**22**	**22**	**23**	**21**	**19**	**19**	**19**	**20**	**22**
Manufacturing/Coagulating																									
Wages expenses	0	0	0	0	0	0	9	8	6	5	3	9	8	8	6	7	7	6	5	3	9	8	8	6	7
Bonus expenses	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oil expenses	5	5	5	5	4	6	14	15	15	17	17	19	16	16	17	16	15	15	17	17	19	16	16	17	16
Maintenance of machineries	5	5	6	5	5	5	6	6	5	5	7	10	9	8	8	8	8	5	5	7	10	9	8	8	8
Electricities/Water	11	11	11	11	12	12	12	28	35	46	48	64	63	64	63	64	63	35	46	48	64	63	64	63	64
Chemical using expenses	0	0	2	3	7	12	14	13	13	14	14	7	8	9	9	9	9	13	14	14	7	8	9	9	9
Wrapping expenses	0	0	0	0	0	0	40	42	39	42	35	36	35	35	35	35	35	39	42	35	36	35	35	35	35
Transport expenses	0	0	0	0	0	0	1	1	2	2	2	2	3	3	3	4	4	2	2	2	2	3	3	3	4
Warehousing expenses	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal	**21**	**21**	**24**	**25**	**27**	**34**	**95**	**114**	**116**	**131**	**126**	**148**	**143**	**143**	**143**	**143**	**141**	**116**	**131**	**126**	**148**	**143**	**143**	**143**	**143**
Taxes																									
Export taxes	0	0	0	0	0	0	18	27	27	12	86	143	135	138	140	142	143	27	12	86	143	135	138	140	142
Export fees	0	0	0	0	0	0	17	20	13	14	27	19	17	18	17	16	17	13	14	27	19	17	18	17	16
Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**35**	**47**	**41**	**26**	**113**	**162**	**153**	**157**	**158**	**158**	**161**	**41**	**26**	**113**	**162**	**153**	**157**	**158**	**158**
Overhead Expenses	36	20	22	22	25	30	22	160	168	154	151	154	149	149	151	148	147	168	154	151	154	149	149	151	148
Total costs	**404**	**226**	**258**	**255**	**294**	**349**	**452**	**649**	**650**	**660**	**739**	**809**	**789**	**787**	**792**	**786**	**785**	**650**	**660**	**739**	**809**	**789**	**787**	**792**	**786**

Notes: All values are in USD per ha of rubber plantation. (1) Land clearing, route, bridging, stream, Setting up poles, digging holes, planting. Source: (Hansen and Top, 2006)

6.3 Smallholder rubber plantation

The field survey in 2007 did not provide reliable data for estimating the costs and benefits accruing in the smallholder rubber plantation. Thus, this study makes use of existing data available for estimating the costs and benefits (EIC, 2006). The benefits accrue only in the sixth year after planting the rubber tree. The present value of net economic benefits is calculated for a time period of 25 years and a 10% discount rate. No attempt was made to estimate the economic value of the change in people's livelihood, environmental damages, carbon sequestration and the opportunity of a clean development mechanism (CDM) component of the project.

6.3.1 Benefits of smallholder rubber plantation

The benefits accruing in the smallholder rubber plantation scheme are generated from selling (1) coagulum latex with the price of USD 0.63 per kg where coagulum latex production varies from 1,400 kg per ha in 6th year to the peak of 3,600 kg per ha in 25th year; (2) old rubber trees estimated at USD 3,300 per ha; and (3) intercropping of soybean and mung bean (twice a year) of USD 250 per ha per year. This last benefit accrues only in the first three years of planting the rubber trees.

Table 6-5: Estimation of benefits accruing from the smallholder rubber plantation

Year	PV	Yr1	…	Yr6	Yr7	Yr8	…	Yr23	Yr24	Yr25
Value of coagulum latex	9,462	0	…	875	1,250	1,625	…	2,250	2,250	2,250
Value of intercropping	622	250	…	0	0	0	…	0	0	0
Value of rubber tree	305	0	…	0	0	0	…	0	0	3,300
Total Benefits	10,388	250	…	875	1,250	1,625	…	2,250	2,250	5,550

Notes: PV: Present value. All values are in USD per ha. Source: EIC, 2006.

6.3.2 Costs of smallholder rubber plantation

For the smallholder rubber plantation, the required investment to transform coagulum latex into dried rubber is high. Thus, the farmer prefers to sell the coagulum latex to an intermediary at the farm gate. Table 6-6 below shows detailed costs incurred in smallholder rubber plantations. Those costs are divided into labor and other input components. Labor for planting includes land preparation, sticking, digging hole and gardening. Labor for maintenance includes weeding, fertilizer application, plant replacement, suckering and treatments. The input components include purchase of rubber tree, fertilizer, chemical products and harvesting materials.

Table 6-6: Costs description incurred in the smallholder rubber plantation

	PV	Yr1	Yr2	Yr3	…	Yr6	Yr7	Yr8	…	Yr23	Yr24	Yr25
Labor for planting	217	226	14	0	…	0	0	0	…	0	0	0
Labor for maintenance	580	113	181	130	…	32	32	32	…	0	0	0
Labor for harvesting	1,269	0	0	0	…	240	240	240	…	240	240	240
Rubber tree	307	293	49	0	…	0	0	0	…	0	0	0
Fertilizer	244	40	40	60	…	0	0	0	…	0	0	0
Chemical	73	23	23	18	…	5	5	5	…	0	0	0
Harvesting materials	37	0	0	0	…	66	0	0	…	0	0	0
Total Costs	2,727	695	307	208	…	343	277	277	…	240	240	240

Notes: PV: Present value. All values are in USD per ha. Source: EIC, 2006.

6.4 Cassava production

World production of cassava root was estimated to be 184 million tones in 2002. The majority of production is in Africa (99 million tons), Asia (52 million tons) in Asia and Latin America and the Caribbean (33 million tons). Cassava is used as animal feed extensively in Asia, South America, Africa, and Europe. Cassava is typically grown by small-scale farmers using traditional methods, and farming on marginal lands not well suited to other crops.

Cassava production growth has been strong at 39 percent over the period 1995-2004, helped by the increasing demand for the starch industry. Increases in production in 1998-99 and 2002-03 have greatly influenced the long term trends in the industry. Even though yield growth has been strong, averaging 23 percent, average yields are still low at 13-16 t/ha for wet and dry season production. Most of the cassava production is carried out in Kampong Cham, with lesser amounts in Kampong Speu, Kampong Thom and Battambang (ACI, 2005).

The field survey in 2007 did not estimate the costs and benefits of cassava production. The study makes use of existing data in the 2005 survey conducted by ACI (2005). No attempt was made to estimate the value of environmental damages or social welfare gain of cassava production.

6.4.1 Benefits of cassava production

The benefits of cassava production are generated from selling cassava roots for the average price of USD 20 a ton. For economic analysis, the study assumes cassava production with an average yield of 12.06 ton/ha (ACI, 2005). Thus, the gross benefit of one-hectare cassava farm is constant over the year and represents USD 254 per year.

6.4.2 Costs of cassava production

The costs are divided into (1) hiring tractor or bullock for land preparation; (2) labor costs covering land preparation, seeding, weeding, harvesting; (3) input components including purchase of seed and (4) transport costs. The costs are considered constant over time and represent USD 98 per ha per year.

6.5 Soybean production

In Cambodia, the growth in soybean production has been significant over the period 1995-2004, averaging 33%. Growth has been sustained, despite several periods of contraction over this period, while in recent years from 2000-2004 it averaged 46%.

Most of the growth in production has been due to increases in area planted (an average of 23% growth over 1995-2004), while growth in yields has averaged only 8%. In 2004, production increased to over 110,000 tons.

In the wet season the major production areas of soybean (greater than 1,000 ha) are Kampong Cham (28,837 ha), Battambang (12,375 ha), Banteay Meanchey (2,700 ha), Pailin (2,660 ha), Kampong Thom (2,531 ha) and Rattanakiri (1,341 ha). Very little dry season production of soybean is carried out, with only Kampong Thom and Kandal provinces growing 105 and 227 ha respectively. The market for soybean production in Cambodia is Vietnam (ACI, 2005).

The field survey in 2007 did not estimate the costs and benefits of soybean production. The study makes use of existing data from the 2005 survey conducted by ACI (2005) and SNEC (2007). There is no attempt to estimate the environmental damages or social welfare gain of the soybean production.

6.5.1 Benefits of soybean production

The benefits of the soybean production are generated from selling soybeans for the average price of USD 327 a ton. The study assumes wet season soybean production with an average yield of 1.217 ton/ha (ACI, 2005). Thus, the gross benefit of a one-hectare soybean farm is considered to be constant over year and represents USD 397 per year.

6.5.2 Costs of soybean production

The costs are divided into (1) labor costs covering plowing, seeding, weeding, harvesting, graining; (2) input components including purchase of seed and (3) transport costs. The costs are considered to be constant over time and represent USD 311 per ha and per year.

6.6 Maize production

Maize production grew strongly at 28 percent on average during 1995-2004, but has been slowing down from 32 percent over 1995-2000 to just under 23 percent over 2000-2004. Yield is the main factor driving growth, with increases in cultivated area averaging only 7.3 percent over 1995-2004 compared with yield, which grew at an average of 16.7 percent over the same period. Nationally, yields are averaging 3.9 t/ha in the wet season and only 1.8 t/ha in the dry season. This varies significantly between a high of 5.5 t/ha for wet season maize in Battambang to a low of 0.6 t/ha for dry season maize in Otdor Meanchey (ACI, 2005).

The field survey in 2007 did not directly estimate costs and benefits of maize production but made use of existing data from the 2005 survey conducted by ACI (2005) and SNEC (2007). No attempt was made to estimate the environmental damages or social welfare gain of the maize production.

6.6.1 Benefits of maize production

The benefits of the maize production are generated from selling maize at the average price of USD 141 a ton. The study assumed maize production with an average yield of 2.71 ton/ha (ACI, 2005). Thus, the gross benefit of one-hectare maize farm is considered to be constant over a year and representing USD 381 per year.

6.6.2 Costs of maize production

Those costs are divided into (1) labor costs covering plowing, seeding, weeding, harvesting; (2) input components including purchase of seed and (3) transport costs. The costs are considered to be constant over time and represent USD 316 per ha and per year.

6.7 Cashew production

Most cashew planting in Cambodia is done by households with small-size lands and low yield. Total cultivated cashew areas reached only about 16,000 ha in 2000, increasing to more than 60,000 ha in 2005 (EIC, 2006). Raw cashew nuts are mostly grown in Kampong Cham and Rattanakiri provinces. Cultivated areas in both provinces accounted for almost 65 percent of total cashew cultivated areas in 2005. With the current cultivated areas, annual production of raw cashew nuts is estimated to reach between 30,000 tons to 50,000 tons, of which 95 percent are exported informally to Vietnam. This level of production represents roughly 1.3 percent of the world's production (MAFF, 2006). However, it is expected to increase in coming years, due to the expansion of cultivated areas and the increasing demand for cashew nuts in Vietnam.

The field survey in 2007 did not estimate directly the costs and benefits of the cashew production, but made use of existing data from the 2005 survey conducted by Hansen and Top (2006) and EIC (2006). No attempt was made to estimate the environmental damages or social welfare gain for cashew production.

6.7.1 Benefits of cashew production

Cashew produces a crop only in 3rd year after the planting. The benefit accruing from cashew production is generated from selling of raw cashew nut with the price of USD 730 a ton. Cashew nut production varies from 300 kg per ha in 3rd to 5th year to the peak of 1,500 kg per ha from 11th to 15th year; falling to 1,100 kg per ha 17th to 25th year and from 6th to 10th year.

6.7.2 Costs of cashew production

The study divided the cost items into four major components described below. The total costs differ from one year to another.

- Land preparation includes the costs to cover, planting materials, land clearing, digging planting holes and planting. These costs accrue only in year 1 of starting the cassava production.
- Fertilizers include the cost to cover the purchase of chemical fertilize (NPK) and manure. This cost accrues every year.
- Operation & maintenance costs include the costs of fertilizer application and management and infrastructure. These costs accrue every year,
- Harvesting covers the costs to hire labor during harvesting. It accrues only in the fourth year after plantation.

Table 6-7: Cost description incurred in the cashew production

Year	PV	Yr1	Yr2	Yr3	…	Yr6	Yr7	Yr8	…	Yr23	Yr24	Yr25
Land preparation	104	114	0	0	…	0	0	0	…	0	0	0
Fertilizers (NPK-manure)	2,126	425	213	213	…	213	213	213	…	213	213	213
Operation & maintenance	536	95	55	55	…	55	55	55	…	55	55	55
Harvesting	82	0	0	0	…	10	10	10	…	15	15	15
Total Costs	2,848	634	268	268	…	278	278	278	…	283	283	283

Notes: PV: Present value. All values are in USD per ha. Source: Hansen and Top, 2006 and EIC, 2006.

7.0 COST BENEFIT ANALYSIS

Cost-benefit analysis of converting existing land uses to rubber plantations is a decision-support tool aimed at identifying the land use scheme that can generate the highest economic return. The five conversion schemes assessed in the study are the following:

- Option 1: Conversion from forest land to large-scale rubber plantation,
- Option 2: Conversion from cassava production to smallholder rubber plantation,
- Option 3: Conversion from soybean production to smallholder rubber plantation,
- Option 4: Conversion from maize production to smallholder rubber plantation,
- Option 5: Conversion from cashew production to smallholder rubber plantation.

The Base Case Scenario for forest conservation applies to Option 1, while cassava, soybean, maize and cashew production comprise the Base Case Scenarios for Options 2 to 5. Option 1 is a conversion to large-scale rubber plantations and the other options involve a conversion to smallholder plantations.

The study assesses (1) the incremental net benefit of converting from forest conservation to large-scale rubber plantations and (2) the incremental net benefit of converting the four crop production schemes to smallholder rubber plantations.

7.1 Incremental net benefit

In the cost-benefit analysis, net benefits are the difference between total economic benefits and total direct costs in each land use scheme. If the net benefits of rubber plantations have higher values than existing land uses, more benefits will accrue directly to farm owners and the community by converting to rubber than maintaining forestlands or other crop production schemes.

Incremental net benefits are the difference between the net benefits of rubber plantation schemes (large-scale or smallholder) and the net benefits accruing for forestland or the four crop production schemes.

The present values of net benefits and incremental net costs are estimated over a 25-year period with a discount rate of 10%. The higher the incremental net benefits, the more economically desirable is the rubber plantation (large-scale or smallholder) option.

Table 7-1: Present value (PV) of incremental net benefits, ranked by most benefit

	PV of net benefit	PV of Incremental net benefit	BCR	IRR
BASE CASE 1 - Forest conservation	14,757	0	0	0%
BASE CASE 2 - Cassava production	1,416	0	0	0%
BASE CASE 3 - Soybean production	785	0	0	0%
BASE CASE 4 - Maize production	584	0	0	0%
BASE CASE 5 - Cashew production	2,270	0	0	0%
OPTION 4 - Maize to rubber (smallholder)	7,661	7,076	47.9	38%
OPTION 3 - Soybean to rubber (smallholder)	7,661	6,875	72.0	36%
OPTION 2 - Cassava to rubber (smallholder)	7,661	6,244	4.4	32%
OPTION 5 - Cashew to rubber (smallholder)	7,661	5,390	43.7	N/A
OPTION 1 - Forest to rubber (large-scale)	15,690	934	1.3	11%

Table 7-1 above shows that all crop conversion options yield positive values of incremental net benefits, ranging from USD 934 to 7,076 per ha over a 25 year period with a 10% discount rate. The benefit cost ratios (BCRs) range from 1.3 for Option 1 (conversion from forest to large-scale rubber plantation) to the highest BCR of 72 for Option 3 (conversion from soybean production to smallholder rubber plantation).

Option 4 (conversion from maize production to smallholder rubber plantation) is the most preferred on economic efficiency grounds and ranks first compared relative to other crop conversion schemes. The incremental net benefit of Option 4 has a positive value of USD 7,076 per ha of farmland with a BCR of nearly 48.

Option 3 (conversion from soybean to smallholder rubber plantation) is the second most preferred on economic efficiency grounds. It ranks second closely behind Option 4 (maize to rubber) with a high BCR of of 72.

Option 2 (conversion from cassava to smallholder rubber plantation) is the third most preferred on economic efficiency grounds. It ranks third closely behind Option 3 (soybean to rubber). The BCR of Option 3 is quite low at 4.4.

Option 5 (conversion from cashew to smallholder rubber plantation) is the fourth most preferred on economic efficiency grounds. It ranks fourth closely behind Option 2 (cassava to rubber). The BCR of Option 5 is 43.7.

Option 1 (conversion from forest to large-scale rubber plantation) is the least preferred on economic efficiency grounds. It ranks last, far behind other crop conversion schemes. The BCR of Option 1 is very low at 1.3.

The resulst of the cost benefit analysis show clearly that the conversion from crop production (cassava, soybean, maize and cashew) to smallholder rubber plantations provides large benefits to farmers involved in those conversion schemes. This suggests a need for technical assistance relating to rubber plantations and an extensive follow-up program from a competent authority. This conclusion is consistent with the finding of the AFD project on establishment of smallholder rubber plantation in six districts of Kampong Cham province.

7.2 Sensitivity analysis

A sensitivity analysis was also conducted to investigate the effects of varying key assumptions (costs, revenues, project lifetime and discount rate) on the present values of incremental net benefits. This analysis provides a measure of the degree to which these variables can deviate from their estimated values before the preferred options cease to be economically desirable. Four scenarios were tested.

7.2.1 Scenario 1: Change the discount rate from 10% to 15%

For all crops and forest conversion Options, the discount rate was increased from 10% in the Initial Scenario to 15% in the Scenario 1. The project duration was set at 25 years. Table 7-2 below shows that there was no change in the ranking of all crops and forest conversion Options. Option 1 would actually result in a negative incremental net benefit of 1,984.

Table 7-2: Scenario 1: PV of incremental net benefits, ranked by most benefit

	PV of net benefit	PV of Incremental net benefit	BCR	IRR
BASE CASE 1 - Forest conservation	10,191	0	0	0%
BASE CASE 2 - Cassava production	1,009	0	0	0%
BASE CASE 3 - Soybean production	559	0	0	0%
BASE CASE 4 - Maize production	416	0	0	0%
BASE CASE 5 - Cashew production	1,016	0	0	0%
OPTION 4 - Maize to rubber (smallholder)	3,944	3,528	5,821	38%
OPTION 3 - Soybean to rubber (smallholder)	3,944	3,384	96.4	36%
OPTION 2 - Cassava to rubber (smallholder)	3,944	2,935	3.1	32%
OPTION 5 - Cashew to rubber (smallholder)	3,944	2,928	51.1	N/A
OPTION 1 - Forest to rubber (large-scale)	8,207	-1,984	0.1	11%

Note: the values in the NPV column are in USD per ha. N/A: not applicable.

7.2.2 Scenario 2: Reduce project lifetime to 15 years

The effects of reducing the life of the project from 25 to 15 years are shown in Table 7-3. This table shows that again there is no change in the ranking of all crops and forest conversion Options.

Table 7-3: Scenario 2: PV of incremental net benefits, ranked by most benefit

	PV of net benefit	PV of Incremental net benefit	BCR	IRR
BASE CASE 1 - Forest conservation	11,938	0	0	0%
BASE CASE 2 - Cassava production	1,187	0	0	0%
BASE CASE 3 - Soybean production	658	0	0	0%
BASE CASE 4 - Maize production	489	0	0	0%
BASE CASE 5 - Cashew production	1,506	0	0	0%
OPTION 4 - Maize to rubber (smallholder)	5,189	4,700	144.0	38%
OPTION 3 - Soybean to rubber (smallholder)	5,189	4,531	451.3	36%
OPTION 2 - Cassava to rubber (smallholder)	5,189	4,003	3.5	31%
OPTION 5 - Cashew to rubber (smallholder)	5,189	3,683	63.2	N/A
OPTION 1 - Forest to rubber (large-scale)	9,953	-1,985	0.3	6%

Note: the values in the NPV column are in USD per ha. N/A: not applicable.

7.2.3 Scenario 3: Increase the production costs by 20%

When production costs for all crop and forest conversion Options are increased by 20% compared with the Base Case Scenario, and assuming a project life of 25 years and a 10% discount rate, there is no change in the ranking of all crop and forest conversion Options. The results are shown in Table 7-4 below.

Table 7-4: Scenario 3: PV of incremental net benefits, ranked by most benefit

	PV of net benefit	PV of Incremental net benefit	BCR	IRR
BASE CASE 1 - Forest conservation	14,571	0	0	0%
BASE CASE 2 - Cassava production	1,239	0	0	0%
BASE CASE 3 - Soybean production	221	0	0	0%
BASE CASE 4 - Maize production	10	0	0	0%
BASE CASE 5 - Cashew production	1,701	0	0	0%
OPTION 4 - Maize to rubber (smallholder)	7,115	7,105	39,9	37%
OPTION 3 - Soybean to rubber (smallholder)	7,115	6,894	60,0	36%
OPTION 2 - Cassava to rubber (smallholder)	7,115	5,877	3,7	29%
OPTION 5 - Cashew to rubber (smallholder)	7,115	5,414	36,4	N/A
OPTION 1 - Forest to rubber (large-scale)	14,767	196	1,0	10%

Note: the values in the NPV column are in USD per ha. N/A: not applicable.

7.2.4 Scenario 4: Increase the value of crops by 20%

For all crops and forest conversion Options, the value of crops was increased by 20% compared relative to the Base Case Scenario. Again, assuming a project life of 25 years and a 10% discount rate the results, shown in Table 7-5 below, indicate that there is no change in the ranking of all crop and forest conversion Options.

Table 7-5: Scenario 4: PV of incremental net benefits, ranked by most benefit

	PV of net benefit	PV of Incremental net benefit	BCR	IRR
BASE CASE 1 - Forest conservation	15,438	0	0	0%
BASE CASE 2 - Cassava production	1,877	0	0	0%
BASE CASE 3 - Soybean production	1,507	0	0	0%
BASE CASE 4 - Maize production	1,275	0	0	0%
BASE CASE 5 - Cashew production	3,294	0	0	0%
OPTION 4 - Maize to rubber (smallholder)	9,738	8,463	57,4	39%
OPTION 3 - Soybean to rubber (smallholder)	9,738	8,231	86,5	37%
OPTION 2 - Cassava to rubber (smallholder)	9,738	7,861	5,3	35%
OPTION 5 - Cashew to rubber (smallholder)	9,738	6,444	52,4	N/A
OPTION 1 - Forest to rubber (large-scale)	18,321	2,884	1,8	13%

Note: the values in the NPV column are in USD per ha. N/A: not applicable.

8.0 CONCLUSIONS AND POLICY RECOMMENDATIONS

The results of the cost benefit analysis and the sensitivity analyses show that despite variations in the basic assumptions relating to the discount rate, project duration, production costs and value of crops, the ranking of all crops and forest conversion schemes remains unchanged. It clearly reveals that smallholder rubber plantations represent the economically most desirable land use.

The conversion from forestland to large-scale rubber plantation is a sensitive issue. The most of the benefits accruing from forest conservation relate to biodiversity values and environmental services. Some previous reports, especially those financed by environmental organizations, put the forest value and preservation of people's livelihoods at the highest level. In contrast, private companies and the government often assert that the conversion of forestland to large-scale rubber plantations would be an ideal means of achieving poverty alleviation targets. Those benefits would include job creation, and other economic benefit from conversion schemes.

Over the past few years, the government has awarded large areas of forestland to private companies under the economic land concession scheme. Some of those companies intend to undertake large-scale cassava production. Extrapolating the results of this study, the conversion from forestland to large-scale cassava production would not be economically viable in the long term.

There is a significant debate ongoing in Cambodia over forest conversion into agricultural industry practice under the economic land concession scheme. This study reconfirms previous studies, finding that the social component has been ignored and the local population generally becomes worse off after the forest conversion scheme. The study recommends that the social component of forest conversion schemes should be considered a high priority. In order that the economic land concession would yield benefits to the local population, the study suggests that civil society and NGOs should be involved in the land compensation procedure. Follow-up programs and technical assistance should be provided to the affected population.

The results of the study indicate that there are significant potential net benefits from large-scale rubber plantations (with a PV of net benefits of USD 15,690 per ha over a 25 year period with a 10% discount rate) compared to the highest net benefit from other crop production (PVs of USD 2,270 per ha for cashew and USD 1,416 per ha for cassava). Large-scale rubber plantations also generate higher net benefits than conserved forests in economic terms. The PV of forest conservation was estimated at USD 14,757 per ha.

However, the PV of *incremental* net benefits for the conversion from forestlands to large-scale rubber plantation represents the least economically desirable option, with a PV of only USD 934 per ha for the project duration of 25 years, assuming a 10% discount rate. This is lower than even the worst performing crop conversion, for which the minimum PV of incremental net benefit is USD 5,390 per ha. Indeed, if the discount rate is changed from 10% to just 12%, the conversion from forestland to large-scale plantations will not be economically desirable, as the PV of incremental net benefits becomes negative.

Smallholder rubber plantations should be encouraged and promoted in an effort to reduce poverty rates in red soil provinces of Cambodia. Although, the development of smallholder rubber plantation requires huge investment in both financial and technical resources, especially for the first 6 years of its establishment, some mechanisms could help farmers to overcome those difficulties.

This study proposes that various mechanisms should be adopted by the government and project developers to help farmers overcome any difficulties. An appropriate mechanism has been implemented by the AFD project in Kampong Cham province, representing a successful pilot project, and this model should be extended to other red soil provinces in Cambodia.

The study also demonstrates that cost-benefit analysis could be used as a decision support tool by the Department of Environmental Impact Assessment of the Ministry of Environment to evaluate the economic return of investment projects that involve forestland conversion schemes. Those projects are obliged to produce a report on environmental impact assessment of the relevant investments and submit it to the Ministry of Environment for approval.

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