Towards improving profitability of teak in integrated smallholder farming systems in northern Laos

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Foreword

One of the poorest countries in South-East Asia, the Lao People's Democratic Republic (PDR), or Laos, is characterised by low population density, high ethnic diversity, poor infrastructure and geographical dispersion of its people. Agriculture employs over 80% of the population and generates 53% of GDP. Forests are a vital economic resource. In rural areas forests provide the basis for one of the few available economic activities and, in forested areas, non-timber forest products contribute more than half of family incomes.

Occurring naturally in Laos, teak is one of the world's finest timbers. The high sustained demand for teak wood, coupled with significant shortages of supply from natural forests, has stimulated the development of plantations in many tropical countries. There are now over 10,000 hectares of teak around Luang Prabang in northern Laos and, for the farmers who have been involved, the sale of even relatively small logs significantly supplements typically very low annual incomes. Broader adoption of teak planting would confer a higher level of economic robustness to farming communities in this area.

There are two significant impediments to realising the economic potential offered by teak in northern Laos: first, the relatively long wait (at least 15 years) for a financial return; and second, the reluctance of farmers to undertake pre-commercial thinning, which in turn restricts the production of the higher value larger size classes of timber.

This study examines the socioeconomic and technical constraints to the incorporation of teak planting into farming systems in northern Laos. It specifically evaluates the economic prospects for integrated systems involving interplanting of teak with tree species that are used locally for the production of non-timber forest products, in particular paper mulberry. This is based on the premise that harvest of the non-timber component could provide an early return to the farmer, while at the same time allowing the silvicultural release required to optimise value production from the teak.

The study also identifies research challenges relating to increasing the profitability of teak smallholdings in northern Laos. It is hoped that the recommendations will provide a guide to several donor agencies that are active in the Lao PDR.

Peter Core
Director, Australian Centre for International Agricultural Research

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Among timbers, teak holds a place which diamonds maintain among precious stones and gold among metals.

Dietrich Brandis, Inspector General of Forests, India, c. 1855

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Abbreviations

ACIAR	Australian Centre for International Agricultural Research
ADB	Asian Development Bank
APAFRI	Asia Pacific Association of Forestry Research Institutions
APFORGEN	Asia Pacific Forest Genetic Resources Programme
ASB	Alternatives to Slash-and-Burn Consortium
ASEAN	Association of Southeast Asian Nations
CGIAR	Consultative Group on International Agricultural Research
CIAT	International Center for Tropical Agriculture
CSO	clonal seed orchard
DAFO	District Agriculture and Forestry Office
DANIDA	Danish International Development Agency
dbh	diameter breast height
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FLUPLA	forestland-use planning allocation process
FSC	Forest Stewardship Council
GDP	gross domestic product
GoL	Government of Lao PDR
GTZ	German Technical Cooperation: Deutsche Gesellschaft für Technische Zusammenarbeit GmbH
ICRAF	International Centre for Research in Agroforestry
IPGRI	International Plant Genetic Resources Institute
IRR	internal rate of return
IRRI	International Rice Research Institute
ITTO	International Tropical Timber Organization
IUARP	Integrated Upland Agricultural Research Project (NAFRI, IRRI, ICRAF, CIAT, IWMI)
IUFRO	International Union of Forest Research Organizations
IWMI	International Water Management Institute
JICA	Japan International Cooperation Agency
LARP	Lao–Australian Reforestation Project
LDSC	State Company for Land Development and Services
LPA	Lao Plantation Authority
LUSLOF	Sustainable Land Use Practices for the Uplands of Vietnam and Laos: Science and Local Knowledge for Food Security. Cooperative Project—NAFRI, NISF Vietnam, ICRAF, Rockefeller Foundation
MAF	Ministry of Agriculture and Forestry
mai	mean annual increment
MMSEA	Montane Mainland Southeast Asia
MSEC	Management of Soil Erosion Consortium: CGIAR
NAFReC	Northern Agriculture and Forestry Research Centre, Luang Prabang province
NAFRI	National Agriculture and Forestry Research Institute
NGO	non-government organisation
NPV	net present value
NTFP	non-timber forest product
PAFES	Provincial Agricultural and Forestry Extension Service
PAFO	Provincial Agriculture and Forestry Office
PDR	People's Democratic Republic
PMO	Prime Minister's Order
RIWI	Research Institute for Wood Industries, Chinese Academy of Forestry
SADU	Smallscale Agro-enterprise Development for the Uplands Project
sed	small-end diameter
SIDA	Swedish International Development Cooperation Agency
SLU	Swedish University of Agricultural Sciences
SNV	Netherlands Development Organisation
SPA	seed production area
Teaknet	Teak Network for Asia and the Pacific
TIC	Teak Improvement Centre, Royal Thai Forest Department
TLUC	temporary land-use certificate
UNIDO	United Nations Industrial Development Organization

Currency (June 2006)

US$1 = 10,000 kip

US$1 = baht 38

US$1 = A$1.36

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A great many people generously shared information on teak growing in northern Laos: in particular, Thongsavanh Keonakhone of NAFRI, who recently completed a MSc thesis on teak, and Sengdouane Wayakone of the Faculty of Forestry, National University of Laos. In Luang Prabang, Kaysone Vongkhamheng, Head of the Provincial Agricultural and Forestry Extension Service; Sianouvong Savathvong, Forestry Director of the Provincial Agriculture and Forestry Office; and Homchitsavath Sodarak, Director of the Northern Agriculture and Forestry Research Centre (NAFReC), and his colleagues Khamen Soubangxay and Saysana Inthavong shared their publications and long experience on teak in northern Laos.

From the industry and processing sectors, Peter Fogde of the Burapha Company and industry consultant Thongthanh Southitham shared their experience with teak processing and markets; and the proprietors of Sawmill Thongsavang, Lak 15, and Laksi Sawmill, Luang Prabang, obligingly provided information.

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Dedication

This study is dedicated to the memory of the late Phengdy Sinhotha, an innovative farmer who established and managed teak smallholdings in Ban Gok Gniew in 1962 and who enthusiastically shared her information with the team before her death in July 2006.

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Notes on the authors

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Stephen Midgley is a specialist in forest genetic resources who began a long association with the Lao forestry sector in 1973 via the Lao-Australian Reforestation Project. Since that time and during his career with Australia's national research body, CSIRO, he has worked continuously in Asia through long-term projects in Nepal, Sri Lanka and China and via short-term projects in many other countries.

Michael Blyth

Dr Michael Blyth is an agricultural economist and development specialist. He worked as a research economist for the Australian Bureau of Agricultural and Resource Economics and in strategic planning in CSIRO. He has worked with many research and development organisations throughout Australia, Asia and the Pacific in the areas of planning, priority setting, evaluation and management improvement.

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Khamphone Mounlamai is a senior research scientist with the Lao National Agriculture and Forest Research Institute (NAFRI) and is National Project Manager of the Lao Tree Seed Project. Khamphone has professional interests in the commercial development of teak, eucalypts and other species of commercial potential in Laos.

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Dao Midgley has had a long association with forestry development projects in many Asian countries. Fluent in several languages in addition to her native Lao, Dao has a strong interest in anthropology and possesses skills in cross-cultural communication.

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Alan Brown, a former Chief of the CSIRO Division of Forestry, ACIAR project leader and member of CIFOR's Board, is currently Production Editor of *Australian Forestry.*

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Summary

Teak (*Tectona grandis)* is a tropical hardwood which occurs naturally in Laos. The high sustained global demand for teak wood coupled with significant shortages of supply from natural forests has stimulated establishment of plantations in many tropical countries, so that the total area is now 5.7 million ha. Increasing amounts of plantation-grown teak wood are being supplied to and accepted on world markets. Reports from several countries indicate increasing investment in teak plantations and farmer smallholdings of teak, and a strong international market for the wood produced.

This report examines the background to the establishment of large numbers of teak smallholdings near the city of Luang Prabang, northern Laos. An estate of 10,000 ha of privately owned plantations in blocks varying in size from 0.1 to 1.0 ha has been established close to roads and rivers over the past 15 years. A field study examined market forces and social and institutional changes that have underpinned community enthusiasm for planting teak.

The forestry sector is important for the economy of the Lao PDR, and plantation establishment features highly in government policies and priorities. Integration of teak plantings into smallholder farming systems in northern Laos is consistent with these policies. It has produced a regional resource with an estimated standing market value of US$80 million (based on an average price of US$10 per tree at age 15–20 years) and an estimated semi-processed value (as squared logs for export) of US$332 million. The estimated current harvest of teak wood from smallholdings is 4,000 m^3/year. This is expected to increase to 18,000 m^3/year in 2010 and 60,000 m^3/year by 2020, offering opportunities for primary and secondary wood processing within Laos.

Private teak plantings have been recorded in northern Laos since 1950. They are largely confined to areas close to roads or rivers, which allow efficient access and transportation of logs to mills. Since 1990 there has been a 'boom' in teak planting near Luang Prabang, with the total area increasing from 500 ha to over 10,000 ha.

A challenge to profitable teak growing is the long rotation, which ties up land and capital for at least 15 years. In this study the prospects for improving short-term returns to teak investments are explored by appraising a number of integrated teak farming options. Data and information from a range of international and domestic Lao sources are used to set the context for teak production, marketing and processing in Laos. From these investigations a number of suggestions are made for further research to increase the profitability of teak smallholdings in northern Laos.

Primary data were collected from interviews with personnel from relevant government agencies and their supporting donor organisations and projects, and from private businesses involved in teak growing and processing. Meetings and structured interviews were held with community leaders and growers in three villages near Luang Prabang. An extensive review of literature was conducted, drawing on previous studies in Laos and relevant international sources.

Past studies of smallholder teak production near Luang Prabang, and the interviews in the three sample villages—each with a long history of planting teak—indicate a common enthusiasm for planting teak, and reveal technical and social challenges facing ongoing expansion. Challenges facing teak smallholders include the long time between planting and generation of income, indifferent genetic quality of planting material, and lack of development and transparency in the supply chain.

This preliminary appraisal of a number of farming system options found that integration of teak into upland farming systems is a profitable option for smallholders. The results are indicative of the financial potential of teak-based farming systems in northern Laos. Enterprise gross margins for alternative land uses are assessed and compared using net present value of returns per hectare and labour returns per person per day.

The highest returns to land and labour inputs were for a managed teak system with periodic thinning and pruning, and a teak–paper mulberry intercropping

system. While the managed teak system generated high returns, its attractiveness to smallholders may be limited by the lengthy period without positive cash flow and competition for land for food and cash crops. On the other hand, the integrated teak and paper mulberry system generates positive cash flow in most years. Further research into the technical and financial feasibility of this latter system is warranted by these preliminary results.

Individual smallholders' land-use decisions are subject to many conditions including the availability of suitable land, family labour, financial resources and knowledge. For this study a number of assumptions are made about the availability and status or nature of each of these factors. Variations in the fundamental factors of production can be explored more comprehensively through whole-farm modelling to assess the feasibility of alternative land uses. This would also need to take into account financial, social and other goals of smallholders. To complement improvements in land and labour productivity, improvements further along the supply chain for food and fibre products, including teak wood and paper mulberry bark, are also needed. Off-farm improvements are likely to provide added incentives for smallholders to adopt more intensive teak-based farming systems.

An opportunity exists for ACIAR to foster a program of participatory, on-farm research in northern Laos to address these and other challenges relating to increasing the profitability of teak smallholdings in northern Laos. The field study revealed unequivocal community-level support for such initiatives, including a strongly expressed willingness to undertake research on individual farms. This support mirrored that expressed by government agencies at both provincial and national levels.

Program components for ACIAR to consider include:

- farming systems incorporating companion crops, including food crops and fibre crops such as paper mulberry, with teak plantings
- agronomic and market information for companion crops including opportunities for primary processing
- support for development and deployment of improved teak germplasm
- market information system development to allow farmers to better evaluate the market value of their plantations and logs, and time their sales accordingly
- preparation of local communities to capture greater value from the increasing volume of teak logs that will mature over the next decade.

Several international donors, NGOs and CGIAR research centres are offering support to develop improved farming systems which include teak and other trees in northern Laos. The components suggested above would complement programs sponsored by other donors.

While this study focused on Luang Prabang province, the conclusions have relevance to other areas in northern Laos, a region that accounts for 41% of the area and 33% of the population of the Lao PDR.

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1 Laos and its forestry sector

Laos

The Lao PDR (Laos) is predominantly a mountainous country with some plains and plateaus and a land area of 236,800 km^2. It is land-locked, sharing borders with China, Myanmar, Cambodia, Vietnam and Thailand; the Mekong River forms a large part of the western boundary with the latter (Figure 1.1). Laos has a small population of 5.6 million dispersed unevenly across the country and increasing at an estimated annual rate of 2.3%. Most people live in valleys of the Mekong River and its tributaries. The population is ethnically diverse, with more than 60 ethnic groups (Stuart-Fox 1986). Based primarily on ethnic, linguistic and geographic characteristics, ethnic groups have been divided into three broad categories: Lao Loum (lowland) 68%, Lao Theung (upland) 22% and Lao Soung (highland) 9%. About 83% of the population is rural and 66% of the people depend on subsistence agriculture (Roder 2001). All major ethnic groups of the country are engaged in slash-and-burn agriculture.

Laos has a tropical monsoonal climate featuring a rainy season from May to November and a dry season from November to April. The seasons strongly influence Lao agricultural and cultural calendars.

Laos is a poor nation by Asian standards, with an estimated annual per capita GDP (2006) of US$491 (Government of Lao PDR 2006). Agriculture employs an estimated 81% of the population and produces 53% of GDP. Subsistence rice farming domi-

Figure 1.1 Laos in South-East Asia

nates the sector. Other rural activities involve coffee, corn, sugarcane, vegetables, tobacco, ginger, water buffalo, pigs, cattle, poultry, sweet potatoes, cotton, tea and peanuts. Fallow land in slash-and-burn systems may account for 6–10% of the land area.

The Lao forestry sector

Laos is endowed with valuable, productive and ecologically unique forests. They are a vital economic resource, providing essential contributions to the livelihoods of the rural population, especially the poorer communities. Some 80% of the population rely heavily on forests for timber, food, fuel, medicines and spiritual protection. In rural areas forests provide one of the few available economic activities, and in forest-rich areas non-timber forest products (NTFPs) contribute more than half of family incomes (Department of Forestry 2006).

Through log production, forests contribute 3.2% of GDP. However, this figure does not include subsistence use, wood processing and NTFPs. Wood products currently contribute some 25% of total export earnings, and log royalties make a substantial contribution to government revenue (23% in 2000–01). At the same time, they provide habitat for the nation's rich natural biodiversity and protection of its soils, watersheds and water resources.

Forests with more than 20% crown cover occupied some 41.5% of the total national area in 2002, down from about 47% in 1992 and 70% in the 1940s. This forest decline has led to a loss of wildlife and plant habitats. Direct causes for the loss are forest clearing and burning by unsustainable shifting cultivation, uncontrolled logging and conversion to agriculture and other land uses. This is spurred by wide-spread poverty, rapid population growth and weak law enforcement. Shifting cultivation in the uplands of Laos was a well-adapted and sustainable farming system for centuries, but now is challenged because increased population pressure has resulted in shorter fallow periods, an increase in weed growth, soil degradation and lower crop yields.

The 7th Party Congress in 2001 set development targets for 2005, 2010 and 2020 that were subsequently endorsed by the National Assembly. The overarching objective is poverty eradication. The development targets include stabilising shifting cultivation by 2005 and phasing it out completely by 2010.

The main development objectives of the Government of Lao PDR for the agriculture and forestry sector, as summarised by the Swedish International Development Cooperation Agency (SIDA) (2004), were to:

- ensure food security for all Lao people
- enhance market orientation, transforming agriculture from subsistence to commercial farming
- maintain an agricultural growth rate of 4–5% per annum
- diversify and modernise the agriculture and forestry sector
- promote commodity production, especially for export
- improve rural livelihoods
- transfer technology through improved research and extension
- strengthen rural financing.

The most important agricultural policies and priorities that affect development in upland areas such as Luang Prabang province are to:

- stabilise shifting cultivation and eradicate poppy cultivation
- conserve the environment, and protect species and habitats
- maintain healthy, productive forest cover
- generate a sustainable stream of forest products, including NTFPs
- implement decentralisation and participatory planning
- encourage village consolidation and land allocation.

For the commercial forestry sector these national policies have resulted in promotion of tree plantations for commodity production, and the acceleration of classification, delineation and management of forests for protection, conservation and production. National policies acknowledge that maintenance of healthy and productive forest cover is integral to the support of rural livelihoods. Substantial areas of Laos have been set aside for conservation, with National Biodiversity Conservation Areas occupying some 12% of total land area.

The response to these development targets has been an expansion in plantation development entirely consistent with national policies. Small-scale and large-scale growers have been encouraged to invest in plantations. The government is in the process of establishing the Lao Plantation Authority to facilitate commercial plantation development, and has also given approval for establishment of a Lao Plantation Growers Association with thousands of potential

members. The main species attracting investors are eucalypts, rubber, agarwood and teak.

Commercial species for Lao plantations

Eucalypts

Eucalypts have been grown in Laos for 40 years. Trials of several species were completed in the late 1960s with Australian assistance under the Lao–Australian Reforestation Project (LARP). Their proven performance in Laos, together with a large regional demand for wood fibre, have prompted significant investment proposals for commercial eucalypt plantations in the country. Proposals are in place from substantial foreign companies such as Oji Paper from Japan and the Aditya Birla Group from India, and others are under discussion. Informal estimates predict that the area under commercial eucalypt plantations will exceed 100,000 ha by 2012. The main species to be planted will be *Eucalyptus camaldulensis* and its hybrids.

Rubber

Rubber was introduced to Laos in 1930, and there are now almost 12,000 ha planted in the country. International prices for natural rubber latex have risen from US$600/t in 2001 to over US$2,000/t in 2006, dramatically altering the economic attractiveness of rubber plantations. In response, domestic and foreign investors, mainly from China, Vietnam and Thailand, are seeking to expand the area of rubber in Laos to a planned area of 181,840 ha (Ketphanh et al. 2006).

Rubber plantations in Laos are dominated by eight domestic and foreign companies, with an average investment total of more than US$800 million (Malychansy 2006). Foreign investors control 70% of rubber tree plantations and domestic investors the remaining 30%. Prospects for development of smallholder plantings of rubber appear promising and, in May 2006, 150 representatives from China, India, France, Thailand, Vietnam, Malaysia, Indonesia, Cambodia and Laos met to discuss the development of rubber production in Laos. At that meeting a dialogue was established on trends and issues in rubber development in Laos and the region. In addition, technical options to strengthen smaller rubber production plants in Laos were identified, and areas in need of follow-up for research and extension were agreed. One issue identified at the workshop was the likely shortage of labour to maintain trees and harvest rubber from a national estate of over 180,000 ha. Further details of the meeting are at: <http://www.nafri.org.la/05_news/workshops/rubber/rubberworkshp.htm>.

Agarwood

Agarwood, the ‘wood of the gods’, is a resinous wood used as incense and for medicinal purposes and perfumery. It has been traded and highly appreciated for thousands of years. A strong connection exists between its use, religion and its curative properties, and elaborate traditional and religious ceremonies are known from around the world. Most agarwood comes from trees belonging to the genus *Aquilaria* of the family Thymelaeaceae. Seventeen species of *Aquilaria* are distributed from north-eastern India to Indonesia and Papua and New Guinea. Only one species (*Aquilaria crassna*, ‘maiketsana’, ‘mai dam’ or ‘mai horn’) has been recorded from Laos. This species is highly valued for agarwood, and natural stands have been heavily exploited throughout its range. The increasing rarity and continued high demand and value of agarwood has led to a marked increase in interest in plantation establishment, particularly in the southern Bolevens area of southern Laos. Some of these plantations have been financed via public investment schemes and managed to meet prospectus demand. Many growers were unaware of the risks presented by the rapid expansion in agarwood plantings in Vietnam and the accompanying technology for inducing heartwood formation.

Teak

Teak is one of the country's most valuable timber species. In response to strong and sustained market demand for teak timber and to prospects of future wood shortages, the area of teak plantations has steadily increased over the past 30 years. The total area of teak plantations in Laos exceeds 15,000 ha. Luang Prabang province has the greatest concentration of teak plantations in the country with an estimated 12,000 ha, of which 98% belongs to farmers and other private-sector owners. Much of this resource is confined to areas close to roads or rivers, allowing easy access when selling, harvesting and transporting logs.

Luang Prabang province

Luang Prabang province, located in the heart of northern Laos, is administered from Luang Prabang city, which has been a UNESCO World Heritage Site

since 1995 and enjoys a strong tourism industry (<http://whc.unesco.org/en/list/479>).

The province consists of 11 districts and has an ethnically diverse population of 433,000, made up of 39% Lao Loum, 45% Lao Theung and 16% Lao Soung. The population is predominantly rural, with 75% of villages being regarded as remote and mainly engaged in shifting cultivation. The annual growth in population of 1.7% is lower than the national rate of 2.3%. Of the total area of about 2 million ha, 96% is classified as forest land and only 61,000 ha (3%) as crop land. The agriculture and forestry sector is important in the local economy, with some 48% of 2003 economic production for the province being derived from agriculture, as shown in Table 1.1. There are three main rice cultivation practices in the province, with areas cultivated in 2004 as follows (Rockefeller Foundation 2005):

- wet season rice cropping, 11,398 ha
- dry season rice cropping, 2,240 ha
- slash-and-burn cultivation, 23,600 ha.

Table 1.1 Sector contributions to the provincial economy (Source: Socio-economic Development Plan 2001–2005, Keoboualapha 2006)

Sector	Fraction of GDP (%)	
	2003	2010
Agriculture (incl. forestry)	48	44
Industry	17	18
Service	35	38

The terrain is predominantly mountainous and dominated by the Mekong River and its tributaries. Climate varies greatly with altitude and aspect, and is strongly seasonal, as the data in Table 1.2 demonstrate. The yearly average temperature is 23.9˚C, with the hottest months from March to October. The average annual rainfall is 1,397 mm, of which 85% falls between April and September (Keoboualapha 2006).

The most common rock types are gabbro, diorite, andesite, basic rock, schist, gneiss and sandstone. A detailed soil survey conducted by the Soil Survey and Land Classification Center (SSLCC) in 1996 concluded that the most widespread soil groups are Acrisols and Alisols (FAO UNESCO System) or Ultisols (US taxonomy). They are found mainly on slopes of 8–50%, which make up most of the surveyed area (IWMI–MSEC undated).

The Provincial Agricultural and Forestry Development Plan for 2006–10 envisages a substantial increase in tree plantations, with teak expected to increase to 30,000 ha, agarwood (*Aquilaria* sp.) to 15,000 ha and rubber (via smallholdings) to 50,000 ha (Keoboualapha 2006).

The approach for this study

A challenge to growing any high-value hardwood in plantations is the long rotation, which ties up land and capital for at least 15 years. Teak is no exception. This study has obtained data from a range of international and domestic Lao sources to provide back-

Table 1.2 Meteorological record, Luang Prabang province (1986–96) (IWMI 2004)

Month	Radiation (hours/day)	Precipitation (mm)	Evaporation (mm)	Max. air temp. (˚C)	Min. air temp. (˚C)	Mean air temp. (˚C)
Jan	6.1	6	64	22.9	19.3	21.2
Feb	6.9	18	96	22.9	19.3	21.2
Mar	6.1	44	120	28.0	23.5	25.9
Apr	6.8	111	126	31.7	23.4	27.7
May	6.4	149	111	30.1	27.6	28.6
Jun	4.2	194	85	28.8	26.5	28.0
Jul	3.4	260	71	29.0	26.8	27.6
Aug	4.4	275	76	28.6	26.4	27.6
Sep	5.6	137	75	27.7	25.7	27.0
Oct	5.8	133	73	26.9	24.0	25.7
Nov	5.7	52	75	25.0	21.3	23.5
Dec	5.5	24	51	20.8	21.8	20.4
Mean annual	5.6	1403	1022	26.0	23.8	25.3

Source: Meteorological Station of Luang Prabang province

ground and suggestions for research that could increase the profitability of teak smallholdings in northern Laos.

The study included interviews with government agencies and their supporting donor agencies and projects, interviews with private businesses involved with teak growing and processing, a review of available literature, and community meetings and structured interviews with community leaders and growers in three sample villages near the northern city of Luang Prabang.

Literature review

The study has reviewed literature, including 'grey' literature, published by several agencies and projects. Apart from the extensive international literature on teak, its cultivation, wood markets and recent trends, the study found several earlier studies related to teak smallholdings in districts close to Luang Prabang city, including those by Fogdestam and Gålnander (2004), Hansen et al. (1997), Keonakhone (2005), Kolmert (2001) and Southitham (2001).

Government agencies

Government officers within the Ministry of Agriculture and Forestry, the Department of Forestry and the National Agriculture and Forestry Research Institute (NAFRI) in both Vientiane and Luang Prabang were interviewed and provided documents and data relating to strategies and plantation management.

Donor-supported projects, NGOs and international agencies

A great many donor agencies, NGOs and international agencies have substantial interests in Laos. In 1999, for example, foreign grants and loans accounted for more than 20% of GDP and more than 75% of public investment. In the forestry sector much-valued and major long-term support has been provided by Sweden and a number of other multilateral and bilateral donors and NGOs (see Appendix 4).

Industry representatives and processors

Interviews were held with teak processors in Luang Prabang, a furniture exporter in Vientiane and an industry consultant.

Field study of teak smallholders

Village meetings and interviews were held in three teak-growing villages belonging to two districts in Luang Prabang province. A total of 58 people participated in community meetings and discussions and 15 growers participated in face-to-face interviews.

Midgley, S., Blyth, M., Mounlamai, K., Midgley, D. and Brown, A. 2007. Towards improving profitability of teak in integrated smallholder farming systems in northern Laos. ACIAR Technical Reports No. 64.

2 Teak growing

Natural teak forests

Teak (*Tectona grandis*) is a tall deciduous tropical hardwood which occurs naturally in a discontinuous distribution in peninsular India, Myanmar, Laos and Thailand, as shown in Figure 2.1. It is believed to have been introduced to Java 400–600 years ago (Phengklai et al. 1994), where it has become naturalised. The area of natural teak is about 27.9 million ha (Gyi and Kyaw Tint 1998), generally occurring on fertile, well-drained soils up to 1,000 m altitude. It does not tolerate flooding or infertile lateritic soils (Phengklai et al. 1994). It grows best on sites with a marked dry season, annual rainfall of 1,250–3,750 mm, minimum temperature of 13–17˚C and maximum temperatures of 30–43ºC (Pandey and Brown 2000).

In natural forests teak is a medium to large tree growing to 50 m tall with a straight cylindrical bole up to 25 m and a diameter up to 150 cm. It is a pioneer species but has a long lifespan. It is light-demanding and does not tolerate shade, and demonstrates a strong capacity to recover after fire. Teak trees coppice well, and this feature has influenced several management systems (e.g. coppice with standards) for natural forests, especially on dry sites or sites of low quality.

Teak timber is mellow in colour, ranging from golden to brown, with a fine grain and smooth texture. Compared with other industrial woods, it is strong and of average hardness. The wood density is 610–750 kg/m^3 and rates of shrinkage are very low. Teak heartwood is very durable and resistant to termites and fungi, but the sapwood is vulnerable to attack by powder-post beetles (*Lyctus* spp.) (Phengklai et al. 1994). Because of its strength, pleasing colour, attractive figure and favourable working and finishing properties, teak is one of the most popular tropical hardwoods, in high demand for:

- furniture
- shipbuilding
- decorative building components such as doors, window frames and flooring
- construction materials
- reconstituted products.

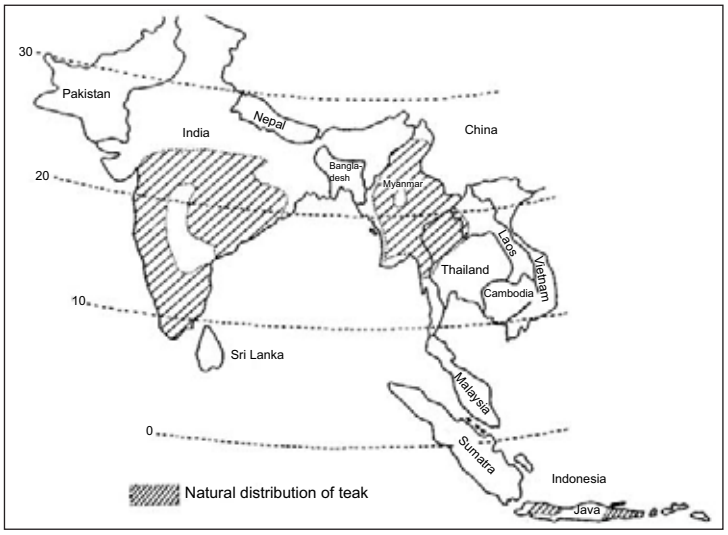

Figure 2.1 Natural distribution of teak (Gyi and Kyaw Tint 1998)

It remains one of the world's premier timbers, for which demand outstrips supply (Keogh 2000).

Conservation status of teak

The natural teak forests of Asia have been greatly reduced in extent by excessive harvesting and encroachment for agricultural land. All countries which have naturally occurring teak report a sharp decline in these forests. FAO reports that management of the resource has not kept pace with demand, and supplies of teak from natural forests have dwindled. Harvesting of teak from natural forests is now banned or severely restricted in all countries within teak's natural range, except Myanmar.

Sumantakul and Sangkul (1998) reported that Thailand's area of teak-bearing forest declined from 2.3 million ha in 1954 to 1.9 million ha in 1993. In Myanmar the Forest Department (1998) reported that the country's forest resources have been decreasing due to population pressure and rising demands for forest lands and products. In 1989 forest cover was 51% and had diminished by 220,000 ha annually during the period 1975–89. Studies of teak stand structures indicated that natural regeneration of teak was insufficient (Forest Department 1998). Oo (2004) reported that teak had the highest priority for conservation activities in Myanmar. In Laos the Department of Forestry (1998) reported that both the area and the stocking of natural teak stands were being rapidly depleted due to population pressure, shifting cultivation and forest fires. Although Laos is still quite rich in forest resources by the standards of mainland South-East Asia, forest cover has diminished from 70% of total land area in 1940 to 47% in 1992 (Phongoudome and Mounlamai 2003).

In India the predominant causes for dwindling forest wealth have been identified as overexploitation, overgrazing, illegal encroachment, unsustainable practices, forest fires and indiscriminate siting of development projects in forest areas. Overall, forest cover declined from nearly 40% of India's geographical area a century ago to 22% in 1951 and to 19% in 1997. India's naturally occurring teak forests have not been immune to these changes. Despite a recent increase in the recorded forest area, population growth has resulted in declining availability of forest area per capita since the 1950s. Withdrawal of forest products, including fuelwood and industrial timber, exceed the productive capacity of Indian forests. For example, the annual consumption of industrial wood is about 28 million m^3 against a production capacity of 12 million m^3 (Gulati and Sharma 2000).

The value of the natural genetic resources of teak and the need to conserve these are well understood in the countries of natural occurrence. All countries have considered genetic conservation strategies, and a number of in-situ and ex-situ gene conservation initiatives are in place in Thailand, Laos and India. Regional initiatives include:

- The Asia Pacific Forest Genetic Resources Program (APFORGEN), initiated by the Asia Pacific Association of Forestry Research Institutions (APAFRI) in collaboration with the International Plant Genetic Resources Institute (IPGRI) to develop a regional network program to strengthen work on conservation and sustainable use of forest genetic resources in the region. APFORGEN has the support of 14 countries in the region to foster closer collaboration and assist coordination and implementation of national programs on forest genetic resources (FGR).
- The Teak Network for Asia and the Pacific, Teaknet, was established in 1995 with the support of FAO and APAFRI. Its objective is to strengthen interaction among all those concerned with conservation and sustainable management of teak-bearing forests and plantations by sharing information and promoting collaborative efforts to deal with common problems. Unfortunately this valuable grouping, which could offer much to regional sharing of information, is currently non-functional.

Table 2.1 Estimated net plantation area of teak by subregion, 1995 (Pandey and Brown 2000)

Subregion	Plantation area ('000 ha)	Annual planting ('000 ha)
West Sahelian Africa	4.02	0
East Sahelian Africa	14.85	–
Moist West Africa	87.88	4
Southern Africa	2.80	0
Tropical Africa	109.55	4
South Asia	1,099.60	55
Continental South-East Asia	302.28	26
Insular South-East Asia	706.01	12
Tropical Asia	2,107.89	93
Tropical Oceania	3.03	0
Central America	22.29	4
Caribbean	8.06	–
Tropical South America	2.72	0
Tropical America	33.07	4
TOTAL	2,253.54	101

Teak plantations

Teak plantations have been established successfully in over 36 tropical countries. Estimates of areas vary. Ball et al. (1999) estimated that the net global area of plantations in 1995 was 2.2 million ha, and Pandey and Brown (2000) concurred with this figure. They found that the rate of establishment of new teak plantations has, as shown in Table 2.1, slowed notably since 1990.

Bhat and Ma (2004) have adopted a more optimistic figure, using FAO's Global Forest Resources Assessment data (FAO 2001), which indicated that 5.7 million ha (3%) of the world's forest plantations of 187 million ha were teak, as shown in Figure 2.2.

Teak is now cultivated widely in many tropical countries, with over 90% of the plantation estate in Asia. India and Indonesia account for over 75% of the plantation resource, as shown in Figure 2.3.

Most of the world's teak plantations have been established under government planting programs, particularly in India, Indonesia, Myanmar and Thailand, which account for 87% of all plantations (Pandey and Brown 2000). Ball et al. (1999) report a general shift from establishment of large-scale teak plantations by the public sector to increasing numbers of smaller plantations grown largely either by 'outgrowers' (who incorporate trees into farming systems) or as small blocks to meet long-term commercial needs. This trend has been particularly noticeable in Thailand, Costa Rica and Ghana and is being encouraged in some cases by government incentives.

In Malaysia the promising performance of teak under humid conditions on sites with high rainfall and a short dry season has prompted a rethink regarding the perceived need for a distinct dry season for successful teak cultivation (Krishnapillay 2000). In India on sites where teak trees received sufficient moisture for at least most of the year, Kondas (1995) reported growth and volume production exceeding that from seasonally dry sites. If proven commercially, this trend could see further expansion of teak plantings on humid sites. Based on extensive Thai experience, Kaosa-ard (1998) reported that optimum growth occurred when annual rainfall was 1,200–1,500 mm with a marked dry season of 3–5 months, defining such a season as a period when cumulative monthly rainfall is less than 50 mm. Under very moist conditions the trees are very large but their boles are fluted.

Silviculture and management of teak plantations

While teak is relatively easy to establish in plantations, the management of plantations varies between and within countries according to variations in environmental, social and economic conditions. Krishnapillay (2000) recognised that the performance and management of teak plantations are influenced by two major issues—the relatively low growth rates and the need to maximise the length of the clear bole to enhance log value.

Teak is a cross-pollinating species with monoecious flowers that are 45–60 cm long. Flowering begins when trees are 5–8 years old, and occurs at the beginning of the rainy season with the fruits maturing during the dry season. Early flowering is seen as a disadvantage for teak as it can lead to stem deformity and depress height growth (Gram and Larsen 1958).

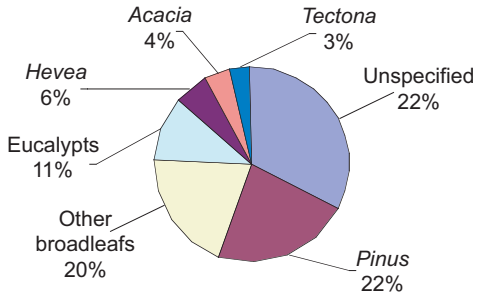

Figure 2.2 Distribution of plantation areas by genus (FAO 2001)

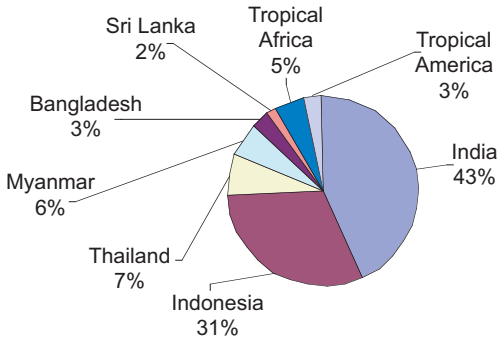

Figure 2.3 Global distribution of teak plantations (Bhat and Ma 2004)

Raren (1966) noted that the age of first flowering determines the length of the straight unforked bole.

Teak 'seeds' (technically fruits) are large (average 2,000 fruits/kg) and robust and have a hard coat. In Thailand and Laos seeds are collected from the ground as and when they fall between February and April. Table 2.2 shows the flowering and seed collection seasons for a number of countries. The bladder-like calyx is removed and the seeds cleaned by winnowing. Seeds store well in gunny bags or sealed tins for 2–3 years (Chacko 1998).

Teak plants can be raised using either seeds or vegetative tissues such as stumps, branch cuttings or tissue-cultured plantlets. Teak seed is generally broadcast sown into cultivated beds for germination. Nursery germination of untreated seed is about 30–50% over a period of 50 days. Germination is sporadic and the exact nature of dormancy is not known. The most common method of pretreatment is to soak the fruits during the night and dry them in the sun during the day, repeating this for 1–2 weeks (Rachmawati et al. 2002). The use of improved seed from seed production areas (SPAs), seed orchards or selected 'plus' trees is essential for improving growth, stem quality and other plantation features. Wellendorf and Kaosa-ard (1988) estimated that improved seed enhanced growth and volume by 5–25%, depending on seed source and planting site. A review of recent literature and country reports confirms that the tight supply of seed of high genetic quality is a major hurdle to any expanded planting of teak. The seed requirements can be large, with Kaosa-ard (1998) estimating that a plantation of 1,000 ha at 3 m × 3 m spacing would require 15 t of seed, representing the annual yield from 500 ha of SPA

Nurseries produce either potted seedlings or stumps, which are 6–12-month-old seedlings which have had both roots and shoots (80:40) pruned to produce a 200 mm 'stump'. Stump production is simple and requires little investment. They are easy to transport and plant but sensitive to dry spells in the first 2 months after planting.

In most countries stump planting is widely practised because it offers reliable early survival if completed early in the wet season. In Indonesia plantations are frequently established through direct dibbling of seeds into planting holes. Potted seedlings are used for commercial investment plantings. White (1991) reported that although stump plants were more costly than direct sowing, they were more reliable, they greatly simplified teak planting and they reduced the tending period by 1 year.

Traditionally, plantations have been established through the taungya system—a practice whereby the trees are planted in association with an agricultural crop which controls weed growth. Once the trees approach crown closure, the agricultural component becomes unviable and is moved to another site. In some parts of India taungya has been discontinued due to declining site fertility, while in some other countries the practice was not adopted at all for various social and economic reasons (Ibrahim 1998). In countries where there is direct commercial investment in teak plantations, intensive site preparation practices similar to those used for other commercial plantation trees are followed. Although a wide range of initial spacing is used, stocking rates are normally 1,000–2,000 stems/ha. Following a major study a 3 m × 3 m spacing, which is equivalent to 1,100 stems/ha, is routinely used in Thailand (Kaosa-ard 1998.

The rotation length for teak plantations varies with site and grower needs—50–90 years within its natural range or 40–60 years outside this range (Ball et al. 1999). Economic pressures favour short rota-

Table 2.2 Flowering and seed collection season of teak in selected countries (Kaosa-ard 1998)

Country	Flowering season	Seed collection
Bangladesh	June–August	February–January
China (Hainan)	July–December	December–February
India	June–September	December–March
Indonesia	December–February	July–September
Laos PDR	July–September	February–April
Malaysia	December–February	July–September
Myanmar	July–September	February–April
The Philippines	June–September	January–April
Sri Lanka	December–February	July–September
Thailand	July–September	February–April

tions, and their duration has steadily declined to less than 20 years in many areas. Growers face the choice of felling early (15–20 years) to generate income quickly, or leaving their trees longer (40–50 years), when they can receive the best log prices (Keogh 2000). Mustain Billah (2005) recognised the need in Bangladesh to reduce the length of rotations to find a balance between financial returns and production of market-quality timber. His study concluded that the optimal rotation for teak plantations in order to make management efficient and long-term investment financially remunerative and attractive would be 20–21 years.

Average growth for teak varies from 5 to 16 m^3/ha mean annual increment (mai), depending on site and management. Dupuy et al. (1999) report best growth of 10–16 m^3/ha/year in West Africa from wetter forest areas, while Ball et al. (1999) record maximum growth rates of 12–21 m^3/ha/year on best sites in Asia.

Yield tables for teak in a number of regions and countries have been published, e.g. Indonesia, the Philippines, Myanmar, India, Thailand, Trinidad, Puerto Rico, El Salvador, Jamaica and Ivory Coast (Kjaer and Foster 1996). If local yield tables are not available, those from regions with comparable soils and climate may be used as guidelines. The gradual acceptance of teak wood from short-rotation plantations has fostered a stronger interest in both management for fast growth and the processing of timber of smaller dimensions. Enters (2000) suggests that yields of 15–20 m^3/ha/year on a short rotation of 20 years should be viewed as the upper limit with present technologies. Claims of higher yields should be treated with caution.

Thinning prescriptions vary with site quality and from one locality to another, and are often governed by financial rather than silvicultural considerations. Chacko (1998) reported that good quality plantations in Kerala, managed on a 50-year rotation, are thinned at ages of 4, 8, 12, 18, 26 and 35 years. The first thinning is commonly carried out when the trees reach about 9 m and the second at about 18 m. If thinning is too early or too heavy, the trees have a greater tendency to produce epicormic shoots and side branches (Krishnapillay 2000) which may lead to defects in the final bole. In Laos, Keonakhone (2005) and others have conducted thinning studies and have reported substantial increases in growth following removal of 50% of trees at age 6 years. Fast-growing, commercial investment plantations typically have three or four thinnings before harvest at age 20–25 years.

Early and repeated thinning 'from above', i.e. removing the largest trees as they progressively reach marketable size, detracts significantly from overall yield because the genetic quality and vigour of the stand is steadily reduced. If at the end of the rotation seed is collected from remaining trees for the succeeding crop, the enterprise is certain to suffer significant and increasing loss of potential yield.

It has been demonstrated that pruning in commercial teak plantations has a positive impact on stand growth and wood quality. Viquez and Perez (2005) reported on experiments in Costa Rica which showed that under an intensive pruning regime a teak tree at a rotation age of 20 years may yield over 60% of the tree volume as merchantable wood, and over 40% as knot-free volume. Centeno (2000) acknowledged the expense associated with intensive pruning regimes of teak, but felt that these would be justified as the demand and price for high quality tropical hardwood increases. In Laos, Keonakhone (2005) reviewed a pruning study and concluded that pruning had a positive impact on tree growth, although the growers interviewed as part of this study were unaware of this. The propensity to produce epicormic shoots and adventitious branches next to the scars caused by pruning needs to be managed.

Insect damage is a serious problem in teak plantations, the most common insects being defoliators and stem borers. Defoliation reduces growth rates and apical dominance. The most important defoliators causing severe damage in teak plantations throughout the tropics are *Hyblaea puera* Cramer (Hyblaeidae) and *Eutectona machaeralis* Walker (Pyralidae) (Kaosa-ard 1998). Outbreaks of these insects may occur two or three times during the growing season and the plantation growth rate may be reduced by as much as 75%. Leuangkhamma and Vongsiharath (2003) reported that, although defoliation did not kill the trees, *H. puera* attack caused an average loss of 44% in potential increment in plantations 4–9 years old. Nair (2001) reported some 187 insects on teak, with *H. puera*, the most serious, causing extensive defoliation in India each year.

Stem borers can cause severe damage; in young plantations (1–5 years old) damaged trees may die back or their top may break, reducing growth rate and stem quality. The most important borer in young teak plantations is the red or coffee borer *Zeuzera coffeae* Nietner (Cossidae). In older plantations, i.e. over

10 years of age, the beehole borer *Xyleutes ceramicus* is the most important. It causes severe damage to the standing trees and also reduces the value of timber (Kaosa-ard 1998).

Though teak is a very hardy species, it is prone to attack by a number of seed-borne fungal pathogens. Seed-borne *Fusarium pallidoroseum* causes nursery mortality. A number of pathogens are responsible for damaging teak plants through root diseases, stem and branch canker and dieback, collar rot, heart rot in dry coppice teak and mortality in natural teak forests. *Amylosporus campbellii* root rots, *Fusarium pallidoroseum* canker and *F. oxysporum* root rot have recently been reported from high-input plantations (Jamaluddin 2005).

Pure teak plantations are considered to be susceptible to erosion. The dense canopy creates heavy shade which restricts the growth of understorey species. After the trees shed their foliage in the dry season the leaf litter is sometimes burnt, leaving the soil surface bare and vulnerable to erosion at the beginning of the rainy season. Surface run-off through plantations in the absence of an understorey can also cause soil erosion. Without effective soil management, productivity of successive teak rotations can diminish.

Tree improvement and deployment of high-quality germplasm

Most countries with large estates of teak have tree improvement programs to enhance the quality of planted teak by providing germplasm of high genetic quality, e.g. Tanzania, Thailand, India, Indonesia, Myanmar, Bangladesh, Papua New Guinea, Sri Lanka, China and Costa Rica (Kjaer et al. 1999). Nakata and Isoda (2004), in a study financed by the International Tropical Timber Organization (ITTO), consolidated information on teak improvement programs in Thailand, Myanmar and the Indian state of Kerala. They concluded that one of the main hindrances to high-quality teak plantation development remains the insufficient production of good seed.

In India provenance testing of teak began in the 1930s. Systematic teak improvement started in 1962 with the introduction of a program for the genetic improvement of teak. Following this, the improvement activities gained momentum and almost all the teak-growing states have now joined teak improvement programs (Subramanian et al. 1994).

In Indonesia provenance trials commenced in 1932. A long history of related research has concluded that, in general, there is no reason to plant exotic teak on a large scale since the best Java variety has qualities equal to those of the best exotic provenances. A formal genetic improvement program commenced in 1974. Seed production areas cover 3,700 ha and, as of 1995, 1,139 ha of clone banks and clonal seed orchards (CSOs) had been established (Suhaendi 1998).

In Thailand the Teak Improvement Centre (TIC) within the Royal Thai Forest Department was established under a bilateral agreement between the Royal Thai and the Royal Danish governments in 1965, and has been the key institute to facilitate the supply of superior teak seed for plantations (Sumantakul and Sangkul 1998). Over a 30-year period (1965–94) the TIC enjoyed notable successes including:

- 357 teak 'plus' trees selected and propagated in teak seed orchards at five localities
- 1,831 ha of teak seed orchards established
- 1,120 ha of teak SPA established in two localities.

International provenance trials were established in the early 1970s under the coordination of FAO and the Danish International Development Agency's (DANIDA) Forest Seed Centre, the evaluation of which showed important differences among provenances for growth and stem quality traits (Nair and Souvannavong 2000).

The development of a bud grafting technique enabled CSOs to be established in Thailand, based upon phenotypic 'plus' tree selection in natural forests and old plantations (Wellendorf and Kaosa-ard 1988). CSOs were subsequently established in India and countries outside teak's natural range from the late 1970s onward. Seed production from these CSOs has been limited (Kaosa-ard et al. 1998), and this constrained supply is both hindering the progress of teak improvement programs and seriously limiting realisation of the potential benefits from tree improvement. Egenti (1981) reported that productivity of CSOs in Nigeria is more than fivefold that of those in Thailand and India. Nair and Souvannavong (2000) reported that there was no problem with seed production in CSOs established in Côte d'Ivoire.

Despite the considerable long-term investments made in teak improvement in several countries in Asia, the seed needed for expanding teak plantation programs cannot be met from improved sources. In India supply of improved seed remains a significant challenge. India has 3,100 ha of SPAs and an additional

900 ha of CSOs for teak. The seeds from these supply only 30–35% of the national demand (Katwal et al. 2003). In Myanmar the seed needs for their annual 20,000 ha teak plantation program cannot be met from improved sources (Oo 2004). In Thailand, despite considerable achievements in teak improvement, the annual production of improved seed of 20 t/year is unable to meet the estimated total national requirement of 164 t/year (Sumantakul and Sangkul 1998). For this reason many teak programs have developed and adopted micro-propagation techniques for teak, and tissue-cultured plantlets are used in commercial nurseries. The extent to which tissue-culture techniques can substitute for conventional practices such as using cuttings and seedlings remains unclear (Nakata and Isoda 2004).

It is expected that the immediacy associated with high-intensity plantations will probably boost clonal selection. A sound long-term strategy, combining sexual and vegetative reproduction to retain genetic diversity while continuing to capture significant genetic gain, is needed (Kaosa-ard et al. 1998).

Plantation establishment costs

Cost of plantation establishment varies from site to site and is influenced by labour costs, site characteristics, spacing, technology used and several other factors. Ball et al. (1999) recorded costs in India of between US$298/ha in Kerala and US$400/ha in Maharastha for stump planting at 2 m × 2 m spacing. These figures were all-inclusive, including maintenance to year 5. They also reported that Indonesian establishment costs—with seed at 3 m × 1 m spacing or with seedlings at 3 m × 2 m spacing with about 25% casualty replacement in the first and second year—were US$140/ha with overheads of about US$12/ha/year.

In India the National Bank for Agriculture and Rural Development (NABARD) has a loan scheme for teak in its farm forestry portfolio. The unit cost is Rs40,000 (US$865) over 4 years, with a recommended stocking of 2,500/ha and thinning at ages 7 and 13 years. The thinnings are expected to generate sufficient returns to repay the entire bank loan with interest. NABARD reports an internal rate of return (IRR) for the scheme of 28% (Haque 2005).

Incentives and teak investment programs

The large demand for high-quality tropical hardwoods and the expected market shortages have prompted incentive programs and investment schemes in many countries. These programs have helped to greatly increase the global area of commercial teak plantations. For example, in Thailand the government currently offers private growers subsidies of up to US$780/ha over 5 years for tree planting (Sumantakul and Sangkul 1998). Costa Rica also has an incentive program which includes a direct payment to plantation owners for the provision of environmental services (Pandey and Brown 2000).

The world's largest private teak plantation is owned by the Floresteca Group (www.floresteca.nl), which consists of a holding and operating company in the Netherlands and operating companies in Brazil. It now has some 22 million teak trees in over 20,000 ha of production plantation in 25 production units, and the group plans to increase the area to 50,000 ha of production plantations. It follows through its large-scale teak farming with processing of teak in sawmills and kilns. The Floresteca forestry programs are certified by the Forest Stewardship Council (FSC), SGS and ISO-14001 standards and are reported to follow the German TÜV environmental certification. No details of investment or anticipated returns are available at their website (July 2006).

In Costa Rica, Tropical American Tree Farms (<www.tropicalhardwoods.com>) offers investments in teak plantations at US$4,769 per 100 trees. Assuming a standard stocking of 1,000 stems/ha, this amounts to an investment of US$47,690/ha, providing cumulative net proceeds of US$1,398,700 over 25 years (less harvesting costs and 6% care and maintenance fee). It also assumes an effective growth rate of about 21 m^3/ha/year.

In Australia tax-effective managed investment schemes have fostered a significant increase in the national plantation estate. Growers in managed investment plantations have financed more than 70% of the 600,000 ha of new plantations established in Australia since 1997. While most of this investment has been in plantations of temperate eucalypts, new opportunities for investing in tropical hardwoods, including teak, are being offered to the community.

In northern Australia ITC Limited (<www.treecrop.com.au>) has offered more modest investments in teak planting with an investment of US$16,000/ha (1,000 trees), providing gross accumulated returns of US$167,400 (less 29% harvest and other fees) at clearfelling at year 20. This investment assumes a more credible effective growth rate of 14 m^3/ha/year.

The Rewards Group (<www.rewardsgroup.com.au>) offers teak woodlots of 0.2 ha at an issue price of US$24,000/ha (1,250 trees), providing gross accumulated returns of US$156,600 over 18 years (less management fees and harvest costs). The investment scheme predicts an average after-tax IRR of 13.3% and assumes an optimistic effective growth rate of 18 m^3/ha/year.

While most teak plantation investment schemes are credible, a number have created considerable controversy in countries including Costa Rica, India and the Netherlands. One high-profile case concerned a Netherlands-owned company, Flor y Fauna S.A. (<www.floryfauna.com>), which was involved in establishing teak plantations in Costa Rica using some US$200 million from Dutch investors. An independent investigation found that the advertised returns on investment were misleading and expected plantation yields of 40–45 m^3/ha/year were exaggerations (Centeno 1996). This company now manages 2,568 ha of FSC-certified teak plantations and has moved to manufacture of indoor and outdoor furniture using teak.

Balooni (2000) offered a perspective on the teak investment programs which have expanded greatly in India since 1991. Many of these investments offered optimistic returns and sought to develop legitimate businesses. They formed the Association of Agri-Plantation Companies of India to safeguard their interests and to prevent unscrupulous operators damaging the image of the commercial tree-planting sector. However, against the background of new and unregulated opportunity, some outrageous schemes were allowed to operate and defraud a public which had great confidence in the intrinsic value of teak. One company, for example, offered a return of US$1,340 after 20 years for each teak tree purchased for US$27. Despite early drawbacks, Balooni concluded that tree investment programs represent genuine opportunities for establishing teak plantations and for meeting national demands for high-quality hardwoods.

A study of teak plantations in Costa Rica quoted an IRR of 12%, where mai was assumed to be 15 m^3/ha/year with a rotation length of 25 years. A similar IRR of 14–15% for teak plantations has been quoted for Papua New Guinea (Ball et al. 1999).

In almost all investment schemes examined, the investment company retains ownership of the land after the trees have been harvested. Teak has the capacity to coppice well, and few of the investment proposals mention ownership of subsequent coppice crops.

Wood quality—native forest and plantation woods

Teak wood colour appears to be influenced by site. Thai loggers report that the colour of teak wood from natural forests on wetter sites along riverbanks or in low moist forests is usually darker than that from drier sites (Kaosa-ard 1998). The colour of plantation-grown teak wood is also strongly controlled by planting site, and there is little effect of provenance on wood colour and wood density. Bhat and Ma (2004) reported that teak wood from plantations differs to that from native forests in colour, grain and texture and, for this reason, plantation teak is unlikely to attract the high prices of premium teak from native forests. They also reported that recent research indicates that short-rotation teak wood is not significantly inferior in density and strength compared to teak from natural forests although, with lower heartwood and extractive contents, it is less durable and attractive. Sanyal et al. (1987) studied the strength properties of teak timber from 20-year-old trees grown in canal strips and found properties that matched well with standard teak. Bhat (2000) summarised recent findings which show that plantation managers can accelerate tree growth in short rotations through fertiliser application and tree improvement without altering timber strength or compromising the yield of heartwood. Young trees (13–21 years of age) are not necessarily inferior in wood density and strength compared to older trees (55–65 years), and rotation length of fast-grown teak can be reduced without compromising timber strength. Studies of 22-year-old and 14-year-old teak in Brazil demonstrated that teak at both these ages had decay resistance comparable to that of naturally grown teak (Laming and Sierra-Alvarez 2000).

Teak in Laos and Luang Prabang province

In Laos teak is one of the country's most valuable timber species. The natural teak stands are a continuation of the large teak forests of Myanmar and Thailand. For a number of social and market-driven reasons, the area of natural teak forest in the northwestern provinces of Sayaboury and Bokeo has declined from over 30,000 ha to about 16,000 ha. On these sites teak grows in association with bamboo, *Lagerstroemia*, *Hopea*, *Dipterocarpus* and *Shorea* species (Pengduoang 1991). Harvesting teak from

native forests is severely restricted by the Lao PDR Government, and harvesting is largely limited to old logs left in the forest from earlier logging operations. The average annual harvest of teak logs from native forests is only 500 m^3 (Department of Forestry 1998).

Recognising the value of teak and the limitations of supply from native forests, teak plantations were initiated in Laos in 1942. In response to strong and sustained market demand for teak timber and to perceptions of future wood shortages, the government and land owners have established small plantings of teak in Laos for over 30 years. A large proportion of the teak plantation estate in Laos was established and is being managed by private, small-scale owners and, for this reason, accurate estimates of the relevant area are difficult to make. The total area of teak plantations in Laos exceeds 15,000 ha (FAO 2001 and assumed annual plantings). Luang Prabang province has the greatest concentration of teak plantations in the country, an estimated 10,000 ha (Siannouvong, pers. comm. 2006), of which 98% belongs to farmers and the private sector. Much of this resource is confined to areas close to road or river access because of marketing considerations and the need to transport logs.

Teak is well suited to northern Laos, although not to sites which are flood-prone, have gravelly or acidic soils or are above 700 m altitude (Hansen et al. 1997). These factors exclude its cultivation from about 45% of northern Laos and concentrate planting in the more populous areas, where pressures of swidden (slash-and-burn) agriculture are high.

Teak plantations are usually established in association with swidden agriculture, in what is known as a 'taungya' system (Figure 2.4). Trees are interplanted for 3 years with agricultural crops such as upland rice, sesame and pineapples, this process offering adequate weed control and protection during the early years of establishment (Hansen et al. 1997). Traditionally, teak stumps have been planted, many of which have been distributed from government nurseries. Commercial nurseries are now selling teak stumps and seedlings, and village-level growers collect or buy their own seed and raise their own nursery stock. Seed from general unselected trees in the district is available for purchase from the Provincial Extension Service for 5,000 kip/kg (US$0.50/kg). Alternatively, improved teak seed is available from the Lao Tree Seed Centre's managed SPAs at 20,000 kip/kg (US$2.00/kg). In 2006 the Luang Prabang Provincial Extension Service nursery produced 4 million stumps which were sold at 700 kip (US$0.07) each (Vongkhamheng, pers. comm. 2006).

The initial spacing used varies from grower to grower and site to site, and is sometimes governed by availability of planting material. Typically, teak is planted at a 3 m × 3 m spacing (1,100 stems/ha).

Few of the teak plantations in Laos have been thinned. This is a result of perceptions by plantation owners who treat their plantation as a bank account from which withdrawals must have a realisable value. Southitham (2001) and Keonakhone (2005) have reported the benefits of judicious thinning in Laos. Unfortunately, there has been limited (or little accessible) demonstration of this and most growers remain unconvinced. Pruning is uncommon, and village interviews indicated that it causes a flush of unwelcome epicormic growth. Hansen et al. (2005) recognised the lack of informed management as a major constraint to the growth and quality of trees. Most trees in smallholdings are harvested at ages of 15–25 years. Rotation length is a function of the farmer's needs rather than silviculture.

The importance of teak to local communities and to the national economy encouraged the Lao PDR Government to establish the Teak Improvement Centre at Keng Ben, near Luang Prabang, in 1991. This centre has received significant support from the Lao–Swedish Program and aims to:

- improve the quality of teak plantations
- conduct R&D on techniques for tree improvement, seed procurement and nursery production
- test teak provenances
- establish orchards to produce better quality seed.

Laos shares the insect pests recorded for teak in Thailand and elsewhere, and villagers have reported an increased incidence of insect attack as the area of teak plantations has increased. Kim and Savathvong (2005) identified the main insect pests in teak plantations in Luang Prabang province. These are the defoliators *H. puera* and *E. machaeralis*, termites (Isoptera), bark beetles, bagworm and *Platypus* sp. (Coleoptera: Platypodidae). They found that *H. puera* occurred on the trees in late April when there was a flush of new leaves. The infestation mainly occurred during the May–September rainy season, and the timing of the first peak of damage was not uniform for all plantations in a given area. A second peak of damage can occur if weather conditions are favorable. Defoliation can be extensive; at one site around 80% of the foliage was lost but the trees recovered in about a month.

Figure 2.4 Teak plantations in northern Laos. (a) Long-rotation crops like teak are better suited to steep slopes than annual crops like rice; (b) Young teak interplanted among pineapples; (c) Teak seedlings in a villager's nursery; (d) Small teak plantations and a large-scale teak nursery, Kengban Teak Improvement Centre; (e) NAFRI teak seed production area near Luang Prabang: Pak Lay provenance, planted in 1971, thinned and converted to SPA in 2004 with 383 trees over 3 ha; (f) Produce of the teak plantations, squared logs, processed in simple local sawmills, is a significant export commodity

At harvesting, trees of a minimum 15 cm diameter breast height (dbh) are selected by the grower and offered to the buyer. Chainsaws are used for felling the trees, which are then cut usually to 2-m lengths. These logs are then carried by hand to the roadside or riverside for transport to sawmills in Luang Prabang or Vientiane (Southitham 2001). The mills visited in Luang Prabang as part of this study were very simple, with few safety features. Southitham (2001) estimated that over 4,000 m^3 of plantation-grown teak was harvested annually, and predicted that this would rise to 10,000 m^3 because of its reasonable price and as other high-value hardwoods became scarce and more costly.

The benefits of, and challenges facing, teak establishment and management in northern Laos were recognized by Hansen et al. (2005), who reported that although teak cultivation provided high incomes and was readily adopted by farmers, returns were limited by:

- poor management of teak plantations
- inferior genetic material
- competition with agriculture for arable land
- inability of farmers to hold on to plantations for 20–30 years.

Midgley, S., Blyth, M., Mounlamai, K., Midgley, D. and Brown, A. 2007. Towards improving profitability of teak in integrated smallholder farming systems in northern Laos. ACIAR Technical Reports No. 64.

3 Teak markets and marketing

International teak markets

The physical and aesthetic qualities of teak have given it a worldwide reputation as a premium timber. It is highly sought after for shipbuilding and the manufacture of both interior and exterior furniture. The current total global production of teak, around 3 million m^3 annually, is small in relation to the total volume of world timber production, but teak is recognised as a high-value hardwood in global timber markets. It enjoys special status and has sustained strength in the marketplace.

India remains the world's largest market for teak wood (Padmanabha 2006; Somaiya 2005) although there is substantial demand from the large furniture markets of China, Thailand and Vietnam. In Thailand harvesting teak from natural forests has been banned since 1989. In Indonesia, which has substantial teak plantations, the export of teak logs is banned. India banned teak harvesting in natural forests in 1982, and in 1997 the Supreme Court of India further restricted the felling of timber of any kind in natural forests.

In the early 1980s the overall size of the teak market in India was 7.5 million m^3 annually. All teak logs consumed in India are now imported—2.5 million m^3 of logs in 2005 (Padmanabha 2006). Teak of natural forest origin is imported from Myanmar but about 60% of the teak imports to India are from plantations in countries in West Africa, and Central and South America. Much of this is 6–15-year-old plantation-grown wood. Timber from thinning operations has flooded Indian markets, adversely affecting prices (Somaiya 2005). There are fears within the teak industry that supplies of teak logs from Africa will be constrained within 5 years as the resource base of mature plantations declines.

The global price for teak logs depends on quality, size, age and origin. Padmanabha (2006) offered the following guidelines for FOB (freight on board) prices for teak logs from plantations:

- US$169 per m^3 for 6-year-old poles 13 cm in diameter (at mid-log length) and 8 m long
- US$270 per m^3 for 10-year-old logs 18 cm in diameter (at mid-log length) and 8 m long
- US$450 per m^3 for 14-year-old logs 24 cm in diameter (at mid log-length) and 8 m long
- US$750 per m^3 for 18-year-old logs 31 cm in diameter (at mid-log length) and 8 m long.

The FOB price for teak logs with diameter above 16 cm from Guatemala was US$240 per m^3 in early 2006 (ITTO 2006), with 70% of the exports destined for the Indian market. The average FOB price from Guatemala was US$219 per m^3 in 2005.

The largest manufacturers of teak products are Indonesia, Thailand, India, Vietnam and China. India produces sawn timber and decorative plywood almost exclusively for its domestic markets (Pandey and Brown 2000). China, Vietnam and Thailand have relatively large teak processing industries based largely on imported roundwood or squared logs. A substantial portion of this production is exported to Europe and North America as finished consumer items. Pandey and Brown (2001) observed that volumes of national imports and exports of teak products were poorly documented or inaccessible.

Suppliers of plantation teak to international markets believe that there is only a small risk of teak prices dropping over the next 30 years because of high demand and the long rotation (Precious Woods 2005). The importance of certification in the global marketplace is also increasing and, although certain traditional teak markets are not yet too concerned with this, many teak producers will seek to meet the various criteria of sustainable forestry management and certification under credible schemes in order to ensure the long-term viability of their ventures (Hardwoodmarkets 2004).

The wood processing sector in Laos

Following a major study by UNIDO (2002) of the wood processing sector in Laos, a strategy for the development of the industry was developed. The study found that the industry concentrated on rela-

tively few commercial species (6) and that most of the mills in Laos used old equipment and technology (Figure 3.1). The installed capacity of the primary wood processing industry (sawmills) far exceeded the capacity of the forests to supply logs. Few safety standards were observed and most mills offered an unsafe working environment. In addition, sawn wood recovery was low and there was excessive waste due to inaccurate cutting.

The report concluded that Laos had not maximised the potential benefits from wood processing in a profitable and sustainable way, and that foreign secondary processing industries were using Laos as a source of cheap raw material. Despite the high level of traditional Lao skills with wood, the secondary wood industries (such as furniture and flooring) in Laos were underdeveloped (Figure 3.1c). The study encouraged Laos to follow the example of other ASEAN neighbours by fostering a secondary wood processing industry, and observed that such a change in focus would provide greater value and more jobs and income for the country. The UNIDO study also encouraged the certification of plantations to facilitate improved access to the high-value markets of Europe and the USA.

Teak marketing in Luang Prabang province

Southitham (2001) reported that over 4,000 m^3 of logs were harvested from teak plantations in Luang Prabang province in 2001, and estimated that the total primary consumption of teak from the province was 3,000–4,000 m^3 in 2001 (most as squared logs), the remainder being exported from the province as logs. This represented a small part of the 2001 national log harvest of 578,000 m^3 (Southavilay 2002). Southavilay reported four sawmills, one miniature sawmill and 74 furniture factories in Luang Prabang province. Southitham estimated that there were about 103 wood processing plants in Luang Prabang district but

(a)

(b)

(c)

Figure 3.1 Small-scale processing of teak. (a) Logs awaiting milling; (b) A typical sawmill; (c) Village-level manufacture of chairs

only some of these processed teak. Savathvong (pers. comm. 2006) reported 12 sawmills which used teak in Luang Prabang district, of which six were totally dependent on teak. The capacity of these mills varies from 1 m^3 to almost 1,000 m^3 per year, with most processing about 2–5 m^3 per year. Teak products manufactured in Luang Prabang province consume a small proportion of the volume of wood cut from teak plantations. Products include chairs, tables, flooring, parquets, desks, beds and wardrobes. Some of the larger sawmills in Vientiane purchase plantation-grown teak logs from Luang Prabang province. The export of squared teak logs derived from smallholder plantations is a legitimate business opportunity for sawmillers, but there remains the important opportunity for Laos to use more of this material in its own secondary wood processing industries.

Sawmillers interviewed in Luang Prabang province expressed confidence in the long-term market prospects for teak and in the availability of a sustained supply of plantation-grown logs in the province. To operate they require a licence from the Provincial Agriculture and Forestry Office to buy and transport logs. A permit is also required from the District Agriculture and Forestry Office (DAFO). Mills are granted quotas and pay annual licence and maintenance fees. No taxes are paid as wood is shifted between provinces. They are not limited by government regulations in buying, sawing and transporting plantation-grown teak.

Southitham (2001) outlined the administration fees, taxes and service charges levied on commercial harvesting of plantation-grown teak, reproduced in Table 3.1. These charges are either waived or reduced when trees are cut for local household use. The person responsible for harvesting takes responsibility for paying fees and levies.

Table 3.1 Taxes, fees and service charges relating to teak harvest (Southitham 2001)

Government levy	Commercial use (kip/m^3)	Household use (kip/m^3)
Survey charge	1,000	500
Log measurement	1,500	1,500
Log marking fee	500	500
Sales tax	25,000	–

Processors interviewed for this study reported that they purchase trees from growers on a tree-by-tree basis. They provide the required size and numbers either to a trader or directly to the growers, who select suitable trees for harvest. The sawmiller, or his trader intermediary, are responsible for all paperwork and formalities and arrange for harvest and transport to the mill. The buyer makes a visual estimate of standing volume of the selected trees and, based on quality (straightness, branches and size) and distance from the road, makes an offer. The average payment by one sawmiller was 1 million kip for 10 trees of dbh 30 cm (US$10 per tree). Another had a sliding scale of prices governed by size, which is presented in Table 3.2.

Table 3.2 Notional scale of prices for standing trees (Luang Prabang sawmill) (This study 2006)

Tree girth/diameter (cm)	Price (kip/tree)	Price (US$/tree)
70/22	70,000	7.00
80/25	80,000	8.00
90/29	90,000	9.00
>100/32	150,000	15.00
>150/48	1,500,000	150.00

Sawmillers generally prefer trees which will provide a 2-m butt log with small-end diameter (sed) of 25 cm to produce a 20 × 20 cm squared log, and two top logs used to produce 15 × 10 cm and 10 × 10 cm squared logs. There is no market for logs with a sed <10 cm, although Savathvong (pers. comm. 2006) reported that there was some harvest of logs at 10 years of age for sale into the expanding Vietnamese furniture market. Most sawn timber is air dried; little kiln drying is used because of the expense, estimated to be about US$25/$m^3$.

Table 3.3 Estimated standing values of teak trees, Luang Prabang province (Savathvong, pers. comm. 2006)

Age (years)	Av. dbh (cm)	Av. ht (m)	Volume/ tree (m^3)	No. of trees/ m^3	Price (US$/$m^3$)
12–15	16	10	0.094	10.64	50
17–20	20	12	0.218	5.00	70
25–30	30	16	0.734	1.36	100
>30	35	17	1.111	1.00	150

Table 3.3 presents a guide to standing tree volumes and prices for average trees at a variety of ages (Savathvong, pers. comm. 2006) The sharp increase

in value for larger trees is acknowledged by growers, but the extended rotations are a disincentive.

Table 3.4 Delivered mill door prices for squared logs 2 m long in Vientiane (for export to Thailand) (this study 2006)

Log section (cm)	Price per cubic metre	
	Baht	US$
10 × 10	7,000	184
20 × 10	10,000	263
10 × 15	12,000	316
20 × 15	14,000	368
20 × 20	14,000	368

The main business of the sawmills visited was squared logs 2 m long, varying in cross-section from 25 × 25 cm to 10 × 10 cm, for sale in Vientiane or Thailand. Larger squared logs (15 × 20 cm and above) were sold to Vientiane for export to Thailand. The main market for the smaller 10 × 10 cm logs was Xieng Khong district in Thailand (near Chiang Mai); these were sold via agents in Bokeo province. The sawmillers understand that some of the Thai buyers re-export squared logs to Indonesia and Malaysia. Prices for squared logs delivered to Nong Khai (Thailand) were 14,000 baht/m^3 (US$368) for all categories of squared logs larger than 10 × 15 cm. Some sawmillers receive graduated prices for their Thai sales depending on size, as shown in Table 3.4.

Hansen et al. (1997) recorded that, in 1996, the minimum size of roundwood accepted by Luang Prabang sawmills was from trees 20 cm in dbh, a size expected to be available at 15 years of age. That study estimated that four trees of 18 cm dbh would make up 1 m^3 of roundwood. Growers were paid US$25 per standing tree of 18–20 cm dbh (about US$100/$m^3$) by traders, who sold the logs for US$130–140/$m^3$ to local sawmills. At this time teak roundwood was sold in Vientiane for US$230/$m^3$ and into the Thai export market for US$350–600/$m^3$ depending on size and quality. The market price for sawn plantation-grown teak in Luang Prabang at that time was US$450/$m^3$, and in Vientiane US$650/m^3.

Southitham (2001) found that the purchase of standing teak trees in plantations was negotiated between the buyer and the grower. For example, a standing tree of 90 cm girth (~29 cm dbh) was worth about 90,000 kip (US$9.40), and with a girth of 100 cm (~ 32 cm dbh) 100,000 kip (US$10.50), per tree. At that time the processor could expect to receive about 1.7 million kip/m^3 (US$180/$m^3$) for 2-m round logs of average diameter >25 cm. The price of squared logs varied with size: for end profiles smaller than 15 × 15 cm the price was 1.5 million kip (US$158) and for end profiles larger than 15 × 15 cm about 2 million kip (US$210).

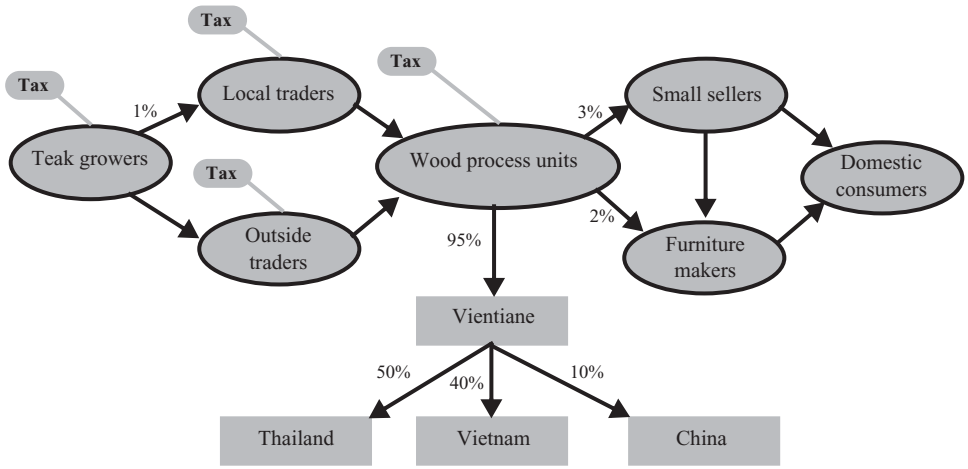

Figure 3.2 Marketing channel of teak logs in Luang Prabang province, Lao PDR (Keonakhone 2005)

Market channels for teak

Farm income from teak sales is influenced by transparency in the supply chain. Keonakhone (2005) described the teak market flow, illustrated in Figure 3.2, and showed that because growers could not access processing units directly, their teak trees were sold via local and outside traders. It was estimated that 99% of the teak logs in a village were bought by outside traders and only 1% by a local trader.

Keonakhone (2005) estimated that about 95% of the teak wood produced in Luang Prabang province was exported. The remaining 5% of the teak logs were used locally, mainly in the form of residues obtained from pre-processing. Of this 5%, 60% (in absolute numbers) was sold to small sellers and 40% was used for making furniture in Luang Prabang. Savathvong (pers. comm. 2006) estimated that about 50% of the squared teak logs produced in Luang Prabang was exported to Thailand, 40% to Vietnam and 10% to China.

Southitham (2001) estimated that the processing of teak into furniture or flooring can generate 10–40 times the price paid for a standing tree. He also estimated that processing to final products increases the mill-door price of logs or squared logs delivered to a furniture factory in Vientiane by a factor of 20.

Adequate market information and effective links with traders and processors are seen as critical to the successful production of teak and other forestry and agricultural commodities. Few, if any, grower groups have been established and local knowledge of market chains is extremely limited.

Availability of teak for future markets

Southitham's estimate of 4,000 m^3 of logs harvested in 2001 was based on a teak estate of 500 ha which was over the age of 15 years at that time. Based on an assumed (and modest) average mean annual increment of 5 m^3/ha for teak smallholdings in Luang Prabang province, and the annual establishment figures offered by provincial authorities (see Figure 4.1), this log harvest could increase to 18,000 m^3 in 2010 and 60,000 m^3 in 2020. The availability of this commercially significant volume of high-value plantation hardwood offers substantial opportunities for value-adding above that currently being undertaken in Laos. The current (estimated) log harvest, with low technology and inaccurate primary conversion to squared logs (yielding a recovery of only 50%), is estimated to provide exports as squared logs from Luang Prabang province worth about US$560,000 annually. With the same low technology (perhaps using some of the reported existing surplus mill capacity) and assuming the same market prices, the export value of squared logs will increase to US$2.5 million in 2010 and US$8.4 million in 2020. There are opportunities to further increase the value of this expanded teak wood harvest in Luang Prabang province through improvements in primary processing productivity, conversion to sawn timber, use of kiln drying and the manufacture of basic furniture components.

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4 Socioeconomics of teak smallholdings in Luang Prabang province

Thailand, Malaysia, Ghana, India, Brazil and Costa Rica have significant numbers of teak smallholdings, reflecting confidence in the reputation and future of teak (Ball et al. 1999). In Java farmers are increasingly planting teak as an investment and to meet the future wood needs of their children (Bhat and Ma 2004). Nair and Souvannavong (2000) and Subramanian et al. (1999) also noted the emergence of teak cultivation by farmers as an integral part of farming systems, in small woodlots, in home gardens or in mixtures with other trees and agricultural crops.

In northern Laos the physical geography and social conditions limit land-use options. The main land-use pattern is shifting cultivation, which is primarily semisubsistence agriculture. There is limited forest cover and sloping land dominates. Widespread poverty and low food security are compounded by limited access to markets. As population increases and densities near the roads change due to resettlement programs, land use intensifies and areas of commercial field crops and teak smallholdings expand (Mahathirath et al. 2001).

Within this setting, teak planting has flourished in Luang Prabang province. Teak is preferred to other perennial tree species because of perceived demand certainty. It is also easy to propagate and manage, grows fast in the early years and is tolerant to fire. Hansen et al. (1997) identified a number of predisposing changes in Laos which fostered enthusiasm and confidence for planting teak, including:

1. depletion of wood supply from natural forest and the emergence of a market for relatively young teak timber (15–20 years old)
2. the possibility of and confidence in secure private land tenure (after periods of insecure tenure and doubts about government land policy, farmers became assured of their user rights to land used productively, including for tree planting)
3. the permanent settlement pattern adopted by most villages (after years of war and unregulated access to land, the Lao PDR Government encouraged permanent settlements and farmers were less likely to resettle at frequent intervals; thus, long-term investments such as teak plantations became more realistic)
4. expansion of the road system, which made plantations possible in new areas (consequently, very few plantations are established away from the roads, since farmers do not expect investors to be interested in buying inaccessible timber or land)
5. land allocation schemes that give additional land for the production of perennials (in principle, 1 ha of land can be allocated to each household specifically for planting timber or fruit trees, but farmers lose the right to such land if it is used for other purposes)
6. promotion by private investors through financial support, the production of stumps and information dissemination
7. promotion and provision of extension services by government agencies.

Teak plantations in Luang Prabang province are predominantly privately owned (Savathvong, pers. comm. 2006), with only 2% of the area (233 ha) managed by the government. Private plantings have been recorded in northern Laos since 1950. As the network of roads in the province has expanded, teak planting has become an option for many more farmers. Teak has been established in a mosaic of small blocks, ranging from 0.1 to 1.0 ha, with most trees in a single block being of the same age. There has been a boom in teak planting near Luang Prabang, with the total area increasing from 500 ha to almost 10,000 ha over the past 15 years, as shown in Figure 4.1. This privately owned estate has become a significant asset, with an estimated standing market value US$80 million (based on an average price of US$10 per tree at age 15–20 years) and an estimated semi-processed value (as export squared logs) of US$332 million.

Roder et al. (1995) identified teak as the most important perennial species planted on upland fields

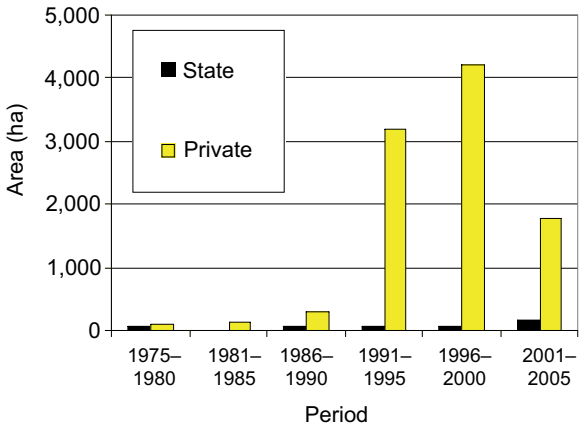

Figure 4.1 Recent establishment of teak plantations, Luang Prabang province (Savathvong, pers. comm. 2006)

in northern Laos. He also noted that farmers growing teak were more likely to belong to the lowland ethnic groups (Lao Loum) and to own lowland rice fields. They found that farmers favoured teak over fruit trees and coffee because of its better market potential. The main reasons for planting teak were to produce cash income or wood for construction (82%). Securing land tenure was of less importance (18%). The main reasons cited for not planting teak were insufficient financial resources (41%), non-availability of land (39%), lack of seedlings (35%), lack of labour (28%) and lack of experience (13%).

In a study of five villages in Luang Prabang province in 1997 Xayvongsa (2001, reported in Southitham 2001) confirmed that 15% of annual household income was derived from the sale of teak trees. In the villages studied teak wood production was the second most important agricultural source of income, ahead of livestock.

Hansen et al. (1997) also found that the most common reasons given by growers for establishing teak plantations were to:

1. sell timber
2. use the timber domestically for construction of houses, boats etc.
3. use the plantations as collateral for obtaining credit
4. ensure land-use rights
5. sell the plantations to investors shortly after establishment.

Farmers have obtained loans of between 40% and 60% of the estimated value of their plantation. Hansen et al. (1997) estimated that 1 ha of 3-year-old trees could be sufficient for a loan of US$1,000–1,500. The authorities have, in recent years, implemented land allocation schemes that assign up to four plots of land per family for cyclical shifting cultivation. In addition, each household can obtain 1 ha of land for production of perennials. Although many households have planted teak on this land, a significant number may not be capable or motivated to manage such plantations, which are therefore likely to be sold.

Hansen et al. (1997) also found that farmers usually claim that selling timber or using the wood domestically are the main reasons for planting teak. This was in line with the official development strategy, which was promoted through the extension system. However, the study found that a more likely, but unstated, motivation for upland farmers is the possibility of selling the plantations when just 1–3 years old to investors such as local businessmen and government staff. Hansen et al. (1997) and Kolmert (2001) reflected on the opportunity to sell teak plantations soon after establishment. In 1996, depending on the location and the age of the trees, growers could expect to sell plantations for US$700–2,000/ha. While it was expected that the sale would include only the trees at maturity, many such arrangements include the land as well.

In 1997 extension staff estimated that, given the opportunity, 80–90% of upland farmers would sell their plantations. Between 1993 and 1997 this occurred in villages close to Luang Prabang. In some villages it was reported that the establishment of plantations was financed by external investors, who took over the land-use rights after farmers' intercropping had ceased. Ambiguity surrounding the laws for transfer of tenure rights at that time was largely responsible for this activity. Kolmert (2001) also reported that prior to 1997 several farmers took the opportunity to plant teak on sites adjacent to roads, and to sell these blocks after 3 years to investors from Luang Prabang and Vientiane. This led to the alienation of some high-quality agricultural land to teak plantations. New legislation since 1997 restricts teak establishment on flat agricultural land and allows growers to sell the trees, but not the land, in a teak plantation.

Hansen et al. (1997) also found that domestic use of teak is a marginal motivation to farmers, as shown by the near absence of teak in those villages without road or river access. However, it is likely that small-scale teak plantings for home construction may increase, even in remote areas, as the natural wood supply diminishes, as shifting cultivation communities become more settled, and as farmers get easier access to planting material.

Keonakhone (2005) reported on the role of teak in the household economy in villages in Luang Prabang province, using data from a survey under the collaborative and multilateral LUSLOF project in 2005. The objective of this survey was to examine constraints and improve the management of teak through better knowledge of the teak market, the household economy and the relationships between trees and soil in teak plantations. Four villages where teak smallholdings had been a feature of land management for about three generations were studied. Growers used teak for house construction, sale and barter. Results from the study, shown in Figure 4.2, revealed that teak was a more significant part of the household economy for those who were relatively better off in the villages (52%) than for the poorer groups (14%), where rice accounted for the dominant part (32%) of the total household income. It was suggested that poorer groups used most of their land to grow rice and other crops for home consumption rather than to plant teak.

Farmers in the Luang Prabang province, especially those near road or river access, remain highly motivated to plant teak. This is confirmed through the figures of the Provincial Agriculture and Forestry Extension Service, which expects to grow and distribute some 4 million stumps and seedlings in 2006. This government-supplied planting stock is sufficient to plant an area equivalent to some 3,600 ha. The research found that most growers produce their own planting material, an observation also made by Kolmert (2001) who estimated that 71% of teak

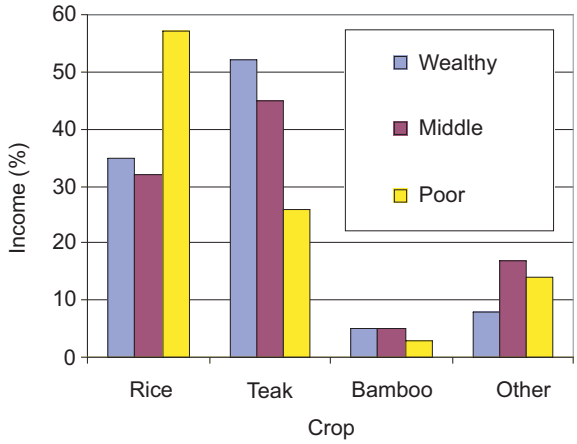

Figure 4.2 Income from rice, teak, bamboo and other plants as a fraction of total income from farm production in Pak Check village (LUSLOF fieldwork report in Keonakhone 2005)

stumps planted on private lands had been prepared by the growers themselves. These findings suggest that teak plantings in 2006 could be as large as 7,000 ha in Luang Prabang province.

Emerging regulations relating to teak smallholdings

Faced with the challenge of fostering wise management of the large, expanding and valuable community teak resource, the Provincial Governor of Luang Prabang issued updated administrative guidelines in 2004. These relate to the sale of trees and logs, timber processing and export of semiprocessed logs (Appendix 6). The guidelines require traders and processors to be licensed and smallholdings to be registered, and they clearly enunciate tax obligations. These guidelines impose a level of government control and involvement not imposed on any other privately grown agricultural crops in the province. While the new regulations will bring a measure of structure and control to the booming teak plantation business surrounding Luang Prabang, the requirement for government licences, surveys and approvals may prove to be a barrier to expansion of successful businesses.

Land allocation and national policies

The Forestry Strategy offers a history and context for the plantation sector in the Lao PDR. Tree planting has been a national priority since liberation. In 1979 PM's Provision No. 74 promoted tree planting on bare land, and in 1980 a National Tree Planting Day (1 June) was designated. Under the current 5-Year National Socio-Economic Development Plan (2001–2006) tree planting for commodity production is strongly promoted, with a target of 134,000 ha. Annual planting areas and seedling production targets are set in the National Socio-Economic Development Plans and distributed to provinces for implementation.

Land is state-owned and allocated to farmers for short-term use. Although villagers describe land as being 'sold', in the official view the transactions would involve only the rights to land use. The land law provides for the allocation of land-use rights to families with a maximum of 1 ha for paddy rice, 3 ha for orchards, 3 ha for commercial tree planting and 15 ha of grassland for livestock. Farmers can also apply to lease more land.

In upland areas shifting cultivation forms the basis of agricultural production. It is a sustainable form of production if fallow periods are sufficiently long for soil fertility to be restored. However, fallow periods are becoming shorter as a result of increased population pressure. The policy objective of the Government of Lao PDR (GoL) is to reduce and stabilise the area under shifting cultivation through a variety of measures and schemes, including resettlement of upland villages and the introduction of sustainable production systems such as agroforestry and plantation forestry (SIDA 2004).

The forestland-use planning allocation process (FLUPLA) remains the primary mechanism to implement GoL policies on allocation of land-use rights to rural villagers, tax collection and stabilisation of shifting cultivation (Sigaty 2003). This process aims to: convert shifting cultivation practices to other forms of agriculture production to stabilise the livelihoods of rural populations; reduce land conflicts; increase production of agricultural commodities; and increase forest protection and prevent illegal timber harvest and forest fires. The FLUPLA program allocates degraded land to households at the village level for commodity production and tree planting through temporary land-use certificates (TLUCs).

The allocation process for the purpose of planting trees is supported by legislation including the Land Law, Forestry Law and the Prime Minister's Instruction on Implementation of the Land and Forest Allocation Process. Besides the Forestry Law, specific support for tree planting is provided in MAF Regulations No. 196/2000 on Tree Plantation Development and No. 1849/2000 on Tree Plantation Registration; and the annual PM Orders regulating forestry activities (PMO 11/99, PMO 10/2000, PMO 15/01 and PMO 18/02).

Within this legislative framework the state authorises individuals and households within a village to use 3 ha of degraded forestland per labourer in a family for tree planting. Those who wish to use more can apply for a lease from the state. In practice the district administrative authorities coordinate with village authorities to allocate the 3-year TLUCs to plant trees on degraded forestland not suitable for agriculture. The provincial land office should convert TLUCs to permanent land title after 3 years if the land has been used for its intended purposes consistent with regulations and without claims or disputes.

A 2003 report by the Asian Development Bank (ADB) indicated that, since 1991, 600,000 to 900,000 TLUCs had been issued in over 5,000 villages, but none had been converted to permanent title. This was primarily due to lack of clear and efficient guidelines for titling rural land and the reluctance of village authorities to subject themselves to a land titling system that potentially restricts their traditional land tenure and use patterns (Xaynari and Sigaty 2003).

To achieve targets GoL provides incentives, including allocation or lease of land for tree planting, property rights on planted trees, land tax exemption for registered plantations and free distribution of seedlings to farmers and organisations.

Land allocation is a sensitive and complex issue in the Lao PDR. A number of useful references in a series of land policy studies conducted by the Lao Land Titling Project II in the Lao PDR in preparation for a coherent and comprehensive 'National Land Policy Statement for Lao PDR' by 2007 provide useful background (Schumann et al. 2006; Soulivanh et al. 2004, 2005).

Midgley, S., Blyth, M., Mounlamai, K., Midgley, D. and Brown, A. 2007. Towards improving profitability of teak in integrated smallholder farming systems in northern Laos. ACIAR Technical Reports No. 64.

5 Smallholder study: Village growers in Xieng Ngeun and Luang Prabang districts

A socioeconomic study was undertaken in three teak-growing villages close to the Nam Khan River, south-east of Luang Prabang city in Luang Prabang province. The three villages selected were: Ban Gok Gniew in Luang Prabang district, and Ban Xieng Lom and Ban En in Xieng Ngeun district, as shown in Figure 5.1. These villages were chosen on the basis of their long history of private teak planting (smallholdings in Ban Gok Gniew were established in 1962—Sinhotha, pers comm. 2006), a demonstrated willingness to try new cash crops, and an expectation that villagers would be happy to share with us in meetings and interviews data and information on their current farming activities and their intentions for the future. This chapter outlines the background to the smallholder study and describes the current physical, social, land-use and institutional conditions governing the smallholders.

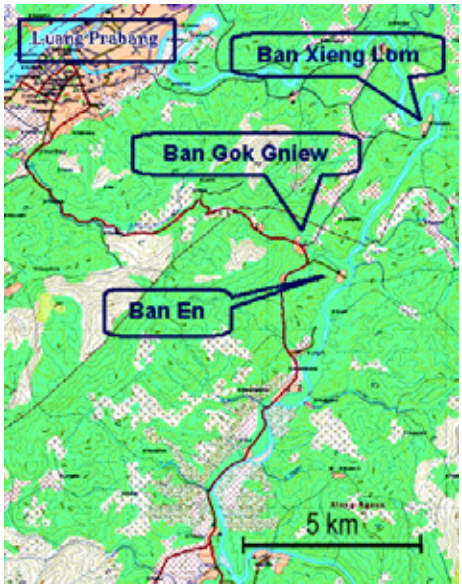

Figure 5.1 Location of study villages

Survey procedure

Survey data were gathered through interviews and meetings in the three villages using two structured questionnaires. These are reproduced in Appendix 2. Meetings were arranged with the Ni Ban (village heads) of each village to explain the nature and purpose of the community meetings and individual interviews. Each Ni Ban provided some basic statistics for each village, and subsequently arranged for meetings and discussions with interested teak growers. The meetings and interviews were conducted over one day in each village during June 2006.

The process had to be sensitively managed, as early June is one of the busiest times on the agricultural calendar. The Women's Committee from each village arranged for lunch and refreshments for meeting participants. A total of 58 people participated in community meetings and discussions, and 15 growers participated in face-to-face interviews. At Ban Gok Gniew some people from neighbouring villages (Ban Laksip, 'Km 10') also attended the meeting as they had a strong interest in the profitable cultivation of teak. The details are shown in Table 5.1.

Table 5.1 Sources of local information: Ban Gok Gniew, Ban Xieng Lom and Ban En

Activity	Village		
	Ban Gok Gniew	Ban Xieng Lom	Ban En
Ni Ban interview	1	1	1
Community meeting (no. of participants)	28	11	19
Structured interviews	5	5	5

Attendance at all meetings was voluntary (Figure 5.2). Selection of the five interviewees in each village was made by the Ni Ban and based on two main criteria: family self-sufficiency and available land to participate in any future experimental trials (3–5-year time frame). In addition, the Ni Ban told interviewees that they would be expected to contribute towards labour requirements associated with any future on-farm experiments in the event of a project being developed.

Village conditions

Physical

The altitude of the villages is 360–390 m above sea level. Each village has good road access and all are close to the main highway running south from Luang Prabang to Vientiane. Traditional river transport has fostered strong links between Ban En and Ban Xieng Lom. The three villages are close physically and there are strong family ties between the three. Ban En was established in 1840, Ban Xieng Lom in 1852 and Ban Gok Gniew, more recently, in 1935. They are predominantly farming villages and have soils of good agricultural quality.

Given their proximity to Luang Prabang and its growing tourist industry, and their location by the banks of the Nam Khan River, Ban En and Ban Xieng Lom are experiencing increased exposure to travellers making day trips by canoe to Luang Prabang. Increased numbers of bicycle travellers, on a day loop route from Luang Prabang, are passing through Ban Gok Gniew and Ban Xieng Lom.

Social

The average family size for the three villages was 6.4 persons. On average 3 persons from each family worked on the farm. Of the farmers interviewed, 80% received part of their income from off-farm work such as government employment or through taxi ownership. Off-farm income for the 15 farmers interviewed averaged 38% of their total income, with farming activities generating the remainder.

Sixty per cent of the farmers interviewed owned at least one motor cycle, while just over 70% had at least one bicycle. Only a third of the farmers had a cultivator, with most using manual labour to prepare fields for planting. All respondents had at least one television and about 70% had either a landline telephone or a mobile telephone. These data are presented in Table 5.2.

Within the cultures of the diverse ethnic groups in northern Laos there are perceptions of the roles, activities, responsibilities and needs of men and women. A concern was raised and discussed during meetings that the establishment of teak woodlots or future establishment of teak-based farming systems might disadvantage one gender or the other. In the villages visited men were clearly responsible for the clearing of land and site preparation. Men and

Figure 5.2 Completing the questionnaires

women worked together during planting and both participated in weeding. Teak planting was a marginal additional activity to normal swidden management and did not, according to discussions, disadvantage either men or women. Farmers from all three villages said that decisions to plant teak or to sell teak were generally a family decision, and were not gender-based. This was confirmed during interviews with the Ni Ban in Ban Gok Gniew and Deputy Ni Ban in Ban En, but the Ni Ban at Ban Xieng Lom felt that the decision to sell teak belonged to males. Tree harvesting was done by teams of men working for the buyer of the trees, and did not involve the household. It appeared unlikely that strategies to improve productivity of teak, such as intercropping or enhanced management, would disadvantage either gender. Given the longer term benefits and the stated equality involved in making decisions about harvesting teak, it was concluded that teak and teak-based farming systems are gender neutral, with benefits accruing to both men and women within the family unit.

Table 5.2 Social characteristics of smallholders (average per smallholding)

Characteristic	Unit	Value
Family size	No.	6.4
Farm workers per family	No.	3
Motorcycle ownership	%	60
Bicycle ownership	%	73
Cultivator ownership	%	33
Television ownership	%	100
Landline telephone ownership	%	40
Mobile telephone ownership	%	47
No telephone	%	27

Source: Interviews with village smallholders, June 2006

Important social development issues identified by the community in Ban Gok Gniew were the village school, which struggles to accommodate the needs of an expanding population and neighbouring villages; and the water supply, which can no longer meet the needs of the village. Ban Gok Gniew does not receive the same level of government development funds as its neighbours in Xieng Ngeun district, which is a poor rural district. Luang Prabang district is classified as a rich district and receives fewer development funds. It is hoped that some of the additional income generated by improvements in agricultural productivity and agro-forestry land-use systems in Ban Gok Gniew may be directed towards these important social development needs.

Land-use activities

Data provided by the Ni Ban for each village indicated that teak planting was a well-established and integral part of the farming systems in all three villages, as shown in Table 5.3. At least 60% of households in each village owned teak smallholdings. The average area of teak planting ranged from 1.5 to 3.8 ha. All the farmers interviewed had teak plantings and all had intentions to plant more in the future. Table 5.4 presents details on farming activities for the surveyed villages.

Table 5.3 Village land use

Attribute	Village		
	Ban Gok Gniew	Ban Xieng Lom	Ban En
Total population	915	786	468
Total families	143	159	94
No. of teak-growing families	85	100	94
Portion of community with teak (%)	60	63	100
Area of teak plantations in village (ha)	322	150	51
Average area of family teak holding (ha)	3.8	1.5	0.54

Source: Interviews with village Ni Ban, June 2006

Table 5.4 Smallholder farming activities (average per smallholding)

Characteristic	Units	Value
Paddy	ha	0.85
Swidden	ha	3.64
Poultry	No.	23
Pigs	No.	5
Buffalo	No.	5
Teak trees	No.	3,039

Source: Interviews with village smallholders, June 2006

Growers broadly followed planting procedures described earlier in this report. Most (85%) grew their own planting material from locally collected seed, and small nurseries were common in village gardens. More than 70% of farmers preferred to plant

stumps in the fields over seedlings because of their better establishment and survival. Only two of the 15 interviewees purchased their seedlings or stumps. Based on foregoing estimates of the current rate of planting, the 2006 requirement for planting stock would have been about 37,400 seedlings or stumps, and 32,000 of these would have been produced in farmers' nurseries.

Planting was conducted at a convenient time between March and early June. Plant spacing used by farmers varied from 2 m × 2 m to 5 m × 3 m, the most popular being 3 m × 3 m. The survival of planted teak was 80–90%. New plantings were weeded up to nine times over the first 3 years. No thinning was reported and only two interviewees did any pruning. There was a perception that pruning increased epicormic growth and could devalue ultimate log quality.

Strong winds were common at Ban En and teak trees provided useful windbreaks.

Leaf-eating insects (probably *Hyblaea puera*) defoliated teak plantings in May–June, and were a concern for all farmers at Ban Gok Gniew and a few at Ban En, but were not mentioned at Ban Xieng Lom.

Farmers rarely use purchased inputs such as fertilisers or sprays to enhance crop productivity. As rotation periods shorten and land use intensifies, there may be increased need for farmers to purchase inputs to sustain productivity. On the other hand, as the market demand for organically grown produce increases, farmers will be seeking organic solutions for maintaining fertility and protecting crops from pests and disease.

Some farmers indicated that they used hired labour, especially to help with land clearing. Many smallholder families exchange labour and help each other out when there is a peak need. Labour inputs are critical to all stages of teak and other crop production. The steepness of most land limits the use of mechanical cultivators and bullocks for land preparation.

Past experience with teak and cash crops varied among the villages. In recent years farmers have planted upland rice, maize, sesame, Job's tears, pineapples, sweet potato, coffee, peanuts and soybean on their swidden land with mixed success. Grazing land close to the villages was limited, restricting livestock numbers. Farmers from the three villages indicated a willingness to try new crops on their swidden land.

Companion crops

Despite lengthy experience in growing teak as a stage in the management of their swidden fields, growers had not considered actively combining the growth of trees and companion crops for extended periods. They saw considerable attraction in growing two crops on the same block at the same time, as this offered potentially more money as well as security if the price for one crop declined. Growers recognised that there was insufficient light for their existing suite of companion crops under closely planted teak, and were curious as to what crops might be tried and how they would be combined.

The villagers had responded positively to government calls to revise agronomic practices to limit soil erosion. In the late 1980s, in response to encouragement from government officials, farmers planted a tree variety of leucaena (possibly K8) after harvest on swidden fields. The attraction was that fast-grown leucaena would be suitable for charcoal production and could be sold in Luang Prabang and other local markets. Unfortunately, although the leucaena grew well, there was poor market acceptance for leucaena charcoal and the system collapsed.

Recent visitors to Ban Xieng Lom had promoted planting of *Aquilaria*, but seemingly offered a biased assessment of this tree crop. Farmers were not receptive to these promotions in view of the perceived high risk and limited information on potential returns.

Smallholder teak growers regard each tree planted as having a future potential value, which explains their reluctance to remove trees in thinning operations. Should external or domestic agencies wish to demonstrate the benefits of thinning on smallholders' teak plots, some recompense would be expected for the trees removed. If use of small teak logs becomes financially attractive and markets for small logs emerge, farmers indicated a willingness to remove trees as thinnings.

Following harvesting of their trees, most farmers indicated an interest in continuing with teak, either replanting teak stumps (50%) or managing coppice regrowth (43%). However, farmers' knowledge of profitable management of coppicing was limited.

Motivation for growing teak

Villagers expressed a range of motivations for growing teak, most of which were in accord with those found in earlier studies. The most commonly stated reasons for planting were income generation

and the prospect of future commercial sales, as well as a commitment to creating household wealth for children and future generations. The successful history of teak in all three villages had demonstrated the long-term benefits that can accrue from teak planting, and were a good example to current growers.

People were extremely confident about the long-term prospects for teak, described by one interviewee as being 'better than putting your money in the bank'. Growers regarded their teak plantings as a secure and negotiable source of wealth that could be drawn on in times of need and that provided a measure of household financial security. Teak trees were sold in response to immediate financial needs (e.g., births, marriages, deaths and schooling were all quoted as reasons for selling trees) or simply to make a withdrawal from their 'teak bank'.

While recognising the value of other hardwoods, teak growers felt that other high-value trees required long rotations that were unacceptable. One interviewee from Ban En expressed an interest in agarwood (*Aquilaria* sp.) and another from Ban Xieng Lom in smallholder rubber.

From discussions at meetings and interviews, it is clear that there is a common expectation that teak smallholdings in all three villages will continue to increase. All growers who participated in the structured interviews had plans to expand their area of teak when the opportunity presented itself—either when they had clear tenure over a block of land or when teak planting suited their swidden cycle. The 15 interviewees collectively estimated that they would plant (or had planted) about 2 ha in 2006. Assuming that other teak growers in these villages have similar planting intentions, the combined teak plantation estate in the three villages could expand by 37 ha in 2006.

Land ownership and tenure

All growers interviewed owned the land on which they had planted teak. Village discussions confirmed that, in the past, teak plantings were regarded as a good way to establish secure land tenure. This is consistent with the findings of previous studies in the province (Fogdestam and Gålnander 2004; Hansen et al. 1997; Keonakhone 2005; Kolmert 2001; Southitham 2001). Although there were many credible reports of investors from Luang Prabang and Vientiane purchasing blocks of teak on village land, this topic was avoided by villagers both in open discussion and in formal interviews, but spoken of in informal conversation. Teak plantings had been sold in times of financial stress, usually at very low prices. There was no market price index or information service that allowed landholders to make a reasonable assessment of the value of either their land or teak trees. Ambiguity surrounds the sale of plantations in this area. While some growers believe that they have sold only the trees to investors, others understand that they have sold the land as well. In Ban Gok Gniew, which has grown significantly in recent years due to relocation and movement from other villages, the original families controlled most accessible land and most of the teak plantations.

Despite the potential, no consideration has been given to renting land to investors for teak planting. There was no knowledge of rents that might be charged.

Markets

The major attractions for teak were its perceived reliable long-term market demand, stability of prices and being able to sell trees all year round (i.e. not confined to any particular season). As an asset with increasing market value, teak plantings played an important role in increasing household wealth, and were drawn upon in times of financial need. Teak is treated as a capital asset rather than another land-use enterprise.

Most growers intend to begin selling their teak trees once they reach 15 years of age, when they are expected to be 22–25 cm dbh. Farmers' expected prices for trees of this size and age vary widely from 100,000 to 200,000 kip per tree, a reflection of the way the market works and the power of the traders in setting prices. For a farmer, selling a tree is like withdrawing money from the bank to pay for urgent family needs. The buyers exploit this situation as well as farmers' limited market knowledge and experience. For example, a smallholder from Ban Xieng Lom was paid only 120,000 kip (US$12) for a standing tree of 35 cm diameter because she needed money quickly for medical reasons. Under different circumstances, with less urgency and more market information, such a tree could fetch more than twice that price.

Most farmers sell one tree at a time rather than a whole plot of trees. The buyer arranges for the removal of the tree and its transport to the market.

The supply chain for annual cash crops and the operations of markets for these crops were poorly understood by farmers. Farmers found them to be volatile and unreliable, and most preferred to sell their surplus produce directly to informal markets in nearby villages.

Market information

At all meetings and in all interviews farmers expressed their frustration at not having access to reliable market information for teak, cash crops and non-timber forest products. They felt totally at the mercy of traders and were obliged to accept whatever prices were offered. There was no mechanism for growers to obtain accurate market information to assist them to negotiate with buyers from a position of greater strength. In addition, there was no mechanism within the village to share and disseminate information. The growers of teak and other crops have not established growers' associations, cooperatives or other forums for representing their commercial interests, negotiating with traders or exchanging information.

There was a lack of awareness among participants of how much their teak plantations were really worth and of being able to use their teak plantations as collateral for bank loans. This perhaps reflects both the villagers' traditional suspicion of banks and a lack of proactivity on the part of the banks.

Opportunities for value-adding

The meetings and discussions revealed that farmers were keen to examine opportunities for primary processing of cash crops, believing that this would help buffer them against seasonal price fluctuations. Processes of interest included cheap, labour-saving ways to husk maize, and preparation of sesame oil should sesame prices again collapse.

Information, research and extension

A great deal of information has been published on the community teak plantations of northern Laos but none of this was accessible in the three villages studied. The interviews revealed poor access to extension services, which were either underused or unavailable. The teak growers interviewed were unaware of the range of support and demonstration that the Provincial Agricultural and Forestry Extension Service (PAFES) and Northern Agriculture and Forestry Research Centre (NAFReC) could offer. No extension posters or other extension material were displayed in public places such as schools, shops or community halls—a disappointing outcome for villages close to the main road and through which NAFReC staff travel each day on their way to work at their research station!

Less than 30% of the farmers surveyed used government extension services. Many farmers sought information from family members or neighbours, while a third indicated that they did not use any external sources of information to support their farming activities.

Land taxes

Respondents were asked to estimate annual land tax payable for their teak plantations. This proved to be difficult for the interviewees to provide. Land assets in the study area are assessed for tax purposes either on a simple area basis, or on an aggregate basis for a farmer's total land assets. It is not possible to divide this value between the teak and other parts of a landholding. Land taxes in Xieng Ngeun district (15,000 kip/ha/year in Ban Xieng Lom or, on the opposite side of the Nam Khan River, only 5,000 kip/ha/year, and in Ban En 10,000 kip/ha/year) are generally lower than those in Luang Prabang district. Ban En and Ban Xieng Lom have lower land taxes than Ban Gok Gniew. The typical total annual land tax for a modest land holding of 4–5 ha (including the home and agricultural land) is of the order of 150,000 kip in Ban Gok Gniew. One grower at Ban Gok Gniew reported that land tax was 3,000 kip/ha/year for unused swidden land and 13,000 kip/ha/year for teak plantations. In Ban Xieng Lom another grower reported that annual land taxes for his teak blocks were 25,000 kip/ha/year.

Cooperation and partnerships to improve profitability

All people interviewed expressed a strong and enthusiastic wish to participate in any future ACIAR-supported on-farm research—a demonstration of their interest in improving existing teak-based systems. They undertook to offer access to land and labour. At the end of any joint on-farm research, the farmers expect that the produce (including teak trees) would belong to them. They also expected that they would be adequately reimbursed for any trees

removed during the collaboration (i.e. for thinning trials or demonstration) because they were not convinced that thinning enhanced long-term returns from their plantings. Because of their willingness to try new things and their relative proximity to the highway and to Luang Prabang, the villagers at Ban Gok Gniew had frequently been approached for surveys and participation in research. Their experience had been that agencies collect information and then simply leave the village, avoiding any responsibility for delivering any results of their work.

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6 Economic aspects of integrated teak farming systems

Recent changes in policy and the institutional environment are influencing teak planting decisions and contributing to changes in land-use patterns in the uplands of Laos. Farming systems are in a period of transition, with governments, communities and individual smallholders seeking options that are economically attractive and sustainable over the long term.

Stabilising agriculture

Increasing interest in planting teak in Laos (Figure 6.1) is being driven by government policy decisions coupled with environmental, social and economic factors. Since 2001 the Government of Lao PDR has pursued the protection of natural forest, discouraged shifting cultivation practices and established permanent subsistence areas. The protection of soil and water resources, especially in steep country, has also been an objective of both the national and provincial governments. In Luang Prabang province the governor has promoted the integration of forestry and agriculture within permanent subsistence areas in an effort to alleviate poverty and improve the livelihoods of smallholders in the province.

Agricultural land use in the uplands of Laos is going through a major transition from shifting agriculture to sedentary agriculture. The Government of Lao PDR plans to eradicate shifting cultivation by 2010. At the same time the government is decentralising power, conferring responsibility for meeting central government targets on provincial and district authorities (NAFRI 2004). Important policy targets include the stabilisation of shifting agriculture, eradication of opium cultivation, reduction in the number of village administration units, and improvement in land-use planning and land allocation. The National Growth and Poverty Eradication Strategy (NGRES) of the central government is aimed at increasing collaboration between agencies and provinces to ensure greater harmonisation of action plans to meet agreed targets.

Figure 6.1 Newly planted teak

A workshop held in Luang Prabang in January 2004 revealed that rural communities practising shifting cultivation in the uplands have experienced a worsening of their livelihoods under these changes (NAFRI 2004). This was associated with the ineffectiveness of policy implementation, policy inconsistencies, inadequate extension services, underinvestment in market services and inadequate access to rural credit and development funds for farmers.

One of the critical changes for smallholders associated with the stabilisation of shifting cultivation is shortening of the fallow period. To maintain family livelihoods and land productivity, changed farming practices are likely to be introduced over the next decade. These may include:

- increased use of purchased inputs which embody technological advances
- the need for more technical knowledge associated with new crops and farming practices
- closer integration with the market economy
- labour management in more diverse production systems
- gaining access to and use of additional land resources.

The learning curve associated with these changes 'can be long and difficult' (Van Gabsberghe 2005, p. 53).

Food security remains the top priority for all farmers, ahead of cash crops and other alternative land uses such as trees. Because cash crops are subject to production and price risk, farmers will seek options that provide diversity and a buffer against variable returns. Other issues of importance, as production systems intensify, include:

- the need for more farm fencing
- better management of water resources
- complementary development of infrastructure to facilitate the transport of farm produce to markets
- fair prices for farmers.

Profitable integration of teak into smallholder farming systems

Teak is a priority tree species for plantation expansion. Planting targets have been set by government and incentives provided to growers to establish plantations. Teak is preferred to other perennials because it grows quickly in the early years, is easy to manage and is fire tolerant. Most farmers from the three villages in Luang Prabang province who responded to our survey nominated the commercial attractiveness of teak as the primary reason for planting it. This is associated with farmers' perceptions that demand for teak is likely to continue to grow. Given their treatment of teak as a capital investment, they are also attracted by its relatively stable and high price compared to other tree species, and the ability to sell trees at any time during the year or at convenient times during the rotation.

Other factors that facilitate the integration of teak plantings into upland farming systems include (Hansen et al. 2005):

- the possibility of securing private land tenure
- government promotion and extension services
- the permanent settlement pattern adopted by most villages (despite practising shifting cultivation, village sites have tended to remain fixed)
- expansion of the road system which makes plantations possible in new regions (plantings tend to occur close to roads to facilitate harvesting and transport to processors or traders)
- land allocation schemes that provide additional land for perennial crops
- the depletion of wood from natural forests and the emergence of markets for younger teak wood
- promotion by private investors through financial support, supply of planting material and technical information for tree and land management.

Constraints

In Chapter 2 it was noted that, despite its attractions, the benefits of teak plantings are limited by:

- poor management, especially insufficient pruning and delayed thinning of trees
- use of inferior genetic material because of the strong demand, limited supplies of improved seeds and associated high prices
- competition with agriculture for arable land, resulting in teak being planted on marginal land, as border plantings or in small plantations
- length of rotation and the difficulty for farmers to retain trees for 20–30 years.

Farmers surveyed for this study identified a number of additional constraints or difficulties that limit teak planting:

- poor infrastructure development
- unsympathetic land allocation policies
- inadequate market information systems
- limited investment in value-added processing
- conservative farmer attitudes and culture

- limited access to and use of government extension services
- farmers' scant knowledge of teak.

Efforts to successfully integrate teak into more sedentary land-use systems must tackle these limitations.

In this study some of these limitations are addressed. The options of pruned and thinned plantations are considered, as well as various intercropping alternatives including annual subsistence crops, cash crops and short-rotation perennials. Useful insights into the benefits of using improved genetic material and planting larger areas of trees per farm are also provided. While the length of rotation is a problem, especially for annual cash flow, the attractiveness of teak planting for timber production compared to annual cropping suggests that financing arrangements that support and sustain smallholders until plantation harvest would be of value to the community. Other limitations listed above are more difficult to address in this preliminary assessment but should be part of a more detailed study. Particular attitudes or perceptions of farmers that may need to change for teak to be successful include the use of modern technology, the use of borrowed funds, and treatment of teak trees as a capital investment. In this preliminary assessment of teak-based management systems we indicate how a change in attitude or approach by farmers can potentially improve their livelihood.

Current smallholder farming systems

To enable valid comparisons with teak farming enterprises, budgets and cash flows are estimated for current land uses. Upland rice production with 1–3 years of cropping followed by up to 10 years of fallow is the traditional crop rotation system. This long-fallow system provides one baseline farming enterprise for our study of alternative land-use systems. However, in view of the government's wish to reduce and stabilise long-fallow shifting cultivation by 2010, a short-fallow cropping system, which is likely to be common in the future, is also included. This is a second baseline system for comparison with teak-based systems.

Traditional long-fallow cropping systems

Upland rice is the principal crop grown within a shifting cultivation (swidden) system in the highlands of Laos. The slash-and-burn system is generally subsistence based, although most upland farmers do not produce sufficient rice to meet their annual household needs (Schiller et al. 2001; Shrestha et al. 2006).

Upland rice-based cropping is practised on a rotational basis. A single wet-season crop may be followed by a period of fallow in the range 2–10 years. A second and third rice crop may be planted, although yields decline rapidly depending on the soil conditions. Crops such as pineapples, maize and Job's tears often follow a rice crop as they are less prone to yield decline in subsequent years.

The benefits of traditional long-fallow cropping systems include partial restoration of soil fertility, reduction of soil erosion due to infrequent tillage, and little or no use of chemical pesticides and fertilisers (de Rouw 2005; Linquist et al. 2005).

Short-fallow cropping systems

The traditional long-fallow cropping system is in decline in northern Laos. Increasing population pressure has reduced fallow periods for traditional upland rice production, but compensating changes in management practices have not been introduced. As a consequence rice yields have declined and the incidence of poverty among rural communities has increased (Linquist et al. 2005). The practice is unsustainable and is likely to be replaced by shorter rotation cropping systems embodying higher levels of technology and knowledge that will reverse the decline in soil fertility and productivity.

Saito et al. (2006) concluded that 'the long-term productivity of upland rice cannot be sustained with increased cropping intensity using the current management practices. Therefore, improved crop and resource management technologies are necessary for sustainable production'.

As the uplands are in a period of land use transition, it is appropriate to take a future perspective in this study and to include farming activities and practices which may develop over the next 10–20 years. In the future upland rice production is likely to be characterised by sustainable short-fallow systems incorporating shrubby legumes which can add nitrogen and other nutrients to the soil and reduce weed competition. Research by Linquist et al. (2005) has identified a number of promising fallow species including leucaena (*Leucaena leucocephala*), pigeon pea (*Cajanus cajan*), crotalaria (*Crotalaria anagyroides*) and paper mulberry (*Broussonetia papyrifera*). Paper mulberry

is not a legume like the others but is included because it is indigenous in northern Laos and has soil-improving properties. Linquist et al. (2005) found that farmers prefer paper mulberry and pigeon pea, especially the latter, because of the higher potential economic benefits. Research into fallow technologies to stabilise upland rice farming systems in West Africa found that legumes can suppress weeds and offer the potential to sustain rice yields under intensified cropping (West Africa Rice Development Association 1999).

In view of the attraction of paper mulberry, and given its potential as a companion crop for teak, a rice–paper mulberry rotation is selected as an alternative baseline farming system for comparative purposes.

Rice–paper mulberry

After the rice is sown and established the paper mulberry can be planted and continues to grow after the rice has been harvested. Paper mulberry is harvested 18 months to 2 years after establishment. Harvesting continues until the next rice crop, at which stage the trees are cut down and the field prepared for the rice crop. Paper mulberry regenerates from roots, stems and seeds during the next rice growing season. However, survival is better for seedlings (80%) compared to root suckers (42%).

Paper mulberry is not intensively managed in existing systems, but as market prospects improve that is likely to change. Furthermore, labour requirements for paper mulberry complement those for rice, which adds to its attraction as a short-fallow rotation species. On the downside, however, paper mulberry fields have to be fenced as cows and buffalo like to graze it. Linquist et al. (2005) found that rice yields in the first year when paper mulberry was established were 1.83 t/ha, which is 14% above natural fallow rice yields (i.e. without a fallow crop). Rice yields decline in the second year as the paper mulberry growth increases.

Teak farming systems

Teak has been cultivated in the Lao uplands for over 60 years. It is commonly grown in a taungya system (i.e. interplanted with agricultural crops) during the first 1–3 years. This makes weeding easier after establishment and is less demanding on labour resources than if teak and food crops were planted in separate plots (Hansen et al. 1997, p. 8). After the third year of production, intercropping ceases as shading by the young teak trees limits the production of the companion crops.

Various initial planting or stocking rates are used for commercial teak plantations. Where the aim is to produce large marketable logs in the shortest time, a spacing of 3 m × 3 m is typically used. However, where it is important to maintain sufficient light to support companion crops, a wider spacing is preferred. Government extension services advise farmers to use the 3 m × 3 m spacing, and almost 50% of the farmers surveyed for this study used this spacing. In the absence of attractive and proven combinations of crops and trees, many growers near Luang Prabang favour closer spacing including 2 m × 2 m and 2 m × 3 m. At these densities the teak trees soon capture the available light, nutrients and moisture on a site and limit aggressive understorey growth, reducing the frequency of weeding and simplifying future clearing should the land be converted to agricultural use. On the other hand, wider spacing offers the opportunity for intercropping with companion crops for a number of years but increases the risk of weed growth to the farmer, especially when the companion crops are harvested.

Once the teak is established the trees receive minimal attention, with the exception of removing diseased and dead trees. Few farmers prune the lower branches or forked trees and thinning is not practised until about year 15, when the larger and best-formed trees are selected for harvest.

In 1997 regulations were introduced restricting planting of teak on agricultural land with a slope of less than 12%. Extension services advise farmers to plant teak on marginal land, not on their good agricultural land.

Clearly there is much scope for improving the productivity and profitability of teak in northern Laos. However, any improvement is not simply a matter of technology but must also involve consideration of culture, family needs (food security), financial capacity and farmers' technical knowledge and skills.

Teak farming systems appraised in this study include:

- long-fallow rice–cash crop (e.g. pineapples, Job's tears or sesame)–teak with and without pruning and thinning
- rice–teak intercropped with paper mulberry with wide spacing, pruning and thinning.

Thinning and pruning teak

Thinning is the deliberate reduction of the number of trees growing in a stand. There are many benefits associated with thinning. Reducing the number of trees in a stand potentially favours vigorous trees of good form by providing more space for crown and root development, enabling remaining trees to reach an optimum size sooner. Larger trees command better market prices. In addition, thinning may remove dead or diseased trees for reasons of stand hygiene (Evans and Turnbull 2004).

Thinning is a common practice in commercial teak plantations to maximise production of large, high-quality logs. Typically, in an intensively managed plantation with an initial spacing of 3 m × 3 m (equivalent to 1,100 trees/ha) and a rotation of 20 years, non-commercial thinning is scheduled at 4 years of age (to 500 stems/ha), followed by a commercial thinning at 14 years (to 125 trees/ha) before final harvest at 20 years. In a study conducted near Luang Prabang, Keonakhone (2005) found that thinning resulted in greater annual volume increment. Southitham (2001) found that diameter growth and 'commercial height' (log length) of teak were both increased by thinning.

Smallholder growers near Luang Prabang consider all planted trees to have some commercial worth. Consequently they manage their trees to generate cash flow as early as possible. They remove and sell larger trees from unthinned stands as soon as the trees reach a saleable size, normally at about 15 years of age. This practice ('thinning from above'), while responding to immediate household needs for income, significantly reduces the opportunity to produce high-value larger logs later in the rotation. In village discussions it was clear that the growers are not convinced of the long-term benefits of more conventional thinning 'from below'. Markets for small thinnings—below 15 cm dbh—do not exist and they see removal of such trees as a waste. Growers also reported an increase in epicormic shoots and side branches on the remaining trees after removal of trees for sale, which is consistent with observations by others (Krishnapillay 2000).

If teak is to be grown in association with companion crops, thinning can prolong the period during which these crops can be grown. However, if thinning is to be accepted by smallholders, there is a need to develop local markets for the small-diameter logs.

Pruning in commercial plantations of high-value tropical hardwoods is undertaken to improve stem and wood quality and to increase market value. Pruning removes branches from the stem while they are small to produce high-value knot-free timber. Pruning also provides an opportunity to manipulate the tree canopy to offer more light to companion crops. Initial spacing, thinning and pruning interact with each other in a complex manner to influence stand value.

Most teak trees observed near Luang Prabang demonstrated good apical dominance and form. The close initial spacing used by growers had limited the development of side branches, and pruning was not regarded as a high priority. In a study near Luang Prabang, however, Keonakhone (2005) reported that pruning had a positive effect on tree growth, although growers interviewed for this study were unaware of this information. Viquez and Perez (2005), working in Costa Rica, reached a similar conclusion.

There is compelling evidence that growth rates and market values for teak grown on smallholdings in northern Laos can be significantly increased through changes in management practices. Growers surveyed were unaware of the field trials which substantiate this assessment, and remained unconvinced that any change from existing practices would improve their household incomes and cash flows. A strong case can be made for establishing highly visible and accessible demonstration blocks and using participative action research to share outcomes with growers.

Intercropping with teak

Species mixtures in agroforestry systems provide diversity and the prospect of income stability in case of market changes.

Teak planting is usually scheduled towards the end of a swidden cycle following agricultural crops such as upland rice, maize, pineapple, Job's tears and sesame; and occasionally cash crops such as peanuts and soybean grown on contract. Douangsavanh et al. (2003) reported on several local agroforestry practices in Luang Prabang province, including teak–upland rice and upland rice–teak–'mak kaen' (*Zanthoxylum* sp.) combinations. Typically, as reported in community interviews for this study, swidden crops are grown on a site for up to 5 years before weed competition and declining soil fertility prompt a change to a new site. At year 3, teak stumps or seedlings are planted and nurtured through the remainder of the swidden cycle, until they are well established and offer considerable competition to any other plants. Established teak trees

compete strongly for light and nutrients, effectively controlling weeds and woody regrowth, and allowing easy conversion should the site use revert to swidden.

Elsewhere in Asia there are examples of successful intercropping high-value hardwoods with cash crops or woody perennials. Rubber, for example, has demonstrated a considerable capacity to accommodate intercropping. Rubber intercropping systems include rubber with food crops such as rice, maize, cassava and banana; and with cash crops such as tea, coffee, sugar cane, pineapple chilli and cardamom (Raintree 2005). Smallholder growers of rubber in Xishuangbanna, southern China, successfully practise a rubber–tea agroforestry combination which balances reliable income from tea against the attractive, but volatile, income from rubber. In a series of operations rubber plants are established with crops such as rice, maize or peanuts, which are followed by pineapples and then tea in year 4. Rubber is tapped from years 6 to 30, and tea harvested from years 7 to 30.

An important consideration in the choice of crops is the timing of essential operations and the demand for labour. Table 6.1 summarises the timing of operations in our study area and indicates competitive and complementary combinations.

During the course of this study it became clear that farmers grow teak as one stage in their use of agricultural land. None had considered combining cultivation of teak with companion crops on a long-term basis. In discussions growers revealed that they did not have the knowledge to change their practices either for teak or for possible companion crops to accommodate longer term interplanting and were unaware of any market imperatives to do so.

Another recurring concern revealed in community discussions was the uncertain nature of markets for cash crops which can be grown in association with teak. This concern is shared by donor-supported projects, which have identified market limitations as a major impediment to rural development in the uplands (e.g. the SADU Project—see Chapter 8).

Village growers are at a distinct disadvantage in the supply chain. Without adequate market information, firm contracts or any ability to undertake basic primary processing, they bear considerable risk when dealing with fluctuating prices in commodity markets for crops such as maize, sesame, pineapples and Job's tears. They are further disadvantaged when they are dealing in perishable products, being unable to effectively store or process them into higher value products.

Smallholders in Luang Prabang province are familiar with the vagaries of markets and the effect on the market price when supply exceeds demand. This has been the case with pineapples. Discussions with farmers at Ban Gok Gniew, a community which has enjoyed success at cultivating and marketing pineapples for 30 years, revealed their concern at the widespread promotion (with donor project support) of pineapples to many other villages in the area. They reported that this resulted in a substantial oversupply in the 2006 season and a collapse in prices to the lowest ever.

Changing market demand for Job's tears was reported to have caused hardship for some families at Ban Gok Gniew. During a time of high demand, farmers were approached by a company offering seed in return for exclusive access to the resulting crop. When the price for Job's tears collapsed, the company abandoned the farmers and most of the crop was left to rot, and it was too late in the season for farmers to plant alternative crops. The company was exposed to minimal risk (the cost of seed and some time) while the farmers risked their season's production and lost the opportunity for some extra income.

Because of the critical importance of markets and market information, a workshop entitled 'Market information systems for agriculture and forest products' was held in Luang Prabang in July 2005. Three broad categories of crops grown for commerce in Luang Prabang province were recognised (Phaphonsai 2005):

- long-term crops—timber (such as teak) and rubber trees
- mid-term products—livestock, fruits
- short-term crops—Job's tears, sesame seed, maize, paper mulberry, soybean, sticklac and cardamom.

The workshop identified some key issues to be resolved in marketing these products:

- Luang Prabang's central but remote location, which results in high transport costs
- insufficient development in human resources, needed to improve economic and social services
- lack of quality control and irregular supply of products.

A preliminary analysis by Inthongxay and Rattantray (2005) of the marketing chains for maize and other export products in neighbouring Sayabouli province revealed that the key issues facing growers dealing with such markets were:

- lack of transparency in price information, which may result in farmers not receiving a fair price for their produce

Table 6.1 Seasonal agriculture calendar: main crops, cash crops and NTFPs[a] (based on Douangsavanh et al. 2003)

Weather and crop	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
Weather												
Wet season												
Cool season												
Hot season												
Main annual crops												
Paddy rice				Plough	Nursery	Transplant	Plant	Weed	Harvest	Harvest	Harvest	
Upland rice		Slash	Burn	Weed, prepare	Plant	Plant	Weed	Weed	Harvest	Harvest	Harvest	
Job's tears		Slash	Slash, burn	Burn, prepare	Prepare	Plant	Plant	Weed	Weed	Harvest	Harvest	
Sesame		Slash	Slash, burn	Weed, prepare	Prepare	Plant	Weed	Weed	Weed	Harvest	Harvest	
Maize		Slash	Slash, burn	Plant	Plant	Weed	Weed	Harvest	Harvest			
Vegetables	Harvest	Harvest	Plant	Plant	Weed	Harvest	Plant	Weed	Prepare	Plant	Weed	Harvest
Cash crops												
Khaem												
Posa												
Pao pet												
Cardamom												
Bamboo												
Tua mae (worms)												
NTFP planting												
Puak muak												
Cardamom												
Posa												
Ginger												

[a] The basis for this classification is not entirely clear

Midgley, S., Blyth, M., Mounlamai, K., Midgley, D. and Brown, A. 2007. Towards improving profitability of teak in integrated smallholder farming systems in northern Laos. ACIAR Technical Reports No. 64.

- storage losses, which further reduce farmers' profits
- lack of on-farm processing, which reduces farmers' ability to add value to products.

During group discussions at all three villages these three issues were raised many times, and were regarded as impediments to successful cultivation of cash crops. Any proposal to cultivate companion crops with teak must include consideration of the development of markets for these crops and the supply chain connecting growers and consumers.

One aspect of marketing not reported in the market information systems workshop, and an opportunity not considered by growers, was the potential to market swidden crops as 'organically grown produce'. Crops such as pineapples, sesame, Job's tears, maize and peanuts are all grown in swidden systems without the use of chemical fertilisers or pesticides. The large and expanding tourist industry in Luang Prabang may be receptive to marketing of organic produce, which presents an opportunity for local growers to exploit.

Possible companion crops for teak include known cash crops and plants that produce non-timber forest products. Most of the farmers interviewed had experience with commonly planted cash crops, and prospects for most of the cash crops were broadly understood. Agencies such as NAFRI have R&D and market support programs in place, but these services were not well-understood in the study villages. Details of crops commonly grown by upland farmers are presented in the following sections.

Cash crop options for growing with teak

Maize

Maize is the second most important crop in Laos after rice. It is cultivated primarily in swidden systems, and some 4,700 ha were harvested in Luang Prabang province during 2000, yielding over 10,000 t (Ministry of Agriculture and Forestry 2001). Some of this production is grown for commercial sale and export, with maize production for export to China beginning in the late 1990s in some parts of northern Laos. This expansion has affected the local farming and livelihood systems and also female labour, because women work until late at night husking the maize by hand. Informal reports demonstrate how vulnerable growers can be when participating in a contract maize production system. For example, seed grain was provided to growers at Ban Gok Gniew for 2,000 kip/kg and the husked grain was purchased by the trader for 500 kip/kg at the farm gate. Despite clear contractual agreements with the growers, the traders were reported to dishonour contracts if the market circumstances went against them. While this might reflect the reality of market forces, it demonstrates how vulnerable rural growers in northern Laos can be.

Job's tears (adlay) (*Coix lacryma-jobi* subsp. *ma-yuen*)

In mainland South-East Asia, endemic edible varieties of Job's tears have traditionally been cultivated on a small scale for household consumption, although production is decreasing as this crop is replaced by rice and maize. The grains are eaten whole in soup, or ground into flour and eaten as porridge or cakes. Farmers in parts of Luang Prabang province have begun commercial farming of introduced improved varieties of Job's tears. Each plant bears a large number of ears which mature at different times and are hand-picked as they mature. Grain is exported to Japan, which has become dependent on imported supplies for its expanding health food market (Ochiai 2002). It is also processed into beer and sweets in Japan (Nakatsuji 2004). Grain is also exported to Thailand from where it is re-exported to Taiwan. There is great potential for value-added processing within Laos for export directly to Japan, Taiwan and emerging markets in North America and Europe (Douangsavanh et al. 2003, pp. 24–25).

The changing status of edible Job's tears, from a relic minor crop to a cash crop, has had local impacts. In Chomphet district (opposite Luang Prabang city on the other side of the Mekong River) cultivation of Job's tears has increased rapidly since 2001 and, in 2003, it was the most valuable sector in the district, yielding US$300,000 (Figure 6.2) (Boomsma 2004).

As a consequence of its increasing popularity and oversupply, the price of Job's tears was reported to have dropped to 1,000 kip/kg in 2002 before recovering to 2,800 kip/kg in 2003. The Chomphet study demonstrated the unpredictable nature of markets for cash crops. Although the production of Job's tears increased enormously, maize, peanuts and soy bean production also went up in 2002 but declined in 2003.

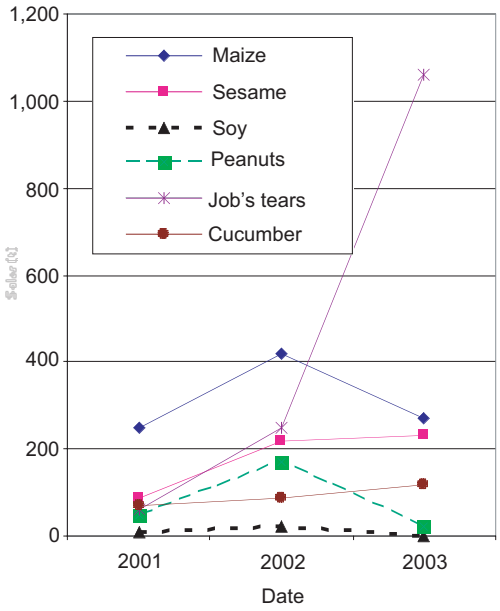

Figure 6.2 Sales volume, Chompet district crops

Sesame

Sesame is an ancient oilseed with unusually high oil content—around 50% of the seed weight, compared to 20% in the seed of soybeans. Sesame is a relatively high-value food crop, harvested for its whole seed which is used in baking, and for cooking oil which is extracted from the seed. Sesame is used widely in Lao cuisine.

Sesame (*Sesamum indicum*) is a broadleaf plant that grows to 1–1.5 m high and is adapted to areas with long growing seasons and well-drained soils. It is considered drought tolerant but needs moist soil to get established. It is not adapted to poorly drained soil and will not tolerate water-logged conditions. Soils close to a neutral pH of 7.0 are recommended.

In Chomphet district Boomsma (2004) showed that cultivation of sesame (along with Job's tears) had increased rapidly since 2001, as illustrated in Figure 6.2. In 2003 sesame was the second most valuable crop in the district, with production worth US$166,000. Its price grew strongly from 4,000 kip/kg in 2001 to 7,000 kip/kg in 2003.

Pineapples

Ban Gok Gniew is a local leader in pineapple cultivation. It is believed that plants were introduced in Laos from Singapore in the late 1950s, and subsequently were cultivated in the village. The modest prosperity that the village has enjoyed over recent years has been largely due to the demand for pineapple. In 2006 the price collapsed due to oversupply. In 2005 farmers received 10,000 kip per fruit at the farm gate, but in 2006 the farm-gate price fell to 400 kip by mid year. Three years ago donor agencies, keen to help national government policies aimed at reducing poverty, began a program to widely distribute up to 100–200 free pineapple shoots per household. The resultant increased plantings have caused a glut in a small but important market.

Potential for production of non-timber forest products in association with teak smallholdings

Non-timber forest products (NTFPs) play an important role in rural areas of Laos, where they serve a wide range of subsistence needs and provide opportunities for earning additional income. At the national level NTFPs provide about 2.5% of annual exports from Laos. Foppes and Ketphanh (2000) reported that NTFPs provide 50–55% of the cash income of rural villages, where 80% of the population lives. They estimated that the value of subsistence use of NTFPs would be equivalent to 20–30% of GNP. The reported export value of NTFPs was about US$6.3 million in 1993. Of the NTFPs exported, medicinal plants represented 70% of the total export value, followed by fibre products at 15%, resin 8%, edible products 6% and incense 2% (Vantomme et al. 2002). Most NTFPs are exported to China (especially medicinal plants), Vietnam and Thailand. Some products are exported to Japan and Europe as well.

From rural surveys villagers identified over 757 species of plants and 150 species of animals that are used. Many species have yet to be botanically identified, however, and frequently names used in reports are inconsistent (Vantomme et al. 2002). Most NTFPs are collected from the wild, and generally the resources have been exploited unsustainably. The process of domestication has begun for a few species such as *Amomum villosum* (cardamom), *Styrax tonkinensis* (benzoin), *Pentace burmanica* ('si siet' bark), *Thysanolaena maxima* (broom grass), rattan

(*Calamus* spp.), bitter bamboo shoots (*Indosasa sinica*) and tout tiang (*Boehmeria malabarica*—possibly *Debregeasia longifolia*, 'puak muak'). Currently cardamom, broom grass, rattan shoots, bamboo shoots and culms, and paper mulberry are collected from small-scale plantations, agroforests and home gardens (Foppes and Ketphanh 2000; Foppes et al. 2004; Vantomme et al. 2002).

Despite progress in domestication and modest market demand, some NTFPs may be incompatible for intercropping with high-value hardwoods. For example, although considerable progress has been made with some species of rattan, Ali and Barizan (2001) found that intercropping rattan with rubber and oil palm caused problems for both plants. The harvesting of rattan could damage the rubber, and rubber management could damage the rattan. Rattan is likely to present similar challenges when grown with teak if the trees are harvested tree-by-tree over a 10-year period. Edible shoots from rattans (*Daemonorops jenkinsiana* and *Calamus tenuis*) are a speciality in Luang Prabang cuisine. Evans (2001) reported an attractive market in South-East Asia and with Asian communities in France and the USA. It is unclear whether this specialist market would respond positively to additional supplies of edible shoots grown by interplanting among high-value hardwoods, or whether new supplies could compete with supplies from commercial planting reported elsewhere in Laos and northern Thailand (Evans 2002). Discussions with village producers of rattan shoots, 'nyot vway', near Luang Prabang revealed that harvesting was an unpleasant task due to the thorns, and that market prices were barely attractive. Given that these edible rattans prefer sites that receive regular flooding and full sunlight, it is unlikely that they would be an agronomic success with teak on well-drained slopes.

Foppes et al. (2004) identified 60 organisations working actively on NTFPs in Laos, more than 40 of which attended the NAFRI/SNV workshop entitled 'Networking non-timber forest products in Lao PDR' in 2004. Among the many issues identified at this meeting were that NTFPs were becoming rare, mainly through overexploitation, and that opportunities were being lost to Laos because of lack of market information, poor skills and few opportunities for primary processing. The value of effective marketing to increased profitability has been demonstrated in the case of bitter bamboo, 'mai khom' (*Indosasa sinica*), in northern Oudomxay province. The establishment of a sustainable harvesting system, a marketing group and clear sales guidelines fostered a sixfold increase in village income (Soydara and Ketphanh 2005).

While NTFPs are important for generating cash for subsistence farmers in Laos, Bounthong et al. (2003) noted that NTFPs are most important for poorer rural households. Research conducted by the NGO Concern in the northern province of Bokeo found that, despite NTFPs being able to contribute to income generation, their potential is not being realised because unsustainable harvesting techniques are being used and market forces generally operate against these products and their producers. Foppes and Ketphanh (2000) noted a decline in traditional forest management practices which underpin sustained production of NTFPs. The reasons for this included rapid population growth, conversion of forests to agricultural land and insecurity over land tenure.

The agronomy for most NTFPs is unproven, with only a few approaching a level of domestication that could ensure reliability in cultivation by resource-poor farmers. The added complexity of growing NTFPs in association with plantations of high-value hardwoods limits the reliability of any technical inputs, based on existing information, which might be offered to farmers. Markets from the supply side are usually unreliable, poorly formed or dependent on opportunistic trade. It is unlikely that markets will be substantially improved without increased production (risking overexploitation) or some affirmative market intervention. In the absence of expanding and reliable markets, it is difficult to see how incomes derived from most NTFPs can be increased, and it could be argued that any ongoing reliance on NTFPs commits suppliers to a subsistence livelihood, a situation at odds with the Lao PDR Government's unequivocal commitment to poverty reduction.

There are a few NTFPs which have both proven agronomy and mature markets. Among these is paper mulberry, a plant with promising market potential that has been traditionally grown and harvested in northern Laos.

Paper mulberry, *Broussonetia papyrifera* (posa-Lao)

Paper mulberry is a pioneer shrub or small tree commonly found in fallow after slash-and-burn cultivation. It is very versatile, with a wide distribution in the Pacific and Asia, including the northern Lao

provinces of Luang Prabang, Oudomxay, Phongsaly, Luang Namtha, Sayabouly and Bokeo, where it has been used for hundreds of years. A resurgence of interest in handmade paper using bast fibre of paper mulberry has resulted in expanded commercial cultivation in Thailand and Laos (POSAA 2001). Trends in production and yields for the districts of Kenthao and Paklay are presented in Table 6.2.

Paper mulberry can provide an income for rural communities and can be established either into upland crops (e.g. rice, maize or sesame) or by itself as described earlier in this chapter. The advantages of establishing it with upland crops include greater farmer acceptability and availability of income from the companion crops. In addition, yields of companion crops may not be reduced by paper mulberry (NAFRI 2004). Douangsavanh et al. (2003) report paper mulberry in existing indigenous agroforestry systems with upland rice, Job's tears and pineapple.

The agronomy of paper mulberry is well understood by growers. NAFRI advises that seedlings (raised in polybags), root suckers and root cuttings can be used as planting materials. Seedlings give the best survival and growth results, followed by root suckers. Root cuttings are not recommended because of low survival, but these could be planted first in polybags before outplanting in the field. Paper mulberry should be planted between late May and late June. Best survival is obtained when seedlings and root suckers are planted immediately after rain. The plants coppice readily after harvest.

Almost all paper mulberry grown in Laos is exported in an unprocessed state to Thailand, where it is processed for export to Japan and Korea. Demand is strong and estimated to be growing at the rate of 15–20% each year. About 18,000 t of bark are exported to Thailand from Laos each year, providing additional income to an estimated 20,000 households in northern Laos (NAFRI 2006).

Paper mulberry bark is collected and dried in Laos and then prepared for export to Thailand without grading or other value-adding. It enters Thailand worth US$0.86 million and leaves as processed paper and other finished products worth US$50 million. Given that Laos supplies 80% of the bark processed in Thailand, it should be possible for Lao traders to negotiate better prices and trade conditions, which would flow on to farmers and stimulate supply and improvements in quality control. To improve trade conditions, both the volume and quality of supplies from Laos must be improved. For example, Aubertin (2004) found that returns from paper mulberry production could be improved considerably through better grading and quality control, a sentiment strongly endorsed by Mohns (pers. comm. 2006).

Farmers in some areas are already moving to domesticate paper mulberry. Simple technologies such as boiling can extend the collecting season, reduce labour and improve the quality of the bark. Beyond such technical interventions, however, it is more important that traders of paper mulberry in Laos develop a common position for negotiation and maintain standards for quality (Phommasane 2006).

Table 6.2 Areas and production of paper mulberry in northern Laos (Aubertin c. 2004)

Location and attribute	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Kenthao district											
Area (ha)				118	118	128	384	427		203	300
Production (t)				117	117	128	460	513		243	360
Yield (t/ha)				1	1	1	1.2	1.2		1.2	1.2
Paklay district											
Area (ha)	10.35	40	124	244	357	360	240	300	450	450	600
Production (t)	7.24	31.5	85	95	324	324	312	390	585	585	780
Yield (t/ha)	0.7	0.82	0.68	0.66	0.9	0.9	1.3	1.3	1.3	1.3	1.3

Source: Statistics of the Agricultural Departments of the Kenthao and Paklay districts. The shaded figures are surprisingly uniform, and may be affected by transcription error.

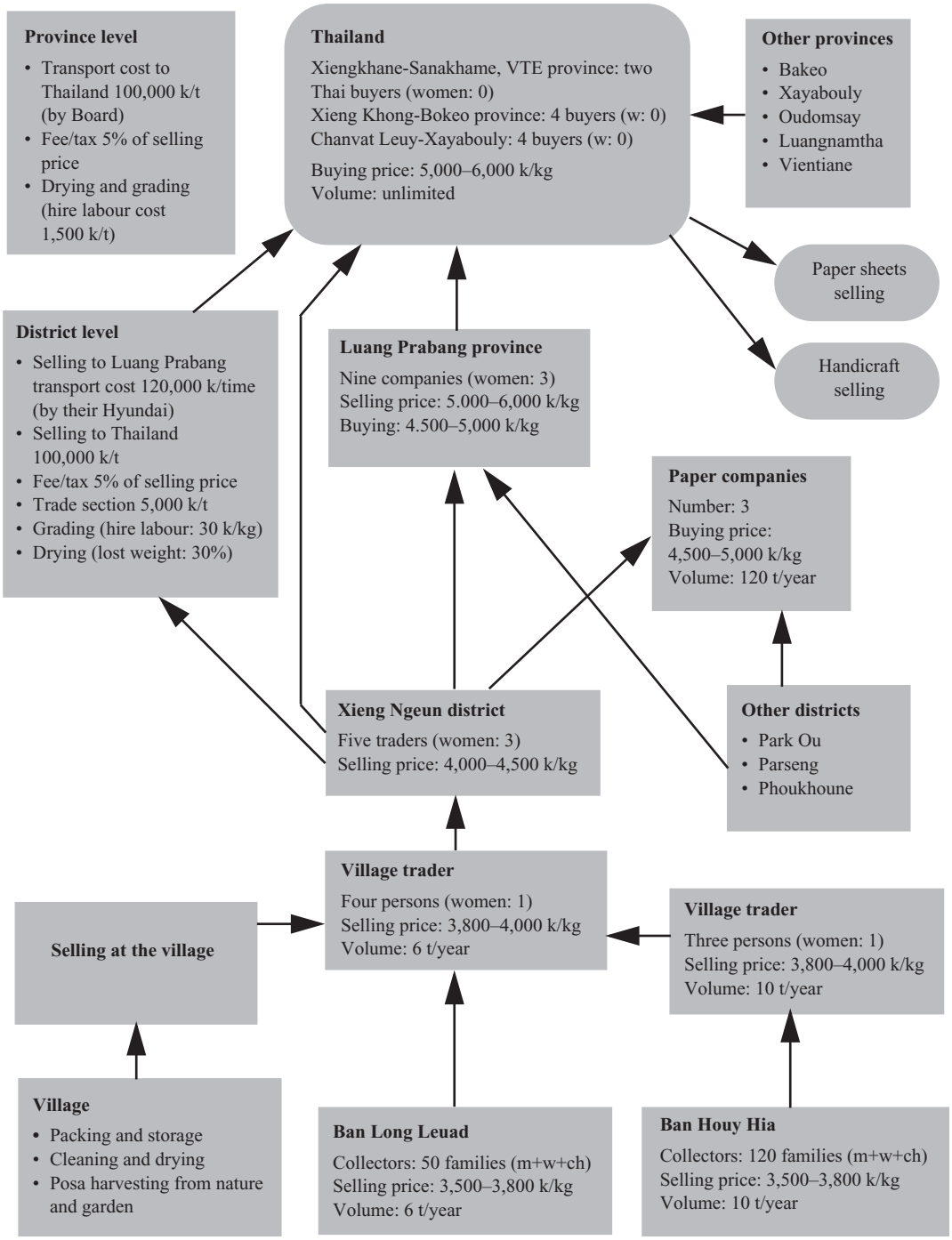

Figure 6.3 Marketing channels for mulberry paper (posa): Long Leuad and Houay Hia villages, Xieng Ngeun district, Luang Prabang province (Mounlamai 2005). Ch = children; m = men; w = women; k = kip

A market information system is not available to growers, with villagers selling their paper mulberry in traditional ways in Luang Prabang province (Mounlamai 2005). Villagers did not know the exact price in the market and contracts were not available to growers. Buyers and sales were controlled by traders, and growers felt there was considerable insecurity associated with the paper mulberry market. The paper mulberry supply chain is shown in Figure 6.3.

A workshop on paper mulberry, held at Luang Prabang in May 2006, brought together growers, traders, government agencies and donor agencies. Among the priorities identified at the workshop was the need for better marketing and the development of value-adding opportunities in Laos, particularly in relation to bark grading and paper production. Establishment of grower groups, quality control and better links with traders were seen as specific areas for action.

Paper mulberry has been intercropped with teak for some time. Thaiutsa and Puangchit (2001) reported an intercropping system using paper mulberry and teak in Luang Prabang province which had been in existence for several decades. Farmers grew teak at a spacing of about 4 m × 4 m, with an irregular spacing of the intercrop. The farmers obtained an income during the first few years from paper mulberry, and then from teak trees thinned from ages of about 6–8 years depending on the site and vigour of the teak. In a series of intercropping experiments on nine sites in Thailand, Thaiutsa and Puangchit (2001) found that paper mulberry with teak planted at 4 m × 6 m gave better growth and yields than paper mulberry with either eucalypts or banana.

Paper mulberry is strongly demanding of light, and if it were to be grown as a companion to teak there would have to be compromises to traditional methods of cultivation of both crops. Thaiutsa and Puangchit (2001) recognised the light requirements of paper mulberry and recommended that, if it is managed as understorey, the overstorey intercrops should be thin-canopied or deciduous species such as teak. The technical feasibility of such as system would have to be demonstrated to smallholders to gain their acceptance.

One of the several attractions of paper mulberry as a companion crop is that the busy time of harvest does not clash with critical periods within the agricultural calendar (Douangsavanh et al. 2003). As noted earlier, this fact makes it an attractive option as a cash crop for intercropping with upland rice.

Midgley, S., Blyth, M., Mounlamai, K., Midgley, D. and Brown, A. 2007. Towards improving profitability of teak in integrated smallholder farming systems in northern Laos. ACIAR Technical Reports No. 64.

7 Assessing profitability of integrated teak farming systems for smallholders

This review of integrated teak cropping systems in northern Laos has identified a number of options suitable for smallholders. Due to increasing population pressure and the decision by government to eradicate shifting cultivation by 2010, land-use decisions made by farmers will be influenced increasingly by profitability. Sustaining productivity of the land under shorter rotations presents a new challenge for smallholders. Furthermore, as land-use intensity increases, so too does the demand for labour, especially for weeding which is critical to successful crop establishment and yield.

Alternative cropping systems need to be able to sustain profitability and productivity over the long term, and generate better returns for each additional labour input required than can be achieved in alternative employment, such as off-farm work. In this study we assess long-term returns to land and labour resources for a selection of alternative land-use systems available to smallholders in northern Laos.

The following cropping systems are assessed:

1. traditional long-fallow swidden including rice and a cash crop, maize
2. transitional short-fallow cash cropping system based on rice and paper mulberry
3. unmanaged teak, without pruning or thinning, within a medium-length fallow system based with rice and pineapples preceding teak
4. managed teak, with pruning and thinning, preceded by rice and pineapples
5. integrated teak cropping, with wide-spaced teak intercropped with cash crops of pigeon peas and paper mulberry, thinned and pruned.

Within each of these systems variations can be explored such as the use of purchased inputs (fertiliser and pesticides) for cash crops, the time for teak to reach a commercially harvestable volume, the availability of a market for young teak thinnings (less than 10 years old) and the length of fallow. The extent to which variations such as these can be explored depends on the availability of suitable data. The assessments made here are indicative of the relative returns from more intensive farming systems and the introduction of managed teak farming. Data used were drawn from many sources including the survey of village communities and smallholders undertaken for this report and the results of previous research. There were many gaps in the data required for this comparative assessment, necessitating a number of assumptions.

Underlying assumptions

These assessments are based on gross margins for each of the cropping alternatives. A gross margin is the difference between the annual gross income from an enterprise or farming system and the variable costs incurred by the enterprise or system. Fixed costs such as the cost of land and capital equipment are not included as they are incurred irrespective of which enterprises are included in the farming system.

The assessments presented here are not dependent on the availability of labour or land on a typical farm. They are cropping enterprise gross margins, which are similar to operational budgets. Each gross margin is expressed on a per-hectare basis to facilitate comparison. From the perspective of an individual farmer whose plots may range from 0.1 to 1 ha, the estimated margins presented here may seem high. Selection of an optimal combination and sequence of crops by an individual smallholder must take into account the total and seasonal availability of family labour as well as the availability of land suitable for particular uses.

All input costs are expressed on a per-hectare basis in Lao kip. All returns are expressed in net present value (NPV) terms given that each of the farming systems appraised extends over many years. Most systems are estimated over a 20-year horizon.

Given the critical importance of labour to upland farming systems, returns are presented on a per-labour-day as well as per-hectare basis. Return to

labour is the wage rate that sets the NPV equal to zero. Where the returns to labour exceed the average daily wage rate, individuals with their own land are better off farming than working in off-farm activities. This is a useful primary indicator of profitability for smallholders.

All farm outputs are priced at their farm-gate values. This is to facilitate comparison between the systems. In most cases farmers retain their rice harvest and portions of cash crops for their own use. However, as land use intensifies, smallholders will change their land-use practices and patterns. This may include changing from growing rice to growing crops with higher returns.

Discount rate

To compare expenses and income, which occur in different years over the period of each cropping system, it is necessary to express outputs in equivalent terms. A discount rate allows all amounts to be expressed in present value terms. A discount rate of 10% is assumed for determining the NPV of each cropping system. The sensitivity of the results can be explored using lower and higher discount rates.

Labour requirements

It is assumed that all labour requirements are sourced from the farm family. Our survey of the three villages in Luang Prabang province indicated that each farm had an average of three workers available for farm work. After land, labour is the most critical input into upland farming systems in Laos. It is unlikely that farmers in Luang Prabang province will adopt farming systems that depend on hired labour. When labour demand exceeds supply for an individual farm family, it is common to exchange labour with other farm families and pay a rate that is below the market rate for farm labourers (Figure 7.1).

Family labour hours are not costed by smallholders in their operations. However, given the increasing demand for labour in the more intensive land-use systems that are expected to be implemented in the uplands over the next 5 years, it is appropriate for this analysis to cost labour at its opportunity cost. The opportunity cost of labour is the best return that can be achieved from alternative employment. From the survey of farmers conducted for this study the average price paid per day for hired labour was 12,600 kip. This rate is used in all assessments.

It is assumed that all farming activities are completed without the need for specialised mechanical equipment. Where practical, machines such as cultivators can be used for land preparation, which reduces the demand for labour. However, on steep slopes it is difficult to use machinery or bullocks for land preparation. Also, there is evidence that cultivators are not as effective in reducing weed growth after

Figure 7.1 Teak is an increasingly significant crop on steep slopes. Seasonal tasks like planting are commonly undertaken cooperatively

the crop has been established, which increases the need for labour (de Rouw 2005).

The first stage in all the cropping systems assessed is clearing and preparing land following a period of fallow. This involves slashing and burning vegetation using family labour and hand tools. The duration of slashing operations varies with the volume of biomass to be cut, from 100 hours/ha for a herbaceous to bushy fallow (fallow period of 2–3 years) to 500 hours/ha for an older fallow of 10 years with trees (Van Gansberghe 2005). Machetes are most commonly used for cutting the vegetation although bigger trees may be cut with axes and occasionally saws. After allowing the slashed vegetation to dry in the sun for about 3–4 weeks, it is burned. A second burning may be required before larger debris is removed from the field. Clearing may require 50–250 hours depending on the volume of organic material to be reburnt or removed (Van Gansberghe 2005).

Following clearing, land may be tilled before sowing, although under shifting cultivation crops are generally sown directly into the cleared field without additional cultivation. Fields sown under short fallows or used for a second or third consecutive year are tilled and weeded using a small hoe. This is commonly done by women and can take about 100 hours/ha.

Sowing or planting the crop is an important family activity, and is accompanied by religious and social rituals. In the case of a newly cleared field, seeds are planted in holes made by a dibbling stick. For fields that have been tilled following a first- or second-year crop, seeds are broadcast. Sowing usually takes between 70 and 150 hours/ha according to experience (Van Gansberghe 2005).

Once a crop is established, weeding is the most critical activity. Weeding generally accounts for around 50% of total labour inputs of a cropping system (Seidenberg et al. 2003; Van Gansberghe 2005). Van Gansberghe reported that weeding may require 400–1000 hours/ha in 3-year fallow fields. It is widely believed that labour requirements for weeding under short fallows are higher than under long fallows because of greater weed growth, although scientific evidence is inconclusive (Seidenberg et al. 2003). Linquist et al. (2005) reported that farmers need to weed up to five times per year in fallows of 2 years or less compared with only twice in fallows of 10 years or more.

Within upland farming systems it is not common for farmers to use chemical fertilisers, herbicides or pesticides for a number of reasons, including capacity to pay, ready access to such inputs and knowledge on their effective use. While this situation may change over the next decade, it is assumed for this appraisal of alternative farming systems that purchased chemical inputs are not used.

Labour requirements for harvesting vary for each particular crop. In some farming systems it is necessary to erect fences around the crop to keep livestock out.

The labour requirements, in person days per hectare, for each of the farming systems appraised are presented in Table 7.1.

Traditional long-fallow shifting cultivation system

This baseline cropping system represents the traditional swidden system, which is being phased out by the Lao PDR Government. The system is based on a 7-year fallow period, after which 3 years of crops are sown. In the first year after the land is cleared and prepared, rice is sown. This is followed by 2 years of maize, after which the land is rested for another 7 years. In the eighth year the cropping sequence recommences. Tables 7.1 and 7.2 present key inputs and outputs of the system. Data sources used for specifying this system include: Seidenberg et al. (2003); Siphandouang et al. (2002); Van Gansberghe (2005); and Chantavisay Keobounum and Sounthala Latsayavong (NAFRI), pers. comm., Vientiane (8 June 2006).

Transitional short-fallow system

An alternative baseline cropping system is one that is compliant with the government's stabilisation plans for upland farming systems. This is a rice–paper mulberry system with 2 years of fallow. This short-rotation system may be practised by villages that have undergone land allocation which provides them with three discrete plots of land (Linquist et al. 2005). After the fallow land is cleared, a rice crop is sown in conjunction with paper mulberry. It is assumed that smallholders use selected traditional upland rice varieties that are suitable for short fallows and can yield 0.3–0.5 t/ha more than local check varieties.

The paper mulberry is maintained for 4 years, after which the land is fallowed for 2 years. The rotation repeats in year 7 for another 4 years and again in years 13 and 19 within a 20-year horizon. Linquist et

Table 7.1 Labour requirements for upland farming systems (person days per hectare)

System and operation	Year																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Traditional long-fallow																				
Land clearing	56.3										56.3									
Cultivation		8																		
Planting	15	15	15								15	15	15							
Weeding	40	55	55								40	55	55							
Fencing	5																			
Harvesting	0	25	25								50	25	25							
Total	**161.3**	**103**	**95**								**161.3**	**103**	**95**							
Transitional short-fallow																				
Land clearing	12.5						12.5						12.5						12.5	
Cultivation	8	8	8				8	8	8	8			8	8	8	8			8	8
Planting	10	2					10	2					10	2					10	2
Weeding	45	50	50	45			45	50	50	45			45	50	50	45			45	50
Fencing	6.25						6.25						6.25						6.25	
Harvesting	25	92	92	67			25	92	92	67			25	92	92	67			25	92
Total	**106.75**	**152**	**150**	**112**			**106.75**	**152**	**150**	**120**			**106.75**	**152**	**150**	**120**			**106.75**	**152**
Unmanaged teak																				
Land clearing	56.3						30													
Cultivation		8																		
Planting	15	20																		
Weeding	40	50	45	35	35	30	25													
Fencing	10																			
Thinning and pruning																				
Harvesting	25		25	30	40	30	20													1
Total	**146.3**	**78**	**70**	**65**	**75**	**60**	**75**													**1**

Continued on next page

Table 7.1 (cont'd) Labour requirements for upland farming systems (person days per hectare)

System and operation	Year																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Managed teak																				
Land clearing	56.3						30													
Cultivation		8				2														
Planting	15	20			15	25														
Weeding	40	50	45	25	25															
Fencing	10																			
Thinning and pruning										6.9					4.5					1
Harvesting	25	25	30	40	30	20														
Total	**146.3**	**103**	**75**	**65**	**70**	**47**	**30**			**6.9**					**4.5**					**1**
Integrated teak–paper mulberry with thinning																				
Land clearing	56.3							8.5												
Cultivation	9	9	9					6												
Planting	16	5.5	11					12.5	0.5											
Weeding	45	50	50	45	25	20	10	25	25	25	20	10								
Fencing	10							2												
Thinning and pruning												1								
Harvesting	43	18		96	96	96	96	18	48	48	48	48								1
Total	**178.3**	**81.5**	**69**	**141**	**121**	**116**	**106**	**72**	**73.5**	**73**	**68**	**59**								**1**
Integrated teak–paper mulberry without thinning																				
Land clearing	56.3							8.5												
Cultivation	9	9	9					6												
Planting	16	5.5	11					12.5	0.5											
Weeding	45	50	50	45	25	20	10	25	25	25	20	10								
Fencing	10							2												
Thinning and pruning																				
Harvesting	43	18		96	96	96	96	18	48	48	48	48								1
Total	**178.3**	**81.5**	**69**	**141**	**121**	**116**	**106**	**72**	**73.5**	**73**	**68**	**58**								**1**

al. (2005) describe a number of short-rotation cropping options such as rice–paper mulberry. These are aimed at improving rice production (self-sufficiency) and providing cash crops as a basis for diversification and to generate income that can be used to purchase rice. Sustainability is an important criterion. They found that farmers were attracted to paper mulberry because of its potential market returns. Other important criteria for short-rotation species include labour requirements, management ease and impact on rice yield. According to Aubertin (2004, p. 224) farmers appreciate paper mulberry 'because they accelerate the regeneration of soil fertility (thanks to their extensive carbon-fixing root system and their large leaves), along with their rapid growth, resulting in rapid canopy closure, which in turn reduces weeds'.

Table 7.2 Traditional long-fallow system

Key inputs and outputs	Quantity (kg/ha)	Value (kip/kg)
Rice seed	65	3,500
Rice yield	1,700	
Farm gate price for rice		1,900
Maize seed	36.8	
Maize yield	3,000	
Farm gate price for maize		900
Indicators of profitability		
NPV (kip)	5,426,975	
Return to labour (kip)	25,521	
Discount rate	10%	

Linquist et al. (2005) reported that research is continuing on rice–paper mulberry systems in the areas of establishment of paper mulberry, bark yield, planting density, impact on rice yield and nutrient cycling. This production system has potential under more intensive land use, especially given the good market prospects for paper mulberry, smallholders' familiarity with the crop and the complementarity of labour demands of the rice–paper mulberry system.

A feature of paper mulberry compared to other cash crops is the high demand for labour for harvesting. It is high because the process of stripping the inner bark from the stems is labour intensive. Aubertin (2004, p. 226) estimated that the labour requirement amounts to 120 days for 1 ha supporting 5,000 plants at spacing of 1.5 m × 1.5 m. The system described here assumes that paper mulberry is planted with rice at the equivalent of 4 m × 4 m, which is a density of 625 plants/ha. At this rate and assuming 20% losses, the labour requirement for harvesting is set at 67 days/ha.

Another attraction of paper mulberry is that farmers can easily change to another crop and let the paper mulberry sprout again in the following year, depending on market conditions.

An important aspect of profitable paper mulberry production is the maintenance of quality from the field to the processor. Best prices are received for bark that is properly dried and free of mould and fungi. It should be clean and free of dirt and sticks when offered to traders. There is much scope to improve the quality control of paper bark harvesting, drying, storage, transport and processing within Laos. Aubertin (2004, p. 230) suggests that traders are not properly accounting for quality in the price they offer suppliers. Improvements in market information systems, product logistics and quality control along the supply chain would add significant value to the paper mulberry crop for growers, traders and processors.

Data sources used to specify this system include Aubertin (2004) and Linquist et al. (2005), in addition to those used for the traditional long-fallow system. Tables 7.1 and 7.3 present the key inputs and outputs of this transitional short-fallow cropping system.

Table 7.3 Traditional short-fallow system

Key inputs and outputs	Quantity (kg/ha)	Value (kip/kg)
Rice seed	65	3,500
Rice yield	1,830	
Farm-gate price for rice		1,900
Paper mulberry plants (plants/ha)	625	900
Paper mulberry yield (dry bark)	560	
Farm-gate price for dry bark		3,000
Indicators of profitability		
NPV (kip)	13,400,276	
Return to labour (kip)	28,421	
Discount rate	10%	

Unmanaged teak

This farming system describes the situation where smallholders plant teak after rice and a cash crop such as pineapples. In this system the teak trees are not thinned or pruned to enhance production. Trees are selected for harvest after year 15 on an as-needs basis rather than a commercial basis. As such, harvesting

rates are low compared to those typical of commercial operations and the best trees are selected first. It is assumed that at year 20 of the cycle, when the teak is 15 years old, 5% of the stock is harvested. For a 1 ha plot planted at 3 m × 3 m spacing and allowing for 20% loss over the 15 years, 44 trees are sold. In reality, the decision to sell trees depends on particular needs of the family, and so less than the equivalent of 44 trees/ha may be sold.

After clearing the fallow, rice is sown, followed by pineapples in year 2. These are maintained for 5 years, at which point they are shaded out by the teak trees that are planted as stumps in year 5. The teak is ready for harvest in year 20. Within this system there is no cash flow from the land occupied by teak from year 8 until year 20. This farming system depends on access to additional blocks of land to make it a viable option for smallholders, as it locks up land for many years without any returns. Alternatively, as Hansen et al. (2005) speculate, farmers could transfer ownership of the plantation to a private investor in return for an annuity. The feasibility of establishing and sustaining such financing schemes should be investigated.

The unmanaged teak system has been an attractive option for smallholders as a means of retaining access to land. Under the land allocation schemes, if land is not used for 3 years it can be reclaimed by the government for reallocation. By planting it with teak, farmers are assured of land-use rights. As Kolmert (2001) explains, under the land allocation policy that commenced in 1996 in Luang Prabang province, a family can be allocated up to four plots of land from 0.5 to 1.0 ha each for shifting cultivation, and they can also obtain 1 ha for planting perennial crops such as timber or fruit trees. Many farmers planted teak before the allocation occurred, which meant that they were allocated additional plots for cash crops and were allowed to keep their previously planted teak plots. For new settlers this option is not available.

The high short-term return from pineapples has made this option an attractive one in Luang Prabang province for established farmers. However, as recounted in Chapter 6, the increased interest in pineapples has oversupplied the market and prices have fallen to low levels. This is the nature of commodity markets. However, the prospects of supplying export markets, developing suitable infrastructure and marketing Lao pineapples as organically grown may help to buoy the price. Tables 7.1 and 7.4 present key input and output data and assumptions for the unmanaged teak system. Data sources used to specify this system include: Armitage (2004); Hansen et al. (1997, 2005); Kolmert (2001); Seidenberg et al. (2003); Van Gansberghe (2005); and Chantavisay Keobounum and Sounthala Latsayavong, NAFRI (pers. comm.), Vientiane (8 June 2006); Sianouvong Sawathvong, Director Forestry sector, Luang Prabang province, pers. comm. (June 2006).

Table 7.4 Unmanaged teak

Key inputs and outputs	Quantity (kg/ha)	Value (kip/kg)
Rice seed	65	3,500
Rice yield	1,700	
Farm-gate price for rice		1,900
Teak stumps (no./ha) (kip/stump) planted in year 5	1,100	500
Teak trees harvested at year 20 @ 15 years old); 80% loss	44 (5%)	
Teak yield @ 15 years old (m^3/tree)	0.157	
Farm-gate price for teak (kip/tree)		100,019
Pineapple shoots (no./ha) (kip/shoot)	20,000	500
Pineapple yield (fruits/ha)	7,500–8,000	
Farm-gate price for pineapples (kip/fruit)	1,750	
Indicators of profitability		
NPV (kip)	24,302,056	
Return to labour (kip)	71,355	
Discount rate	10%	

Teak prices

The price of teak varies with volume and quality. At the farm gate smallholders are quoted a price on a per-tree basis without any formal estimation of volume and only basic quality assessments. Traditionally, farmers sell one or two trees at a time when cash is required for a family need. In this situation farmers are price takers. The lack of a market information system makes it difficult for smallholders selling single trees to know what a fair price is. The farmers surveyed for this study quoted prices ranging from 60,000 to 200,000 kip for a tree with a circumference of 80 cm (≈ diameter 25 cm). A market information system would allow smallholders to plan their sales and improve returns. Over the longer term, access to market information may encourage teak growers to improve the management of their trees for volume and quality and help them to receive fair returns for their efforts.

To ensure consistency and realism in pricing for teak, we relied on data provided by Mr Sianouvong Sawathvong, Director of the Forestry Sector in Luang Prabang province. Using those data we estimated a relationship between tree volume and price, as presented in Figure 7.2. Teak prices used in this appraisal of alternative farming systems are based on this relationship.

Managed teak

This farming system is similar to the unmanaged teak system but with the addition of thinning and pruning of the teak trees. The production system is the same as for unmanaged teak, with rice sown after a fallow, then 5 years of pineapples. The teak is planted at 1,100 trees/ha in year 5 using stumps. The first non-commercial thinning occurs at year 10 when the trees are 5 years old. The trees are removed using farm labour, thinning at a rate of 50%. There is no market for these thinnings, which may be left on the ground or used for construction poles or firewood. The commercial utilisation of young teak thinnings is likely to become more attractive as plantation areas expand. The existence of a market for thinnings will provide an incentive for farmers to thin and prune their stands. Options for utilisation of teak thinnings need to be investigated.

The first commercial thinning, again at the rate of 50%, occurs in year 15 when the trees are 10 years of age. While some farm labour is involved the task of removing logs and transporting them to the mill is undertaken by the buyer.

The benefits of thinning are reflected in increased volumes of timber and higher returns. As reported in Chapter 6, there has been some research on thinning and pruning of teak, although long-term assessments in Laos have not been conducted or reported. Evidence from other countries including Panama, Costa Rica and Nepal indicates the production benefits of pruning and thinning (e.g. Thapa and Gautam 2005; Viquez and Perez 2005; Zanin 2005).

The remaining trees are removed in year 20 when they are 15 years of age. The NPV of the managed system compared to the unmanaged system demonstrates the financial benefits of thinning. Also, thinning generates income in more years than unmanaged teak. The development of a market for

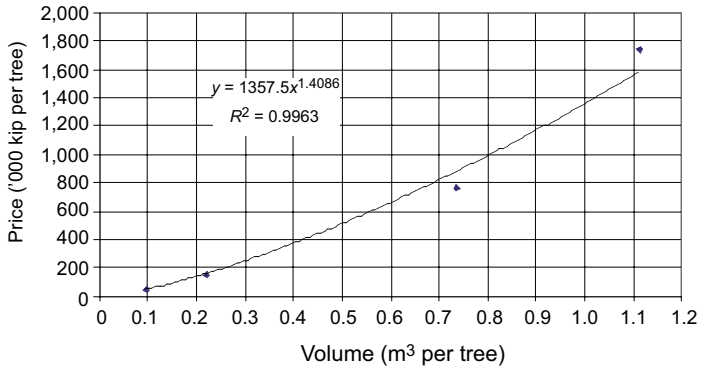

Figure 7.2 Farm-gate price for teak trees

teak thinnings will make this option even more attractive to smallholders.

Tables 7.1 and 7.5 present key input and output data and assumptions for the managed teak system. Data sources used to specify this system are the same as those used for the unmanaged system.

Integrated teak

This farming system attempts to capture the benefits of teak and generate more continuous cash flow for smallholders. The system is based on the intercropping of teak and paper mulberry. In the first year a rice crop is sown into the cleared fallow. As described by Linquist et al. (2005, p. 303), pigeon pea is planted a month of so after rice at a spacing of 1.25 m × 1.25 m, to minimise competition with the rice. The pigeon pea is a perennial legume and continues to grow after the rice is harvested. The pigeon pea is left in the field for 2 years and two crops are harvested. The pigeon pea has a positive effect of reducing nematode infestation and suppressing weeds. Teak stumps are planted in year 2 at a rate of 417/ha, equivalent to a spacing of 6 m × 4 m. This wide spacing is to accommodate the companion crop, paper mulberry, which is planted in year 3 in wide alleys between the teak rows. Paper mulberry is planted at a rate of 4,000 plants/ha. Replanting of teak and paper mulberry occurs in the year following sowing, based on assumed establishment rates of 85% for teak and 80% for paper mulberry.

Paper mulberry is cut from years 4 to 7, after which it is re-established to ensure bark quality. At this point farmers can decide to plant an alternative crop depending on relative returns and growing conditions. It is assumed that a second crop of paper mulberry is planted at 2,000 plants/ha and continued until year 12. At this point the teak trees are at 10 years of age and the companion crop is gradually removed.

Within this system it is assumed that the teak is thinned in year 12 when the trees are 10 years old. This is a commercial thinning with 50% of the stems removed. The remaining trees are harvested in year 20 when the trees are at 18 years of age. Table 7.6 presents the yield, price and return data.

Table 7.5 Managed teak

Key inputs and outputs	Quantity (kg/ha)	Value (kip/kg)
Rice seed	65	3,500
Rice yield	1,700	
Farm-gate price for rice		1,900
Teak stumps (no./ha) (kip/stump) planted in year 5	1,100	500
Teak trees thinned at year 10 (@ 5 years of age)	550 (50%)	
Teak trees thinned at year 15 (@ 10 years of age)	275 (50%)	
Teak trees harvested at year 20 (@ 15 years old)	275	
Teak yield at 10 years old (m^3/tree)	0.1	
Teak yield at 15 years old (m^3/tree)	0.203	
Farm-gate price for teak (kip/tree) @ 10 years old		52,983
Farm-gate price for teak (kip/tree) @ 15 years old		143,641
Pineapple shoots (no./ha) (kip/shoot)	20,000	500
Pineapple yield (fruits/ha)	7,500–8,000	
Farm-gate price for pineapples (kip/fruit)	1,750	
Indicators of profitability		
NPV (kip)	31,843,071	
Return to labour (kip)	91,340	
Discount rate	10%	

An alternative integrated teak–paper mulberry system without the year 10 thinning was considered as well. The results for this alternative are presented in Table 7.7.

These production systems have not been proven in practice, but preliminary indications suggest that they would be valuable options for smallholders. One of the big advantages over alternatives is a longer period of cash flow, possibly up to year 12. Field trials of teak–paper mulberry intercropping systems would be a worthwhile undertaking to identify sustainable farming systems for smallholders in the uplands of Laos. These investigations would have to take into account the feasibility of such systems at the scale of a smallholding, among other factors involved in the transition of farmers to new farming systems.

Data sources used for the integrated teak–paper mulberry options include: Aubertin (2004); Chun Lai et al. (2005); Linquist et al. (2005); and Thaiutsa and Puangchit (2001).

Comparing system profitability

Key indicators of the profitability of each system are presented in Table 7.8. The results indicate that all are profitable compared to off-farm work for individuals who possess land-use rights. All have positive NPVs and returns to labour. The indicators also reveal the positive financial impact of introducing shorter rotation cash crops and teak into upland farming systems.

While the traditional long-fallow system generates a NPV that is 40% of that of the short-rotation system, the returns to labour for the two systems do not differ greatly. The short-rotation system has the advantage of more years with positive cash flow. As the long-fallow system will be phased out by 2010, a more reliable base line for comparison is the short-rotation cropping system. Compared to this system, each of the teak-based systems generates higher returns to land and labour inputs. The highest returns are for the integrated teak-paper mulberry system without thinning, and the managed teak system,

Table 7.6 Integrated teak and paper mulberry with thinning

Key inputs and outputs	Quantity (kg/ha)	Value (kip/kg)
Rice seed	65	3,500
Rice yield	1,700	
Farm gate price for rice		1,900
Teak stumps (no./ha) (kip/stump) planted in year 2	417	500
Teak trees thinned at year 12 @ 10 years of age	208 (50%)	
Teak trees harvested at year 20 @ 18 years old	209	
Teak yield @ 10 years old (m^3/tree)	0.1	
Teak yield @ 18 years old (m^3/tree)	0.374	
Farm-gate price for teak (kip/tree) @ 10 years old		52,983
Farm-gate price for teak (kip/tree) @ 18 years old		339,693
Paper mulberry plants (plants/ha) and kip/plant:		
Year 3	4,000	200
Year 8	2,000	
Paper mulberry yield (dry bark)	800	
Farm-gate price for paper mulberry (dry bark)		3,000
Pigeon pea seeds	18	17,500
Pigeon pea yield	500	
Farm-gate price for pigeon pea		2,800
Indicators of profitability		
NPV (kip)	24,928,837	
Return to labour (kip)	46,384	
Discount rate	10%	

which includes thinning and pruning. This indicates that adding various management inputs to teak production systems generates higher returns to land and labour inputs.

As mentioned earlier, the assumptions used in this analysis can be varied to test the robustness of the results and the impact of technical and other improvements. The teak systems described and analysed here are very different to traditional systems, requiring increased knowledge inputs as well as off-farm improvements in market information services, extension service delivery and investment in resource processing, especially for small-diameter teak thinnings.

Farmers of the Lao PDR uplands have not been as ready as farmers in other regions of the country to adopt new technologies (e.g. see Shrestha et al. 2006). Linquist et al. (2005, p. 4) suggest that adoption of new technologies and methods may be limited by the high level of diversity in the uplands in the following areas:

Table 7.7 Integrated teak and paper mulberry without thinning

Key inputs and outputs	Quantity (kg/ha)	Value (kip/kg)
Rice seed	65	3,500
Rice yield	1,700	
Farm-gate price for rice		1,900
Teak stumps (no./ha) (kip/stump) planted in year 2	417	500
Teak trees harvested in year 20 @ 18 years old	417	
Teak yield @ 18 years old (m^3/tree)	0.374	
Farm-gate price for teak (kip/tree) @ 18 years old		339,693
Paper mulberry plants (plants/ha) and kip/plant:		
Year 3	4,000	200
Year 8	2,000	
Paper mulberry yield (dry bark)	800	
Farm-gate price for paper mulberry (dry bark)		3,000
Pigeon pea seeds	18	17,500
Pigeon pea yield	500	
Farm-gate price for pigeon pea		2,800
Indicators of profitability		
NPV (kip)	39,712,038	
Return to labour (kip)	66,444	
Discount rate	10%	

Table 7.8 Profitability of alternative farming systems

Farming system	NPV (kip/ha)	Return to labour kip/pd	Return to labour relative to wage rate[a]
Traditional long fallow	5,426,975	25,521	2.03
Transitional short fallow	13,400,276	28,421	2.26
Unmanaged teak	24,302,056	71,355	5.66
Managed teak	31,843,071	91,340	7.25
Integrated teak–paper mulberry, with thinning	24,928,837	46,384	3.68
Integrated teak–paper mulberry, without thinning	39,712,038	66,444	5.27

[a] Wage rate for farm labour is 12,600 kip per day (pd)

- biophysical diversity—climate and soils
- socioeconomic diversity such as ethnic and cultural diversity and large differences in opportunities and constraints between individual households
- market diversity—particularly market opportunities and market access.

In view of the level of diversity, they advised that technology solutions and recommendations should be site specific. Furthermore, they argued in favour of participatory and adaptive research to ensure that researchers and farmers develop solutions that are suited to local conditions. Further research to improve the technical, social and economic attractiveness of more intensive teak-based farming systems should heed this advice.

These results are indicative of the financial potential of teak-based farming systems in northern Laos. Enterprise gross margins for alternative land uses were appraised and compared using basic economic indicators—NPV of returns to land and returns to labour. Individual smallholders' land-use decisions are subject to many conditions including the availability of suitable land, family labour, financial resources and knowledge. Furthermore, they must deal with the risks of weather, pest and diseases, and fluctuations in markets. For this study we have made assumptions about the availability and status or nature of several production factors. Variations in the fundamental factors of production should be explored more comprehensively through whole-farm modelling to assess the feasibility of alternative land uses. This would also need to take into account financial, social and other goals of smallholders.

Midgley, S., Blyth, M., Mounlamai, K., Midgley, D. and Brown, A. 2007. Towards improving profitability of teak in integrated smallholder farming systems in northern Laos. ACIAR Technical Reports No. 64.

8 Conclusions and opportunities for ACIAR to contribute

Teak has become an integral part of farming systems in parts of northern Laos. In Luang Prabang province there are over 10,000 ha of privately owned teak plantations in smallholdings varying in size from 0.1 to 1.0 ha. Because of promising long-term markets for teak wood and expanding road infrastructure, this resource is increasing and is now making a positive contribution to household incomes and to the regional economy. Expansion of plantations is entirely in accord with government objectives to reduce poverty and policies to increase the area of commodity crops, and is also in alignment with land allocation regulations and policies.

Teak is established as a stage in the management of swidden land. Towards the end of the cropping period for upland rice, maize, pineapples, sesame and other swidden crops, teak is planted in conjunction with these crops and benefits from the weeding and maintenance of the companion crop.

This study sought to assemble a foundation of information and to identify opportunities for smallholders to increase the profitability of their teak-based farming systems by improving cash flows through a 20-year teak rotation. Profitability of smallholdings could be improved in two ways:

- via improved management of the teak and, specifically, use of better genetic stock, shorter rotations, and timely thinning and pruning
- by extending the use of companion crops including non-timber forest products (NTFPs) in longer term agroforestry systems.

Challenges to these technical approaches are that growers are unconvinced of the benefits of thinning and pruning, while the concept of a more prolonged association between teak and other crops in agroforestry systems has not been considered. The study concurs with the conclusions of Roder et al. (1995) that resource-poor farmers generally cannot risk the long-term investments and credit associated with the cultivation of teak alone, and that modified systems combining cash crops or NTFPs with timber production will assist them to participate in lucrative teak production.

NTFPs play an important role in rural areas of Laos, where they serve a wide range of subsistence needs and provide opportunities for earning cash income. Some 60 organisations are working on NTFPs in Laos. The potential of NTFPs to contribute to income generation has not been capitalised upon because unsustainable harvesting techniques and inefficient markets generally operate against rural producers and collectors. The agronomy for most NTFPs is unproven, with only a few approaching a level of domestication that could confer reliability in cultivation by resource-poor farmers. The added complexity of growing an NTFP in association with plantations of high-value hardwoods limits the reliability of any technical package offered to farmers. In the absence of expanding and reliable markets, it is difficult to see how incomes derived from most NTFPs can be increased.

The study collated a great deal of information related to teak silviculture and its management and markets that has not been available to growers involved in teak-based farming systems.

The annual volume of teak being harvested from smallholdings in Luang Prabang province is expected to increase from the current 4,000 m^3/year to an estimated 18,000 m^3 in 2010 and 60,000 m^3 in 2020. The availability of a commercially significant volume of high-value plantation hardwood offers substantial opportunities for value-adding and processing in addition to the current activity.

Assessments of the profitability of a number of cropping systems in this study indicated that more intensive integrated cropping systems based on teak offer sustainable financial benefits for smallholders in the uplands of Laos. Further research is warranted on the technical, economic and social aspects of more-intensive production systems involving teak intercropped with food and fibre crops. On-farm pro-

ductivity improvements need to be complemented by improvements in the off-farm sector for food and fibre crops, including timber.

The most significant challenge identified by this study is effective engagement with markets for teak, companion crops and NTFPs. The requirement for such an improvement was strongly expressed by teak smallholders, government officials and donor supporters, and was seen as a fundamental requirement to the success of any research-driven interventions. The markets and market chains for potential companion cash crops and NTFPs were poorly understood by those interviewed, who regarded them as volatile and unreliable. Growers lacked adequate market information regarding both teak logs and their teak smallholdings, and were vulnerable to unscrupulous opportunism when selling either. Earlier studies, and farmer interviews associated with this study, clearly demonstrated that farmers were at a great disadvantage because of their lack of market information.

Most farmers in the region had agricultural experience with most of the cash crops considered as potential companion crops for teak. However, little information was available regarding cultural modifications that would have to be made if these crops are to be cultivated in the longer term with teak. There was also a lack of information for farmers considering basic primary processing of crops to buffer fluctuations in market prices.

Although considered gender neutral, the recent and continuing expansion of teak smallholdings will have a series of social impacts on communities. Apart from offering stable land use and increased and secure household incomes, teak plantings by roadsides will inevitably alienate some potential agricultural land. Incorporating teak into farming systems was an opportunity pursued by farmers who were well established in their villages; new arrivals at the villages who do not have access to traditional family lands do not enjoy the same opportunity.

Increasing the profitability of teak-based farming systems in a sustainable fashion will require a package of information, advice and services to the growers that includes (Figure 8.1):

- components on market information for both teak and companion crops
- identification of potential companion crops and their agronomy and capacity to grow with teak
- the social impacts of an expanding resource of privately owned teak smallholdings
- the technical issues surrounding the improved cultivation of teak itself.

Opportunities for ACIAR

Within the framework of a package for delivery to teak smallholders involved in teak-based farming systems, a number of opportunities are available to

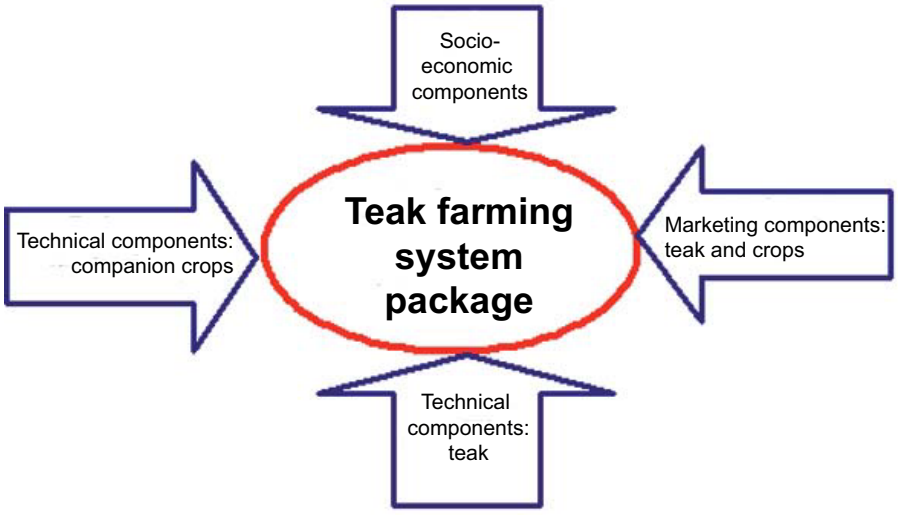

Figure 8.1 Opportunities for ACIAR

ACIAR. A prerequisite will be a thorough understanding of the supply chains and market channels for both teak and potential companion crops. We suggest some association with the Smallscale Agro-enterprise Development for the Uplands (SADU) Project managed by the International Center for Tropical Agriculture (CIAT) and its partners at NAFRI. The approach of this project—to identify and evaluate market opportunities for agro-enterprise development through local stakeholder interest groups—engages farmers and offers market insights. The SADU approach starts in the villages and moves out along the market chain, focusing initial attention on products that are currently being produced and which have a stable or growing market demand. These products will be teak, cash crops or NTFPs. This approach provides assurance that there is a useful market for particular products (such as organic produce) and lays the framework for future market-orientated extension, which will establish closer links between growers, traders and processors. Such an activity will ensure that subsequent research is consistent with the overarching commitment of the Government of Lao PDR to alleviate poverty. As part of a program that seeks to offer improved market knowledge, ACIAR might encourage membership and participation in Teaknet, a regional network that has recently been reactivated through a commitment from the Kerala Forest Research Institute with modest ongoing support from FAO and APAFRI. An opportunity exists for the Lao PDR to become a fully participating member.

An Australian example of an industry-wide association which has involved growers, processors and retailers is the 'Blackwood Industry Group', which arose from an ACIAR project and is now sponsored by the Joint Venture Agroforestry Program.

With the knowledge of secure markets and within the context of a package available for teak smallholders, the following opportunities exist for collaboration in Laos.

Market components

Important marketing issues include:

- understanding supply chains and opportunities for cash crops and NTFPs selected through the SADU approach of market-orientated agricultural development
- obtaining and disseminating information on prices and trends in markets for round and squared teak logs
- developing markets for small teak logs (thinnings). If thinning is to be promoted in any package of improved silvicultural practice, it is important that a market be fostered for the small logs resulting from these thinnings. Opportunities exist through the furniture sector and small piece sizes of kiln-dried lumber. The Research Institute for Wood Industries (RIWI) at the Chinese Academy of Forestry is well acquainted with the large Chinese markets for tropical plantation hardwoods (including teak) and with a number of low-cost, value-adding processing possibilities including rotary veneer. This veneer can be made on inexpensive, spindleless lathes from logs as small as 15 cm in diameter. The RIWI has indicated that it would be willing to provide access to its facilities and work with ACIAR in examining improved value-adding and market prospects for plantation-grown teak from Luang Prabang province.
- increasing market opportunity for the expanding volumes of teak from smallholdings. ACIAR might assist NAFRI to examine possibilities for certifying private teak smallholdings near Luang Prabang under a 'group certification' scheme. Plantation-grown, certified tropical hardwood is now gaining a premium (sometimes as high as 30%) in the discerning markets of North America and Europe, and furniture industries are keen to gain access to increased and sustainable supplies of wood which are certified. Australian Forestry Standard Limited could assist ACIAR and its Lao partners in this endeavour. In addition, the Tropical Forest Trust is well acquainted with certification issues in Laos and has indicated a willingness to share its smallholder experience with ACIAR and work towards certification of the teak smallholdings in Luang Prabang province. WWF has also indicated such willingness. This work would accurately quantify and characterise the resource of plantation teak as a basis for attracting commercial processing investment.
- developing simple methods to value teak smallholdings as the basis for sale or for loan agreements.

Technical components: teak

The main technical issues for smallholders include:

- availability of quality germplasm and effective dissemination of improved germplasm: establishment of SPAs and CSOs

- adequate and publicly accessible demonstrations of the economic benefits of both thinning and pruning
- monitoring of insect pests and consideration of methods of control.

These technical issues have been identified and acknowledged by Lao professionals working in Luang Prabang province. ACIAR could offer research assistance through a series of technical support initiatives.

Technical components: integrating companion food crops and NTFPs with teak

The economic and ecological implications of integrating teak in mixed farming systems need to be better understood. Most teak research has focused on the technical and economic aspects of growing the species alone in plantations. While this has provided important information relevant to smallholders, other areas such as the effects of teak on the yield of associated agricultural crops, as well as the effects of agricultural crops on teak productivity, need more research. Using reliable market information from the market-oriented approach suggested as a pre-project activity, likely companion crops and NTFPs could be selected and used in studies of their integration with teak in various conformations. Likely yields, agronomic inputs and changes in agronomy will need to be assessed.

The preliminary assessments conducted for this study indicated the potential of intercropping teak and paper mulberry. Further research into the technical and financial aspects of this intensive cropping system is needed, along with social investigations, to establish the most effective way to promote and implement this and similar teak-based systems. Participative action research has been shown by others to be most effective in the uplands. Scientists and farmers work together, planning, implementing, evaluating and revising candidate systems.

Socioeconomic components

Important social issues include:

- organisation or coordination of growers into formal or informal groups to support local initiatives and provide market power when selling produce
- the impact of increasing areas of potential agricultural land being dedicated to teak
- ways through which new arrivals to villages near roads can benefit from teak cultivation.

Networks

Many organisations and committed professionals are working with Lao communities and scientists in northern Laos. Much of this current work is relevant to the package which might be offered to teak smallholders. It makes good sense for ACIAR to establish strong networks to avoid duplication and achieve complementarity with current efforts. In exploring collaborative opportunities relating to teak-based farming systems in northern Laos, ACIAR has contributed to meetings such as the ‘Sustainable sloping lands and watershed management’ conference, held recently (12–15 December 2006) in Luang Prabang. The main purpose of the conference was to explore different strategies to promote environmental sustainability and enhance livelihoods of rural communities that inhabit upland areas.

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10 Appendixes

Midgley, S., Blyth, M., Mounlamai, K., Midgley, D. and Brown, A. 2007. Towards improving profitability of teak in integrated smallholder farming systems in northern Laos. ACIAR Technical Reports No. 64.

Appendix 1: ACIAR's project proposal

FST/2005/180. Scoping study on teak and non-timber forest products as elements of agroforestry systems in Laos

Terms of reference

Background

There are several thousand hectares of teak planted in Laos, and good prices are now being paid to farmers for trees of harvestable size. Productivity, however, is clearly affected by inadequate silviculture. Non-timber forest products (NTFPs) contribute a significant proportion of family income in many rural areas of Laos, and farmers are increasingly planting these species as an alternative to exploiting diminishing wild resources. Species involved include tree-form NTFPs such as paper mulberry and cinnamon.

As a component of its Lao forestry program portfolio, ACIAR is considering studies aimed at enhancing the productivity of agroforestry systems involving teak (or other high value species) and NTFPs. The intention is to develop silvicultural systems that optimise the economic productivity of both elements, and to develop and deploy improved cultivars of NTFPs. The scenario envisaged is that teak would be interplanted with tree-form NTFPs, conferring the form advantages from close spacing needed for teak. The NTFP component would subsequently be harvested, providing a significant economic return as well as releasing the teak through the equivalent of a thinning. Non tree form NTFPs could also be interplanted among the trees.

It is envisaged that, optimally designed and managed, these agroforestry systems could be low-input systems providing significant income streams, in both the short and long term, to rural Lao families.

In order to determine the potential value of such studies, and to more accurately identify potential constraints and economic benefits, ACIAR has decided to undertake a scoping study that will investigate the economic, social and other factors influencing the production and marketing of non-timber forest products and plantation teak in Laos. In particular, the scoping study will define the prospects for this type of agroforestry system, estimate potential economic benefits, and identify likely constraints and other factors to be considered.

The scoping study

The contractor is thus required to provide a publishable report that includes the following:

1. An overview of the teak and NTFP sectors in Laos, including:
   - Market chains, trade patterns, potential demand
   - Influence of developments in neighbouring countries
   - Lao competitive advantages, with respect to both growing and processing
   - The potential for value-adding and industry development in these sectors
2. An analysis of factors that could influence the adoption of agroforestry systems using teak and NTFPs, for example:
   - Availability and tenure of suitable land
   - Social factors, e.g. community attitudes, gender
   - Government policy, priorities and programs
   - Financing requirements and limitations
   - Infrastructure limitations
   - Local capacity, e.g. in management, R&D, extension
3. An analysis of prospects for more productive teak and NTFP plantations in Laos, especially in agroforestry systems, in particular:
   - Potential to contribute to rural incomes, also more broadly through value-adding, and to GDP. Quantitative estimates should be provided.
   - Possible risks
   - Environmental impacts
4. A review of relevant activities of other agencies in Laos, including international donors, NGOs etc
5. A synthesis of researchable issues, their significance as impediments, and the extent to which these are issues of relevance also to Australian agencies, and to which Australian agencies have a comparative advantage to add value.

Midgley, S., Blyth, M., Mounlamai, K., Midgley, D. and Brown, A. 2007. Towards improving profitability of teak in integrated smallholder farming systems in northern Laos. ACIAR Technical Reports No. 64.

Appendix 2: Project questionnaires

Questions for village chief, 'Ni Ban'

Village.....
Name of Ni Ban.....
Main ethnic group.....

1. How many families live in the village?
2. What is the total population?
3. What is the age and gender structure of the village?
   Males: Females:
4. Current birth rate (trend)
5. How many years has the village been here?
6. Highest level of education achieved by village youth:
   Primary Secondary College
7. What proportion of youth remains in the village and works on farms?
8. What access does the village have to government extension services—forestry, agriculture, agro-forestry?
9. What fruits are commonly consumed in the village?
10. Are there foreign-aided projects operating in the area?
    What are they about?
    Are you involved?
11. How many families in the village have teak plantations?
    Estimate the approximate area.
12. Do women and men take equal responsibility in planting and maintaining teak plantations? Are there any community concerns about teak plantations?
    If yes, what are they?
    What are the attractions/benefits and challenges for teak in your village?
13. Who makes the decision to sell?
    Is the decision likely to change?
14. How does the village gain access to new information about crops, and market prices for both companion crops and teak?
15. How is this information shared within the village?
16. Do you know of any research being done on teak/crop combinations or other land uses that might make teak more profitable?
17. How do people sell teak wood? By weight? By volume? By individual tree?
18. Who conducts measurement of the weight/volume?
19. Does the village sell trees to the same buyer or are there several buyers competing for the trees?
20. Are teak trees used for construction within the village?
    Do people plant the trees for their children's benefit?
21. What area of teak trees are owned by absentee landlords—city and foreign investors?
    Where do these plantings tend to occur?
22. Uses of teak plantings
    – to protect farmland and soil and water resources
    – demarcate boundaries
    – to provide living fences
    – to shelter more valuable crops
    – to provide windbreaks
    – for timber
    – for fuel wood
    – for poles.
23. Are trees planted on the best land or marginal land?
24. NTFPs—explore current and possible future activities

Questions for farmers

Village.....
Name/ethnic group.....

I. Household background

1. How large is your direct family?
   (a) Number and ages in the household
   (b) Gender and age of 'farmer'
   (c) Income earners
2. Is your family self-sufficient in rice?
   If not, how do you make up the shortfall?

3. How many family members work on the farm?
   (a) Do you only do one type of farming?
   (b) Part-time/full-time
4. What are your main sources of income?
   (a) Farm sources (%)
   (b) Off-farm sources (%)
   (c) Income from forest resources—each year?
5. What type of animals do you have and how many?

   Poultry
   Pigs
   Buffalos
   Cattle
   Goats
6. Do you have:

   (a) Car/motorbike/bicycle
   (b) Motor cultivator (age)
   (c) TV
   (d) Telephone Mobile
7. Do you plan to purchase any of the above in the next 3 to 5 years?
8. What type of land do you own / control?
   Estimate areas of each type? Note areas owned and areas rented

   Their own
   (a) Paddy
   (b) Swidden
   (c) Fish ponds
   (d) Where does most of your farm income come from?
9. Do you rent land from others?
   How much and for what purposes?
   Where is the land located?

II. Teak trees

1. Do you have teak trees on your landholding?
2. Are you considering planting teak trees in the next 3 to 5 years?
3. Why was this block(s) chosen for teak planting?
   Commercial/income prospects?
   Soil, proximity to road, slope?
4. What was the land used for before planting teak?
5. When were the teak trees planted?
6. Did you plant the trees or did you obtain them in some other way?
7. How many times has teak been planted on this site?
8. How many trees were planted?
9. For the current tree crop, did you use seedlings or stumps?
10. Technical details—spacing, source of seedlings, cost of seedlings, month of planting, seedling survival rate (number surviving/number planted); labour inputs at planting (family and hired); hours to plant (number of trees planted and area planted)
11. Ground preparation—describe how land is prepared; how many hours work?
    Family labour only and/or hired labour?
12. Sources of advice
    Neighbour
    Other farmers
    Government extension service—forestry, agriculture etc.
13. What maintenance have you offered the teak trees?
    Weeding
    Fertiliser
    Pruning
    Thinning
14. With respect to Q 13—when was maintenance conducted and what inputs were used:

    Labour (family and hired—hours)
    Any purchased inputs—chemicals, fertilisers
    Rate of application (kg/ha)
    Frequency (how many times since planting)
    Type of fertiliser; price per kg
15. Any problems with pests and diseases?
    How are these treated?
16. Other risks—fire, drought, flood: likelihood and potential impact?
17. Do you plan to extend your teak plantings?
    If so, over how many years?

lII. Ownership—Land and trees

1. Do you rent the land on which you have planted trees?
2. Do you own the trees?

IV. Companion crops / interplanting

1. What crops have you tried in association with teak?
   Dryland rice
   Job's tears
   Sesame

Papaya
Sweet potato
Banana
Maize
Peanut
Pineapple
Other

2. Why have they been successful/unsuccessful?
   Comments on profitability and productivity.
   Highlight problems experienced.
   Are they problems beyond farmer control or can they be overcome (i.e. are solutions available)?
   If productivity problems could be overcome what crop would you prefer to plant in association with teak?
   Why?
   Seek details for gross margins.
3. What research is going on to address these limitations and improve agroforestry system productivity and profitability?
4. If you tried another crop, how long do you think it would take to be productive?
5. Where is the market to sell these type of crops?
6. How were the other crops marketed?
   Direct? Via middlemen? Farmer cooperatives?
   Unprocessed/semiprocessed; fresh/wet market or for processing?
7. Problems faced in market access—
   Keeping products fresh?
   Sufficient volumes?
   Distance to market?
   Infrastructure—roads, storage facilities?
   Transport services, taxes and regulations?
8. What other crops might be tried—
   Food (e.g. mushrooms)
   Fibre (e.g. posa)
   Fodder (e.g. legumes for domestic animals)
9. What new types of crop would be of interest to you?
10. Are you willing to participate in trial plantings of mixtures of teak and other crops in new designs?

V. Economic prospects

1. Why plant teak? To protect farmland and soil and water resources; demarcate boundaries; provide living fences; to shelter more valuable crops; to provide windbreaks; timber; poles.
2. What are your expectations from the trees?
   At what age do you plan to harvest the trees?
   How will you sell them?
   Will you sell all your trees at the same time or will you stagger sales?
3. Would you be willing to sell the trees before harvest age if the offer was right?
   Have you received any such offer?
   How much were you offered per year?
   Did you accept or reject?
   Why?
4. Is it possible to borrow money against the expected future earnings from the trees?
   If yes, what organisations/businesses offer such credit?
5. Will you plant trees again after harvest of this rotation?
   If not, why not?
   What will you plant instead of trees?
   If yes, will you plant teak or another species? If another species, which one—rubber, posa, other
6. Who do you expect will buy the trees?
   For what purpose?
   Will they sell them to other people or process them?
7. What do you expect to receive when selling the trees—price?
8. Do you have any ideas of how teak planting could be made more profitable?
9. What expenses limit you to make a teak plantation?
   Are there high expenses associated with harvesting and transport?
10. Would you sell your land to a large commercial plantation company if an attractive offer was made to you?
    Yes—why?
    No—why?
11. Do you use hired labour?
    (a) If yes, for what purposes and how often?
    (b) What are the current labour wage rates per hour? Are they set or do they vary from village to village?
12. Land rental rates—per ha per month:
13. Land prices—per ha:

Midgley, S., Blyth, M., Mounlamai, K., Midgley, D. and Brown, A. 2007. Towards improving profitability of teak in integrated smallholder farming systems in northern Laos. ACIAR Technical Reports No. 64.

Appendix 3: People consulted during the field study

Ministry of Agriculture and Forestry

Mr Xeme Samonty
Deputy Permanent Secretary

National Agriculture and Forest Research Institute (NAFRI)

Dr Mounthathip Chanphengsay
Deputy Director

Mr Bounhom Thaphavong
NAFRI

Mr Chanthavisay Keobounnam
Farming Systems Research

Mr Sounthala Latsayavong
Farming Systems Research

Mr Peter Jones
Land Management Advisor
NAFRI

Mr Michael Victor
Acting CTA, SIDA
NAFRI

Mr Bhandith Ramangkoun
SIDA Projects, NAFRI

National University of Laos (NUoL)

Dr Sengdouane Wayakone
Faculty of Forestry

Forest industries, Vientiane

Mr Peter Fogde
Director, Burapha Group

Mr Thongthanh Southitham
Forest Industries Consultant

Project staff, Vientiane

Mr John Connell
CIAT in Asia, SADU

Mr Souvanpheng Phommasang
NTFP Marketing Advisor, SNV

Department of Forestry, Vientiane

Mr Thongsoune Bounphasaisol
Senior Research Scientist
Department of Forestry

Mr Sousath Sayakoummane
Deputy Director
Planning and Cooperation Division
Department of Forestry

Mr Khamphachanh Boungnakeo
Planning and Cooperation Division
Department of Forestry

In Luang Prabang

Mr Kaysone Vongkhamheng
Head
Provincial Agricultural and Forestry Extension Service

Mr Sianouvong Savathvong
Forestry Director
Provincial Agriculture and Forestry Office

Northern Agriculture and Forestry Research Centre (NAFReC)

Mr Homchitsavath Sodarak
Director, NAFReC

Mr Saysana Inthavong
Deputy Director, NAFReC

Mr Khamen Soubangxay
Head, Kengban Teak Improvement Centre

Mr Thongsavanh Keonakhone
Senior Research Scientist, NAFReC

Dr Paulo Pasicolan
Forest Research Advisor, NAFReC

Mr Martin Greijmans
NTFP Advisor, NAFReC

Project staff, Luang Prabang

Mr Phousit Phoumavong
Acting Manager
Forest Management and Community Support Project (FORCOM)

Mr Phetsakhone Soulygnalath
Technical Officer
Forest Management and Community Support Project (FORCOM)

Forest industries, Luang Prabang

Mr Bounthan
Director, Sawmill Km 4, Luang Prabang

Mr Thongsavi
Director, Sawmill Km 15, Luang Prabang

Midgley, S., Blyth, M., Mounlamai, K., Midgley, D. and Brown, A. 2007. Towards improving profitability of teak in integrated smallholder farming systems in northern Laos. ACIAR Technical Reports No. 64.

Appendix 4: Donor agencies and projects in the forestry sector of northern Laos

Several donor agencies, international organisations and NGOs support activities related to strengthening farming systems, tree planting and improving markets in the northern provinces of Laos. Among those identified are:

Donor and international organisations

Swedish International Development Cooperation Agency (SIDA)

The Government of Sweden has provided substantial technical assistance to the Government of Lao PDR in the natural resources sector since 1977. Until the mid 1980s the assistance focused on support to the Department of Forestry and two State Forest Enterprises. From 1985 assistance was expanded to include support for the establishment of a forestry training organisation including the Forestry Technician School at Mouang Mai. In the late 1980s the Lao–Swedish cooperation was further expanded to cover the stabilisation of shifting cultivation and nature conservation. During the first half of the 1990s the cooperation gradually changed to institution building and strengthening of the Department of Forestry at the centre and in selected provinces. SIDA also supports a number of initiatives being implemented by CGIAR centres and the Southeast Asian Network for Agroforestry Education (SEANAFE), which works with member institutions in Vietnam, the Lao PDR, Thailand, the Philippines and Indonesia. Phase 1 (2001–2005) and Phase II (2006–) of the Lao-Swedish Upland Agriculture and Forestry Research Project (LSUAFRP) work through NAFRI and aim (among other things) to develop productive upland technologies and land management recommendations that are acceptable to farmers for poverty alleviation and sustainable use of natural resources. SIDA is in the process of developing a new Upland Development and Poverty Alleviation Project (UDPAP) that will be closely linked with Phase II of LSUAFRP.

Consultative Group on International Agricultural Research (CGIAR)

Several CGIAR centres have had a strong relationship with Laos since the establishment of NAFRI in 1999. This is best demonstrated through NAFRI's Integrated Upland Agricultural Research Project (IUARP), which involves IRRI, ICRAF, CIAT and IWMI, and receives support from ACIAR. The main aim of IUARP is to develop sustainable upland livelihood systems through an integrated and participatory research approach. The target area consists of seven villages in Pak Ou district, Luang Prabang province, in northern Laos, representing a range of ethnic, socioeconomic and market conditions.

World Agroforestry Centre (ICRAF)

ICRAF operates the Agroforestry Support Project for Vietnam and the Lao PDR (ASP—V&L), which receives support from SIDA. The project enables ICRAF to progressively engage partner institutions and colleagues in Vietnam and Laos in collaborative activities related to agroforestry research and development, as well as to support further linkages and collaboration within the Montane Mainland Southeast Asia (MMSEA) ecoregion. Commencing in July 2001, the ASP—V&L activities built upon the foundation and informal network of partners established through the Vietnam Agroforestry Capacity-Building (VACB) project, which was supported by SIDA from May 1998 to June 2001.

ICRAF also participates in upland research in Laos via the ASB global partnership: Alternatives to Slash-and-Burn Consortium and the SLU/ICRAF/Rockefeller Foundation project on Sustainable Land Use Practices for the Uplands of Vietnam and Laos: Science and Local Knowledge for Food Security (LUSLOF).

International Center for Tropical Agriculture (CIAT)

The Smallscale Agro-enterprise Development for the Uplands (SADU) Project works with NAFRI. Among the objectives of this project are to identify and evaluate market opportunities for agro-enterprise

development through local stakeholder interest groups, and to design and facilitate the implementation of agro-enterprise initiatives with supply chain participants.

International Rice Research Institute (IRRI)

IRRI is conducting relevant work via the Lao–International Rice Research Institute (IRRI) upland component and the Integrated Upland Agricultural Research Project (IUARP).

International Water Management Institute (IWMI)

IWMI coordinates the CGIAR Management of Soil Erosion Consortium (MSEC). This initiative uses an integrated, interdisciplinary, participatory and community-based approach to research that involves the land users and other stakeholders on a catchment scale. Six partner countries are directly involved in implementing the project. The coordination of the consortium is primarily supported by contributions from the governments of Japan, France, Norway, Australia, Thailand and the Philippines through CGIAR. Implementation of activities in these countries is funded through the ADB-supported project Catchment Approach to Managing Soil Erosion in Asia (ADB-RETA 5803) (IWMI 2006).

In Laos the consortium partner is the Soil Survey and Land Classification Center (SSLCC) and the benchmark watershed is Houay Pano in Luang Prabang province. The Institute of Research for Development (IRD) in France is a major collaborator in Laos. The other international partners in the consortium are:

- International Center for Research in Agroforestry (ICRAF), Indonesia
- International Crops Research Institute for the Semi-arid Tropics (ICRISAT), India
- Southeast Asia Regional Center for Graduate Study in Agriculture (SEARCA), the Philippines
- Asian Institute of Technology (AIT), Thailand.

German Technical Cooperation (GTZ)

GTZ is working on the following aspects of land use for rural development in mountainous areas of northern Laos:

- village-based land-use planning focusing on definition of permanent upland plots, definition of grazing areas, community forestry
- introduction of permanent upland plots—contour farming, hedgerows and cover crops, economic hedgerows (paper mulberry), soybean cultivation
- livestock improvement, live fences, veterinary services
- inland fisheries
- small-scale irrigation—infrastructure development, rotational use of paddy lands (soy beans in the dry season)
- commercial aspects of small-scale forestry—use of bamboo
- value chains of agricultural products—decentralised manufacture of mulberry paper pulp, bamboo charcoal processing, soy bean processing.

Japan International Cooperation Agency (JICA)

The JICA-supported Forest Management and Community Support Project (FORCOM) is based in Luang Prabang and has a target area of six northern provinces—Vientiane, Luang Prabang, Oudansay, Bokea, Luang Namtha, Houaphan and Sayaboury. This program of technical cooperation seeks to improve forest management and encourage production and income generation activities which contribute towards stabilisation of shifting cultivation and poverty reduction. The project promotes planting of teak and has established some village-level demonstration blocks.

World Bank

The Sustainable Forestry and Rural Development Project (SUFORD) was launched in late 2003 with financial and technical assistance provided by the World Bank and the **Government of Finland**. The project aims to establish Production Forest Areas (PFA) all over the country and implement participatory sustainable forest management based on new GoL policy in eight priority PFAs located in four provinces in central and southern parts of Laos.

European Union (EU)

The EU supports a number of initiatives in northern Laos, directly and via NGO partners. The Programme for Micro-Project Development through Local Communities is based in Luang Prabang (<www.microprojects-lao.org>). Among the project activities are marketing ecotourism and improvement in animal husbandry and upland farming techniques.

The Phongsaly Forest Conservation and Rural Development Project, based in the northern province of Phongsaly, promotes economic development interventions aimed at enhancing productivity from the sustainable management of natural resources. Among several project components are agroforestry and improved extension services, as well as participatory natural resource management planning, joint forest management and conservation strategies for Phou Den Dinh National Biodiversity Conservation Area.

Food and Agriculture Organization of the United Nations (FAO)

The Marketing System Development for Non-Wood Forest Products in Lao PDR Project aims to contribute to the GoL development goals through development of NWFP marketing systems.

Australian Centre for International Agricultural Research (ACIAR)

ACIAR is supporting a project aimed at enhanced processing of and manufacturing from Lao plantation timbers, especially teak and eucalypts. This is aimed at capturing more value from the teak plantations of northern Laos in particular. Work on the silviculture of teak interplanted with non-timber forest product tree species such as paper mulberry is also under consideration. ACIAR also supports a project on the domestication of Meliaceae species in South-East Asia, including Laos.

Non-government organisations (NGOs)

Twenty-six NGOs are active in the agriculture, forestry and fisheries sectors in Laos, supporting some 53 projects (<http://www.directoryofngos.org>). A number of these encourage activities related to strengthening farming systems, tree planting and improving markets in the northern provinces.

CARE International

Poverty Alleviation in Remote Upland Areas (PARUA)—supported by the Swiss Agency for Development and Cooperation (SDC), this project is based in Xayaboury province. The project goal is to sustainably increase livelihood security among poor ethnic groups in remote upland areas. Among the objectives is to improve the performance of agricultural livelihood systems by providing households with an expanded range of viable and sustainable agricultural production options.

Pak Lai Forest Conservation and Livelihood Development Project in Xayaboury province—Care International also supported this project, which sought to enhance the abilities of both villagers and government staff to manage and protect the forests of Pak Lai district, and to improve the livelihood of the communities there in a sustainable manner.

Adventist Development and Relief Agency—Laos (ADRA Laos)

Sericulture Promotion and Integration for Community Empowerment Project (SPICE)—now complete, the SPICE project was based in Luang Namtha province and promoted mulberry tree cultivation and silkworm raising to provide an alternative and increased income source for 100 families. The goal of the project was to increase the income and food security of people in the target villages.

Subsequently, ADRA Laos has supported the Poverty Reduction through Land Tenure Consolidation, Participatory Natural Resources Management and Local Communities Skill Building Project, also based in Luang Namtha province. The purpose of the support is for nine typical poor rural ethnic minority communities to be socially prepared with secure land tenure and basic health and education, and able to manage their natural resources and respond to the opportunities and challenges brought about by improvements to Route 3.

ADRA Laos currently supports the Sustainable Agro-Forestry Systems for Livelihood Enhancement of Rural Poor Project in Luang Namtha province. The overall development objective is to bring about socially, economically, environmentally and ecologically sustainable rural poverty alleviation throughout the northern provinces of Laos. Project activities include on-farm activities to develop sustainable intensive interlinked agriculture and forestry land-use systems to enhance farm productivity, improve rural livelihoods and lay a foundation for secure land tenure certification.

Concern Worldwide (CONCERN)

Community Livelihood Development Project (CLDP)—based in Bokeo province, the project

focuses on improving practices of land-use planning, land allocation and community resource management (e.g. NTFPs).

The Sisaket Sub-district Community Development Project is also based in Bokeo province along the Namtha River. This project marks the first phase of an integrated project which seeks to strengthen livelihood security and includes studies of NTFPs gathered from native forests.

Cooporazione e Sviluppo Onlus (CESVI—Italy)

Food Security Project in Luang Prabang province—this project adopted an integrated approach with the objectives of increasing rice availability and upland households' cash income, and included activities related to the improvement of the productivity of upland farming systems.

Deutsche Welthungerhilfe / German Agro Action (DWHH/GAA)

Community-Based Rural Development Project for Sustainable Food Security in Nga district—this project has support from the EU and is based in Oudomxay province. It aims to improve food supply, nutrition and health standards, and ensure that natural resources are used in an efficient and sustainable manner. It includes activities promoting the use of NTFPs.

Community-Based Rural Development Project for Conservation—this project was also based in Oudomxay province and is a continuation of the Community-Based Rural Development Project for Conservation of the Nam Beng/Nam Mau Watershed implemented by DWHH/GAA in 1999–2003. The project development goal is the efficient and sustainable use of the natural resources to improve food security and living conditions of the local population, and for conservation of the watershed function of the designated headwaters and provincial conservation areas. A major focus is on developing sustainable farming systems, including management of NTFPs.

Integrated Poverty Reduction Project Muang Mai—this project, based in Phongsaly province, aims to reduce poverty through agricultural and community development activities, and includes assistance to develop improved farming systems.

Mennonite Central Committee (Laos) (MCC)

Integrated Agriculture Experimentation Project Borikhamxay Agriculture and Forestry College—based in Borikhamxay province, this project aims to provide improved agricultural production methods for villagers to ensure their food security and reduce poverty. It also includes the development of alternative models which can establish how much sloping land would typically be needed to support the needs of a Lao farm family to produce its own food and income needs using improved, integrated agricultural and forestry practices.

Norwegian Church Aid (NCA)

Drug Demand Reduction and Poverty Alleviation for Ethnic Minorities—based in Luang Namtha province, this project seeks to improve food security through rural infrastructure, paddy land expansion and irrigation, livestock and management of NTFPs in a sustainable upland agriculture system.

Netherlands Development Organisation (SNV)

Non-Timber Forest Products Advisory Programme—based in Luang Prabang province, this project operates via 'advisory programmes', with SNV advisers working alongside Lao organisations, but it does not fund them or implement their activities. SNV delivers advice on a range of topics within the NTFP sector, with a strong emphasis on networking and research. Two SNV advisers are based at the government's Forest Research Center (FRC), advising on the creation of a national NTFP network, development of micro-enterprises and support for forest users groups. One adviser is based at the Northern National Agriculture and Forestry Research Centre in Luang Prabang. In order to produce increased numbers of Lao specialists in this field, another adviser supports participatory curriculum development with the National University of Laos (<http://www.snv.org.la/ntfpindex.htm>).

Appendix 5: Sources of information and cooperation

International Union of Forest Research Organizations (IUFRO)

IUFRO has an active Working Group 5.06.02 – Utilization of Planted Teak (<http://www.iufro.org/science/divisions/division-5/50000/50600/50602/>), which has recognised that a priority for research is the use (properties and processing) of juvenile and/or sap wood available from thinning of teak plantations, and the establishment of grading/quality standards for improved market-value of small-dimension teak timber.

Teaknet

With a commitment from the Kerala Forest Research Institute to host Teaknet, modest ongoing support from FAO and APAFRI, and a planned 2007 regional workshop (see below), it is expected that the Teaknet network and operations will be resumed. An opportunity exists for the Lao PDR to become a fully participating member.

International Tropical Timber Organization (ITTO)

ITTO has a Committee on Economic Information and Market Intelligence and has supported a number of projects in the fields of economic information and market intelligence. It has provided the Kerala Forest Research Institute a grant to finance a regional workshop in 2007 to critically appraise the challenges for processing, marketing and trade of quality products of teak from plantations. All major Asian teak producer countries, viz. India, Indonesia, Malaysia, Myanmar and Thailand, are expected to participate, as well as the importing countries.

Midgley, S., Blyth, M., Mounlamai, K., Midgley, D. and Brown, A. 2007. Towards improving profitability of teak in integrated smallholder farming systems in northern Laos. ACIAR Technical Reports No. 64.

Appendix 6: Regulation of the timber trade in Luang Prabang[1]

LAO PEOPLE'S DEMOCRATIC REPUBLIC

PEACE INDEPENDENCE DEMOCRACY UNITY PROSPERITY

The Governor of Luang Prabang Province

No……./PG.LP
Date

**DIRECTIVE FROM
THE GOVERNOR OF LUANG PRABANG
ON THE PROTECTION OF THE COMMERCIAL EXPLOITATION AND TRADE IN TIMBER**

- Whereas the Prime Minister's Decree on the Promotion of Timber Plantations for Commercial Purposes and on Environment Protection, Number 150/PM, dated 20/10/2003
- Whereas the Regulations on the Extension of Timber Plantations issued by the Ministry of Agriculture and Forestry, No. 196/MAF, dated 11/08/2000, and Guidelines on the Registration of Tree Plantations, No. 1849/MAF dated 07/10/1999
- Whereas the Guidelines on Financial Contribution from Timber and Non-Timber Products Sector, issued by the Ministry of Finance, No. 1059/MF dated 13/06/2003

In order to ensure that the protection of the commercial exploitation and trade in timber follow official guidelines and regulations, the Governor of Luang Prabang province has issued a directive on the protection of the commercial exploitation and trade in timber. The directive is as follows:

1. Encourage all commercial interests to participate in timber plantation business so as to increase timber plantations of all economic sectors. The principals of the commercial interests wishing to participate in this plantation business initiative must be the head of a business concern that has been approved by the Provincial Agriculture and Forestry Service, Provincial Finance Office and the Provincial Commerce Office. Only the principal who owns a registered timber trading business or is operating timber processing mills in Luang Prabang province will be approved as a party to participate in this initiative. Further, the principal concerned must not be a convicted criminal, must have some operating funds in a bank deposit, and must have a plan for either public or private timber plantations of no less than 5 ha per annum. These requirements will be taken as indications of the strength of the foundation of the principal's own business in the future and of the development of timber plantations and environment protection, as well as providing a contact office in Luang Prabang.
2. The interested parties must fully and correctly fulfil the following state obligations:
   - The principal of the commercial interest must undertake to pay all taxes on behalf of the growers on income derived from the sale of timer within the province of Luang Prabang. The amounts of taxes to be paid will be calculated and collected by the District Office of the Ministry of Agriculture and Forestry in which the plantation is located. The calculation will be based on the base price of a percentage of the unit price of sale of timber within the province, that is 800,000 kip/m^3 x 5% = 40,000 kip/m^3 of lumber.
   - [The principal of the commercial interest must undertake to] Pay all taxes on business turnover figures per consignment at the rate of 5% of the sale price in the Vientiane market. The calculation will be at the average of 1,200,000 kip/m^3 of the timber, with the Finance Office doing the calculation and collection of the taxes, totalling at 60,000 kip/m^3.
   - [The principal of the commercial interest must] Pay a withholding tax at the wholesale rate of 35% of the 10% commercial duties, to be calculated by the Finance Office; that is 120,000 kip/m^3 x 35% = 42,000 kip/m^3.
   - [The principal of the commercial interest must] Pay for all lodgements of documentation as required by law (Commercial Service 10,000 kip per set; Assets Control Office of the Finance

[1] This is an unofficial translation of the Lao original.

Service 10,000 kip; excise stamps 10,000 kip; registration based on the value at the last point of sale multiplied by 0.1%, that is 1,200 kip/m^3; documentation at the Customs Office 10,000 kip; Provincial Agriculture and Forestry Office for timber brand at the rate of 3,000 kip/m^3 of logs and 5,000 kip/m^3 of sawn wood; authority for transportation 10,000 kip; authorisation for exploitation approval 25,000 kip.

3. In the case where the principal of the business interest wants to export the timber overseas, they must fully comply with all tax and excise obligations in Luang Prabang. The calculation of the value of these obligations will be based on the average export price of the timber. That is, the average export price of timber of 12,000,000 kip/m^3 will translate to the following tax and excise obligations: (1) Excise on the growers 40,000 kip/m^3; (2) Excise on the wholesale business turnover 100,000 kip/m^3; Withholding Tax on profit 70,000 kip/m^3.

4. In the case where the timber is harvested from a private individual's own plantation, and the business principal has registered it as his own, the taxes will be calculated at the rate of 5% of the sale price at the destination sale point. That is, if the harvested timber is sold in Luang Prabang the tax will be 40,000 kip/m^3; if it is sold domestically in other provinces, the tax will be 60,000 kip/m^3; and if it is sold overseas, the tax will be 100,000 kip/m^3. The calculation and collection of these taxes will be carried out by the District Office of the Ministry of Agriculture and Forestry in which the plantation is located.

   [N.B. The collection of the income tax from the grower will be undertaken by the district level offices, and the collection of all other obligations will be done by the provincial level offices].

5. Procedures for approval of the harvest and transport of timber:
   - The business principal can buy timber from individuals per tree or per plantation. The bill of sale must specify the numbers of trees and quantity involved, the expected time of harvest from the original plantation as well as the full commercial price agreed between the two parties. Furthermore, the original plantation must have an authorisation for planting of timber or a registration as a timber plantation.
   - The business principal must carry out a survey of the trees to be harvested and have this survey approved by the District Office of the Ministry of Agriculture and Forestry in which the plantation is located before he can seek approval for commercial exploitation of the said timber.
   - After the harvest all the cut timber must be transported to an accessible location (called a 'secondary holding yard') so that the officials from the District Office of the Ministry of Agriculture and Forestry can inspect, measure and register all the timber.
   - The business principal must submit the timber registration form from the District Office of the Ministry of Agriculture and Forestry, together with receipts for the payments of all relevant duties and taxes, for approval by the Provincial Office of the Ministry of Agriculture and Forestry to obtain authorisation for the transport of the timber in question.

This directive is effective from the date of signature until being superseded by a further or new directive.

The Governor of Luang Prabang

Distribution of copies

Provincial Commerce Office	1 copy
Provincial Finance Office	1 copy
Provincial Agriculture and Forestry Office	1 copy
All District Administrative Offices	11 copies
Archive	1 copy