

Teak production by shifting cultivators
in Northern Lao P.D.R.

By

Peter Kurt Hansen, Houmchitsavath Sodarak
and Sianouvong Savathvong

Shifting Cultivation Research Sub-programme
Lao Swedish Forestry Programme
Luang Prabang, Lao P.D.R.
July 1997

Paper prepared for the workshop on Indigenous Strategies for Intensification of Shifting Cultivation in Southeast Asia. 23-27 June 1997, Bogor, Indonesia. Cornell University and International Centre for Research in Agroforestry.

*^{1,2} Advisor and Head, respectively, Shifting Cultivation Research Sub-programme, Lao-Swedish Forestry Programme.
P.O. Box 487 Luang Prabang, Lao P.D.R. Tel 856 71 212 099, fax 856 71 212 467
Head, Luang Prabang Provincial Forestry Office, Lao P.D.R..*

Teak production by shifting cultivators in Northern Lao P.D.R.

P.K. HANSEN¹, H. SODARAK² and S. SAVATHVONG³

Key words: Shifting cultivation, Taungya, improved fallows, teak (*Tectona grandis*), Laos,

Abstract. Shifting cultivation is the most important farming system in Northern Laos, but population pressure and government regulations are increasingly undermining its productivity and sustainability. Identifying and promoting alternative production systems is a high priority of the Lao Government. However, farmers' adoption of new technologies is often hampered by the predominantly mountainous topography, the undeveloped infrastructure, the limited market demand, the relative poverty of the population, and by other factors. Teak (*Tectona grandis*) planting by shifting cultivators is one of the more promising possibilities, and has expanded rapidly since about 1988. Despite the high income potentials and ready adoption by farmers, the benefits of teak planting are limited by the inferior genetic material currently planted, by the inadequate management of farmers' teak plantations, by the competition with agriculture for arable land, and by the inability of farmers to hold on to plantations for 20-30 years. There are also concerns that plantations may be prone to serious pest attacks, excessive erosion, and soil depletion. Teak planting may provide an alternative or supplement to shifting cultivation, but is not likely to have a role in improved fallow systems.

1. Introduction

Shifting cultivation is the dominant cropping system in the uplands and mountains of Lao P.D.R. At least 300.000 families are fully or partially engaged in shifting cultivation, equal to about 1.8 million people or 40 percent of the population. Assuming that each family plants about 1.5 hectares per year, the shifting cultivation area used annually would be around 450.000 hectares. The total area in the shifting cultivation cycle is difficult to assess, but may be 2 - 2.5 million hectares, equal to about 10 percent of the area of Laos.

The population of Laos consists of 66 officially recognised ethnic groups, many of which contain several sub-groups (Chazee 1995). The many ethnic groups are often divided into three main categories: Lao Lum (lowlanders), Lao Theung (midlanders) and Lao Sung (highlanders). The Lao Lum consists of the ethnic Lao and other Tai speaking groups and accounts for about 60 percent of the population (NSC 1997b). Although the majority of Lao Lum farmers are engaged in paddy farming, a large proportion are shifting cultivators. The Lao Theung and Lao Sung groups make up 30 and 10 percent of the population, respectively. They are relatively more dependant on shifting cultivation than the Lao Lum groups, but the land-use is very diverse and ethnic stereotypes often prove misleading (Roder et al. 1991, Hansen 1995).

Most shifting cultivators remain subsistence producers of upland rice, but commercial production of other crops is expanding in areas with adequate infrastructure and market

access. In most places, the fallow periods have become critically short during the past 20-30 years; the main causes being population increase, government restrictions, and competing land-use objectives, as well as the concentration of people around urban centres and in areas with road and river access. Land pressure has increased problems such as soil degradation, weeds and pests, and has therefore usually lead to lower yields and to higher labour requirements.

Today, shifting cultivation in Laos is largely based on the cyclical use of young secondary vegetation, although limited swiddening in older forest still takes place in isolated areas. However, over the years, shifting cultivation has considerably reduced the forest area to the detriment of the timber resources and natural habitats. Where shifting cultivation is intense, accelerated erosion and changes in the water discharge may impair the water resources for irrigation, hydropower and domestic use.

Because of these environmental and social problems, stabilisation of shifting cultivation is a major priority of the Lao Government. The development strategy (DoF 1997) includes:

- Land allocation,
- Promotion of permanent cash cropping,
- Expansion of the paddy area,
- Expansion of livestock production
- Tree planting by farmers
- Infrastructure development, and
- Socio-economic development work.

Attempts to improve land-use in shifting cultivation areas of Laos have proven difficult because of the mountainous topography, limited infrastructure, low market demand, limited processing facilities and the poverty of most shifting cultivators (Hansen and Sodarak 1997). Furthermore, alternative land-use practices, especially permanent arable cropping, can be equally or more damaging if carried out in the mountainous forest areas. Thus, shifting cultivation partially restores soil fertility during fallow periods, and limits erosion through minimal tillage, maintenance of a favourable soil structure, and through the distribution of erosion over a large area. From an environmental point of view, shifting cultivation may also be preferable to the types of cash cropping that use large amounts of pesticides.

Because of declining productivity and limited alternatives, shifting cultivators are among the poorest and most disadvantaged groups in Laos. Few farmers would opt for shifting cultivation if alternatives were available, and, where this is the case, farmers have readily adopted new technologies. One such option is teak planting, which has spread rapidly among shifting cultivators in many places of Northern Laos, as described and evaluated below.

2. Methods and study area

This paper evaluates shifting cultivators' adoption of teak in Northern Laos, but much of the analysis is relevant to other areas of Lao P.D.R. The Northern Region consists of seven provinces: Phongsaly, Luangnamtha, Bokeo, Udomxai, Houaphan, Luangprabang and Sayabouly. It accounts for 41 percent of the area and 33 percent of the population in Lao P.D.R. It is a predominantly mountainous region with only small areas of basins and larger

river valleys. Permanent upland cropping and paddy farming is therefore secondary to shifting cultivation and about 65 percent of the shifting cultivators in Laos live in the North (Souvanthong 1995). Upland rice makes up at least 65 percent of the total rice area in the North, compared to a national average of 31 percent (NSC 1997a). The large proportion of shifting cultivation is partly responsible for the existing forest cover being only about 36 percent, compared with 52 and 58 percent in the Central and Southern Regions, respectively (NOFIP 1992). Improving the agricultural production is particularly difficult in the North because of the small potential for paddy cultivation, the hilly topography, and the limited infrastructure and market access.

The ministerial and provincial authorities have prioritised tree planting, particularly of teak, in the development strategy for Northern Laos. The authors of this paper have been engaged in extension of teak planting to shifting cultivators in Luang Prabang Province since 1988. During this time, much of the information presented here was collected through discussions with farmers and staff from the district agricultural and forestry offices. In addition, a village survey was carried out in 14 villages in Nane District of Luang Prabang Province to monitor farmers' perception of teak planting. A survey was also carried out in 16 districts focusing on the plantation activities carried out by farmers, private investors and public agencies. Available statistics from the Department of Forestry were also used. A study of the age and diameter relationship from cut teak logs was carried out to assess the growth of teak and the current cutting regime.

3. History and recent planting of teak in Laos

Teak occurs naturally in central and south India, Burma, Northern Thailand, and in two small areas in Laos close to the Western border with Northern Thailand. The ecological distribution covers the semi-arid to moist lowlands below approximately 1000 meters.

The teak forests in Laos are believed to be the eastern limit of teak's natural distribution (White 1991). The largest area occurs in Sayabouli Province where there may be 10-20.000 ha of mixed deciduous forest with teak inclusions (Hedegart 1995), although some estimates go as high as 50.000 ha (Rao 1993). Small areas also exist in Bokeo Province, which are possibly the only natural stands on the left side of the Mekong River. However, in most of Northern Laos teak was of little commercial and domestic importance compared to, e.g., *Azelia xylocarpa* and *Pterocarpus macrocarpus*.

HISTORY

The history of teak planting in Laos may be divided into three periods: the years before the revolution in 1975, the years between 1976 and 1988 when a plan economy was followed, and the years after 1988 when the economy was liberalised.

Before 1976, tree planting was very limited, partly because of the ample wood supply from the natural forest. Also, the export opportunities were limited by the political situation, and by the lack of ports and processing facilities. A plantation programme was started around 1950 by the Department of Forests and Water (DFW), mostly using teak planted in the taungya system. The plantations were usually established by shifting cultivators on land

belonging to the DFW, who took over the management and ownership of the plantations after farmers had ceased inter-planting with rice for one or two years. Teak plantations were mostly planted in the south of the country, and amounted to around 1500 ha, of which 1000 ha may have survived by 1972 (L.A.R.P. 1972).

After the revolution in 1975, a centrally planned economy was adopted and the authorities took ownership of all land. Farm collectives and state farms were introduced, although traditional tenure systems generally prevailed in shifting cultivation areas in the uplands and highlands. Responsibility for logging and tree plantations was given to state forest enterprises, and logging became the major earner of foreign currency along with hydroelectricity generation. During these years the Government attempted more ambitious plantation programmes in all provinces, mostly carried out by the state forest enterprises. Nevertheless, by 1991 the plantation area reported in official statistics was only 6250 ha, of which 1140 ha were established before 1976. Furthermore, sample surveys indicated that only 2900 ha were really existing or of an acceptable stocking rate, (LSFCP 1991). As before, teak was the main species, accounting for 47 percent of the reported plantation area, but other species had also become important including *Pterocarpus macrocarpus* (20 %), *Azelia xylocarpa* (17 %), *Eucaplyptus spp.* (6 %), and *Alstonia scholaris* (4 %). The remaining 7 % were made up of 19 minor species.

ADOPTION OF TEAK PLANTING BY SHIFTING CULTIVATORS

The first farmer-owned teak plantations in Northern Laos were established around 1950 through the promotion of the French colonial regime (Bounchamii, personal communication). These plantations were limited to a few areas along main rivers near Luang Prabang Town. The river communities were targeted because they were permanent, unlike the predominantly shifting cultivation villages in the uplands. Teak was moreover attractive because of its suitability for boat construction and because logs could be transported by river. Since most villagers living along the rivers were Lao Loum, teak planting was almost solely carried out by this group.

Since the late 1980's, farmers have greatly expanded the teak plantations (Table 1). Luang Prabang Province has been the main centre for this expansion because of the relatively better infrastructure, the larger scale of commerce, and the presence of older plantations that can supply seed. However, teak planting has expanded around most of the provincial seats in the North.

It is also significant that teak was adopted by shifting cultivators and thus expanded into the uplands where previously very little tree planting had taken place. This furthermore meant that more non-Lao ethnic groups have adopted teak, especially people of the Khamu ethnic group.

Table 1: Teak plantation area established by farmers in Luang Prabang Province, Northern Laos 1975-1996

Period	Teak planting, ha
--------	-------------------

1975-79	33
1980-84	42
1985-89	242
1990-94	1278
1995	1419
1996	2039

Source: un-published data of Luang Prabang Provincial Forestry Office

FACTORS FACILITATING ADOPTION OF TEAK

The rapid expansion of teak plantations in the North, particularly in Luang Prabang Province, has been facilitated by political and socio-economic changes since the late 1980's. The main factors promoting teak in shifting cultivation areas have been:

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 the government land policy farmers became assured of their user-rights to land used productively, including tree planting.
3. The permanent settlement pattern adopted by most villages. After years of war and unregulated access to land, the government now encourages permanent settlements and farmers are less likely to resettle at frequent intervals. Thus, long-term investments, such as teak plantations, have become more realistic.
4. The expansion of the road system, which has made plantations possible in new areas. Thus, very few plantations are established off the roads, since farmers do not expect investors to be interested in buying the timber or the land.
5. Land allocation schemes that give additional land for production of perennials. In principle, one hectare of land can be allocated to each household specifically for planting timber or fruit trees. Farmers would lose the right to such land if used for other purposes.
6. Promotion by private investors through financial support, the production of stumps and information dissemination.
7. Promotion and extension by government agencies (see below).

The government strategy for development in shifting cultivation areas aims at a rapid and considerable expansion of farmers' tree production, including that of teak, *Eucalyptus* spp., and *Acacia* spp. According to these plans, all farmers with suitable land and necessary resources should plant trees on some of their land. It is also envisaged that about 16 percent of the current households practising shifting cultivation will take up wood production as their main source of income within 5 to 10 years (DoF 1997).

The means to achieve these goals include:

1. Extension of tree planting to farmers through information, distribution of seedlings or stumps, and through credit schemes.
2. Allocation of land for plantation purposes to farmers.
3. Tax exemption on plantations with a tree density of more than 1100 trees per hectare.

4. Encouraging private companies to establish plantations and processing facilities in combination with farmer-plantations.
5. Plans to finance farmers' basic food requirements while they wait for income from plantations (DoF 1997).

Up to 1994 the authorities and various projects gave away or subsidised teak stumps to encourage farmers to expand the teak area. Predictably, many stumps were never planted and many plantations were not cared for. It also hindered the establishment of private nurseries.

MOTIVES FOR PLANTING TEAK

The most commonly stated reasons for establishing teak plantations are 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 usually claim that selling timber or using the wood domestically are the main reasons. This is in line with the official development strategy, which farmers are informed about through the extension system. However, it is generally believed that the main motivation for upland farmers is the possibility of selling the 1-3 year old plantation to investors, such as local businessmen and government staff. Farmers' reluctance to state this reason is caused by the still unclear laws for transfer of tenure rights. Extension staff estimate that - given the opportunity - 80-90 percent of upland farmers would sell their plantations. This has happened in some villages close to Luang Prabang Township during the past 3-4 years. In many villages, the establishment of plantations has been financed by external investors, who will take over the use-rights after farmers' inter-cropping has ceased.

Another important impetus is the possibility of using the teak plantations as collateral for credit. Farmers are thus able to obtain loans of 40-60 percent of the estimated value of the plantation. In a three year old plantation of one hectare this could amount to a loan of 1000-1500 US\$.

The authorities have in recent years implemented land allocation schemes that allocate up to four plots of land per family for cyclical shifting cultivation. In addition, each household can obtain one hectare of land for production of perennials. Many households have taken this opportunity to plant teak on the land. However, many families may not be capable or motivated to manage such plantations, which are therefore likely to be sold.

Domestic use of teak is a negligible motivation to farmers, as indicated by the near absence of teak in villages without road or river access. However, small scale teak planting for home construction may increase, even in remote areas, when the natural wood supply diminishes, when the shifting cultivation communities become more settled, and when farmers get easier access to planting material.

4. Potentials and Constraints

PROPERTIES AND USE OF TEAK

Teak has exceptional wood properties, which makes it one of the most sought after and expensive timber species, both locally and in the international market. Heart wood is structurally strong, durable, and very resistant to fungus and termites. The risk of splitting and warping during drying and processing is small and the wood is easily carved and turned. These properties make teak wood favourable for house construction, boat railings, furniture and for carvings.

The international market for plantation teak is likely to expand with the increasing consumer demand for certified plantation wood. The high market price makes long distance transport of teak economically feasible unlike industrial tree species such as eucalyptus and acacias, which depend on nearby processing facilities for pulp or board production.

In Laos, teak is used for a few secondary, and largely negligible, purposes. A yellow dye for silk yarn is made from boiling the dry leaves, thinning and pruning of trees provide firewood, and leaves may be used to thatch roofs and for packaging.

PROPAGATION

Teak is usually established from stumps, which are easy to transport and plant, but are sensitive to dry spells in the first two months after planting. Stump production is simple and requires little investment. Since 1993 many private nurseries have therefore emerged, producing stumps for family use or sale.

The advantage of genetic improvement of teak is well established from, e.g., Thailand; even simple selection of superior trees in plantations may give a 10-15 percent increase in volume production (Hedegart 1995). Nevertheless, hardly any systematic selection of seed trees, stands or provenances takes place in Laos and the plantations established in recent years were therefore propagated from genetically unknown, un-selected and, possibly, inferior sources.

Rather, a negative selection currently takes place since the largest and best formed trees in plantations and natural stands are selectively cut to generate a quick income. This also favours trees that are genetically disposed to early flowering, which is considered a negative trait related to excessive branching and reduced volume increment. The loss of older trees has increased in latter years after timber prices have risen and trade has been liberalised.

The rapid expansion of teak planting in Northern Laos has caused a shortage of seed, and it is therefore likely that un-selected seed material will be used for yet many years. The lack of seed has limited teak planting in some areas, especially where there is no local seed source.

The scarcity of seed is reflected in the price of dry fruits, which in Luang Prabang Province increased from 35 to 800 Kip (5 to 80 US Cents) per kilogram between 1992 and 1996. However, even at the higher price the seed costs represent only 5-10 Kip per seedling or stump, equivalent to 10-20 percent of the price of a teak stump.

MANAGEMENT

Teak is usually established in taungya systems, i.e., inter-planted with agricultural crops during the first one to three years. This normally ensures adequate weeding and protection of the teak in the early years, which few farmers would have sufficient labour resources to carry out if crops and teak were planted in separate areas.

The teak stumps are normally planted in June or July after completion of the first weeding in the associated crop. Planting after mid-July is not recommended as the small teak trees would be vulnerable to weed competition, browsing animals and dry season fires.

When inter-planting of agricultural crops ends after 1-3 years, little management is applied except slashing of taller weeds and, sometimes, controlled burning early in the dry season. Regrettably, few farmers prune low branches or forked trees, the latter sometimes occurring in more than 50 percent of the plants. Furthermore, thinning usually takes place too late, often when the trees are ten to fifteen years old. The lack of sufficient management is a major constraint on the growth and quality of trees. There is thus much scope for improving the production through timely weeding, thinning, pruning and fire control, as well as improved propagation methods and the selection of seed sources. However, farmers' incentives are low if they intend to sell their plantations.

Teak is usually preferred to alternative perennials because of it is relatively easy to manage and propagate, grows fast in the early years, and is tolerant to fire. The consequent expansion of teak planting has led to concerns that teak mono-cropping may lead to devastating pest attacks, especially of bee-hole borers and caterpillars. Furthermore, teak offers little soil protection, and sheet, rill and gully erosion are often seen in older plantations, which have also been remarked upon by Hedegart (1995) and White (1991). Casual observations in 15-20 years old plantations also suggest that little accumulation of organic matter takes place.

INCOME GENERATION

Teak is relatively fast growing compared to most other high value timber species. Although commercial teak rotations usually are 50-80 years, teak in farmers' plantations is mostly cut at the age of 15-25 years, with an average age for trees cut in 1996 of only 16 years. This reflects that very few farmers planted teak before 1970, and that few farmers are willing to produce timber beyond the minimum diameter required by local timber companies. However, the limited formation of heartwood in the young trees means a large loss in potential income.

The minimum size of round wood accepted by the local sawmills is 20 cm diameter at breast height (dbh). In Luang Prabang Province this size is attained at an average age of about 15 years (range 10-25 years). On average, four trees of 18 cm dbh makes up 1 cubic meter of round wood.

Farmers currently receive about 25 US\$ per tree of a diameter of 18-20 cm, equivalent to about US\$ 100 per m³. The middlemen usually sell the timber for US\$ 130-140 per m³ to provincial sawmills. Round wood sold in Vientiane is about 230 US\$ per m³ and at the export market 350-600 US\$ per m³. Lately, however, farmers seem to be getting a slightly better deal due to better access to information on prices. Cut wood (planks) in Luang Prabang and Vientiane sell for about 450 and 650 US\$ per m³, respectively.

Compared to upland farming, teak planting seems very favourable: A well managed plantation can after 20 years produce about 130 m³ of wood per hectare, equal to US\$ 13.000 or US\$ 650 per year. This can be compared with upland rice production every fourth year, which may yield 1400 kg/ha equal to US\$ 210 per hectare and year, or US\$ 1260 from the six crops produced during the 20 years. In addition, the labour requirement is maybe three times higher than for teak production.

Although these figures are merely indicative, they suggest the huge economic potential of teak. For farmers, however, the problem is to wait for the income for 20-30 years, and teak is therefore primarily suitable for wealthier farmers, for businessmen and for government employees. Many farmers have therefore sold their young plantations to investors. Since plantations are predominantly established on flatter land next to roads, farmers lose much of the best agricultural land where the production of cash crops would be eased by road access. Furthermore, such areas often have relatively gentle slopes where permanent cultivation is more accomplishable.

On the other hand, farmers get an income that would be very difficult to obtain through other means. Depending on the location (especially proximity to cities) and age of the trees, plantations sell at 700 to 2000 US \$ per hectare. This can be compared to a mean annual household income for shifting cultivators (cash and goods) of 500 US \$.

While land is still plentiful in most of the country, it is generally scarce in areas where teak planting is most common and feasible, i.e., along roads near the major cities. The rapid expansion of teak in parts of Northern Laos could therefore result in poor farmers losing much of their best land to richer people.

ENVIRONMENTAL SUITABILITY AND GEOGRAPHICAL DISTRIBUTION

Teak is well suited to the diverse environmental conditions in Northern Laos. The main environmental limitation is elevation, as teak does not thrive above 7-1000 m (depending on local climate). This excludes its cultivation from about 30 percent of the Northern Region. Nor are flood-prone lowland areas, and shallow, gravelly or strongly acidic soils suitable. These site requirements effectively exclude teak from another 10-15 percent of the land in the Northern region. They also mean that teak plantations do not optimise the use of marginal land.

The distribution of teak is also limited by the availability of transportation. Thus, more than 95 percent of the plantations are established along roads and rivers, where the sale of plantations or logs would be possible. Teak planting is therefore confined to a minority of villages, and is currently unlikely to spread to areas of more difficult accessibility.

Because teak is confined to areas with road or river access, it is mostly planted in the more populous areas, i.e., where shifting cultivation is under relatively high pressure. In such areas the fallow periods are generally only 2-6 years and few farmers are able to produce sufficient rice for their household requirements. Rice deficiency is often farmers' stated reason for selling their plantations.

More ethnic Lao are planting teak compared with the Khamu (Lao Theung) and Hmong (Lao Sung) ethnic groups (Roder et al. 1995, Juville forthcoming). This may be because Lao people more frequently occupy land close to roads, along rivers, near larger cities and at the lower elevations. Also, the Lao farmers generally have better economic resources, rice security, access to information and contacts in the cities than the Khamu and Hmong farmers.

The differences in ownership are accentuated by the high proportion of Khamu farmers selling their plantations and by many Lao villages having made communal restriction on the sale of land to outsiders.

INTEGRATION WITH AGRICULTURE

Teak is associated with agriculture through the initial inter-planting of teak and agricultural crops and through grazing in the young plantations. The potential for economically improved fallows has also been proposed.

Since teak is usually planted in taungya systems the plantations will necessarily occupy agricultural land, although much of this land is unsuitable to permanent cultivation. Current extension recommendations promote teak planting on marginal land. This may be desirable from a general land-use perspective, but will limit teak growth and postpone the time of timber sale.

The number of years teak is inter-planted depends mainly on whether a reasonable production from the agricultural crop can be expected. Thus, with a 2×2 m spacing of teak usually only one year of inter-cropping is possible, whereas the more common spacing of 3×3 m facilitates 2-3 years of inter-planting. The crop species will also influence how many years inter-planting can take place. Upland rice, for instance, can normally be produced for only one or two years, because of weed competition and a rapid yield decline when planted in consecutive years. Other crops may be planted for two or three years, e.g., pineapple, maize, and sugar cane, as they are less prone to rapid yield declines, are more competitive with weeds, and are easier to weed. Roder et al. (1995) found that inter-planting in year 1, 2, 3, and 4 took place in 86, 57, 37 and 7 percent of teak plantations, respectively.

Grazing in teak plantations is limited by the risk of damage to young trees and, after 3-4 years, by the closure of the canopy. There may be possibilities of introducing systems of cut and carry or browsing of legumous trees or herbs planted for soil improvement and protection. However, farmers are not likely to intensify their livestock production, as it is based on low input-low output (Hansen and Sodarak 1997).

The possibility of using teak in improved fallows is limited by the long production cycle of 15-25 years, compared to the 2-6 year fallows available to most farmers. Even if long fallow periods were possible, teak plantations as currently managed would probably have limited or negative effect on soil fertility. Furthermore, if farmers could retain their teak plantations until logging starts, the high income would make crop production irrelevant. Lastly, the high coppicing potential of teak would make conversion of the plantation into swidden fields unrealistic, since farmers would rather opt for a second cycle of teak production.

The possibility of replacing some shifting cultivation with teak planting may be technically and economically feasible. Thus, the value of the annual increment of teak plantations and

the return on labour far exceeds those of upland rice cropping. It would therefore seem possible to devise schemes which finance farmers' tending plantations until logging can start. The ownership of such plantations may lie with private investors, with the farmers or a shared ownership. The forest village projects in Thailand are examples of such mixed ownerships (Boonkird et al. 1984). The main constraints are, however, the financing, the organisation and the acceptance by farmers.

Given the above mentioned constraints, the most realistic role of teak is as a supplement to shifting cultivation, i.e., planting teak on a part of the farm land while continuing upland cropping on separate land. Relatively small plantations would be preferable and suitable to most farmers if they are to apply adequate management and retain the ownership.

5. Conclusion and recommendations

The potential income and economic spin-off from teak planting in the uplands of Northern Laos is very high, particularly compared with current land-use. Further expansion of teak planting is facilitated by the large areas of degraded forest and by the relatively equitable distribution of land. Improvements in the road system will expand the potential for teak planting to new areas. Until recently, the government strategy has been to promote as much tree planting as possible. However, various problems and constraints have been identified, such as:

1. The supposedly inferior genetic material currently planted.
2. The inadequate management of farmers' teak plantations.
3. The competition with agriculture for the better land.
4. The inability of farmers to hold on to plantations for 20-30 years.

Some suggestions to amend the problems are listed below.

TEAK IMPROVEMENT

Following Hedegart (1995) the following recommendations can be made regarding genetic teak improvement in Laos:

- Conservation of the existing natural teak forest.
- Conversion of selected natural stands and plantations into seed stands. This would involve setting up a system for selection, control and certification.
- Provenance trial using local and foreign material.
- Selection of plus trees.
- Establishment of progeny trials for selection and multiplication of improved material.

TEAK EXTENSION

As mentioned above the current management of farmers' plantations is inadequate. There is much potential for improving the growth and quality of teak through relatively simple measures. These include timely weeding, thinning, pruning and fire control, as well as

improved propagation methods and selection of seed sources. Better silviculture can enable quicker sale of logs and thus help farmers retain their teak plantations. The main initiatives needed are:

- Formulate improved technology recommendations for propagation and plantation management.
- Produce better information material to farmers and extension workers.
- Establish sites for demonstrating improved management techniques
- Promote the establishment of smaller plantation (e.g. 50-200 trees), which farmers can realistically maintain over many years, can apply adequate management techniques, and will be less likely to sell off.
- Promote teak planting in areas without road or river access to provide timber and seed sources for local usage.

RESEARCH NEEDS

Much research on teak silviculture is carried out internationally, including countries near to Laos. Considering the limited economic resources and research capability in Laos there is much scope for more systematic evaluation and adaptation of foreign research. Research in Laos should concentrate on solving concrete problems of specific local interest. Some technical research needs can be suggested:

- Systems for teak inter-cropping with crops and other trees species to improve overall production and sustainability.
- Study the ecology and structure of natural teak stands to help improve their protection and use.
- Adapt or develop improved silvicultural practices that will facilitate higher income and shorter rotations, especially practises that are relevant to resource poor farmers in the uplands.
- Investigate the environmental suitability of teak, especially regarding elevation (temperature), rainfall and bedrock. Such research may be combined with provenance trials for specified climatic zones.
- Survey pest and environmental stress affecting the performance of teak under different production conditions.

Carrying out the suggested research and extension recommendations would require considerable staff training and institutional strengthening

Acknowledgements

The authors acknowledge the suggestions made to an earlier draft of this paper by Ms Susan Kirk, Mr Manfred Fischer, Mr Bengt Frykman and Dr Nicholas Tapp. The Swedish International Development Co-operation Agency (Sida) has supported our teak research and extension, which is gratefully acknowledged.

References

- Boonkird SA, Fernandes ECM and Nair PKR (1984) Forest Villages: An Agroforestry Approach to Rehabilitating Forest Land Degraded by Shifting Cultivation in Thailand. *Agroforestry Systems* 2: 87-102.
- Chazee L (1995) Atlas des Ethnies et des Sous-Ethnies du Laos. Bangkok, private publishing. 220 pp.
- DoF (1997) Plan to the Year 2000 for Stabilizing Shifting Cultivation by Providing Permanent Occupation. Department of Forestry. Vientiane. Paper presented at the "Stakeholder Workshop on Shifting Cultivation Stabilization", Vientiane, Laos, 6-7 February 1997. Ministry of Agriculture and Forestry and Asian Development Bank.
- Hansen PK (1995): Shifting Cultivation Adaptation and Environment in a Watershed Area of Northern Thailand. Communities in Northern Thailand. Ph.D. Dissertation, Department of Crop Husbandry, Royal Veterinary and Agricultural University, Copenhagen, Denmark. 280+140 pp.
- Hansen PK and Sodarak H (1997) Potentials and Constraints on Shifting Cultivation Stabilisation in Lao P.D.R. Paper presented at the "Stakeholder Workshop on Shifting Cultivation Stabilization", Vientiane, Laos, 6-7 February 1997. Ministry of Agriculture and Forestry and Asian Development Bank.
- Hedegart T (1995) Teak Improvement Programmes for Myanmar and Laos. FAO Regional Project "Strengthening Re-forestation Programmes in Asia" (STRAP), Field Document No. 3. Food and Agricultural Organization of the United Nations. 29 pp.
- Juville M (forthcoming) Household Census 1996. EU Microprojects Luang Prabang. Luang Prabang, Lao P.D.R.
- LSFCP (1991) Survey of Forest Plantations in Lao P.D.R. Forest Inventory Report No. 1. Lao-Swedish Forestry Co-operation Programme Department of Forestry and Environment. Ministry of Agriculture and Forestry. 13 + 4 pp.
- L.A.R.P. (1972) Manual of Operations. Laos-Australian Re-forestation Project. Forest and Water Department Royal Laos Government.
- NOFIP (National Office of Forest Inventory and Planning) 1992 Forest Cover and Land Use in Lao P.D.R. - Final Report on the National Reconnaissance Survey. Department of Forestry, Ministry of Agriculture and Forestry. 71 pp + appendices.
- NSC (National Statistical Centre) 1997a Basic Statistics about the Socio-economic Development in the Lao P.D.R. State Planning Committee, Vientiane. 129 pp.
- NSC (National Statistical Centre) 1997b Results from the Population Census 1995. State Planning Committee, Vientiane. 94 pp.
- Rao YS (1993) Teak - A Plundered World Heritage. Occasional Paper: 8, Regional Office for Asia and the Pacific (RAPA), Food and Agricultural Organization of the United Nations, Bangkok. 11 pp.
- Roder W, Leacock W, Vienvonsith N and Phantanousy B (1991) Relationship between ethnic group and land use in Northern Laos. Poster presented at the International Workshop on Evaluation for Sustainable Land Management in the Developing World. Chiang Rai, Thailand 15-21 September 1991. IBSRAM, Bangkok.
- Roder W, Keoboulapha B and Manivanh V (1995) Teak (*Tectona grandis*), fruit trees and other perennials used by hill farmers of Northern Laos.
- Souvanthong P. 1995 Shifting Cultivation in Lao P.D.R.: An Overview of Land Use and Policy Initiatives. IIED Forestry and Land Use Series No. 5. International Institute for Environment and Development, London. 38 pp.
- White KJ (1991) Teak - Some Aspects of Research and Development. RAPA Publication: 1991/17. FAO Regional Office for Asia and the Pacific, Bangkok. 70 pp.

Table x Evaluation of the potentials and constraints on teak planting by shifting cultivators in Northern Laos.

Evaluation criteria	Potentials and benefits	Constraints and problems	Recommendations and solutions
Policy and legislation	Tax exemptions given on plantation land. Land allocated to small scale farmers.	Decrees and laws have changed frequently. Tenure is often transferred by selling the teak "on the root" at 1-3 years. Teak plantations legalises land grabbing.	Clarification and more rigorous implementation of tenure regulations.
Environmental suitability	Climatically suited to most of northern Laos. Fire tolerant.	Not suitable on flood prone land, shallow soils and under very low pH. Upper altitude limit probably at 7-800 m.	Extension recommendation should consider the environmental suitability
Environmental impact	Probably causes less erosion than farming does.	Soil loss on slopes may be excessive. Often very little humus accumulation.	Erosion control through cover cropping and inter-planting with other tree species.
Markets and infrastructure	Ready market and not dependant on nearby processing facilities.	Only planted along roads and rivers. Competes with agriculture for flat and accessible land.	
Seed and germplasm	Seeds are locally available. Good opportunities of improving production through simple selection of seed trees.	Negative selection as the biggest trees are cut first. Grading and selection of seeds are rarely carried out. Provenance testing in Laos is rudimentary.	Selection and conservation of seed trees in plantations and natural stands. Establish a seed centre. Provenance trial in representative environments. Establish links with international organisations.
Propagation	Easy and cheap propagation. Rapid adoption of farm nurseries. Stumping eases transplanting.	Often low germination percentage. Stumps are often too small because of dense spacing and insufficient nutrient and water supply.	Inform farmers of the advantages of good planting material.
Land selection			
Management	Fire tolerant and fast growing. Competes well with weeds after the second or third year. Good potential for optimising production.	Usually insufficient weeding, pruning and thinning. Mono-cropping may lead to pest and erosion problems. Management recommendation not formulated and extended to farmers.	Extension and demonstration of improved management.

Income generation	High income potential for farmers and the processing industry. Also income from seed and stump production. Shorter rotation than most other high value timber species.	Most farmers cannot wait 15-25 years for income. Plantation are often sold to investors. Low quality following insufficient management leads to low prices.	Long term credits through public or private funds. Improved management to improve volume and quality. Promote high-price wood industry.
Integration with agriculture	Plantations are an economic security and collateral. Teak suited to 1-3 years of intercropping. cattle grazing possible in year 3-5 after planting	Low degree of processing. Suffers greatly from light competition. Few shifting cultivators have time to manage their plantations properly.	
