

Teak (*Tectona grandis*), fruit trees and other perennials used by hill farmers of northern Laos

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Abstract. Hilly topography and inaccessible markets leave limited alternatives for Lao upland farmers who grow rice in slash-and-burn systems. They plant banana, mango, papaya, coconut and other perennials and collect forest products, specially bamboo shoot, banana inflorescence, rattan, cardamom, and benzoin for home consumption and market. Teak is the most important perennial planted on upland fields but farmers having teak are more likely to belong to the lowland ethnic groups and own lowland rice fields. Farmers preferred teak over fruit trees and coffee because of the better market potential and 82% considered cash income or wood for construction and 18% the securing of land tenure as major reasons for planting teak. Insufficient financial resources, non-availability of land, lack of seedlings, lack of labor and lack of experience were regarded as the main reasons for not planting teak by 41, 39, 35, 28 and 13% of non-teak growers, respectively. Plantations are often interplanted with rice for the first 1–3 years. Resource-poor families generally cannot risk the long-term investments and credit or modified systems combining food, livestock, and timber production are necessary to allow them to take part in the potentially lucrative teak production.

Introduction

Slash-and-burn agriculture remains a dominant land-use system in many parts of the tropics. Depending on the perspective of the observer, the criteria applied, and the system used, slash-and-burn farmers have been either commended for having a harmonious relationship with their environment [Posey, 1985; Warner, 1991], or criticized for destroying the forest resources [Mackie, 1985; Singh and Singh, 1980]. Although systems used vary greatly, most slash-and-burn farmers depend on perennials to suppress weeds and recover soil fertility in the fallow period, to provide fruits, substitutes for vegetables, emergency staple food, and hunting ground.

The population of Laos is made up of over 60 ethnic groups [Stuart-Fox, 1986]. Based on ethnicity, linguistics, and geographical characteristics, the ethnic groups are divided into three broad categories: Lao Loum (Lao of the lowlands), Lao Theung (Lao of the mountain slopes), and Lao Sung (Lao of the mountain summits). The population of Luang Prabang Province comprises of 39, 47 and 14% of Lao Loum, Lao Theung, and Lao Sung, respectively [Ethnographic survey 1985, Department of Ethnography, Vientiane, unpublished]. The Lao Theung and Sung categories consist mainly of the ethnic groups Kamu and Hmong, respectively. All major ethnic groups of the country

are engaged in upland (upland refers to fields that are not bounded and usually not level) agriculture, but in proportion to their total numbers Lao Sung and Lao Theung farmers are more dependent on upland agriculture. Similarly, Lao Loum farmers are more likely to have lowland (lowland refers to fields that are level and bounded to retain surface water) rice fields. Most upland farmers use slash-and-burn fallow rotation systems to produce rice as their main crop.

Some of the ethnic groups prevalent in the north may have been traditional slash-and-burn farmers, whereas increasing population pressure pushed others from the lowlands into the hills [Halpern, 1961; Izikowitz, 1951]. Casual observers have related specific slash-and-burn practices to particular ethnic groups [Roder et al., 1991]. Kamu farmers are often credited for their appreciation of trees and environment [Hakangard et al., 1990; Tayanin 1992]. Hmong farmers, on the other hand, are frequently accused of using destructive practices [Hakangard et al., 1990]. Recent quantitative observations of land-use systems, however, did not support the association of positive or negative practices with ethnic categories [Roder et al., 1991]. It appears that extrapolations of ethnic labels, coined by Kunstadter and Chapman [1978] for describing land-use systems in northern Thailand, have been applied repeatedly without validation in the Lao situation.

It is widely accepted that trees and other perennials are better adapted to adverse and unstable environments than annual crops [Felker and Bandurski, 1979]. Agroforestry systems have thus been promoted as an alternative to replace slash-and-burn systems [Robison and McKean, 1992]. Various products from trees and perennials of high value but low density have traditionally served as important trade commodities in northern Laos. Such products included sticklac produced by the insect *Laccifer lacca* feeding on pigeon pea [Malpuech, 1924], benzoin, a resin of *Styrax* sp. [Mouhot, 1864], cardamom, and various medical plants. Perennials have a specific significance for the Lao upland farmer because a large percentage of the land presently used for slash-and-burn agriculture has slope gradients over 40%, and will therefore not be suited to the production of annual crops such as rice in a permanent system [Roder et al., 1992]. Present government policies and on-going development programs, however, generally give priority to rice production and food self-sufficiency. Perennial crops have unfortunately not been given due recognition or priority by policy makers and donor agencies.

Lack of market is a serious constraint to horticultural production, except for villages around small urban areas such as provincial capitals [Roder et al., 1992] and opportunities for upland farmers to integrate trees and other perennials into their farming systems are limited. Over the past decade, teak (*Tectona grandis*) was the most widely planted perennial, second only to fruit species planted for home use. Under similar ecological conditions but less favorable legislation in neighboring Thailand, teak has become a favorite cash

crop for farmers [Hoare and Patanapongsa, 1988] and a lucrative investment opportunity for small investors [P. Ngarmpring, In: Shift into Teak land, Bangkok Post, November 1, 1993].

During 1992 and 1993 the LAO-IRRI project carried out various investigations in the Luang Prabang Province (northern Laos) to quantify and/or qualify: (1) the importance of fruit trees and plantation crops for individual farmers, (2) the importance of forest products in the household economy and market, (3) the motivation and circumstances that lead farmers to plant perennials, especially teak, and (4) the importance of upland rice in the management of teak plantations.

Materials and methods

Household and village survey

Data pertaining to trees and perennials were obtained in the following surveys conducted during 1992 and 1993:

- a) Village surveys were conducted in Viengkham, Pakseng, and Xiengngeun districts in 1992 (Luang Prabang province has a total of 11 districts). In each district 10 villages were chosen randomly from a list of all villages. The sample of 943 households represented about 7–10% of the total population of the districts. Information on all individual households pertaining to land, livestock and tree use and ownership was recorded.
- b) Household surveys (Survey 1, 1992) were conducted in the same villages. In each village 2–4 individual households were visited and additional questions asked relating to land use problems and ownership of perennials (coconut and papaya).
- c) Household surveys (Survey 2, 1993) focusing on rice economics were conducted in Xiengngeun and Viengkham districts in 10 villages; interviews were conducted in 10–20% of the households in each village. The total number of households used was 72. Questions relating to tree ownership and the use of forestry products were included in this survey.

Records available with district authorities

Village level data for household numbers, ethnic identity, lowland area, upland area, livestock figures, distance from road, and teak area were obtained and analyzed for Xiengngeun, Viengkham and Nambhak district of Luang Prabang Province. All 382 villages were included, but since teak plantations are only found for Lao Loum and Lao Theung villages the data was only summarized for these two ethnic categories.

Market survey

The town of Luang Prabang (Capital of the Luang Prabang Province) has two daily markets for fresh products. Some farmers sell their products directly, while others use a intermediary. A survey was conducted during September to December 1992 to appraise the importance of products of perennial species, prices, and distance of producers from the market. Markets were visited once a week and 15–25 randomly chosen vendors were interviewed. The volume, source (distance of village) and price of the goods sold were recorded.

Survey of teak

A survey was conducted in 1993 in Xiengngeun and Viengkham districts in 17 villages having teak plantations. Villages were chosen randomly from all 55 villages that had teak. In each village 2–5 households with teak plantations and 2–5 households with no teak were selected with the help of the village headman. Interviews were conducted using a formal questionnaire. Questions asked included: extent of plantation, motivation for planting teak, why teak was preferred against other perennials, source of planting material, plantation management, and major problems.

Results and discussions*Tree species and their importance*

The farmers surveyed use a large variety of trees and other perennial plants. Mango and banana are the most important fruits, followed by papaya, and jackfruit (Tables 1 and 2). The introduced papaya has become an important component of the daily diet of many Laotian families. A preparation ('mak hong tam som') made from shredded green papaya fruits, fermented fish paste and spices is frequently eaten with sticky rice. The average number of trees and other perennials available per household is small and many families reported having none (Table 1). Most of the households listed as not having fruit species may harvest banana and papaya and other fruits from plants growing wild on fallow land or in the forest. The list of perennial species in Tables 1 and 2 is far from complete. Less important species used occasionally by the Lao farmer include: jujube (*Zizyphus jujuba*), custard apple (*Annona squamosa*), star apple (*Chrysophyllum cainito*), starfruit (*Averrhoa carambola*), lychee (*Nephelium litchi*), and 'mak monkhay' (*Diospyros decandra*).

Apparent ethnic differences in choice and importance of tree species used are largely a result of environment and available resources. Mango and coconut are the most important fruit species for Lao Loum, while banana and

Table 1. Frequency and average number of fruit trees and other perennials for the ethnic categories.^a

	Loum (n = 115) ^b		Theung (n = 604)		Sung (n = 224)	
	Frequency (%)	Average ^c (no.)	Frequency (%)	Average (no.)	Frequency (%)	Average (no.)
Mango	44	11	25	6	24	11
Banana	29	9	25	21	56	21
Papaya ^d	25	5	11	8	30	12
Orange	4	2	7	11	11	4
Coconut ^d	33	8	14	5	0	0
Coffee ^e	0	0	3	80	4	8
Teak	21	92	5	39	1	2

^a Data pooled from household and village surveys.

^b n = number of households.

^c Average of households having a particular species.

^d For coconut and papaya the sample size was 24, 103, and 27 households for Lao Loum, Lao Theung, and Lao Sung, respectively.

^e Mostly *Coffea arabica*.

Table 2. Frequency and number of less important fruit tree species.^a

Species	Frequency (%)	Average numbers and range ^b
Jackfruit	17	10 (2–57)
Pomelo	7	8 (1–20)
Lemon	6	3 (2–4)
Tamarind	3	7 (6–7)
Peach	3	4 (3–5)
Mak lot (<i>Elaeagnus conferta</i>)	2	2
Guava	2	3

^a Data from household survey 2, 72 households.

^b Average for households having the particular species.

papaya are more important for Lao Sung farmers. This is clearly influenced by climatic conditions, since mango and coconut are not suited to the high elevations generally inhabited by the Lao Sung farmers. Age of settlement may be another factor affecting choice of species. Banana and papaya can both be harvested within one year after planting and may therefore be the preferred species in newer settlements.

Over the last decade teak has become by far the most important tree planted, except by Lao Sung farmers. While numbers and area increased only moderately with other species, an exponential increase was observed for teak (Fig. 1). The increase in teak plantations started in 1975 and gained phenomenal momentum in 1985. Although various factors may have contributed to an increased interest in teak, changes in the laws governing use

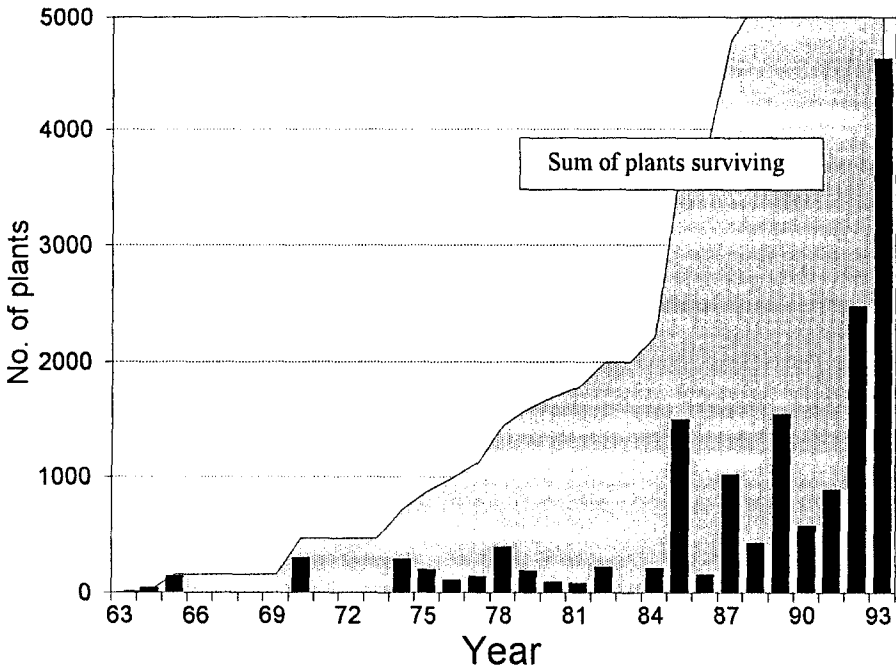


Fig. 1. Number of teak planted (bar) and the total number of teak plants that survived from the 62 households interviewed.

of timber, departure from collectivized agriculture, and increased confidence of farmers in political stability are probably the most important factors.

A large variety of wild plants, animals and insects are collected and used by the rural population. Many of these are collected from fallow land (rice slash-and-burn rotation) or from the forest. In the household interview conducted during 1992, bamboo shoot was the most important commodity collected for home consumption and sale (Table 3). Other forest products including benzoin, cardamom, and 'posa' (*Broussonetia papyrifera*) are collected for cash income only.

Non-timber products from trees and other perennials in the market of Luang Prabang

Luang Prabang town with about 20,000 inhabitants, although relatively small, is the most important local market in northern Laos. Products from trees and other perennials sold in the market are seasonal. The list in Table 4 indicates the main products available during September to December. Species important for the rural population such as banana, papaya and coconut are also the most important species in the urban market. Mango did not appear because its season was already over at time of the survey.

Table 3. Forest products collected, volume and use.^a

Product	Frequency ^b	Volume ^c	Use
Bamboo shoot	27	220 kg	Home and market
Banana inflorescence	7	230 no.	Home and market
'Posa' (<i>Broussonetia papyrifera</i>)	6	73 kg	Market
Cardamom (<i>Amomum</i> sp.)	4	2 kg	Market
'Mak kha' (<i>Pahudia cochinchinensis</i>)	4	20 kg	Market
Rattan	3		Home and market

^a Data from household survey 2, 72 households.

^b Percent of households reporting collection of the product.

^c Average per household.

Table 4. Products from perennials in the market of Luang Prabang and distance of producers.^a

Species	Frequency ^b (%)	Average distance (km)	Average Price (US\$ kg ⁻¹)
<i>Cultivated</i>			
Banana ^c	71	11	0.18
Papaya	71	12	0.14
Lemon	57	15	1.38
Orange	43	150 ^d	0.18
Coconut	29	16	0.49
Tamarind	21	4	0.06
<i>Wild</i>			
Bamboo shoot	43	3	0.48
Trumpet flower (<i>Oroxylum indicum</i>)	36	14	0.97
'Some pone' (<i>Acacia rugata</i>)	29	18	0.71
Pepper wood (<i>Piper ribesoides</i>)	21	90 ^d	0.93
'Mak kok' (<i>Spondias mangifera</i>)	14	3	0.24

^a Data from market survey.

^b Frequency based on the presence in the weekly samples during 14 weeks.

^c Includes leaves and inflorescence which may often be harvested from banana growing wild in shifting cultivation fields.

^d These products need special conditions not available in the vicinity of Luang Prabang.

A large variety of products from wild growing plants collected from the forest or fallow land (fallow progresses into forest and no clear separation exists) are very important in the market. The list in Table 4 includes the most important species, but is far from complete. Interestingly the prices for products from wild species are quite high. Although the rural population may use forestry products mainly during scarcity of rice, this is no longer the case for the urban population, which has acquired a taste for these 'fancy' products. Many of the products sold are carried to the market by producers and/or collectors from the surrounding villages. The average distance from the

production or collection site is generally less than 20 km and is the same for products from cultivated and wild species.

Motivation of farmers and circumstances that favor teak plantation

Most of the teak growers in the area surveyed are Lao Loum farmers in spite of them representing only 10–30% of the population in the districts surveyed (Tables 1 and 5). Compared to Lao Theung households they are about 4 times more likely to have teak (Table 1) and have a much higher number of teak plants per household. Lao Sung farmers generally live at elevations above 800 m which is outside the adaptation range for teak. According to village level data provided by district authorities, villages having teak are generally much closer to the roads or rivers, are more likely to have lowland rice, have larger areas of lowland rice, and higher numbers of buffalo per household (Table 5). This pattern is the same for Lao Loum and Lao Theung farmers. Availability of lowland area and the number of buffalo are both indicators of the farmer's wealth. Furthermore, under Lao conditions the production of rice from lowland areas may require about 60% less labor compared to upland rice [Roder et al., 1994]. It may therefore be argued that rather than ethnicity it is the resources and the proximity to the road that are the major determinants whether a family will plant teak or not. This argument is strongly supported by the reasons cited for not having teak by families who were interviewed in the same village as the teak plantation owners. Poverty, lack of land, lack of seedlings, lack of labor, no experience, and being a newcomer were mentioned as the main reasons for not planting teak by 41, 39, 35, 38, 13, and 7% of the households interviewed (n = 42), respectively. The four most important reasons are all resource related. Investments made in teak plantations consist mainly of labor and land. Some farmers may buy planting material and barbed wire for fencing. Financial returns from the sale of timber can be expected after 15–20 years. Families that need to use all their labor resources to produce food may therefore not be in a position to make any labor investments in teak plantations.

Slash-and-burn farmers have no ownership of the land they use for rice production, but they can claim ownership of perennials planted on the land. Planting of teak thus is almost equivalent to long-term land tenure and many outside observers expected that securing land tenure would be the most important motivation for teak plantation. When asked to rate motives for planting teak, 82% of the households interviewed mentioned 'expected cash income and availability of timber for house construction' as the main motive. 'Securing land tenure' was only mentioned by 18% as the most important criteria. The limited importance given to land tenure perhaps reflects the fact that individual land ownership is not part of the culture for most ethnic groups.

Teak has the potential to produce excellent returns. Logs of medium size trees are presently sold in the local market for US\$100 per m³. Assuming

Table 5. Distance from road or river, availability of lowland ricefields and number of buffaloes for villages without and with teak.^a

Category	Xiengngeun		Nambhak		Viengkham		Average	
	No teak	Teak	No teak	Teak	No teak	Teak	No teak	Teak
<i>Lao Loum</i>								
Distance (km) ^b	18.0	0.1	1.9	0.8	12.7	2.9	10.9	1.3
Lowland (ha hh ⁻¹) ^c	0	0.30	0.54	0.67	0.18	0.02	0.24	0.33
Lowland frequency (%)	0	100	100	100	88	38	63	79
Buffalo (no. hh ⁻¹)	1.0	1.0	2.7	3.0	2.0	1.7	1.9	1.9
Frequency (no. of villages)	2	14	13	17	26	13	41	44
<i>Lao Theung</i>								
Distance (km)	5.6	4.0	3.8	0.5	14.6	2.9	8.0	2.5
Lowland (ha hh ⁻¹)	< 0.01	0.10	0.04	0.12	< 0.01	< 0.01	0.01	0.07
Lowland frequency (%)	11	60	22	65	3	38	12	54
Buffalo (no. hh ⁻¹)	0.3	0.5	0.9	1.1	1.0	1.4	0.7	1.1
Frequency (no. of villages)	46	20	64	20	82	8	192	48

^a Following village level statistics made available from the districts of Xiengngeun, Viengkham, and Nambhak districts.

^b Distance of village from road or river.

^c hh = household.

modest growth rates of 6 m³ per year the value of the annual production per hectare would be US\$600. The same family may grow 1 hectare of upland rice with a labor input of 300 days producing 1.5 t of rice at a value of about US\$150.

The reason for the large increase in the popularity of teak is probably due to the lack of other alternatives. Farmers are familiar with other tree species but many of them have had disappointing experience in marketing the products. Most farmers cite the absence of market as the main criterion for the preference of teak over fruit tree or coffee plantations (*Coffea arabica* and *C. canephora*, Table 6). Farmers assessment reflects past experience. Local processing and market promotions may make some products such as coffee more attractive. Some farmers may also be willing to experiment with other timber species but they may require planting material and expertise. Farmers, however, rightly fear that most other timber species may take much longer to provide them with a marketable product.

Up to 1990 over 90% of the farmers interviewed had to rely on their own source of planting material by collecting teak seedlings in plantations or in the forest or by raising teak in their own nursery (Table 7). In the last few years nurseries maintained by the government or by various development projects provided substantial numbers of teak plants. This availability

Table 6. Farmers' response to the question 'Why is teak preferred over: 1) fruit trees, 2) coffee and 3) timber species'.^a

Reason	Fruit trees (%)	Coffee (%)	Timber species (%)
No market	94	55	–
No planting material	3	15	45
No experience	–	21	32
Long period to get marketable product	–	–	31
No land	6	6	3
Not adapted to environment	3	31	–

^a Data from teak survey, n = 62 households.

Table 7. Source of teak plants.^a

Source	Percent of households		
	1965–85 (n = 25)	1986–90 (n = 27)	1991–93 (n = 40)
Seedlings from plantations or forest	100	84	41
Government or project	–	6	40
Farmers' nursery	–	10	19

^a Data from teak survey, n = 62 households.

of planting material undoubtedly contributed to the large increase in teak planting in 1992 and 1993. Teak seeds used in the nurseries are collected indiscriminately from any teak tree available. Unfortunately none of the nursery operators has made any efforts to identify their seed sources or select superior provenances.

Planting and management of teak

Damage by livestock is a major problem in the initial years of the plantations. Control and protection are very important and most farmers considered proximity to the village as the main reason for field selection (Table 8). The land used for teak plantations is generally closer to the road and village than the upland rice fields. Often the most fertile land with lesser slope gradients is used for the plantations. Over 90% of the farmers reported that they did not receive any advice in field selection, layout or planting of their teak. Planting distances of 3×3 m are very common. Most farmers plant teak in the rice crop about 1–2 months after planting rice (Table 9). Field preparations for the rice crop provide a good environment for teak; but competition from rice can reduce teak growth substantially in the first year, especially if planting of teak is delayed and if the rice crop is vigorous. Nevertheless planting teak in a rice crop is probably the best method for upland farmers because no extra labor for field preparation and weeding is required. Intercropping with rice or other crops remains important through the first 3 years of the plantation. Farmers generally burn the crop residues every spring before planting a new intercrop. Depending on the heat intensity during the burning the young teak plants can suffer substantially from this practice. Weeding methods and intensity are largely dependent on the intercrop. As long as intercrops are used weeding will be done 2–3 times per season using a hoe or a weeding blade. Without intercrop weed control mostly consists of slashing with a knife.

Table 8. Criteria applied by farmers for site selection of teak plantations.^a

Criteria	Respondents (%) ^b
Near village	68
Good soil	13
Near road	10
Near river	8
Inherited	8
No other option	8
Unsuitable for cropping	2

^a Data from teak survey, n = 62 households.

^b Sum < 100% because some respondents gave two reasons.

Table 9. Management of teak plantations in the first 4 years after planting.^a

Management (intercropping & weeding)	Percent of respondents			
	Year 1	Year 2	Year 3	Year 4
<i>Intercropping</i>				
Rice	52	20	5	—
Bananas	5	2	—	—
Rice + bananas	4	5	—	—
Sugar cane	7	16	18	3
Bananas + sugar cane	4	5	5	—
Pineapple	3	2	2	—
Fruit trees	2	2	2	3
Other annual crops ^b	9	5	5	—
No inter crop	14	43	63	93
<i>Weeding</i>				
Hoe or blade	100	58	23	3
Slashing	0	42	77	86
No weed control	0	0	0	11

^a Data from teak survey, n = 62 households.

^b Others annual crops include maize, cotton, sesame, peanut, chilli and other vegetables.

Summary and conclusions

Agroforestry systems (including slash-and-burn systems), fruit and timber plantations are the only sustainable land use systems for slopes above 40%. Lao upland farmers presently use tree products mainly for home consumption. Market inaccessibility is a major constraint for increased fruit production. Improved communication, fruit processing industries and growing local markets may provide opportunities for increased fruit production in the near future. In the absence of other opportunities teak has become the most important plantation crop in Luang Prabang Province.

The investigations have shown that:

1. *Fruit trees, except for home consumption, are inappropriate if markets do not exist;*
2. *Farmers are willing to invest in considerably long-term strategies;*
3. *Change in policies and regulations provided a strong incentive to plant teak.* The exponential increase in the number of teak planted observed from 1985 onwards coincided with major changes in land use law;
4. *Presently promoted teak plantation systems are not viable options for upland farmers.* Investigations have shown that most of the teak plantation owners are farmers having lowland rice areas, indicating that teak although planted under upland conditions is not an alternative crop for the upland farmers;

5. *Promotion of teak may result in further deterioration of upland farmers resource base.* Since resource-poor families, representing the bulk of the slash-and-burn farmers, cannot risk the long-term investments (land, labor, fencing material, planting material) required, lowland farmers will continue to be the main beneficiaries of any teak promotion scheme. In the extreme case, these efforts aimed at helping upland farmers could result in lowland farmers permanently occupying more and more prime upland areas for the production of non-food crops.

Efforts should be made to support resource-poor upland farmers through credit and other means to make it possible for them to plant teak. Modified plantation systems combining food, livestock, and timber production could be possible alternatives. Although such systems would not optimize teak production, cash could be available from the beginning of the plantation. Joint plantations by groups of farmers could help to reduce costs for fencing and if necessary building access roads at the time of harvesting.

Development projects working in upland conditions should strongly emphasize the promotion of perennials rather than annual crops. Furthermore the importance of planting these perennials before soil fertility has been depleted through inappropriate annual cropping can never be overemphasized. Although farmers generally know the techniques of simple nursery management or fruit tree propagation, it will be important to support them by providing high quality plants of adapted and suitable cultivars.

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