Intensifying upland rice Systems with Stick lac Production in Northern Lao PDR

Bounthanh Keoboualapha[1], Niphavanh Philavanh[2], Attachai Jintrawet[3]

The Lao Peoples' Democratic Republic (Lao PDR) is a land-link country with a total area of 236,800 km^2 and a population of 6.5 million. The country is located in Southeast Asia, bordered by Vietnam to the east, Thailand to the west, Myanmar and China to the north, and Cambodia to the south. About 20% of the area is flat land (70-200 msl), which is prevalent in the southwestern region, while the other 80% is sloping land and mountainous (200-2820 msl), which is predominant in the northern region (Figure 1.). The country has a tropical monsoon climate with mean annual rainfall of 1000-1500 mm.

Figure 1. Geographic location of the Lao PDR.

Shifting cultivation has widely been practiced by Lao farmers of all ethnic groups throughout the country, especially in the Northern provinces where about 80% of the land area is mountainous slope. The farmers grow upland rice as a main crop for household food security. However, being concerned with deforestation and degradation of the environment shifting cultivation is seen as unsustainable land use practice, the Lao government plans to reduce the area under shifting cultivation and stabilize the area of upland rice by promoting upland farmers to adopt more stable and productive farming methods, including more sustainable rotational land use systems, crop diversification and agroforestry.

Shifting cultivation or slash and burn agriculture practiced in northern Laos is undergoing change, transforming from pioneering to intensifying rotational shifting cultivation systems. This change resulted from limited access to lands, growing population pressure, increasing market demand for agriculture and forestry produce. In Louang Prabang province shifting cultivation area with upland rice as the main crop has been considerably decreased for the last seven years, from 30,900 ha in 2001 to 16,400 ha in 2007. Meanwhile upland cash crops, including maize, sesame, job's tear, soybean, have gradually been increasing over the years, from 13,000 ha in 2001 to about 42,000 ha in 2007. In addition, intensifying upland rice with

[1] Provincial Agriculture and Forestry Office (PAFO), Louang Prabang, Lao PDR.
[2] Crop Section, PAFO, Louang Prabang, Lao PDR.
[3] Multiple Cropping Center (MCC), Chiang Mai University (CMU), Thailand.

crops such as paper mulberry, rubber, pigeon pea for stick lac production is becoming widespread in the areas.

Intensifying lac insect cultivation in upland rice is being adapted by upland farmers in Louang Prabang province. The system may help to stabilize shifting cultivation and upland rice area in 3 ways:

- Stick lac provides direct cash income for farmers. They can use cash to purchase rice in time of need, decreasing land area needed for upland rice production,
- Stick lac can be cultivated with upland rice. Do not need much more land for sticklac production. In addition, planting host trees like pigeon pea in rice field may do good than harm to the rice crop. The host trees may also create more favorable environment for farmers to work in the sun, and
- Perennial host trees allow permanent cultivation.

This study aims to explore farmer knowledge and experience in intensifying stick lac in upland rice system in Louang Prabang province, emphasizing on cultivation practices, constraints, and knowledge gaps and research opportunities for development of more productive and sustainable stick lac management practices.

Methods of the study

The study followed the following steps:

1. Meeting with village authorities

At the beginning of the study, the study team met with the head of Houay Lek village and his committee. The purpose of this meeting was to gather general information regarding village history, social and economic development, and the importance of stick lac for their community.

2. Focus-group discussions

Twenty farmers were selected by the village headman and his committee. This group then met together for focus group discussions. The main topics discussed included the importance of stick lac production to local livelihoods, current production practices and constraints, and economic issues.

3. Individual farmer interviews

Following the focus group discussions, 10 farmers were purposely selected by the village authorities based on the quality of information they could provide. Individual interviews took place in the farmer's fields in order to collect additional information about crops, cultural practices, and constraints.

Study area

Houay Lek village is located along road number 1C, approximately 12 km northeast of Ngoi municipality, Ngoi district. The village has a history dating back more than 100 years. People living in the village belong to Khamu ethnic group. Originally, it was a small village of about 7 households. However, the population of the village increased after the construction of road by the Chinese in 1973, since people from remote villages moved to Houay Lek in order to be near the road and to take advantage of government services and development opportunities.

In 2006, Houay Lek village had 92 households with a total population of 536 people. Almost all of the villagers are upland farmers. Shifting cultivation with upland rice as the main crop has long been practiced by the villagers. However, due to limited access to land, increasing population pressure, the villagers had to adapt their traditional shifting cultivation. Crop diversification and intensification of upland rice are widespread in the village and other surrounding villages.

Stick lac production has been practiced by some villagers as part of their upland farming system just for household uses. Stick lac was intensified into upland rice system for commercial purpose in 2003. This had resulted from growing demand for stick lac from China and Vietnam. Houay Lek village, Ngoi district, is known as the center of stick lac production providing technical experience as well as lac production materials for the northern districts of Louang Phabang province.

Basic characteristics of lac insect

Lac insect is the insect which lives on trees called **lac host trees** where they secrete the **lac resin** or **stick lac** which is scrapped off and manufactured into shellac.

Lac insect is distributed in Tropical Asia such as India, Pakistan, Bangladesh, Myanmar, Thai, South China, Taiwan, etc. There are about 20 species in the world. However, only two species, *Laccifer lacca* in India and China and *L. Chinensis* in China and Thailand, are used for industrial purpose. The life cycle of a lac insect takes about six months and consists of four stages: 1) egg, 2) larva, 3) pupa and 4) adult (Figure 2.). With this cycle, the lac industry obtains two lac crops each year from each tree.

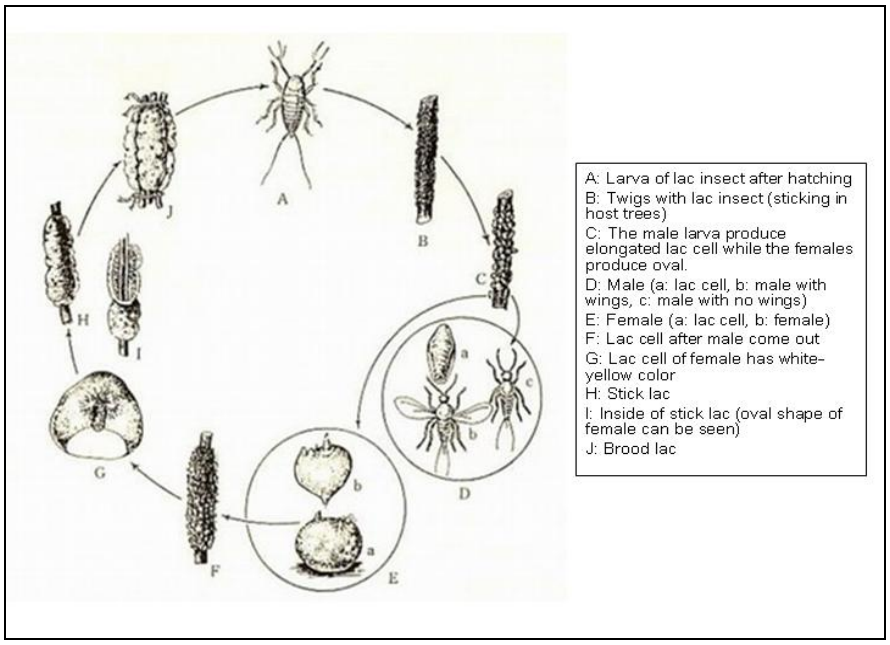

Figure 2. Lac insect life cycle (*Kerria lacca*), Kepur; 1962.

Lac insect can be very destructive to trees, stunting or killing twigs and branches of the host trees by inserting their long suctorial mouthpart into the tree and draw out sap.

Lac insects do not only drain out the sap but they also transmit germ. Therefore, we must realize lac insect is vermin for plant.

Host trees for lac insect

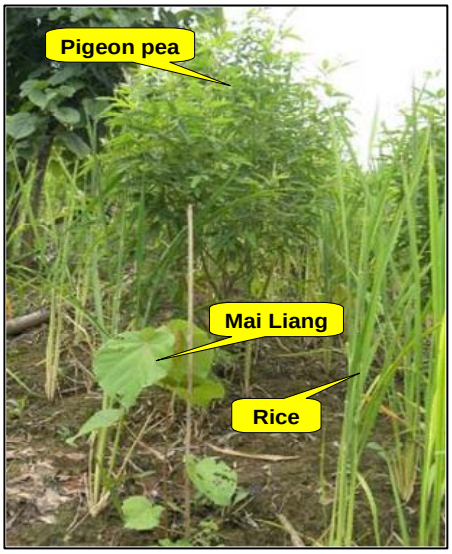

Figure 3. Intensified upland rice-stick lac production system.

Pigeon pea had been promoted by research and extension agencies, and projects for improving fallows, hedgerows, cropping systems: rotation, intercropping, alley cropping etc. This was negligible by farmers, although pigeon pea was proved to be good crop for soil improvement, weed suppression, and reducing nematode in upland rice.

In Huay lek village, Ngoi district, Louang Prabang province, although there are at least 10 host species listed by the villagers, only few species are currently used for stick lac production. Pigeon pea (*Cajanus cajan*) has been planted as a lac host tree in the village since 2003 and now it can be seen in many surrounding villages.

Recently, Mai Liang 'Liang tree' (*Berrya condifolia*) are integrated in to pigeon pea for stick lac production by many villagers in Louang Prabang.

Use of stick lac

Figure 5. Stick lac dyed cotton.

Stick lac has traditionally been used as glue to make or repair farm equipment, connecting between iron part and wooden part. Stick lac has also been widely used for dyeing silk and cotton. In Laos, stick lac produced is mainly exported to China and Vietnam.

Figure 4. Farm equipments

Process of stick lac Production

Stick lac production in upland rice involves host tree establishment, inoculation, management, and harvest of stick lac. The following table shows the stick lac production activities in relation to upland rice cultivation.

Table 1. Stick lac production in relation to upland rice cultivation.

Activities / Month	Dry season						Wet season					
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
▪ Land preparation				■	■	■						
▪ Planting host trees							■	■				
▪ Inoculation of lac insect	■	■				■	■	■				■
▪ Management	■	■	■	■	■	■	■	■	■	■	■	■
▪ Harvesting	■	■				■	■	■				■
Upland rice production	vesting			Land preparation			Planting		Weeding			Har-

Host tree establishment

Host tree establishment involves land preparation, planting and maintenance. Villagers in Houay Lek village traditionally plant lac host trees during April-May after fields have been cleared. There are two main species commonly used: pigeon pea (*Cajanus cajan*) and mai liang (*Berrya condifolia*).

Pigeon pea seed is dibbled into the soil in April before planting upland rice. The planting distance is about 1.5-2m x 1.5-2m or , using 3-5 kg of seed/ha. Pigeon pea can also be planted with many other upland crops, but not sesame.

Mai liang can be either regrowth or planted. If mai liang were to plant, they would plant in the same field with pigeon pea and upland rice in May by seedling or root cutting. The planting distance is about 3-4m x 3-4m or about 600-1,000 seedling/ha.

Weeding is necessary during the cropping period. The farmers never used chemical fertilizers, but they did use the small amount of insecticide. Pruning of host trees before lac inoculation was not done for pigeon pea.

Inoculation

Inoculation is the process of binding the brood lac or lac seedling to the lac host trees (Figure 6.). There are two inoculating seasons in a year. These take place between March and May and September and November. Inoculation is very seasonal work, it has to be done in the morning or late afternoon with light sunlight and it has to be finished in a short time (within 2-3 days).

Brood lac used for 1 ha varies depending on the size and the species of the host trees. However, for pigeon pea it is estimated at about 100-150 kg/ha.

Farmers carefully collect the brood lac to be inoculated. Collection too early would result in no lac insects after they are put on host trees, because the lac insects are not yet mature, and collection too late would mean that the lac insects have come out in large quantity, and there would not be enough lac insects left for putting on the host trees, and hence low productivity.

Figure 6. Inoculation of lac insect.

Management

Selection of healthy host trees and good quality of brood lac to be inoculated is an important process to ensure successful stick lac production. After inoculation, the farmers regularly come to check their fields:

- to ensure that the brood lac is still tightly fastened and there is a suitable quantity of lac insects on the branches. If so, the brood lac would be moved to the branches that have smaller quantity of lac insects; if there are too many lac insects, they would be removed immediately.
- to collect the empty brood lac, the brood lac which all lac insects have come out. The empty brood lac (stick lac) would be collected on time to reduce the loss by pest (especially rats) and the deterioration of the stick lac quality.
- to prevent destruction by human beings or animals, and
- to prevent the host trees and lac insect from being damaged by pests (weeds, ants, rats) on time.

To secure brood lac for the next crops, about two thirds of the pigeon pea field is used for inoculation (September-November), and another one third is left for the following season (March-May).

Harvesting

Figure 7. Scrapping stick lac from twigs.

Stick lac is normally harvested five to six months after inoculation. Stick lac harvesting is done by cutting off the twigs sticking brood lac or lac nest. In Ban Houay Lek, stick lac is harvested two times a year, between March and May and between September and November. During the harvest, stick lac with good quality is observed for use as brood lac for the next crops.

Soon after harvest, twigs and other extraneous matter are removed by hand picking. The harvested stick lac is known as "*wet stick lac*", and it is then dried in the sun to become "*dried stick lac*". Dried stick lac is stored in bags or in bamboo baskets for sale.

Figure 8. Stick lac ready for sale.

Labor and inputs

In 2005, land used for stick lac production by the households interviewed ranged from 0.6-1.2 ha with an average of 1.1 ha. However, for the purpose of comparison labor inputs were converted into 1 ha basis.

In addition to upland rice, additional labor used for stick lac production is needed. Labor used for 1 ha of upland rice-stick lac production varied from one farmer to another, ranging from 26-184 man/days with an average of 64 man/days. About 70% of the labor was used for the management of lac insect and harvesting of stick lac (Table 2.). The labor used for transportation was not included. Transportation may use a lot of labor, especially when the fields are far away from one another.

Table 2. Labor inputs (man/days) for 1 ha.

No. Farmers	Host tree planting	Inoculation	Management	Harvesting	Total
1	10	16	72	50	148
2	13	25	41	54	133
3	4	5	8	13	30
4	7	16	28	12	63
5	4	8	23	13	48
6	4	10	24	8	46
7	5	13	18	18	53
8	10	6	11	23	50
9	7	6	3	10	26
10	6	6	10	20	42
Average	**7**	**11**	**24**	**22**	**64**
Range	**4-13**	**5-25**	**3-72**	**8-54**	**26-148**
% of total labor	**11**	**17**	**37**	**35**	**100**

Stick lac production, especially management of lac insect and harvesting of stick lac is a very seasonal work. Therefore, the farmers usually hire labor. Other important inputs are brood lac and host tree planting materials (new stick lac farmers), and pesticide for controlling ants and rats.

Stick lac production constraints

Constraints to stick lac production were identified in the focus group meeting as well as in individual farmer interviews. There are many constraints faced by the local farmers in their stick lac production. The first three most important constraints relating to the lac insect are ants, rodents and weather. Constraints to the host trees are grasshoppers, rodents and stink bugs (Table 3.). Death of pigeon pea related the management of lac insect, too many lac insect on the branches, and the damage of rodent on the roots or stems. Weather such as heavy rains and strong winds, hail storms and drought, can be destructive. In some crops farmers may not even have enough brood lac for the next crop.

Other constraints such as low or high temperatures, diseases and parasites were also mentioned but not so important. These constraints take time to yield effects and, therefore it may not easily be seen by farmers.

Table 3. Stick lac production constraints.

Constraints	Wet season						Dry season						FG[1]	FI[2]	Types of damage	
	A	M	J	J	A	S	O	N	D	J	F	M	Rank[3]	# resp[4]	Host trees	Lac insects
Grasshoppers	■	■											1	10	Young plants	
Ants	■	■	■	■	■	■	■	■	■	■	■	■	2	17		Lac insects
Rodents					■	■	■						3	14	Stems & roots	Brood lac
Stink bugs				■	■								4	9	Stems	
Stem borers					■	■							5	6	Stems	
Weather	■	■	■	■						■	■	■	6	5	Kill hosts & Lac insects	
Pigeon pea death	■	■	■				■	■	■	■	■	■		6	Death after inoculation	
Theft	■	■					■	■	■			■		1	Brood lac & stick lac	

[1] *Focus group discussion,* [2]*Individual farmer interview,* [3] *Group ranking: 1-the most dangerous, 6-less dangerous,* [4] *No. of respondents (sample size 20).*

Stick lac production per ha

Stick lac yield is uncertain. There can be very high yields in one crop and very low yields in another. Together with the constraints stated above, weather can be a very important factor that stabilizes stick lac yield. In addition to heavy rains and strong winds, hail storms and drought, which are destructive to hosts and lac insects, cold weather in the dry season (Dec to Jan) and hot weather at the beginning of wet season (Apr) can harm lac insects and therefore lower stick lac yield.

However, it was reported that the production of dried stick lac for pigeon pea (*Cajanus cajan*) was on average about 1,000 kg/ha (800-1,200 kg/ha). The production can be considerably higher for mai liang (*Berrya condifolia*), about 80-100 kg/tree.

Income generation

Stick lac production provides regular cash income for farmers, during March-May and Septem-ber-November. In 2006, dried stick lac was sold in the village at 15,000 kip/kg. Assuming that 1 ha of pigeon pea produced on average 800 kg of dried stick lac, farmers would cash in from the sale of stick lac of 12 million kip which is enough to purchase 6 tons of rice (sale price for rice is 2,000 kip/kg). Currently, 1 ha of upland is capable to produce 1.5 tons of upland rice. Therefore, to produce 6 tons of upland rice farmers have to cultivate 4 ha.

Knowledge gaps and research opportunities

Following is the list of potential research questions that should be considered to develop productive and sustainable management practices for stick lac production in northern Laos:

What is the cultivar and optimal spacing for pigeon pea?

Different cultivars are varied with respect to duration, canopy covers, and plant architecture. Different cultivars may use for different purposes to overcome a certain problem as such light and humidity. Appropriate spacing for a certain cultivar encourages the growth of pigeon pea and lac insect. Hence increase in stick lac production.

What is host tree species and cropping system?

Crop rotation and intercropping show promise in terms of nutrient recycling, and pest management. Growing only one crop on large area is not recommended as a result of the

given reasons. Locally, there are at least 10 host tree species known by local farmers. Appropriate rotation (some host trees are left for fallow) or intercropping for slopping land would help improve the productivity and sustainability of the system.

What is the technique of pruning of the host trees?

Pruning is the operation of removing unproductive twigs or branches from a tree. Pruning also creates favorable environment for lac insect to grow and develop. Unlike the flat land, pruning may be easier to put on brood lac on the host and to harvest stick lac. Therefore, appropriate pruning techniques would help enhance growth of the host trees and reduce pest.

What is nutrient removal from the harvest of stick lac?

Harvesting stick lac means exporting nutrients from the system. Even though the loss of nutrients may not be large, because most of the host plant parts remain in the fields, it would be helpful to know the actual quantity of certain nutrients leaving with the stick lac harvested. Understanding nutrient balance in the system would allow development of a long term strategy for more sustainable production systems.

What is the important pest?

Pest damages to either host trees or lac insect affect stick lac production. Identifying what pest is important and understanding their existence and causes would help develop strategies for sound pest management practices. The sound pest management practices do not only prevent or reduce loss of production and stick lac quality from pest outbreak, but also preserve the environment and biodiversity.

Conclusion

Intensifying upland rice with lac insect cultivation provides regular cash income for the upland farmers from the harvest and sale of stick lac. Under the current price of 15,000 kip/kg of stick lac, the intensified systems provide sufficient economic benefits to the upland rice farmers to pay for the extra labor and inputs required to maintaining the upland rice-stick lac production system. Recently, the system has become more intensified, incorporating perennial host trees into the system which allows more permanent type of production, and expanded throughout the province.

Although, the stick lac production system is seen as a potential alternative to improve shifting cultivation and reduce upland rice area in Northern Laos, based on the current knowledge, there are a lot more need to be done to secure the productivity and sustainability of the intensified stick lac production system.

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