CHAPTER V

CHARACTERISTICS, STRENGTHS AND WEAKNESSES OF THE *hai* SYSTEM AND IRFS PRACTICE

This chapter will describe in detail the practices of the *hai* system and the integrated rubber-based farming system. The strengths, weaknesses, opportunities and threats of both practices will be discussed in this chapter as well.

5.1 The *hai* system practice in study area

Regarding the *hai* practice in study area, the main cropping period for upland farmers was carried out in the wet season. A *hai* plot is generally cultivated for one year, started in early January and ended around early December, after crop yield was harvested, that plot was allowed to be a fallow for a few years. During which time, farmers shifted to tillage in another plot, but sometimes the same plots were planted for two or three consecutive years, when the yield still showed in high yield quantity. In addition, the majority of the grain crops in the upland area were the upland rice, maize and job's tear. Most of them, upland rice is the main crop grown for family consumption. Therefore, farmers considered to grow upland rice as the first alternative of their land utilization. Beside the upland rice production, several others cash crops were grown in smaller quantity in the same and in adjacent plots e.g. maize, job's tear, sesame, galingale, taro, sweet potato, cassava, etc., for family consumption and extra income generation. Maize and job's tear were found as the alternatives which grew in the next seasonal cropping after upland rice has already harvested in the 2nd and 3rd year. Based on farmers' experiences in study areas, they

also cultivated some kind of vegetable together in the field, as multiple-cropping or mix-cropping, for self-consumption. For example, pumpkin, cucumber, gourd, chilies, etc. Although, most crops grown by the upland farmers, some of them were also becoming more involved in plantation crops (tea, rubber, cardamom) or timber (teak). Domestic animal and NTFPs were often sold by upland farmers, while nowadays most Lao upland farmers were connected to the market economy even if they still often practiced barter trade.

Table 5.1 shows activities in the *hai* system practice in one season of crop cultivation. Several steps on the *hai* process are included site selection, tool preparation, slashing, main burning, clearing and re-burning, sowing, weeding, harvesting, threshing and transporting. Each step was describing in more detail as below.

Table 5.1 Farm activities cropping calendar in the *hai* system

Activities	**Month**											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Site selection												■
Tool preparation	■											
Slashing		■	■									
Main burning			■	■								
Clearing & Re-burning			■	■	■							
Sowing					■	■						
Weeding (3 times)					■	■	■	■	■	■	■	
Harvesting									■	■	■	
Threshing												■
Transporting												■

Site selection

Site selection began in December. In general, upland farmers seek out areas with the best soil available or the soil most suitable to the particular crop where the top soil was black or dark color and had much moisture. The *hai* field plot for the coming season was chosen by villagers in the community. Several groups of families had their plots adjacent to each other on the selection site. The size of each family plot depends on the availability of workforce in the family. There were many indicators used for choosing a plot of land, such as forest cover, soil type, plant species, presence of leaches, field orientation, distance to village, and so on. Hilltops and ridge are usually left uncultivated due to both rapid interval drainage of the soil there as well as for forest protection and conservation. Primary forest with too many tall trees was not often selected for cropping because it required more work to slash the vegetation and it was needed to protect for preserving the upper stream of water supply on the mountain as well. In the other hand, secondary forest was often preferred to cultivate at the lower elevation.

Tool preparation

The upland farmers in the study area started to prepare their tools and materials from early January. The tools used were general locally-made traditional implements, but market-bought tools are now reaching to those villages. Some people bought tools directly from the market in town, while others exchange their agriculture products for tools with local trader such as hoes, knap-sack sprayers and modern axes. In early January, head of families prepared chopping knife, curved-hand hoes, dibbling stick head, hoe and slashing knives (machetes). Moreover, farmers in the Hmong group usually made their own tools. They had the group for iron works of

their own, and each group consisted five to seven families and then each family would start making tools in late January.

Generally, the necessary tools in *hai* system practice are included: machetes, axes are used for slashing brush trees, planting or 'dibbing sticks' are used for sowing. Locally-made small weeding tools (curved-hand hoes) are used every where, sometimes alongside bigger hoes that purchased for land preparation. Sickles are used in harvesting (for rice only), but not all upland farmers used sickles to harvest rice: many farmers strip the grain straight from panicles into their baskets. Various types of local baskets are used to carry seeds, agricultural products, firewood and other NTFPs production. Big tractors and walking tractor are not used on slopping land under the *hai* practice, but they were sometimes used for transporting the harvested crop to home.

Figure 5.1 Curved-hand hoe

Slashing

Slashing commonly started in February, though specific timing depends on the kind of vegetation and the availability of family labour. Each family (mostly husband and wife) mainly worked to slash the vegetation on their family plot. Two days after slashing starts, the heads of families organized the groups for labour exchange with group ranging in size from 10 to 20 people. The Khmue group always respected the spirits of the forest and the bigger trees, the first day of the slashing season, the head of family would sacrifice a chicken and pray to spirits to ask permission to slash the selected area. For the Hmong group, slashing usually occurred a little bit late, started in March, due to conditions are different higher up in the mountains. Machetes were widely used for cutting the vegetation but bigger trees were cut with axes and sometimes saws. After slashing the standing vegetation, farmers dried the slashed vegetation by leaving it in the sun for about three to four weeks, depending on the weather condition. This created humic natural mulch that covered the soil and protects it against the sun and the impact of violent tropical rains and they were good for the seed germination as well.

Main burning of dry vegetation

The burning season mostly began around the end of March to early April. It normally takes only one day and then about 10 to 15 days to complete burning for a whole village. Once the slashed vegetation were dried, the land plot owners who have the *hai* field were located close to each other must try to agree on the burning day to ensure that the fire does not spread to fields that were not yet dry enough, all family plots must be burnt in the same day. When the areas were ready for burning, sacrifices were first made to the spirit of the field and few traditional no-entry signs symbol

(made from bamboo) were placed at the *hai* area boundaries to warn people that those areas were dangerous place. Then, fires were started at the bottom of fields and were allowed to spread little by little. To help control the fire, farmers avoided to burn the dry vegetation on the windy days. They generally took place during the hottest sunny hours of the day, but if the risk of village fire was high, burning took place at night time. Because it was easier to spot accidental fires.

The upland farmers believed that fields' burning is useful to get rid of the slashed vegetation, reduce weeds, cook the soil, and produce fertilizer from the ash. The burning quickly decomposed the vegetation and soil organic matter into plant nutrients that were readily available for the crops. It reduced soil acidity, increased the availability of phosphorus, and also killed weed seed and the parasites. In contrast, the main burning was a spectacular and noisy operation, causing huge flames on the hills and producing heavy smoke that reduced visibility and polluted the atmosphere.

Clearing and re-burning

Depending on the quality of the main burning, a second burning may be required before trunks and debris were removed from the field. Three days after main burning, usually in early March, farmers would start cleaning their plots. Any remaining debris left after the initial burning was collected and re-burned once more. Burning stack of debris results in spots with higher concentrations of ashes that were often used for planting some associated crops. The areas clearance was a family activity performed at primary responsibility in every level of each individual family plot, and it was carried out by both men and women (mostly husband and wife). Although the amount of time spent on cleaning varies according to how successful the initial burning was, activities generally last for about 20 days, but system of mutual

assistance or labour exchange were used if there were high volumes to be removed. While women were cleaning and burning, men constructed a hut on the site which was temporary structure, made from bamboo with a thatched roof of *Imperata* grass. which was used for sheltering during heavy rains or strong sun, for family cooking and eating and also preparing sacrificial meals, for temporary storage of rice during harvest time, and overnight shelter when guarding fields (just before and during harvesting) because fields was far from village, farmer had to take around two to three hours by walking. Lao Soung (Hmong) farmers left their fields open and unfenced.

Sowing

The crop sowing began after the rainy season is well established. Rice and maize were found as the mainly crop in the sowing period. The labor exchange typically was found in the sowing processes by group of farmers in community, groups of 15 to 20 people (sometimes, 40 peoples) organized themselves, each group finished sowing for a family's plot in one day. This job needed to be working in the couple-worker. Materials used for sowing included seeding sticks (dibbling stick), seed bags, rice seeds and bamboo baskets or cotton bags for holding the seeds. Men used the dibbling stick to make a hole, by spacing was around 20-25 cm, and 5-10 cm depth, while women followed with the seed bags and filled with five to ten rice seeds in the holes. If the rains were good then the seed will start to germinate with in five days after seeding. The sowing period in study areas were different by ethnic groups depending on their familiar skills, Lao Thueng (Khmue) group started for sowing usually in mid-April (if the rains regularly), but Hmong group lately began in May or later (ended June) because Hmong group lives in the higher latitudes where was lower

temperature. It normally takes about 15 days to complete the dibbling and seeding activities for a whole village.

Weeding

Weeding was the most labour-consuming and tedious activity of the cropping cycle and was perceived by many upland farmers as the major constraint to upland rice production. It was performed almost continuously from May to October, by using the curved-hand hoes and digging hoes. Traditionally weeding was done by the individual family labour, most often by women and children, but sometimes the men also joined in. A cropping season, weeding was performed three times. The first weeding, upland farmers use knives and curved-hand hoes, started when the rice reached the height of a finger span (about 15 cm). The second weeding was normally carried out in early July which was also the flowering time for rice plants, by using the hoe and curved-hand hoe. This time was more difficult than the first weeding due to the high density of rice plant. Some upland farmers were forced to hire extra labor to do this weeding. The third weeding normally started in August by using the curved-hand hoes. For Hmong upland farmers sometimes weeded four times. They did an extra weeding before harvesting because they only cut the panicle of rice.

Harvesting

The harvest season started anywhere between September and November. There were three harvests according to rice variety: short, medium and long term. Short-term rice variety harvesting was normally started in early September, often without using labour exchange. They were afraid that the previous year's supply would not be sufficient. In addition, the early varieties had a type of rice grain that drops easily when ripe. It must therefore be harvested quickly and was not grown in

large quantities. The rice was not cut but was harvested with bare hands. Farmers carried bamboo baskets and walked around the field pulling the rice from the stem to the top end by hand. The harvested rice was spread on bamboo to dry in the sun for about three days, then the grain can immediately be stored in the granaries. Medium-term harvesting normally started in October and was finished with a week, yield were higher than those of short-term variety. Brunches of rice plant were cut by using sickles and dried in the field for three days. After this, they were gathered in huge pile in the middle of the field. To protect the rice from animals and unexpected rain, a special method of piling the rice is used, with the top end of the sheaf of rice placed inside the pile. Long-term harvesting started between late November and early December, by taking about seven to ten days. Harvesting was performed individually without hiring extra labour, by using the sickle. Yields were much higher than those of the early and medium varieties.

After harvesting was complete, the farmers would let the field become fallow. Associated crops were generally harvested before rice. Upland rice yields varied from between 0.8 and 2.5 ton per hectare depending on fallow length, seasoning rainfall, soil type, pest incidence and weed infestation e.g. different species of vegetation will subsequently appear, including *Nha Farang (Chomolaena odorata), Nha Khai (Pgonatherum crinitum), and Mai khom (Muntogia calabura).*

Threshing

Threshing began in early December in the fields. After harvested, the piles of rice were kept in the middle of the rice field for two or three months, depending on weather conditions. Traditionally threshing practice, rice was threshed using a pair of sticks joined with a rope. The sheaf was then hit against some boards placed on

bamboo mats. To make sure all the grain comes away, the sheaf was cut and hit again by stick which curved at one end. When threshing was completed the grain was fanned to remove any empty husks. In generally, threshing activity takes time around 10 to 15 days per individual household and if the rice was good yield in the year, labour exchange sometimes was needed as well.

Transporting

Transporting the harvested crop to the village was a tedious job but labour exchange was not often used because the rice would go to each individual family. Materials used for carrying upland rice were various kinds of bamboo baskets and bags. Rice was transported by both men and women, who carried rice baskets which hold about 10-30 kilogram of upland rice yield. Hmong farmers sometimes used horses for transportation. If the harvest was good then it could take two to three weeks or more to carry all the rice back to village. Some farmers hire a truck for transporting the harvested yield by their production, when their fields were closely to road that it was done then in only one or two days.

Storage

After threshing was finished, the main grain was taken out of the fields and kept in the temporary storehouse. Seed for next year's sowing was stored in special bamboo baskets in the barn. Upland farmers did not store grain in their houses but built granaries some distance away from the house to protect them in case of accidental fire. Usually two to more families members slept in the temporary store (field house) to guard the rice against animal and thieves until it could be carried to village.

The traditional *hai* system practice involved long fallow with short cropping period, provided subsistence requirements for mountain people for a long time and was considered an ecologically and environmentally friendly land use in mountain areas**.** However, the *hai* system has become increasingly unsustainable, reflecting the combined effects of population growth, resource depreciation, and international perceptions of environmental impacts (Manivong, 2008), forcing farmers to considerably shorten their fallow periods over the years and has been reduced to a few years. As a result, widespread problems of weed invasion, soil erosion, soil nutrient mining, and considerably reduced crop yields**.**

5.2 The strengths, weaknesses, opportunities and threats of the *hai* system practice

5.2.1 Strengths and weaknesses of the *hai* system

The traditional *hai* system practice involves long fallow with short cropping period, provides subsistence requirements for mountain people for a long time and is considered an ecologically and environmentally friendly land use in mountain areas**.** Based on field survey in the study areas, upland farmers were advised several strong point of the *hai* system. Several productions of the *hai* system provided farmers as food for family (rice, maize, livestock, vegetable, pineapple, galingale, tea, root and tube crop). The *hai* system output could offer the annual productivity and quick sale; it also is an income source when farmers need cash and/or exchange for other foods, tools, taxes, etc. Generally, upland farmers had many experiences on agriculture production in the slopping land for many decade of year, and then it was likely the low risk alternative and produced high yield. In addition, the northern people prefer

upland rice more than lowland rice due to the fact that upland rice is large grain, better milling quality and weight, high market demand and stable price.

In the other hand, the *hai* system practice also has weaknesses. Upland farmers complained that the high demand of labor needs is the primary problem in the *hai* system because it needed more maintenances and needed to shift to another place every year, but labor supply in family was low because the main labour are normally husband and wife. Pests and weeds were also endangered crop yield (e.g. rats and bird), and short fallow period (two to three years) was influenced to weed growing faster and decreased the soil fertility which resulted in low productivity. Based on upland farmers' poor economic status, they did not have enough capital and they are less skilled to do other types of farming system. They tried to avoid to risk from another farm system. The farm land plot must be shifted each year in the *hai* system, farmers had to move to another land plot every year. Some farmers encroached the primary forest area to open the new land which caused degradation in natural resources especially water and endangered wild life habitat.

5.2.2 Opportunity and threats of the *hai* system

Upland farmers in study area claimed that there were some opportunities in the *hai* system. For example, more good maintenance of the system would have good yield and food sufficient in family, because when farmers pay more attention in take care the cultivated crop, they would have good yield which could fulfill food consumption in family and be enough for sale. In addition, fallow's rotation could be improving yields in the *hai* system, because the cropping system on slopping land needed some fallow period for improving nutrient and texture of soil.

In contrast, there are several opinions regarding the threats of the *hai* system as well. Land will be limited soon due to a greater number of people in village every year. Farmers could not have more lands because the government provided specific number of land plot for a family. Old forest areas and fallow shortages could be invaded because of many lands become bare land. Recently, soil erosion has been a problem and crop yield usually reduced when growing crop in the same place in a few years continuously. The *hai* system crop yield could provide in a yearly productivity and income, depending on farmers land suitability. Sometimes, it could not support enough money for the family due to low yield, fluctuated price, when farmers have surplus yield quantities but the market demand was also low. Moreover, upland farmers mentioned the threats of the weather condition which influenced in the *hai* system practice e.g. the temperature has been hotter every year because of deforestation and rivers have been drying due to the cutting down of big trees every year. There could be no trees for children in future. Natural disaster (heavy foggy, strong winds, heavy rain) could be occurring frequently as well.

Table 5.2 The strengths, weaknesses, opportunities and threats of *hai* system practice

SWOT	Interviewed farmers' opinions
Strengths	• Objectives: family sustenance, food exchange and sale • Output provided: annually • Long-term experience • Low risk and produced stable yield • Upland rice had bigger grain, higher weight and was preferable to lowland rice • High market demand and stable price

SWOT	Interviewed farmers' opinions
Weaknesses	• High demand of labor with low labor supply • High pest and land abandoned risk • Short fallow period decreased soil fertility and resulted in low productivity • Difficulties to open new land, e.g. big trees, weeds • Lack of capital for diversification of farming system • Opening of land endangered wild life habitat • Lack of natural resources especially water
Opportunities	• Good maintenance will provide more yield • Fallow rotation can improve crop yield • More produce, more money from crop sale • Fulfill rice or food for family consumption
Threats	• Land would be limited soon, have not much land for the hai system because a greater number of people in village increased • Old forest area was decreasing, only fallows existed. • Lost of vegetation cover • Limited fallow period, famers could not shift to another land because government will provide specific number of land plot for a family • Soil would be poor (low nutrient, low fertility) • Weeds grew too fast, then less crop yield • Fluctuated price, some time there were much productivities but no market for sale • Crops yields were usually low when it was always grow in the same land • Would have only an yearly income and productivity, no legacy for children • Farmers needed to cut down big trees every year, there would not be any trees for their children in the future

SWOT	Interviewed farmers' opinions
	• Lack of wild life habitation • Natural disaster – heavy foggy, strong winds, heavy rain • Soil erosion and drought always occurred every year • Weather was hotter because of deforestration

5. 3 Integrated Rubber-based Farming System practice

The integrated rubber based farming system (IRFS) is, being an agroforestry system, an introduced technology practice which was supported by LSUAFRP, characterized by growing different species of woody perennials in association with fruit tree and field crops. It is considered by government strategy on poverty reduction program to reduce and change the *hai* system and opium field to be the permanent farm which helps farmers in upland to control soil erosion, reverse environmental degradation through biological interactions of tree, and cash crops, and also increase income from farmland.

In addition, the rubber is as a perennial crop which provides the long term benefits such as the rubber's latex and timber, enhance to improve forest by covering the open land and reduce the soil erosion, and it supported some decade of years for stable land use pattern in the rubber farm. Moreover, there are recently some companies from China supported the rubber market in the northern part of Lao PDR. Rubber plantation is therefore booming and attracting for upland farmers and other parts overall country. A number of farmers in the study area have modified some plots of their own land to be rubber plantation.

L-SUAFRP was consequently selected rubber to introduce in the integrated rubber-based farming system with fruit tree and annual crop intercropping (IRFS 2) to

farmers under their perspective and appropriate resources. In addition, the project participating farmers were allowed to select the kind of annual crop by themself, then 60 seedlings of litchi and orange were provided per household. The project technical staff supported some technical training and information about growing and maintaining to farmers who participated in the project by teaching them simple methods e.g. the A-flame for making the contour line, the hole size for planting, the water drop system for rubber and fruit tree, etc.

Regarding the farmers' interesting of the rubber plantation, in the study area. Farmers realized the advantage of the IRFS 2 that rubber and annual crop can provide better benefit of income and also save the time for working in the same place than the traditional practice. Therefore, the non participating farmers had learnt and applied the process of IRFS 2 to become the integrated rubber based farming system with annual crop intercropping (IRFS 1), by themselves, based on their existing suitable resources and preference. Moreover, the non-participating farmers, or IRFS 1's farmers, were also learnt many techniques from their relatives in the neighboring province (Luang Namtha province) where the rubber has already harvested. Land preparation technique and other maintenance technique such as seedling producing, seedling grafting, selecting the stock, etc. was learnt.

In general, the implementation of both IRFSs (IRFS 1 and IRFS 2) was the new skill for upland farmers in the study area, and the upland farmers had used to practice in the *hai* system as a long indigenous knowledge. Therefore, they were still applied their original experiences of the *hai* system practice into the IRFSs system. Most of both systems were almost similar processes, only some steps of IRFSs were more difficulty e.g. planting holes preparation, planting and weeding. The IRFSs'

farmers more concentrated in the new skill of implementations in IRFS system, because they wanted to avoid the risk of new alternatives (rubbers and fruit trees)

Table 5.3 Farm activities cropping calendar in the IRFSs system

Activities	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Site selection												
Tool preparation												
Slashing												
Main burning												
Clearing & Re-burning and Land preparation												
Sowing & planting												
Weeding (3 times)												
Harvesting												
Threshing												
Transporting												

Remark: Annual crop; Rubber and fruit tree

Table 5.3 shows activities in the seasonal calendar of the IRFSs system practice. Because of several activities on the IRFSs system process were modified from the *hai* system processes. The IRFSs system practice could be classified extensively in 3 periods of processes: initial period process, middle period process and last period process. Consequently, the IRFSs and the *hai* system practice were different in the middle period process in a cropping season, which will be explained in detail.

The initial process

The initial period process was usually same to the *hai* system, involving the site selection, tools preparation, slashing and main burning. Site selection begun in December, upland farmers generally tried to find out the best soil available or the most suitable areas. Tools preparation started to prepare since early January that the slashing knives (machetes), weeding knives, dibbing stick, digging hoes, and sickles were prepared as usual. Then, slashing normally started in February, each family generally worked to slash the vegetation on their family plot or had labour exchange. Later than slashing, farmers was left the slashed vegetation to dry by sun for a month. Lastly, the main burning of dry vegetation began around the end of March to April. The land plot owners group who had the field plots were sited close up to each other must be burnt the same day. Mostly, land plot owner group would be burning on the day or night time, depending on risk of village fire is high or not. Fields are burnt to get rid of the slashed vegetation, reduce weeds, cook the soil, and produce fertilizer from the ash. It decreased the soil acidity, increases the phosphorus, and also killed weed seed and the parasites.

The middle period process

The middle process was an important part in the IRFSs system practice involving land preparation, crop sowing and planting, and weeding.

a) land preparation

Three days after main burning, usually in early March, according to the quality of the main burning, farmer would start cleaning their plots. Any remnants left after the initial burning was collected and re-burned. After that the head of family would ask for labor exchange group. Men normally constructed a field house which was

used for sheltering family member, family cooking and eating, temporary storage of rice during harvest time; while women cleaned and burned field area.

As realized that the IRFS 1 and IRFS 2 system practice were similar on processing, mostly was prepared by individual family in April and May, labour hiring sometimes were needed to finish in this task. Terrace was made as hedgerow on the slopping land with an objective to cultivate the rubber and/or fruit tree and to prevent soil erosion as well. The terrace was prepared by using digging hoe along contour line at the same level though areas (from a part of field boundary to the opposite part). The terrace areas had spaces about 60 to 100 centimeters and the spacing between each other were six to eight meters, depending on the slope of areas, if the slope was steeper, the spacing will be closer. Planting holes were made by using hoes dug on the terrace sized 40 to 60 centimeters, depending on the solid of soil, e.g. the hole sizes 40 centimeters: 40 x 40 x 40 cm (40 width x 40 length x 40 height centimeters).

Figure 5.2 The IRFSs pattern (terrace on the slopping land)

Regarding farmers' skill, the IRFS 1 system used the planting holes mostly sized 40 to 60 centimeters, and rubber tree's holes in the terrace uses spacing generally between a tree to another tree is two or three meters, and then they were left to dry by sun for 15 to 20 days, after that recover those holes again and waited for rains were established before planting. On the other hand, based on the IRFS 2 system practice that the participating project farmers had followed by the technical method from project, tree holes were made by digging hoe, and was sized 50 centimeters or wider, if soil is not good (dry and not enough moisture). Then, left them to dry by sun for 10 – 15 days. After that, cattle residues was put in the holes and mixed together with the top soil surface. Later, the holes were recovered by the rest of soil, and left until the rains started. Rubbers and fruit trees were planted separately on the terraces as alternating cropping by using different distances, rubber tree with tree spacing of two to three meters, while fruit trees use spacing between tree about eight meters.

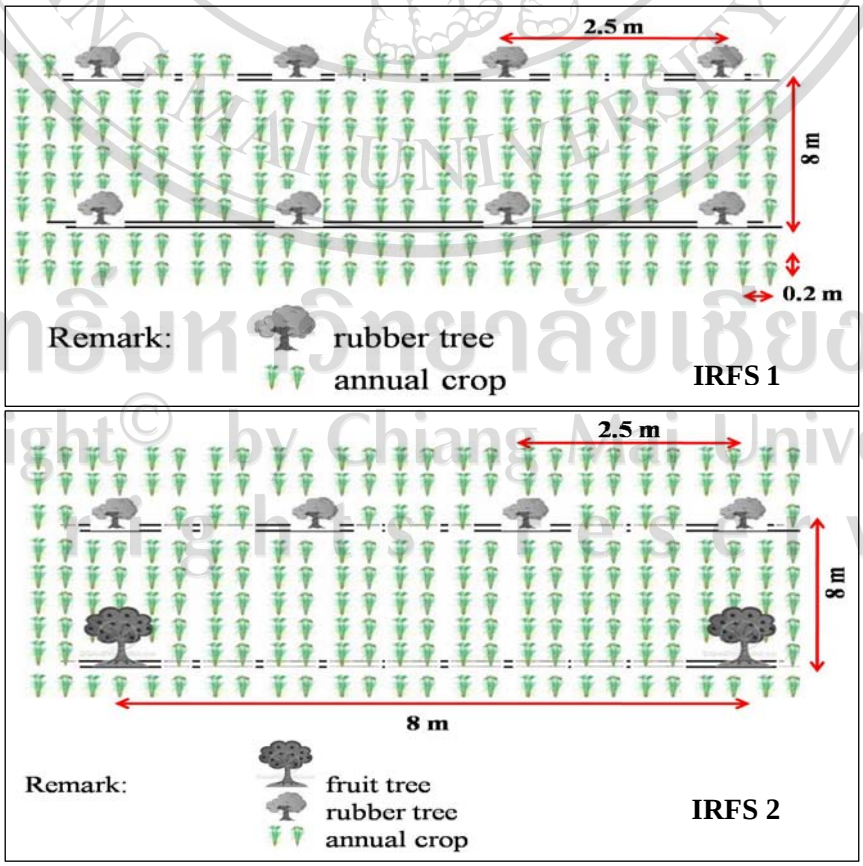

Figure 5.3 Diagram of IRFS 1 and IRSF 2 system practices

b) Crop sowing and tree planting

The crop sowing began after the rainy season is well established, at the same time as normally the *hai* system practice. This stage typically was dealt with the labor exchange by farmers group in community (sometimes, 20 – 40 people). Materials used for sowing included seeding sticks (dibbling stick), seed bags, rice seeds and baskets or cotton bags for holding the seeds. Men used the dibbling stick to make a hole, by spacing is around 20 – 25 cm, and 5 – 10 cm depth, while women followed with the seed bags and filled with five to ten rice seeds in the holes and covered with soil.

Tree planting was started in May and June, when it rained twice or triple times. Materials used included hoes, seedlings and basket for carrying seedlings. The IRFS 1 system practice, after the rains begun, farmers prepared rubber seedling to the field by carrying he bamboo basket. Some farmers have experienced to graft and selection the rubber seedling for planting. They selected seedling with good sizes (approximately five centimeters diameter) and a shoot has about 10 – 15 centimeters length, as it can grow well. This task was simple and easy, only one or two people were done in a few hours per hectare. There was no irrigation as the trees would wait for the rain. For IRFS 2, the plating was more complex than IRFS 1. After planting the rubbers and fruit trees, farmers had to pin a stick and tied it with the tree to prevent it from being broken when faced with the strong wind. They also needed to support a water dripping system which was made from bamboo stem, farmers have to take water to field two to three times in a week.

c) Weeding

The weeding process for annual crop was mostly done likely the *hai* system practice, it is carried out almost continuously from May to October, by using small curved hand hoes and hoes. Traditionally weeding is done by the individual family labour, mostly women and children, but sometimes the men also joined in. A cropping season, weeding was performed three times. The first weeding, upland farmers use knives and curved hand hoes, started when the rice reached the height of a finger span (about 15 cm). The second weeding was normally carried out in early July which is also the flowering time for rice plants. The third weeding normally stated in August.

The weeding for the IRFSs was also carried out three times per year, but because of those are the perennial crops and the spacing used, the weeding process may not often have weeding like the annual crop. Although, the first weeding started at the same time with the first annual crop weeding, by using the hoes slashed weeds in one meter radius surround the tree. These weeding needed to be done carefully, because it might cut the trees. Second weeding would be in November and December, which was after the annual crop harvested already. The third weeding was done in February which was the one year cycle of planting and it also the land preparation for new season of the annual crop. It was complicated task because farmers had to slash and clear the weeds in over the field areas, dry sun the slashed vegetation for some period of time and then move them out from the field for protecting fire burnt to the one year rubbers and fruit trees seedlings. Some farmers needed more hired labour in this process. The farmers in the IRFS 2 system had to take animal residues about two to three kilograms per tree into the soil and break up the soil to destroy the structure

of the soil surface in one meter radius surround the trees, to help the soil easily mixed with the residues and increase the nutrient for rubbers and fruit trees.

The last period process

The last period process was the harvest period season. After weeding activities were performed likely to the *hai* system practice again, because annual crop only could be harvested, while others needed more maintaining as well. The last period process involved to harvesting, threshing, transportation and storages.

The annual crop harvesting started between September and November. Brunches of rice plants were cut by sickles and dried in the field for three days. After this, they ware gathered in huge pile in the middle of the field, to protect the rice from animals and unexpected rain, a special method of piling the rice was used, with the top end of the sheaf of rice placed inside the pile. Harvesting was performed independently without hiring extra labour. Yields are much lower than the traditional practice in the *hai* system around 30 – 60 percent (according to farmers' interviews), because of some rice yield was lost from spacing where rice was not allowed to grow around trees in a meter radius. However, farmers claimed that the yield was depended on the soil fertility. If that area has good soil, the yield also was high. After harvesting, threshing was begun in early December in the fields. The piles of rice were kept in the middle of the rice field for two or three months, depending on weather conditions. Rice was threshed using a pair of sticks joined with a rope. The sheaf was then hit against some boards placed on bamboo mats. To make sure all the grain came away, the sheaf was cut and hit again by stick which curves at one end. The grain then was fanned to remove any empty husks. In generally, threshing activities take time around 10 – 15 days per individual household. Farmers sometimes

used labour exchange, which could be finished in a few days. Transporting the harvested crop to the village is the responsibility in each individual family. Bamboo baskets and bags were used for carrying upland rice by walking and farmers sometimes used horses for transport. If the fields have access to road, farmers sometimes hire a truck for transporting the harvested yield. Finally, the main grain was taken out of the fields and kept in the temporary storehouse. Seed for next year's sowing was stored in special bamboo baskets in the barn. The grain was stored in the granaries which was a bit far away from the house to protect them in case of accidental fire.

IRFS practice was mostly preferred by farmers who had more than 3 ha of land area, and/or at least two plots of land. Likewise, most of them are still using *hai* system for their food subsistence, due to lack of experience in new farming system, lack of land, small farm size and dislike of the risk in rubber production. Although IRFS are performed as the famous alternative in the study area, the rubber has only been grown for four years and is not yet ready to be harvested. Nevertheless, most of the land on mountainous area in northern Laos has become the rubber plantation being hedgerows along contour line in recent years.

5.4 The strengths, weaknesses, opportunity and threats of the IRFS system practice

5.4.1 Strengths and weaknesses of IRFS

There are some highlights of the integrated rubber-based farming systems (IRFS) given by those farmers have been applying them in the study area. Firstly, this system was acknowledged by farmers as more stable system compared with the *hai*

system in the mean of mobility of land use for doing the farming system. In IRFS system, they did not have to change the location for planting every year as *hai* system. Also, farmers found out that maintaining rubber plantation is easier than growing rice, especially when rubber or fruit trees were in mature periods. Based on the observation in other integrated rubber-based farming systems exist outside the study area, farmers distinguished that the IRFS used less labor for weeding and operational process after four or five years planting compared to annual crops. This reduced the labor cost and increased the efficiency of family-labor use.

Secondly, rubber and fruit trees which mostly included in this system were the perennial crops that had high value which could improve farmers' farm income and their livelihood. In other side, this system helped farmers in maintaining the environment such as reforestation with the form of IRFS as agroforestry. Since it is perennial, so, this activity reduced the slash and burn activity annually.

Nevertheless, this system also recognized for its weaknesses by farmers, such as: IRFS required more labor in the early stage of planting, especially during the preparation of planting, such as making hedgerows and digging holes. In relation with this, it increased the labor cost for hired labor since the family-labor used was inadequate. Also, the risks of pest attack were high during the early stage of rubber growing and it would require more skill of farmers to determine. Moreover, young rubber trees are vulnerable and it needed fully awareness from farmers to grow. Further, the first harvest of rubber or fruit trees need few years after planting and it was longer than the annual crops, so farmers lose the opportunity of land use for other crops during these periods.

Other weaknesses from this system is in the processing of rubber product which the odor of latex processing could contaminate the atmosphere surround it. Also, as the development of rubber plantation increased, it will drag people to expand the land for IRFS and it could destroy the biodiversity of the natural environment. The IRFS 2's farmers were lack of maintenance skill in the litchi plantation (Table 5.3).

5.4.2 Opportunities and threats of IRFSs

The pattern of integrated rubber-based farming systems adopted by farmers in the study area mostly hedgerows. According to interviewed farmers, this system helped to protect the soil by preventing soil erosion and reduced the nutrition-loss from soil surface run-off in the rainy season. As the rubber trees or the fruit trees grow bigger, it would provide the shade that inhibit weeds and also could be the shelter for other small animal, e.g. birds. In addition, the produce of this system had high value that could improve farmers' prosperity and their livelihood. Also, these trees are multipurpose trees, so farmers could gain other products instead of the main product as diversification for their farm income, e.g. resin and wood from rubber trees, or fruit and wood from the fruit trees.

Further, these trees had long-term productive life cycle (approximately 30 to 60 years) so this would provide the opportunity of long-term income stability for farmers. Moreover, since integrated rubber-based farming systems were perennials and had long-term economic life cycle, it could be used as pledge assets for farmers' capital-borrowing from the bank. As the IRFS farmers succeeded with their new systems, they would properly reduce and discontinue the shifting cultivation. This would encourage them to be intensifying in doing the integrated rubber-based farming

systems and influenced them to improve their skill in order to gain better understanding and knowledge about this system.

However, there are many threats recognized by farmers in the study area about this system. The most important threat for farmers was the instability of price of crops and its post-harvest product, either from rubber trees or fruit trees. Also, they feared market demand in the future since recently they just started to adopt this system, and it was unclear concerning the continuity of this system, and this affected their motivation to maintain the integrated rubber-based farming systems. In addition, the deforestation caused by expanding the rubber plantation areas, farmers thought that it could damage the natural environment, source of soil erosion, land degradation, and reduced the water resources availability. Also, rubber trees required more water, and since the water sources are one of limitations of the study area, this could be the threat for its continuity. Since rubber trees were high value crops and newly introduced in the study area, it required more capital to develop it. This was one of the limitations of farmers in the study area since they are small-scale farmers with lack of capital.

Table 5.4 The strengths, weaknesses, opportunities and threats of IRFSs

SWOT	Interviewed farmers' opinions
Strengths	• Objectives: optimization of land use • Some farmers were skilled in rubber and fruit tree planting • The characteristic of rubber tree helped to inhibit weed • Provided better income than annual crop

SWOT	Interviewed farmers' opinions
	• Supported the reforestation (tree plantation) and reduced out migration and maintenance efficiency after it was fully developed • Perennial or long-terms multipurpose crop investment, e.g. rubber provided long-term productivity (latex) & wood income for 30-60 years
Weaknesses	• Required more labor in planting process (making hedgerows and digging holes) • High pest risk at the beginning of planting (rat and termite) • Young trees needed more awareness from farmers • High capital demand • Reduced the opportunity of land use for other crops • Opening new area for rubber plantation could diminish the biodiversity • Air pollution caused by the latex processing • High-condition of requirement of rubber tree to grow • Lack of skill on maintaining litchi plantation
Opportunities	• Rubber plantation could be a constant assets and it will have more money when rubber resin is harvested • Hedgerows in the rubber plantation could be protected soil erosion and store some nutrient for soil from soil surface runoff in rainy season • It could be used as credit for the warranty to borrow money for another alternative investment • Rubber and fruit tree could provide more income and change from the *hai* system practice • The rubber resin products will be supported at least for 30 – 60 years

SWOT	Interviewed farmers' opinions
	• Rubber plantation could be heritage for another new generation of family in the future • Good price and could provide money to buy other food items • Could have better living and prosperity, have more money for buy a new car, motorcycle for driving as other people • Could have more money for saving in the bank and build a new better house • Many people still wanted to grow and expand rubber plantation • Rubber tree could be sold as wood after resin was finished
Threats	• Forest areas would be reduced due to expantion of many people expand a number of rubber plantation areas yearly • Dried soil and erosion could happen, the soil after end of rubber plantation was poor and dry, and could not grow rice and/or other crops • River could dry up inadequate for water using and drinking due to rubber tree intake much water to produce its resin • Rubbers' yield price could be fluctuating, no company could give guaranteed price • People could be poor, hungry with rice shortage, if their rubber products could not be sole • Fear that! rubber would not have resin and farmers did not have skill to tap resin • Could have some land conflicts for reserving land to plant rubber in the village