

Chapter IV

Results of Field Survey

4.1 Study site

Luang Prabang province is one of the 18 provinces of the Lao PDR. It is located in the mountainous northern part of the country. Its boundary stretches from longitude of 101° 40' to 103°30'E and latitude of 19°00' to 21°00'N, with base altitude of about 305 m above mean sea level, and ranging to about 1,500 m (Keoboualapha, 1999). Luang Prabang province has two distinct climates: wet season from May to October and dry season from November to April, average annual rainfall is about 1,387 mm and average annual temperature was recorded at 25.9°C. The 85% of the province is upland and covers an area of 1.68 million hectares (7% of total land areas of the country), of which 6% of the area or 98,137 hectares were used for agriculture.

Luang Prabang province is divided into 11 districts, 1,176 villages, 63,582 households with a population of 335,000 and has three major ethnic groups, of whom 46% are classified as Lao Theung, 40% Lao Loum and 14% Lao Sung. In Luang Prabang province, over 80% of the population are engaged in agricultural production. Of the remaining 17% are involved in commerce and 3% are government officials and others. Two thirds of the population practices shifting cultivation (Luang Prabang Provincial Brochure, 2000).

There is a main national road and number of large river flow through the province facilitating regional trade and transport-it is a gateway to the North. Apart from this, the climate in the province is cool that is suitable to extend the maturity of mango until July that can create good opportunity for farmers to get a high price. All of these are high potentials for Luang Prabang province to grow mango and distribute the fruits to the other northern provinces where there are less mango trees or have the potential to be a main source of raw materials for processing industry in the future.

4.2 Mango production systems in Luang Prabang Province

In Luang Prabang province, mango especially local Kaew cultivar is favorable and popular fruit tree among the other perennial crops or fruit trees. Farmers have been growing mangoes for a long time. If compared with coconut, banana, jackfruit and tamarind, mango occupies a high percentage than the others. There were 23,960 households or 43% of the total households of the whole province who grew mango, and occupied an areas of 1,726 ha in which 661 ha of the areas were accounted for compact plantation systems. The farmers' practices in mango production is described as in the following section.

4.2.1 Farmers' practices in mango production

Farmers' profile

All selected farmers involved in mango growing and few in mango propagation. Of whom, 20% were women. The 80% of farmers were Lao Loum and only 13% are Lao Sung. From the selected households, there were no Lao Theung farmers. The farmers' ages varied from 32 to 73 years (Table 3), of which 13% is accounted for those, who are under 40 year-old, 19% under 60 year-old, 40% under 70 year-old and 13% over 70 year-old. 96% of farmers were literate, of whom 60% have finished primary school, 26% have finished secondary school, 7% have finished high school, and only 7% of farmers were illiterate. Farmers' family size varied from 3 to 10 persons. However an average family size was 6 persons per one family. Labors that are used in their families ranged from 2 to 4 (Table 3) of which, a half of family labors were women.

Table 3 Farmers' profile in Luang Prabang province

Item	No. of farmers reported	Average	Maximum	Minimum	SD
Farmers' ages (years)	15	55.9	73.0	32.0	± 13.6
Family size	15	6.0	10.0	3.0	± 2.4
No. of labor	15	2.7	4.0	2.0	± 0.8

Source: Survey, 2002

Land holding

The number of parcels of land holding for the families in the study area varied from one to four (Table 4). 33% of households having two parcels of land, 33% and 26.6% having three and four parcels of land respectively, and only 6.6% occupied one parcel of land. 2.8 parcels are accounted as average number of land holding with an area of 1.16 ha. All of them had their own land, the areas varied from 0.6 to 4 ha (Table 4). All of them had fruit tree orchards in which they grew mango, tamarind, jackfruit, lemon, longan and litchi. Fruit trees played an important role as source of supplementary food and income for their families. Apart from growing fruit trees, all farmers grow rice, raise livestock and practice home gardens for their home consumption. Besides, all of farmers plant teak trees as a source of a long-term income for their generation.

Table 4 Land holding, mango areas and mango ages in Luang Prabang province

Item	No. of farmers reported	Average	Maximum	Minimum	SD
• No. of parcels of land	15	2.8	4.0	1.0	± 0.9
• Total area of land holding (ha)	15	2.3	4.0	0.6	± 1.1
• Mango area (ha)	15	0.7	1.5	0.2	± 0.5
• Mango ages (years)	15	17.0	30.0	6.0	± 8.9

Source: Survey, 2002

Mango areas and their location

Mango areas in the study site ranged from 0.2 to 1.5 ha (Table 4) with a number of 20 to 230 mango trees. This number depended on spacing. The land size of 0.7 ha is accounted as an average area with an average number of 83 mango trees.

Majority of mango orchards (60%) are located on slightly sloping land (5-10°), the remaining 26.7% and 13.3% are located on flat land (0-5°) and highly sloping land

(20-30°) respectively (Table 5). Some of the mango orchards are established along the roads, while the others are on the riverbanks and hillside.

Table 5 Location of Farmers' mango areas in Luang Prabang province

Location of mango areas	No. of farmer reported	Percentage
Flat land (0-5°)	4	26.7
Slightly sloping land (5-10°)	9	60.0
Highly Sloping land (20-30°)	2	13.3
Total	15	100.0

Source: Survey, 2002

Since most mango orchards in the study area are located on slightly sloping land, therefore, farmers have limited access to water, so they rely heavily on rainfall in wet season to grow mango, even though those which are located on flat land and riverbanks. Therefore, all areas are under rainfed condition. This was one of the important problem that caused low yield or productivity of mango.

Mango growing systems, their forms and components

The results from the field survey showed that 93% of farmers have practiced compact system of growing, and only 7% followed scattered systems. 86.7% of farmers' orchards were mixed fruit system in which the mango trees were dominant and 13.3% of orchards were mango monoculture (Table 6). More than 50% of farmers' mango orchards were relatively old (15 – 30 years) and the rests were quite young (6-12 years).

The main components of mango based mixed fruit system are (mango + tamarind + jackfruit + coconut), (mango + lime + litchi + jackfruit), (mango + tamarind + pineapple + banana), (mango + litchi), (mango + litchi + longan + guava + lime). Most farmers reported that mangoes are the major sources of supplementary food and income, while banana, coconuts and lime are found less important.

Table 6 Forms of mango orchards in Luang Prabang province

Form	No. of farmers reported	Percentage
Mango monoculture	2	13.3
Mixed fruit system	13	86.7
Total	15	100.0

Source: Survey, 2002

Mango varieties

Farmers in Luang Prabang province as in many other places of the country grow many varieties of mango, which included local and imported (improved) varieties. Local varieties are commonly grown in all districts of the province such as Og-Hong, Kasen, Kaew-Loop, Kaew-Cho, Kaso and Gnaxang. Among these varieties, Kaew mango is common and popular for farmers up to now. This is due to its comparative advantages are over another varieties with respect to drought tolerance, care, good quality and suitability for resource poor farmers, as the result of which most farmers have widely grown this variety. Apart from growing local varieties, farmers also grew improved varieties that come from Thailand. Improved varieties are divided into two groups: first is green delicious varieties including Khiew-Sawoer and Fa-Lan, and second is ripe delicious ones such as Nam-Dokmai and Chok-Anan. From the interview only 13.3% of farmers have grown these improved varieties (Table 7), Besides, only a small number of them are available in each orchard (12% of the total number of mango trees).

Table 7. The use of mango varieties by farmers in Luang Prabang province

Variety use	No. of farmers reported	Percentage
Local varieties only	7	46.7
Improved varieties only	2	13.3
Using both local and improved varieties	6	40.0
Total	15	100.0

Source: Survey, 2002

Cultural practices

Farmers have practiced different methods of mango establishment, 67% of them had sown the seeds in plastic bags and then kept the seedling in the nursery for one year and thereafter the seedlings were transplanted in the fields. Some of them (20%) had sown the seed directly into the pits in the fields or put the seeds into pits surrounded by banana, and after 2-3 years banana were cut down and left mango trees to continue to grow. Some farmers (13%) used bamboo tubes instead of plastic bags to sow the seeds, and then kept the seedlings in the shade. After one year the seedlings were transplanted into the pits in the fields. This local method could help farmers to reduce the cost of production. The most suitable time of transplanting mango seedling in Luang Prabang province is May and June (the beginning of wet season), because during this time of the year there was enough moisture in the soil.

Different spacing was used in the study area. Spacing depended on land location, soil fertility, size of trees, experiences and purposes of growers such as 4 m x 4 m; 5 m x 5 m; 6 m x 6 m; 7 m x 7 m; 7 m x 5 m; 8 m x 8 m; 8 m x 3 m and 9 m x 9 m. The size of pits also varied and depended on growers' practices such as 20 x 20 x 20 cm³; 30 x 30 x 30 cm³; 40 x 40 x 40 cm³; 40 x 40 x 60 cm³, and 50 x 50 x 50 cm³ (Table 8). In the study area, all the farmers reported that after transplanting more attention was paid to take care of seedlings, especially in the first, second and third years and before flowering- reported by some farmers. During this time farmers had to keep the fields clean and free from weeds and pests. Apart from growing mango, in order to intensify the land use in the first; second and third years upland rice, bananas and pineapple were intercropped between the row with the purpose of getting supplementary food or income while waiting for mango trees to bear fruits.

Table 8 Spacing of mango growing in Luang Prabang province

Spacing (m)	No. of farmers reported	Percentage
4 x 4	2	13.3
5 x 5	3	20.0
6 x 6	4	26.8
7 x 7	2	13.3
8 x 8	2	13.3
9 x 9	2	13.3
Total	15	100.0

Source: Survey, 2002

Fertilizer application

The results from field survey indicated that 46.7% of growers used organic fertilizers only (Table 9). Organic fertilizers included fermented duck, chicken, pig and buffalo manure. This manure is locally available without having to buy from outside and it lowers the input cost of mango production. The rate and frequency of using manure varied. Some farmer (27%) applied only one time in the first year by putting it into the pits before transplanting with the amount of 0.5 to 5 kg per pit. Some farmer (13%) applied once a year (2–5 kg/tree); and only 6% of farmers applied two to three times yearly (4–5 kg/tree) with interval of four to six months. Indigenous knowledge has been found among the farmers in preparing the pits before planting. The topsoil around the pits (surface soil) and plant residues, which are rich in plant nutrients are used instead of manure to fill their pits. 80% of farmers did not use chemical fertilizers. The reasons are that they did not know how to use or they did not have enough money to buy or they just grew naturally and traditionally. Only 20% of farmers applied chemical fertilizers together with organic fertilizers (Table 9). Fertilizers grade 16-20-0 and 15-15-15 were commonly used with transplanting the seedlings by mixing them into the pits (0.2 kg/pit) and one more time in a year after transplanting (0.3–0.5 kg/tree depended on tree age).

Table 9 The use of fertilizers by the farmers in Luang Prabang province

Type of fertilizers	No. of farmers	Percentage
Organic fertilizers only	7	46.7
Chemical fertilizers only	0	0
Both fertilizers	3	20.0
No fertilizers use	5	33.3
Total	15	100.0

Source: Survey, 2002

Pest management

The major pest problems that most of farmers faced were mango stone weevils (*Sterochetus* sp.), mango stem borer beetles (*Olenecamptus optatus* Pascoe., *Bactocera rubus* L.), mango shoot borer (*Chlumetia transversa* Walker), anthracnose (*Colletotrichum gloeosporioides* Penz.), cogon grass (*Imperata cylindrica*) and mistletoe (phanerogamous parasites *Dendrophthoe pentandra*) (Table 10). 46.7% of farmers reported that the most serious pest is mango stone weevil (Table 11), which was difficult to control and caused undesirable fruit quality that led to low price. In term of insecticide application, only 13% of farmers sprayed insecticides to protect their mango from insect damage. Parathion (Folidol) was sprayed during the flowering (20 cc/20 l of water) and carbaryl (Sevin) was sprayed every three-month interval (20 g/20 l of water). 87% of farmers they did not apply any insecticides. The use of fungicides was not familiar to all farmers. To control weed, all farmers used hoes and knife to kill the weeds and remove the mistletoe. In the past five years, few farmers learned to use herbicides such as Gramoxone (paraquat dichloride) to kill the weeds, especially cogon grass, but the trial ceased shortly after then. Farmers also used cultural method to protect their trees by hand weeding and burning the infected and damaged branches.

Table 10 Most commonly reporting pests in Luang Prabang province

Pest	No. of farmers reported	% of farmers controlling
Insects		
Stone weevils	8	0
Mango stem borer beetles	7	53.3
Mango shoot borer	1	13.3
Diseases		
Anthraxnose	2	0
Mistletoe	1	86.7
Weeds		
Cogon grass	6	100.0

Source: Survey, 2002

Table 11 Farmers' perception on seriousness of pests

Pest	No. of farmers reporting	Percentage
Insects		
Stone weevils	7	46.7
Mango stem borer beetles	5	33.3
Weeds		
Cogon grass	3	20.0
Total	15	100.0

Source: Survey, 2002

Pruning and harvesting

After harvesting, 80% of growers pruned their trees. Pruning was conducted mostly at the end of June to July; some did it in August, while the others practiced twice a year in July and in December (Table 12). During the pruning period, dried and death

branches or shoots, unproductive branches were removed and burned, in order to shape tree canopy and create a good microclimate that will support normal growth.

Table 12 Time of mango pruning practiced by farmers in Luang Prabang province

Month	No. of farmers reported	Percentage
July	12	80.0
August	1	6.7
December	2	13.3
Total	15	100.0

Source: Survey, 2002

The mango trees bear fruits every year, but not all trees could give fruits in the same year. The mango trees, which come from seedage, could provide fruits 6-7 years after planting. In the other hand the trees, which grew from grafting could supply fruits within 3-4 years. Bearing ability of mango trees depended on many factors such as farmers' management of pest and weed control, pruning, and fertilization. Climatic factor also influenced on bearing, for instance in the year 2002 farmers faced a problem of fruit drop caused by hailstorm. Mangoes are harvested green, unripe and ripe. In Luang Prabang province, harvesting of mango fruits started from the middle of May and extended to the end of June. Kaew-Loop mango was harvested as early in May, while Kaew-Cho fruits were harvested later in June (Table 13). This late harvest will provide better income than the early harvest, due to another varieties are already out off season.

Harvesting is done manually by hand-picking for short mango trees, but for the taller trees is extended by using bamboosticks.

The weight of mango fruits varied from variety to variety i.e 6-7 fruits/kg (143-167g/fruit) for Kaew-Loop; 5-6 fruits/kg (167-200 g/fruit) for Kaew-Cho and 3-4 fruits/kg (250-333 g/fruit) for Gnaxang, Khiew-Sawoer, Fa-Lan and Chok-Anan. In general, the productivity of mango in the province was low about 5-15 kg/tree due to poor management, lack of technical knowledges and irrigation systems.

Table 13 Time of mango harvesting in Luang Prabang province

Time	No. of farmers reported	Percentage
15 - 30 May	8	53.3
1 – 15 June	4	26.7
16 – 30 June	3	20.0
Total	15	100.0

Source: Survey, 2002

4.2.2 Farmers' practices in mango propagation

It was found that farmers have practiced two methods of propagation: seedage and graftage. 87% of farmers have exercised the first method for a long time. The second one was recently introduced in the past 6-10 years, therefore, only a small number of farmers have practiced this method. The process of seedage started from sowing the seeds into the soil beds or plastic bags or bamboo tubes. Thereafter, the seedlings were kept in the nursery or under the shade for one, year then the seedlings were transplanted into the pits in the fields and maintenance was taken until trees are fruitful.

In the study area, 20% of farmers used approach grafting to produce grafted materials, 60-80% success was noticed for this technique (Table 14). Detached methods that farmers like to use included whip or splice grafting (20%), side veneer grafting (27%), and bark grafting (20%) with the success of 60-90%, 60% and 40-80% respectively. Some farmers used veneer grafting and bark grafting to change undesirable varieties using the rootstocks of two years or more ages. Mostly Kaew mango and wild mango were used for rootstocks. Khiew-Sawoer, Nam-Dokmai are now popular varieties, which are used as the best scions because of their high consumers' demand, good taste and high price. Some farmer bought grafted materials of Khiew-Sawoer from Xayabury province, which is located near the border between Lao PDR and Thailand. Some techniques were used for stimulation of the growth of scions after grafting such as cutting the rootstocks above grafted union 45 days after grafting and cutting the bark of

rootstocks above grafted union 2-3 weeks after grafting. The most suitable time in the year for grafting is during May to July.

There were only two farmers, who produced commercial grafted material. They can produce 300 to 500 grafted materials in each year and sold at the price of US\$ 0.8 /grafted material. They can earn money from their grafted materials from US\$ 240-400 /year. Most of their grafted materials were distributed to many rural development projects within and outside the province i.e. MPLP-I & II (Luang Prabang Micro-Project), GAA (German Agriculture Action), EDI (Eco-Development Irrigation), UNDCP (United Nation for Drug Control Program).

Table 14 Farmers' methods of mango propagation in Luang Prabang province

Methods of propagation	% of farmers involved	% of success
Seedage	87	>90
Graftage in the nursery		
approach grafting	20	60-80
whip grafting	20	60-90
Graftage on rootstocks in the field		
vener grafting	27	60
bark grafting	20	40-80

Source: Survey, 2002

4.2.3 Mango marketing

Not all mango fruits were sold in local market (within the province), through the local middlemen. Over half of mango production was transported to sell in another province such as Odomxay and Luang Namtha (Table 15). Only some mango fruits which the farmers kept for their home consumption and relatives. The prices of mango fruits depended on harvesting time and varieties. The fruit price of local varieties was lower than improved ones i.e. US\$ 0.08-0.2 /kg for Kaew-Loop and Kaew-Cho and US\$ 0.5-1 /kg for Khiew-Sawoer and Chok-Anan.

Table 15 Marketing channel of mango in Luang Prabang province

Market	No. of farmers reported	percentage
• Local market (selling in Luang Prabang Province)	3	20.0
• External market (selling in another provinces)	12	80.0
Total	15	100.0

Source: Survey, 2002

4.2.4 Farmers' family economy

Annual income: It was found that an average annual income was \$US 1,275. Annual income varied from US\$ 500 to 3,430, which was depended on number and size of agricultural activities and off farm activities. The farmers, who had both activities, could earn a better income than those, who had only agricultural activities. However, agricultural activities are still the main sources of family income, in which including rice, fruit trees, vegetables and animals. It was noticed that over 75% of farmers had their own teak for at least 500 trees, which were important potential income for their families in the future.

Income from selling mango fruits was also important for the families as supplement income. This income ranged from US\$ 6 to 200 a year depending on mango production, which related with the size of orchards, number and age of mango trees and farmers' management. However majority of the farmers (80%) had income from selling mango fruits between US\$ 10–100 per year (Table 16). On the other hand, income from selling grafted materials was found for few farmers (13%), who produced for commercialization. They can earn from US\$ 240–400 per year.

Annual family expenses: It was found that all farmers spent more money for food than the other expenses, in which including education, clothes, health, investment in agriculture, transportation and other social activities. An average annual family expense

was US\$ 860. In term of investment of mango growing and producing grafted materials, farmers spent not much money, the amount varied from US\$ 10 to 100 for growing, which included fencing, seedling, labor, fertilizers and pesticides. At least US\$ 4 was required for farmers who did the grafting with a purpose of changing to the desirable varieties in their fields. While the farmers, who produced grafted materials for sale, used US\$ 30-100, which including tools and materials for grafting and labor (Table 17).

Table 16 Income from mango fruits and grafted materials

Income (US\$)	No. of farmers reported	Percentage
• Mango fruits		
<100	1	6.7
10-40	5	33.3
50-100	7	46.7
>100	2	13.3
Total	15	100.0
• Grafted materials		
0	13	86.7
240	1	6.7
400	1	6.7
Total	15	100.0

Note: US\$ 1=10,000 Kip

Source: Survey, 2002.

Table 17 Expenses in growing mango and producing grafted materials

Expenses (US\$)	No. of farmers	Percentage
• Expenses in growing mango		
<10	0	0
10-50	14	93.3
>50	1	6.7
Total	15	100.0
• Expenses in producing grafted materials		
0 (do not produce)	8	53.3
<5 (for top working)	5	33.3
5-30	1	6.7
>30	1	6.7
Total	15	100.0

Note: US\$ 1=10,000 Kip

Source: Survey, 2002