

Chapter III

Materials and Methods

The study is divided into three parts. The first part is examining and understanding the existing mango production systems, farmers' problems and needs and their practices in Luang Prabang province by conducting field survey and interview in March and April 2002. The second part is based on data gaining from field survey and then field experiment on grafting techniques with different ages of seedling rootstocks was designed and conducted at MCC, Chiang Mai University from June 2002 to February, 2003. Then the grafting techniques that have been done in field experiment were assessed as the third part by the farmers in Luang Prabang province to gain farmers' understanding and their preference about those techniques as shown in the Figure 8.

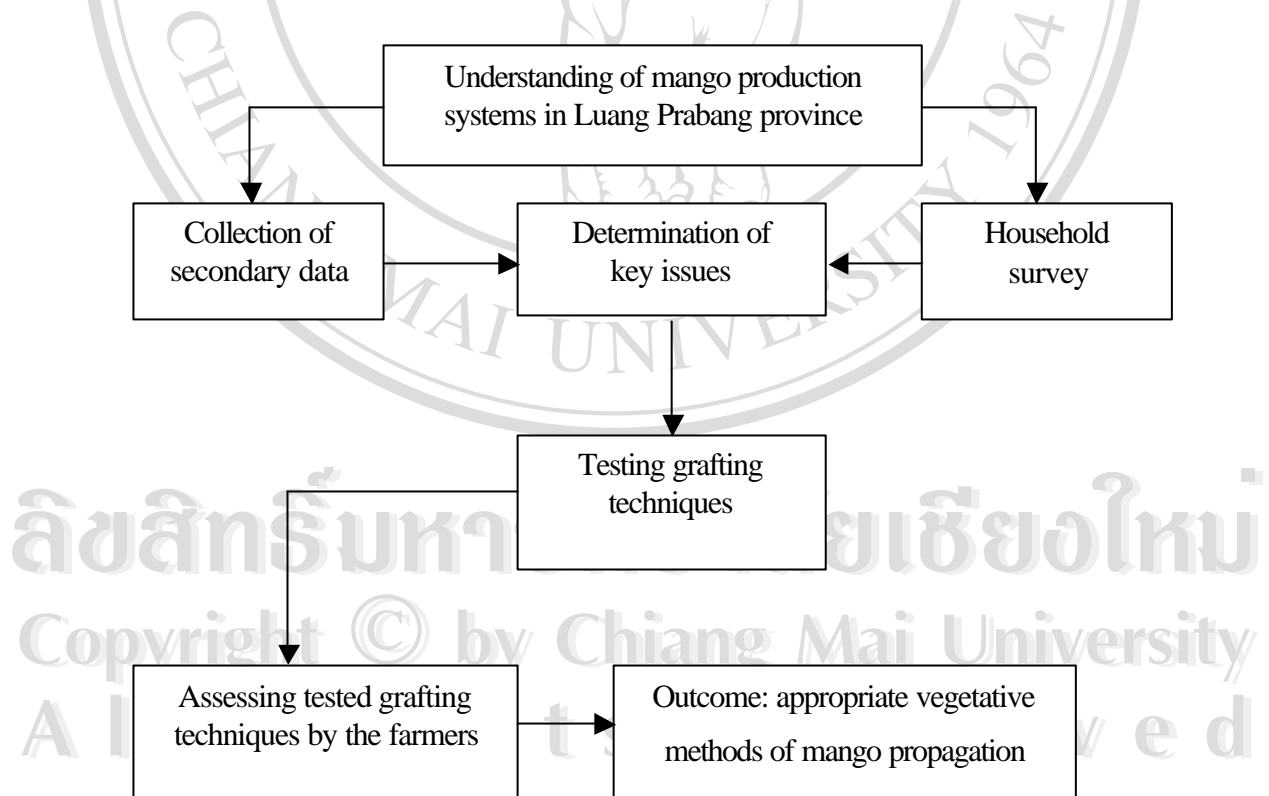


Figure 8 Problem and research perspective of grafting techniques of mango

3.1 Household survey

3.1.1 Site selection

The reason that Luang Prabang province was selected to represent the area of the northern part of the country is that, firstly, the province has over 40% of the total households of the whole province that are involved in growing mango and cover an area of 1,726 hectares. This is high in term of both number of household involved and area cultivated if compared with the others northern provinces. Secondly, Luang Prabang province has higher proportion of upland rice areas than the other northern provinces. This has been given special attention by the provincial authorities towards its forest protection, improving quality of life in shifting cultivation areas through integrated farming systems in which fruit trees take major part as important component of the systems and other environmentally sound development. Thirdly, Luang Prabang province has potentials in term of infrastructure i.e. main national road and number of large river flowing through the province facilitating regional trade and transport-it is a gateway to the North. Apart from this the cool climate in the province is suitable to extend the maturity of mango until July that can create good opportunity for farmers to get a high price. These potentials will help the province to improve mango production and its market in the future.

3.1.2 Data collection

Field survey was carried out in Luang Prabang province during March and April, 2002. Household survey, key informant interview were used to collect data for the research. A total of 15 sample households involved in mango growing and propagation were selected and interviewed using questionnaire. The questionnaire focused largely on farmers' practices and management of mango production, especially propagating methods in the province. Secondary data on climatic conditions such as rainfall, temperature and soil properties was collected from the reliable authorities. Additional data were also collected from District Agricultural & Forestry Offices (DAFO), Provincial Agricultural & Forestry Office (PAFO) and other publications and institutions.

3.1.3 Data analysis

The data collected from the field survey was checked for normality. Descriptive analysis was used to qualify and quantify the significant relationship between selected variables.

3.2 Field experiment

3.2.1 Experimental site

The field experiment was conducted in the nursery at the Research Station at MCC, Faculty of Agriculture, Chiang Mai University from June 2002 to February 2003. The station is located at North latitude of $18^{\circ}46'$ and East longitude of $98^{\circ}57'$ at 330 m above mean sea level. The average rainfall is 1,200 mm, which largely concentrates from May to September. Average temperature during cropping periods is 22°C .

3.2.2 Experimental design

Based on results of examination of the existing farmers' practices in mango propagation from the field survey, two experiments were designed separately to address the objective number two.

3.2.2.1 Grafting on old seedling rootstocks

Experiment 1. Evaluation of survival and growth of Kaew scions after grafting on different ages of Tlap-Nak seedling rootstocks

The experiment was laid out in a randomized complete block design (RCBD) having three different ages of seedling rootstocks (1 year-old, 2 year-old and 3 year-old) as treatment, with 10 seedlings per unit and replicated four times. Veneer grafting technique was used for this experiment.

1. Preparation of rootstocks

Tlap-Nak seedlings with different ages of 1, 2 and 3 year-old were used as rootstocks. The media comprised of soil and rice husk at the ratio of 2:1. They were grown in the black plastic bags with the size of 17.8-35.6 cm and placed under the 50% shade in the nursery. Water was applied regularly in order to keep soil moisture.

2. Preparation of scions

The good and vigorous scions with an appropriate age about 1 year-old of cv. Kaew from Maehae Agricultural Research Station and Trainning Center, Faculty of Agriculture, Chiang Mai University were selected to graft on old cv. Tlap-Nak seedlings using veneer method. The scions were taken care to be free from damage and infection by insects and diseases. The leaves of scions were cut and then scions were placed in the box to maintain its freshness. After that grafting was done immediately.

3. Operations of veneer grafting

The rootstock was prepared for veneer grafting by making a slanting cut of five centimeter long; an oblique cut was then made at the base of the first cut, so that a piece of wood along with was removed. The base of the scion wood was then fitted into the rootstock in such a manner that the cut surfaces, including the cambium layers of scion and rootstock, were facing each other. The rootstock and scion was secured together with polyethylene tape. The graft union was placed at 5-10 cm high from the ground.

4. Crop management

After one and a half months, when the grafted union was formed, and scion growth began, the rootstock was removed completely after new leaves of the scion turned green. This was done above the graft union. Polyethylene tape used for securing grafted union was removed two months later when new leaves of the scion turned green.

Bud forcing was operated when the grafted unions were perfect. It was done in the same direction of grafted union by cutting the bark of the rootstock above grafted union, in order to stimulate the growth of buds. After bud forcing and cutting, the

crown of rootstocks, the new flushes from the rootstocks was also removed in order to accelerate the growth of good scions.

Weed control in the nursery (between the rows and inside the plastic bags) was carried out. The fertilizer grade 16-16-16 was applied three times during the study period at 10 g/tree to all ages mango trees every month after grafting. To prevent grafted trees from insect damage and disease infection, insecticide as Carbaryl (Sevin 85%) and fungicide as Mancozeb (Dithane M-45) were sprayed weekly during the study period at the rate of 20 g and 80 g/20 liters of water respectively. Watering was given to the trees regularly.

5. Data collection

1. Percentage of scion survival at 20 and 60 days after grafting (when scions were still green).

2. Growth data

The following growth parameters were measured once a month starting from 20 days after grafting until the end of experiment (five times).

2.1 Rootstock diameter was measured at the marked level 2 cm below the grafted union using vernier, in centimeter.

2.2 Grafted union diameter was measured at the marked level in the middle of grafted union using vernier, in centimeter.

2.3 Scion diameter: it was measured at the marked level on stem scion 5 cm above the grafted union using vernier, in centimeter.

2.4 Scion length: it was measured from the marked level from the first point of flushing to the tip of the tallest leaf, in centimeter.

2.5 New number of leaves was counted (all the leaves that appear on the scion)

2.6 Duration for the first flush was recorded starting from a day of grafting until

first flush with 1 cm long and its leaf number was also counted.

3.2.2.2 Grafting on young seedling rootstocks (stone grafting)

Experiment 2. Evaluation of survival and growth of Kaew scions after grafting on young Tlap-Nak seedling rootstocks

As the experiment 1, it was also laid out in a randomized complete block design (RCBD) having seven different ages of young seedling rootstocks (5, 10, 15, 20, 25, 30 and 35 day- old) as treatment, with 10 seedlings per unit and replicated three times.

1. Preparation of rootstocks

Fresh mango stones of cv. Tlap-Nak was sown in the black plastic bags of 3 inches x 5 inches in size in the nursery. The media consisted of soil, organic fertilizer and rice husk at the ratio of 2:1:1. After germination, they were kept in a nursery under the 50% shade until they reached a specified age of 5, 10, 15, 20, 25, 30, and 35 day-old respectively. Before stone grafting was done, fungicide as quintozene (Terraclor) of concentration 0.5 ppm was sprayed to protect young seedlings from infection by soil fungus. Water was applied regularly in order to maintain soil moisture. Then the seedlings of healthy and uniform age were selected for grafting.

2. Preparation of scions

The plot of mother plants of Kaew mango needed to take care regularly such as weeding and spraying insecticide and fungicide. Then the good and vigorous scions with an appropriate size and age of about 3 to 6 month-old of cv. Kaew were selected to graft on young cv. Tlap-Nak seedling rootstocks using cleft method of grafting. The scions were cut then placed in the box to keep the freshness, after that grafting was done as soon as possible.

3. Operation of stone grafting :

3.1 The seedling stems were headed back leaving 3-4 cm long. A 1.5-2.0 cm longitudinal cut was made running down through the middle of the stem.

3.2 A wedge shaped cut starting on both sides was made on the lower part of scion stick. The scion stick was 3 to 6 month-old and 5-10 cm long containing plump terminal buds.

3.3 The scion stick was then inserted in the cleft of the seedlings and tied with polyethylene strips.

3.4 The grafts were then placed in the big polyethylene bags, 46 grafts per bags. The bags were then kept under the 80% shade in the nursery, protecting from heavy rain for three weeks.

3.5 After three weeks, when the scion sprouted and the leaves became green, the plastic bags was opened for 2-3 days by making small holes to give a chance to the grafts inside to adapt to outside environment.

3.6. Then the white plastic bags were opened fully and the grafts were planted in the nursery beds.

4. Crop management

After three weeks, when the grafted union was formed and scion growth began, the care of trees was taken. Weed control in the nursery (between the rows and inside the plastic bags) was carried out. The fertilizer grade 16-16-16 was applied three times during the study period at 3 g/tree to all aged mango trees every month after grafting. To prevent grafted trees from insect damage and disease infection, the same insecticide and pesticide with the same rate as the first experiment were sprayed. Watering was also given to the trees regularly.

5. Data collection

1. Fruit size and fruit weight were measured in centimeter and in gram respectively
2. Seed size and seed weight were measured in centimeter and in gram respectively.
3. Percentage of seed germination.
4. Percentage of scion survival at 20 and 60 days after grafting (when scions were still green).
5. Growth data

The growth parameters were measured once a month as in the first experiment

start at the day 20 after grafting until the end of experiment, totally five times.

3.3 Climatic data

Air temperature in the nursery was recorded during the period of grafting. Besides, air temperature and rainfall data from the Irrigated Experimental Station of Multiple Cropping Center were also used.

3.4 Economic data

The cost of materials and each management practice of both experiments were recorded

3.5 Assessing the feasibility of grafting techniques

To address the objective three, the costs of materials and labor of each management practice was recorded and calculated to compare with farmers' practices as a part of assessing economic viability. The explanations of characteristics of each technique that was used in the experiment were used to assess the technical feasibility i.e. percentage of success, time consumption, labor and input requirements and level of skill requirement. These characteristics were compared among themselves and compared with farmers' practices in order to define the feasible technique for the farmers to adopt and apply in their mango production systems. Grafting techniques was demonstrated to farmers (40 farmers) in Luang Prabang province. Questionnaire was used to assess the farmers' acceptability and preferences.

3.6 Data analysis

The analysis of variance (ANOVA) was used for comparison between the treatments, and LSD was used to test the differences between the treatments. The cost that might vary from treatment to treatment was calculated to assess the economic viability.