Chapter VI

Discussion

6.1 Effect of farmers' management on mango production and propagation

The number of parcels of land holding of farmers' families in the study area ranged from one to four, but most of them had two to three parcels of land. All of them had their own land. Mango areas ranged from 0.15-1.5 ha. Over half of mango orchards were old (15-40 years) and located on the rainfed uplands, which were suited for local mango, especially Kaew cultivar due to their drought tolerance (Schaffer *et al.*, 1994).

In the study area, 93% of farmers practiced compact systems of growing, only 7% were concerned with scattered systems and 86% of orchards were mixed fruit system in which the mango trees were dominant, since farmers wanted to have many kind of fruits all year round and for risk reduction. In term of variety use, Kaew mango was familiar and popular with the farmers, since it is drought tolerant, less care and was suited for the resource poor farmers and good quality for both fresh consumption and processing (Radanachaless *et al*. 2002). In addition, Kaew mango will become an important source of raw material for the agro-prosessing industry, which is located in Vientiane province. This industry requires the amount of 300-400 tons of Kaew mango fruit each year, two thirds of this amount was imported from the north-east part of Thailand (Kalasin province). So promotion of expanding growing areas under Kaew mango and providing techniques, especially vegetative propagation one will be a key mean to reduce import, while more income is generated to the rural economy.

Different spacing was used in the study area, but the relative close spacing of 6 m x 6 m was practiced widely by the farmers, due to the infertile soil so that the mango trees grow slowly and exhibit their small shape (Wangnai, 1986). Most of the farmers in the province transplant mango seedlings during May and August as Radanachaless and Krasaechai (1991a) reported that these times are naturally the

highest moment of soil moisture of the year, which can reduce mortality rate of seedlings. After transplanting, more attention was paid to taking care of seedlings, especially in the first, second and third years. Radanachaless et al. (2002) reported that the first year mango seedlings are not tolerant to drought and percentage of mortality will be high up to 90%. Since, the farmers consider mango orchards as a part of their farming systems, which less attention is paid for them, therefore mango orchards were ignored naturally, and also chemical fertilizers and pesticides were not widely used. So, mango production in the province faced various pest problems, which led to low quality and productivity as reported by Pena (1993), it was mentioned that with current world emphasis on quality for local consumption and export, insect that blemish fruit by feeding, scratching or ovipositing in the pulp or seed can cause high losses. In Thailand Yachai (1991) reported that production of mango in the rainfed area can be reduced up to economic level, due to the farmers' lack of knowledge in pest management, which includes pruning practices.

Mangoes are harvested unripe and ripe. In Luang Prabang province, harvest of mango fruits starts from the middle of May and extends to the end of June. Kaew-Loop mango was observed as early-harvested variety-in May, while Kaew-Cho fruits were harvested later- in June. The later harvesting provides farmers a good opportunity to get high price, particularly in the Upper North of Thailand reported by Radanachaless *et al*. (2002).

With know how to do. Besides, propagating by seeding took time at least 3 years over the vegetative one.

However, vegetative propagation was introduced in the past 6-10 years, but only a small number of the mango growers have practiced this method, due to the lack of training and information from extension services. However, approach grafting was applied to produce grafted materials for sale with 60-80% of success. Local and wild mango varieties such as Kaew, Khai and Kham were used for the rootstocks, due to their advantages over another i.e. drought tolerance, fast growing and cheap. As at the present time and in the future, Kaew mango is the alternative for raising rootstocks for

sale to people who produce grafts for commercialization. This is due to its large numbers of trees and availability if compared to wild variety, which is rarely found and will be no longer inexistence caused by slash and burn cultivation. Kaew mango was used popularly for rootstocks in Thailand, since it grows fast and is compatible with various varieties (Wangnai, 1986). In addition, side veneer grafting and bark grafting were also practiced by farmers to change undesirable varieties using the old aged rootstocks (two or more years) that were grown already in their orchards. These techniques are used in top working to rejuvenate unproductive trees (Wangnai, 1986), and after top working, trees come to bearing within 2 years (Furon and Plaud, 1972). The farmers operated grafting during May to July as the most suitable time of the year. However, most of the farmers still use seedlings at the present time, while vegetative methods are practiced by a few farmers and their effects have not been tested and evaluated. So, it became an important issue of this study.

6.2 Effect of old aged seedling rootstocks on scion survival and growth of grafted seedlings

In grafting of Kaew scions on old Tlap-Nak seedling rootstock, it was found that the survival rate was not different at 60 DAG, which the highest survival rate was observed on the 3 year-old rootstocks. In the same manner, the duration of flushing also was not different. Similar results was obtained by Junngam (2000), when the Kaew scions were grafted on the main, secondary and tertiary branching positions of 9-10 year-old Kiew- Sawoer and Nang Klangwan cultivars in farmer field, the survival and duration of new flushing growth were not different. Due to the selected rootstocks and scions, which used for grafting were physiologically perfect. Ram and Bist (1982) reported that age of the rootstock is not as important as the maturity of the scion, and good success has always been reported with older shoots. Gunjate and Limaye (1978) stated that the use of seedling rootstock at different ages (3 months to 2 years) has resulted 40-100% grafting success, depending upon the season, scion maturity, predefoliation period, storage condition of scions, etc.

The use of 1 and 3 year-old rootstocks performed more growth in term of stem diameter (Figure 11). In case of grafted union diameter (Figure 12) the 1 year-old rootstocks illustrated a markedly faster growth rate after the 60 DAG. Hossain *et al.* (1991) found that plant with the young age would have a large number of cells, which split faster and stimulate plant growth faster than those plants with old ages.

The study showed that the use of all 3 year-old rootstocks was different in term of

scion diameter and scion length. In which, the 2 and 3 year-old rootstocks exhibited a greater diameter and longer scions. The smallest scion diameter and shortest scions were observed on the 1 year-old rootstocks (Figure 13 and Figure 14). Similar results were obtained with respect to number of new leaves (Figure 15), which the use of the 3 year-old rootstocks showed a larger number of leaves at the 60 to 90 DAG. In contrast, the small number of leaves was found on the 1 year-old rootstocks.

According to the analysis of correlation among parameters measured after side veneer grafting was done in July, survival rate was found not to correlate with any growth parameter. On the other hand, it was found that rootstock diameter highly correlated with grafted union diameter, especially scion diameter and length. As well as, high correlation was found between grafted union and scion diameter and length, scion diameter and scion length (Appendix B4). The possible reason is that the old aged rootstocks had more food reserve accumulation, due to strong root system containing in the big plastic containers that is enough to support scion growth. And the 1 year-old rootstocks were contained in the small plastic containers, which limited nutrients and root system growth. Samuel *et al.* (1993) found that the height of trees was a good indicator of the magnitude and vigor of the root system. Bevington and Castle (1985) reported that shoot growth had a pronounced influence on both number of growing roots and rate of root elongation when soil moisture was not limited.

6.3 Effect of young aged seedling rootstocks on scion survival and growth of grafted seedlings

According to the analysis of correlation the results showed that fruit weight highly correlated with all fruit size parameters and seed weight and seed size parameters (appendix B3). In case of percentage of seed germination, it was noticed that even the stones were sown when available at the different time, the average percent of seed germination was 82.8%, which was quite high (Table 22). Mabangcru (2001) found that stones with perfect morphological characteristics had more chance to germinate up to 93%. About 80% seed germination occurs if they are sown within a month of extraction (Chacko and Singh, 1971).

The study was found that the survival of Kaew scions was not significantly different and less than 60% at the 20 DAG. Thereafter big change in survival rate of scion was observed at the 60 DAG, which the 5 day-old rootstocks showed the highest survival rate of 47.6%. Majumder and Rathore (1970) reported that in comparison tests, the percentage of success of splice and wedge grafting methods using in stone grafting were 50% and 33% respectively; however, much better success has been reported in other studies (Singh *et al.*, 1989; Patil *et al.*, 1991). Unlike, epicotyl grafting can be highly successful (>90%) in protected polyhouses under subtropical conditions (Ram, 1993). Low survival rate of scions occurred with all young aged rootstocks, due to the grafted seedlings were infected by diseases (anthracnose), which might come with the scions. This disease spread during the period of planting in the transparent plastic bags in the nursery. The nursery was covered or protected the direct sun light for four sides by 80% shading material. During this time warm temperature and a high relative humidity in side plastic bags stimulated the better infection of diseases. Bose *et al.* (1973) reported that anthracnose is the most important and universal disease of mango, and can be a serious problem on foliage, crowded and moist conditions in nurseries may result in considerable damage to young tree canopies. High success of stone grafting was recorded at 80% and can be reached 90%, if diseases are well controlled reported by Cheuinbounh (2001). In the Philippines, Pilapil (1978) and

Marciales (1980) found that in stone grafting, using very young defoliated seedling rootstocks 2, 4 and 6 weeks of age, success was 78.5, 87.5, and 78.5% respectively.

In the study, a significant difference was found for stem growth rate between treatments (Figure 16). The faster stem diameter growth rate throughout the period of the study was found for the 5 day-old rootstocks (55.2 %). This was due to plants with the young ages would have a large number of cells, which split faster and stimulate plant growth faster than those plants with old ages reported by Hossain *et al*. (1991).

The remaining growth parameters such as grafted union diameter, scion diameter, scion length and number of leaves were not significantly different. However, high correlation was found between growth parameters of rootstocks (rootstock diameter and grafted union diameter) and growth parameters of scions (scion diameter, scion length and number of leaves) (Appendix B5).

6.4 Feasibility assessment of grafting techniques

6.4.1 Economic aspect

In term of economic aspect, because total cost of management and gross margin that differed in each treatment as well as the survival, the value of both cost and gross margin were applied to assess the appropriate technique of grafting and management practices. Survival rate was considered as an important indicator for decision making. McConnel and Dillon (1997) mentioned that financial profit (gross margin) as a criterion for measuring the performance of farm-household systems is normally measured in money terms as gross financial revenue minus total financial cost per period.

Table 26 shows that side veneer grafting on the 3 year-old rootstocks performed the relatively high invested cost of US$ 0.6/graft, but it had higher gross margin of US$ 34.8 /100 grafts, due to its high percentage of graft survival (92.5%). On the other hand, the 2 and 1 year-old rootstocks exhibited the lower value of gross margin/100grafts (US$ 31.8 and 21.8 respectively) due to their low survival rate (80 and 60% respectively). It is evidenced that the use of 3 year-old rootstocks for side veneer grafting was the best. This will provide the reliable information for the farmers' decision-making.

In case of stone grafting, the results of economic analysis (Table 27) showed that stone grafting on the 5 day-old rootstocks was the best alternative, because it obtained the higher survival rate (47.6%), which led to higher gross margin of US$ 24.3/100 grafts. In contrast, the rest treaments revealed the lower value of gross margin, especially the 20 day-old rootstocks, which showed the negative value of US$ 20.7/100 grafts, and this caused by its lowest survival rate (only 3.3%)

Bondad (1980) reported that asexually propagated plants are more manageable and give early return on investment, especially epicotyl grafting one, which could save the propagator considerable time, money and effort in producing the graft, and the success of the stone grafting is satisfactory although it needs refinements and identification of suitable conditions for higher percent success.

6.4.2 Timing aspect

In grafting on old aged rootstocks using side veneer grafting, there was a wide range of times between the treatments. A wide range was observed at the period of seedling preparation as 1, 2 and 3 years respectively, due to these times needed to take care of seedlings until they reached specified ages. However, side veneer grafting technique is more appropriate for the farmers to produce the grafts for sale. In addition, it is also suitable for farmers who want to change undesirable varieties in their fields for the old trees by top working. Another way is planting rootstocks in the field in the first year, then in the second or third year grafting can be made. This practice will ensure high success, due to rootstock have been established in the field already (Radanachaless *et al*., 2002).

In case of using stone grafting technique on the young aged rootstocks, 3-4 months was required for completing whole process. If compared to grafting on old aged rootstocks, which required at least 1 year; stone grafting could save a lot of time, especially the use of the 5 and 10 day-old rootstocks. Stone grafting may be one alternative for the farmers to produce the grafts for commercialization, if this technique is improved and developed by the grafters to eliminate its weakness and diseases are well controlled. Cheuinbounh (2001) reported that the use of stone

grafting would save a lot of time with low input if compared to approach grafting, which took 80 days for completion (from seed sowing till completed grafts for planting), while only 45-50 days were needed for stone grafting.

6.4.3 Trade off between side veneer grafting and stone grafting

Advantages and weakness of side veneer grafting and stone grafting are showed in the Table 36. It was observed that if, farmers decide to select side veneer grafting, they have to consider that this method is costlier and takes more time than stone grafting, but it has more advantages with respect to survival rate of the grafts, revenue and gross margin for producing 100 grafts.

If farmers choose stone grafting, they have to think that this method takes the shorter time and lower costs than side veneer grafting, but it has weaknesses with respect to lower survival rate of the grafts, revenue and gross margin compared to the former one.

However, stone grafting will have a chance to obtain more advantages over side veneer grafting, if its weaknesses are eliminated and can achieve high percent of success. This can be done, when environment and diseases are well controlled and skills of the grafter are well developed.

Table 36 Comparison of advantages and weaknesses between side veneer grafting and

stone grafting

Side veneer grafting	Stone grafting
Advantages • High survival rate of the grafts (60-92.5%). • High revenue/100 grafts (varied from US$ 60-93). • High gross margin/100 grafts (varied from US$ 21.8-34.8).	**Advantages** • Taking a short time to complete producing the grafts 86-116 days. • Low costs of production of 100 grafts (varied from US$ 23.7).
Weaknesses • Taking a long time to complete producing the grafts at least 1 year and 3 months. • High costs of production of 100 grafts (varied from US$ 38.2-58.2)	**Weaknesses** • Low revenue/100 grafts (varied from US$ 3-48). • Low gross margin/100 grafts (varied from US$ -20.7-24.3). • Low survival rate of the grafts (3.3-47.6%).

6.4.4 Farmers' opinions on feasibility of grafting techniques

As a result of the workshop on feasibility assessment of grafting techniques, farmers understood that mango trees propagated by both techniques exhibit a small shape and medium height, which are easy to take care and harvest. Trees will bear the fruits within the short time 3-4 years, while mango trees grown by seedings will take a long time to give the fruits (>5 years). In addition, both techniques are easy and comfortable to do, just practicing several times then they can do with a high success.

Bhambota *et al.,* (1971) mentioned that veneer grafting has proved to be more effective than other methods of grafting in most mango producing area. It is highly successful and easy (≥ 90% success) reported by Ram and Bist (1982). Ram and Sirohi (1989) compared the performance of "Dashehari" propagated by cleft grafting, approach grafting, veneer grafting, stone grafting, stooling and air layering. It was found that the establishment of grafts in the field, during the initial stages of growth (12 years), stone grafts grew more rapidly than the other. Ram (1993) reported that maximum yield was recorded in trees propagated by stone and cleft grafting followed by veneer grafting, stooling, air layering and approach grafting respectively.

As mentioned in the chapter four (results of field survey), majorities of mango orchards in Luang Prabang province were old as well as in the country as a whole. In this case, there will be a good opportunity for the growers to use side veneer grafting to make their trees to become young and highly productive. Singh (1990) suggested that common methods used for top working are shield budding or veneer grafting, half of a tree should be top worked in one year and on the other half in the second year, although top working of a complete tree in a single year has been highly successful. In addition, side veneer grafting is also appropriate for the growers, who just planted the rootstocks in the field with the age of two or more years but not more than five years. Side veneer and stone grafting are more suitable for the growers who have limited land, but want to have density of mango trees. Because, both side and stone grafts can be planted in closed spacing system, due to these grafts exhibit a small shape and medium height. It is concluded that farmers preferred these two grafting techniques, because they are easy to perform, appropriate to farmers' condition and effective in the real practice.

To improve mango production systems and vegetative propagation of mango in the future, farmers need more practicing by themselves, training course on growing and propagating techniques and pest management, and tools for propagation. They request extension service unit to promote them to grow mango systematically in plantation, promote economic varieties of mango, which farmers can get more income, to set up farmer school for them to learn and produce more grafted materials to support them. Moreover, they request Agricultural Extension Bank to support fund with low interest.