

Chapter 3

Tangerine Production Systems in Chiang Mai Province

Introduction

In 1996, a lot of farmers replace lychee with tangerine due to the lower price and shorter shelf life of lychee on the market. However, the price of tangerine has greatly fluctuated in the domestic market since 2002. The farmers held back from expanding the cultivated area and started looking for strategy to protect themselves against continuously lower prices (Radanachaless *et al.*, 2005). Several aspects of indigenous knowledge used in the orchards are adopted from the tangerine farmers of the Central region of Thailand. Application of fertilizer by using the nutrient balance principle has been proved to increase the yield and quality of durian (Poovarodom *et al.*, 1998) and lychee (Kumlung *et al.*, 2003). Therefore, more concern will be taken into account on this study because tangerine is one of the heavy fertilizer consuming plants. The adoption of this principle will serve as a cost-reduced alternative. However, the basic understanding of the tangerine production system in Chai Prakan-Fang-Mae Ai valley was also important to cope with the problems arisen in the areas. This chapter is focused on a better understanding of the tangerine production system and fertilizer management in Fang district of Chiang Mai province.

Materials and Methods

The samples are the non-purposive selected orchardists from seven of eight sub-districts in Fang district of Chiang Mai province where tangerine cv. Sainampueng is produced. The methodology is the non-purposive sampling with specific random sampling. The total population is 100 orchardists and standard divagation just about 0.10, then the right samples is about 50 as follows

$$n = \frac{N}{1 + Ne^2}$$

Where: n = Total sample

N = Total population

e = Standard divagation

$$n = \frac{100}{1 + [100 \times (0.10)^2]} = 50$$

The orchardists were surveyed and interviewed by a structured interview method in March 2006 – March 2007. Data were collected by open-ended questionnaire (see Appendix A). The collected data were evaluated and analyzed by descriptive statistic module and percentage.

Results and Discussion

1. Tangerine agro-ecosystem and land use history

The agro-ecosystem of tangerine in Fang district, Chiang Mai province comprised lowland, hill slopes and upper terrace. It was found that 47.9 percents was hill slopes as well as the upper terrace. With long experience of leading orchardists, some of local knowledge was brought from the central plain to the Upper North of Thailand. Raised beds techniques were used in most of tangerine orchards to rapidly drain water and to comfortably apply fertilizer to tangerine trees. For history of land utilization, the orchardists mentioned that 7 types of vegetations were grown before tangerine including lychee, shallot, garlic, lowland rice, longan, vegetables and mango. Some orchards were cultivated on the deteriorated forest area. However, most of the crop before tangerine was lychee 32.9 percents (Table 3.1). This evidence was supported by the findings of Radanachaless *et al.* (2005). As we know, the former plants in this area was lychee when the lychee's price extremely decrease, the orchardists also overthrew its to plant tangerine instead.

2. Land holding

Tangerine orchardists had 4 types of land ownership certificates which were land title deed, Sor Por Kor 4-01, Sor Tor Gor and Nor Sor 3 Gor. The majority of them held land ownership certificate, 80.3 percents (Table 3.2) and 49.3 percents of the orchardists kept land title deeds. Therefore, the lands were previously used for cultivation, except the land which used to be denuded forest area and the non-certificate land. The latter land area had poor drainage and soil fertility. The soil was

not appropriate to tangerine planting, so the orchardists in these areas needed to improve the soil condition and applied more fertilizer than other orchards.

Table 3.1 Preceding crops found before tangerine cultivation in Fang district, Chiang Mai in 2006.

Preceding Crop	Percentage
Lychee	32.9
Shallot and garlic	27.1
Rice	12.9
Longan	11.8
Vegetables	4.7
Mango	3.5
Denuded forest	7.1
Total	100.0

Table 3.2 Land ownership certificate of tangerine orchardists in Fang district, Chiang Mai in 2006.

Land ownership certificate	Percentage
Land Title deed	49.3
Sor Por Kor 4-01	24.0
Sor Tor Gor	4.2
Nor Sor 3 Gor	2.8
No land certificate	19.7
Total	100.0

3. Size of tangerine orchard

Sixty four percents of tangerine orchardists managed only one orchard. The majority of them (88.7 %) were small size orchards (less than 20 rais) and 11.3 percents were medium size orchard (20-100 rais). The result concurred with the findings of Radanachaless *et al.* (2005) that approximately three-quarters of tangerine

orchardists in Chiang Mai were small size growers. Most of them were local people. These orchardists inherited the land from their ancestors and carried on the cultivation for years. The small size growers have an elaborate system of agriculture including fertilizer management and pest and weed control.

4. Cultivar and propagation method

The result confirmed that the important 3 cultivars of tangerine grown in Fang district were Sainampueng, Sithong or Pellthong and Freemont. Over 93 percents of them were tangerine cv. Sainampueng (Table 3.3) because its flavour was highly accepted among domestic and foreign consumers (Phrukumphai and Ratanaporn, 2004). For propagation method, the majority (94.4 %) of orchardists preferred the air layering technique. This result was also similar to Radanachaless *et al.* (2005). There were only 5.4 percents of the orchardists who used grafting methods. The common rootstock cultivars were Troyer citrange, Cleopatra mandarin and tangerine cv. Sainampueng. The air layering technique became popular were lower price and higher growth rate in the first 3 years, producing more fruits and a quick return on their investment. The same is found among tangerine orchardists in Nan who prefer air layering to grafting. Because of having more monopodium branches in grafting material; it wasted labour for branch trimming. The scion tree produced a few rootlets so the absorption of fertilizer was poor. The deeper root system apparently appeared therefore it used more fertilizer (Department of Agriculture, 2007). However, the disadvantages of air layering were well recognized, particularly that they were mostly susceptible to virus diseases.

5. Age of tangerine tree

The age of tangerine trees was rather diverse, less than 1 year to 8 years (Table 3.4). Most of them (82.8 %) were 2-5 years: some of the orchards were still immature, but the rest had borne fruits for 2-3 years. This supported the belief that most lychee were cut down for replacing with tangerine in Chai Prakan-Fang-Mae Ai valley in 1996.

Table 3.3 Cultivars of tangerine grown in Fang district, Chiang Mai in 2006.

Tangerine cultivar	Percentage
Sainampueng	93.4
Sithong or Pellthong	5.3
Freemont	1.3
Total	100.0

Table 3.4 Tree age of tangerine in Fang district, Chiang Mai in 2006.

Age	Percentage
< 1	4.9
1	4.9
2	12.4
3	28.4
4	17.3
5	24.7
6	5.0
7	1.2
8	1.2
Total	100

6. Tangerine planting method

There are three tangerine planting methods used in Chai Prakan-Fang-Mae Ai valley as follows: raised bed, ridge and contour and terrace. Raised bed is planting by raising the plant bed. The bed was flat and the furrow is wide. Ridge refers to planting by raising the plant as a raised bed. The difference is the ridge consisted of a curved bed back and narrow furrow. It is similar to corrugation at a distance. The bed heights of the first two methods were rather diverse. Contour planting and terrace planting were found in high slope areas. Nevertheless, 69.0 percents of all tangerine orchards practiced the raised bed method (Table 3.5) because of the poor water drainage of soil group no. 59. The raised bed method favours rapid drainage and prevents soil born

diseases (Land Development Department, 2007). Single row is preferred (94.5 percents) to double row planting (2.5 percents).

Table 3.5 Planting methods of tangerine in Fang district, Chiang Mai in 2006.

Planting method	Percentage
Raised bed	69.0
Ridge	28.2
Contour & terrace	2.8
Total	100.0

The space between tangerine trees was also diverse, more than 10 distances were found. Depending on the orchardists' experiences, the tree spacing were (metre \times metre) 3 \times 3, 3 \times 4, 3 \times 6, 4 \times 4, 4 \times 5, 4 \times 6, 5 \times 3, 5 \times 3.5, 5 \times 4 and 6 \times 4. But 17.7 percents of orchardists practiced (metre x metre) 4 \times 4 spacing (Table 3.6). The reason was the ease of fertilizer and pesticides application. The overlapping between the tree canopies was less. The tree spacing adopted depended on the landscape, orchard size and the management in the orchard. Sethpakdee (2000) and Phrukumphai and Ratanaporn (2004) recommended the tree space at (metre x metre) 3 \times 7 and 4 \times 6 spacing. It might be proper for the large orchards which heavy farm machine was practised.

7. Water systems and resources

There were 4 irrigation systems in tangerine orchards. The systems consisted of mini sprinkler, hose, furrow and drip irrigation. The mini sprinkler was the most used 85.4 percents (Table 3.7). The findings corresponded to the work of Radanachalee *et al.* (2005). They reported that 73.0 percents of orchardists applied sprinkler water system to their orchards because of the rapid water conveying, consistency, water saving, the wider irrigation area, covering all ground area under the tree canopy and be able to apply fertilizer to the trees through the water system.

The water came from 4 sources which were rainfall harvesting reservoir, rivers and water ways, water supply from hill and artesian well. However, 84.7 percents of

came from rainfall harvesting reservoir (Table 3.8). The farm risk management in dry period, some orchards might have access to several water resources.

Table 3.6 Tree spacing of tangerine in Fang district, Chiang Mai in 2006.

Tree spacing (m x m)	Percentage
3 x 3	2.5
3 x 4	8.9
3 x 6	3.8
4 x 4	17.7
4 x 5	6.3
4 x 6	5.1
5 x 3	15.2
5 x 3.5	11.4
5 x 4	13.9
6 x 4	3.8
others	11.4
Total	100.0

Table 3.7 Irrigation systems of tangerine orchard in Fang district, Chiang Mai in 2006.

Irrigation system	Percentage
Mini sprinkler	85.4
Hose	12.0
Furrow	1.3
Drip	1.3
Total	100.0

Table 3.8 Source of irrigation water for tangerine orchard in Fang district, Chiang Mai in 2006.

Source of irrigation water	Percentage
Rainfall harvesting reservoir	84.7
River and water way	12.5
Water supply from Hill	1.4
Artesian well	1.4
Total	100.0

8. Type and quantity of fertilizer application in tangerine orchards

Three types of fertilizer were applied to tangerine tree in orchards at Fang district; organic fertilizer, organo-chemical fertilizer and chemical fertilizer. Organic fertilizer referred to plant garbage and manure compost which the orchardists did by themselves. The composted garbage was husk where manure came from cow dung. Some orchardists produced their own bio-extract or bio-fertilizer from animal wastes (e.g. fish offal) and plant residues. This organic raw material will be decomposed by local micro-organisms (Sittirungson, 2006). The result of bio-fertilizer usage was affirmed by the growers that it encouraged a good taste of produce, increasing fruit size and quantity of products. The organo-chemical fertilizer was a combination of chemical fertilizer and organic fertilizer. It was a ready made fertilizer which was available in local market.

Chemical fertilizer which the orchardists applied to tangerine trees was their own formulas. According to survey data, 14 formulae were applied to the trees. These comprised 15-15-15, 25-7-7, 16-16-16, 46-0-0, 15-0-0, 25-5-5, 13-13-21, 0-9-20, 0-20-0, 8-24-24, 24-4-24, 15-0-14, 19-19-19 and 0-0-60 (Table 3.9).

Table 3.9 Formula and quantity of fertilizer applied in tangerine at different stages in Fang district, Chiang Mai in 2006.

Stage	Fertilizer formula	Quantity (kg/tree)	Percentage
Vegetative	15-15-15	0.2 – 0.5	19.6
	25-7-7	0.5 – 1	11.5
	16-16-16	0.5	4.8
	46-0-0	0.5 – 1	4.8
	15-0-0	0.5 – 1	1.9
	25-5-5	0.3	0.5
	Flower development	13-13-21	1
Fruit development	0-9-20	0.5	0.5
	0-20-0	0.8	0.5
	15-15-15	0.5 – 1	19.6
Pre-harvest	16-16-16	0.5 – 1	8.6
	8-24-24	1	3.8
	13-13-21	0.5	1.9
	24-4-24	0.5	1.9
	15-0-14	0.5 – 1	1.4
	19-19-19	1	0.5
	13-13-21	0.5 – 1	12.0
Pre-harvest	8-24-24	0.3 – 1	3.3
	0-0-60	0.2	1.0
Total	-	-	100.0

The amount of fertilizer used depended on the age of the tree. Fertilizer quantities for first year tangerine trees were 0.2-0.3 kg/tree. The fertilizer given to the fruit bearing trees was higher. The additional amount was about 0.4-1 kg/tree. Tangerines at Fang district produce flowers and fruits all the year and each tree afforded various sizes of fruits. The effects of fertilizer on quality of tangerine at different stages were not well understood by the growers. However, most orchardists 19.6 percents, applied 15-15-15 fertilizer formula in the vegetative growth stage.

While, the prominent formulas for flower development, fruit development and pre-harvest period were 13-13-21, 15-15-15 and 13-13-21, respectively.

The soil application fertilizers such as chemical fertilizer, manures, bio-fertilizer, and organic chemical fertilizer were heavily used by the tangerine growers. They were broadcasted direct to the tree canopy about 50 centimetres (cm) away from the trunk. Chemical fertilizers were given at the different quantity in each orchard, whereas the common amount of cow dung was 20 kg/tree. Bio-fertilizers were given together with irrigation system approximately 200 ml/20 l of water. Calcium (Ca), boron (B), zinc (Zn), and concentrated seaweed were mixed with water and applied to the leaves.

9. Knowledge source

The seven knowledge sources of the orchardists for tangerine management were their own experiences, neighbours, pesticide shops, agro-chemical agents or salesman of private company, publications, radio or television and local extension officers. The majority of orchardists, 28.7 percents (Table 3.10), relied mainly on their own experience when deciding to pay money for fertilizer and pesticides. They used the best fertilizers and pesticides. However, the orchardists' decision did not depend only on a single source of knowledge but on several.

The tangerine orchardists in Chai Prakan-Fang-Mae Ai valley encounter many pest problems, insect pests and citrus mites in particular. They destroy both the tangerine trees and their products. The insecticides used for pest control include imidacloprid, abamectin, phosalone, and methomyl; carbosulfan, thiometon, carbaryl, and cyhalothrin; propargite, amitraz, and hexythiazox; amitraz, sulfur, and petroleum oil; methomyl, carbaryl, and methamidophos; imidacloprid, flufenoxuron, dimethoate, and cypermethrin. They are used to exterminate the thrips, aphids, African red mite, citrus rust mite, leafroller and citrus leaf miner, respectively. Farmers used alternate spray materials to reduce the chance a pest will become resistant. The pesticides are used according to quantity suggested on the label with spraying interval 7-10 days.

Fungicides such as carbendazim, mancozeb, copper oxychloride as well as, Ca, and B, were sprayed when fruits are at the age of 3-7 months in order to protect fruit drop; benalaxyl, mancozeb, and metalaxyl were applied to prevent the wilt; copper

sulfate was sprayed to defend against canker. The tangerine trees were logged to control the declined diseases and then replaced with new planting material.

Table 3.10 Source of knowledge gained by tangerine orchardists in Fang district, Chiang Mai in 2006.

Source of knowledge	Percentage
Self experience	28.7
Neighbours	22.8
Pesticide shops	17.7
Chemical agent or Salesman	11.0
Publications	10.3
Radio and Television	7.3
Local extension officers	2.2
Total	100.0

10. Tangerine market

There were three outlets of the tangerine products including; self marketing, trader and waxing house. Most of the small size orchards, 71 % (Table 3.11), sold to the traders. These dealers accepted quality fruits in mix size at the orchard. They announced the farm gate price in the morning and changed it day by day. The baskets provided by the dealer are loaded with tangerines at exactly 21 kg/container. The destination of all fruit products is at waxing house in Fang district Chiang Mai, before reaching the consumers.

The fruit size of Sainampueng graded at the waxing house in Fang district covers 7 numbers ranging from 3-9. The fruit diameters assigned to the corresponding number were 5.0-5.4, 5.5-5.9, 6.0-6.4, 6.5-6.9, 7.0-7.4, 7.5-7.9 and more than 8 cm, respectively. While the size of tangerine assigned by Ministry of Agriculture and Cooperatives (2002) covered 6 numbers ranging from 1-6. They had limited diameter more than 7, 6.6-7.0, 6.1-6.5, 5.6-6.0, 5.1-5.5, and less than or equal to 5 cm, respectively.

Table 3.11 Market flow of tangerine produce in Fang district, Chiang Mai in 2006.

Direction	Percentage
Through traders	71.0
Self-marketing	22.6
Citrus waxing house	6.4
Total	100.0

Conclusions and Recommendations

The main selected area agro-ecosystems for tangerine were on the gentle hill slopes and the upper terraces areas. There were seven previous crops found before the cultivation of tangerine. Lychee was the most farmer crops (32.9 %). Most orchardists (80.3 %) held full land ownership certificates. They possessed a single farm and the majority of them (88.7 %) were the small orchard (less than 20 rais) holders. Sainampueng was the common (93.4 %) cultivar which was generally (94.4 %) propagated by air layering method. The greatest numbers of trees (82.8 %) were at 2–5 years old and most of them were already productive. Tangerine trees were predominantly (69.0 %) planted in a single row on the raised bed system with a close spacing of 4 m x 4 m. Most farmers (85.4 %) irrigated their orchards by mini sprinklers and the most water came from rainfall harvesting reservoir (84.7 %). The orchardist fertilizer applications were organic, organic-chemical, and chemical fertilizers of 14 different formulas. The most preferred fertilizer programme was the application of 15-15-15 at vegetative and fruit development stage, while 13-13-21 at flower development and pre-harvesting stages. The purchasing decisions on fertilizers and pesticides were mostly made on the basis of self experience while other sources of knowledge were also obtainable. Most orchardists (71.0 %) sold their produces through traders without fruit grading.