

## **CHAPTER V**

### **CULTIVATION PRACTICES**

Cultivation practices are key to take care of the litchi orchards; success or failure of the litchi season would depend mainly on cultivation practices the litchi farmers apply in the orchard. So the study on cultivation practices help to understand more real situation, litchi-based cropping systems; characteristics of litchi orchards; caring; and economic aspects of the litchi production systems.

#### **5.1 Situation of fruit tree and litchi production**

Litchi is the crop belongs to group of fruit tree. So its distribution among the fruit trees would have some certain effects on not only group of fruit tree, but also on cultivation practices. When the litchi develops and expands in a certain level, the cultivation practices would be followed. So study on situation of litchi and fruit tree production would create a really general view on situation of fruit tree in general and on litchi production in particular.

##### **5.1.1 Situation of fruit tree production**

Haiduong has been an agriculture-based province, so its agriculture is relatively development. However fruit tree production has just developed for recent years with thriving of Vietnam economy. So types of the fruit trees and varieties are not really abundant. However with the efforts of whole province and Haiduong people, areas as well as fruit tree production have developed continually (Table 5.1).

The results expressed that litchi, longan, orange, banana, and tangerine are major fruit trees of the province. In term of area, total fruit tree area in the whole province in year 2001 was 16,036 ha, in which 12,354 ha were fruiting and a total production of 75,371 tons. The litchi is leading tree with 11,200 ha planted or 69.8% of total area

with 8200 ha fruiting and total production of 28,000 tons. Continuously the longan is the second tree with 1,376 ha planted with 1,062 ha fruiting and total production of 2,528 tons, and the banana is the third tree with 1,140 ha cultivated with 1,081 ha bearing and a total production of 29,404 tons. In terms of productivity, fruit trees' average productivity was not high, event low. Average productivity of litchi was only 3.4 tons/ha, lower than the average productivity of year 1998 and 2002 in the province (Haiduong statistics department, 2003).

Table 5.1 Fruit production area in Haiduong province, 2001

Fruit tree	Planted area (ha)	Productive area (ha)	Productivity (tons/ha)	Gross output (tons)
Litchi	11,200	8,200	3.4	28,000
Longan	1,376	1,062	2.4	2,528
Orange, and tangerine	781	690	8.8	6,058
Banana	1,140	1,081	27.2	29,404
Others	1,539	1,321	7.1	9,381
Total	16,036	12,354	n.a	75,371

Source: Haiduong statistics department, 2003

## 5.1.2 Situation of litchi production

### 5.1.2.1 Litchi production in whole province

Besides other trees, Haiduong has identified litchi as the major fruit tree in the province's cause of hungry eradication and poor reduction for the farmers. From this orientation, with veteran litchi cultivation tradition, the tree has been growing and expanding increasingly over years. This was cleared by its expansion over years (Table 5.2).

The findings showed that the litchi cultivation area was only 6,100 ha in year 1997, increased gradually over years and up to 12,139 ha in year 2002. Although the litchi cultivation and productive areas have been increasing gradually, its productivity

and gross output have been fluctuating up and down over years. In year 1998, the gross output was 20,710 tons, but it declined down to 15,724 tons in year 2000 and increased again up to 40,226 tons in year 2002. The main reason for this difference is by affection of unfavorable weather conditions on flowering, fruiting resulting in decline or increase of the litchi gross output (Nguyen, 1999a. Nghe and Ngo, 1991).

Table 5.2 Litchi planted area, output and yield in Haiduong province over years

Year	Litchi planted area (ha)	Productive area (ha)	Productivity (ton/ha)	Gross output (ton)
1997	6,100	4,665	1.9	8,910
1998	6,463	4,814	4.3	20,710
1999	8,142	6,376	3.1	19,660
2000	10,116	6,972	2.3	15,724
2001	11,200	8,200	3.4	28,000
2002	12,139	8,939	4.5	40,226

Source: Haiduong statistics department, 2003

### 5.1.2.2 Litchi production among the districts

Haiduong is considered as the native of commercial cultivar of “Thieu Thanhha” and favorable geological and weather conditions to grow and develop the litchi tree. The litchi is grown in all of the province’s districts, however area was quite different among them (Table 5.3).

Haiduong has 12 districts and city, all of these most grow litchi. Total litchi production acreage was 11,200 ha with 8,200 ha bearing and a total production of 28,000 tons in year 2001. However the area in each district was unequally distributed. So agricultural and litchi production were also quite different. Haiduong city had the most modest area with 17 ha only over total the province’s area. The districts with the leading litchi cultivation area were Chilinh and Thanhha that occupied 5,202 ha or 46.4% and 4,144 ha or 37.0%, respectively. Besides these two districts, Kinhmon, Tuky, and Ninhgiang were also the districts with considerable areas of 582 ha or 5.2%,

373 ha or 3.3%, and 357 ha or 3.2%, respectively. Variations of the litchi cultivation area among the districts were similar in that of the gross output. Chilinh and Thanhha districts were still the leading litchi cultivation districts with 13,833 tons and 9,781 tons respectively.

Table 5.3 Litchi production in various districts of Haiduong province, 2001

District	Planted area (ha)	Productive area (ha)	Productivity (tons/ha)	Gross output (tons)
Haiduong city	17	15	2.9	43
Chilinh	5,202	3,867	3.6	13,883
Namsach	146	111	1.9	214
Thanhha	4,144	2,955	3.3	9,781
Kinhmon	582	398	2.5	975
Kimthanh	118	85	2.2	191
Gialoc	84	75	4.8	357
Tuky	373	295	3.7	1,092
Camgiang	101	92	4.6	427
Binhgiang	31	29	4.4	126
Thanhmien	46	39	3.9	150
Ninhgiang	357	239	3.2	764
Total	11,200	8,200	3.4	28,000

Source: Haiduong statistics department, 2003

However figures of productivity were quite different. They were not in line with the variations of the litchi cultivation areas and gross output among the districts. Meanwhile two leading districts' average productivity was 3.6 tons and 3.3 tons/ha in Chilinh and Thanhha, respectively. This was 4.8 tons and 4.6 tons/ha in Gialoc and Camgiang districts, respectively. As known, litchi productivity not only depends on litchi cultivation professional skill, but also on weather conditions and others. In year 2002, Gialoc, Camgiang, and several others had more favorable weather condition than Chilinh and Thanhha districts, so productivity of these districts was higher temporarily than that of Chilinh and Thanhha districts. There was a difference among

the districts in terms of the litchi cultivation area. The main reasons caused these differences were in potential, and orientation. Most districts are similar to climatic condition, but land potential is quite difference. Chilinh has area of inefficient forest, idle hill, and garden (Table 4.1), where cultivation of food crop is ineffective. Thanhha has veteran litchi cultivation over many years and with right orientation of the local government for litchi development. Because of these, litchi cultivation area of both districts went beyond other districts in the provinces.

### 5.1.2.3 Litchi production in Thanhha and Chilinh districts

As known, litchi cultivation area of the Haiduong province was about 11,200 ha in year 2001, in which areas of Chilinh and Thanhha were around 5,202 ha and about 4,144 ha, respectively. By basing on available natural and human resources as well as socio-economic conditions over years, two districts' litchi cultivation area increased highly much more than other districts, especially after year 1997. The findings were expressed in Table 5.4.

Table 5.4 Litchi planted area and gross output in Thanhha and Chilinh districts

Year	Litchi planted area (ha)		Gross output (tons)	
	Thanhha	Chilinh	Thanhha	Chilinh
1997	2,570	1,275	3,152	1,837
1998	3,030	2,687	11,783	5,858
1999	3,256	3,552	8,542	7,035
2000	3,723	4,694	5,860	6,133
2001	4,254	5,452	10,727	13,458
2002	5,748	6,227	14,562	17,612

Source: Thanhha plant protection station, 2003; Chilinh plant protection station, 2003

This area was 2,570 ha in year 1997 up to more than two times, 5,748 ha in year 2002 in the Thanhha district. In the same period, Chilinh district had a growth rate that was much faster than the Thanhha districts; this was 1,275 ha in year 1997 up to nearly 5 times, 6,227 ha in year 2002. Paralleling with increase of litchi cultivation area over

years, gross output of these two districts also followed. In year 1997, gross output was only 3,152 tons in Thanhha district and 1,837 tons in Chilinh district. This was up to 14,562 tons and 17,612 tons in Thanhha and Chilinh districts, respectively. However, growth pace of the gross output between two districts was quite difference. From year 1997 to 1999, gross output in Thanhha district was always higher than that of Chilinh district because litchi orchards in business stage were more stable than that of Chilinh district. However, this was quite difference from year 2000 up. The gross output in Chilinh district was higher than that of Thanhha district because the productive area and number of bearing trees were much higher than that of Thanhha district.

The main reason for the differences was that the Thanhha's litchi farmers expanded the growing area in home garden (unused land of the household) and a small area of illegal transformation area of paddy land (Table 4.7) up to year 2001. However this has been improving since year 2002 when local government has permit the litchi farmers to transfer paddy land into litchi orchard. So the litchi farmers have the right to expand the litchi area depending on real situation of the litchi production. The litchi area of year 2002 expanded by 1,494 ha over that of 2001 and the litchi area here increased more quickly and stably over years.

#### **5.1.2.4 Litchi cultivars in Vietnam and in the studied areas**

Vietnam is also considered as one of the native areas of litchi. Because of this, its litchi cultivars are quite various. Up to now, the varieties of litchi grown have not been scientifically classified, particularly local varieties. Present varieties of litchi are mainly named by basing on appearance and morphology of the ripe fruits. This fact can lead the result that the exact number of litchi varieties is much less than number of existing varieties by giving different names on the same varieties in quite different location. However, Vietnam scientists also pointed out that there were as many as 31 litchi varieties cultivating in Vietnam (Table 5.5). However there are only some of them are considered to be promising and have been commercially developed in the main areas of litchi production such as the cultivars Duong phen (as sweet as sugar),

Hoahong (rose-like coloured fruits), Hunglong, Phudien, Phuchoa, Yenhung, and Thieu Thanhha (local name).

Table 5.5 List of litchi cultivars cultivated in Vietnam

No.	Cultivars	Original area	No.	Cultivars	Original area
1	Duongphen	Hatay	17	Thachbinh	Hanam
2	Hoahong	Hatay	18	Thieuthanhha	Haiduong
3	Banhtroui	Hatay	19	Thieu	Haiduong
4	Dua	Hatay	20	Laithanhha	Haiduong
5	Vanganh	Hatay	21	Hunglong	Phutho
6	Vatkhan	Hatay	22	Phudong	Phutho
7	Longvang	Hatay	23	Laihungyen	Quangninh
8	Luc	Hatay	24	Laibinhkhe	Quangninh
9	Ongthieu	Hatay	25	Phuchoa	Bacgiang
10	Moidai	Hatay	26	Laihuongson	Hoabinh
11	Nhonoï	Hatay	27	Lailienson	Hoabinh
12	Bieuquan	Hatay	28	Moga	From China
13	Bop	Hanam	29	Phi Tu Tieu	From China
14	Chintrang	Hanam	30	Sau Yue hong	From China
15	Laithuyxuyen	Hanam	31	Pai thang ing	From China
16	Laingocson	Hanam			

Source: Vu and Nguyen, 2001

Among 31 varieties, many varieties originated from Hatay province of the red river delta (12 varieties), where was considered as the most litchi cultivation area for long time ago (Vu, 1996). The rests are from other provinces such as Hanam (5 varieties), Haiduong (3 varieties), etc. and some from China (4 varieties). However mainly commercial, and well-known variety nowadays is “Thieu Thanhha” from Haiduong province. This variety’s characteristics is as follows: fruit weight – 20.7 g; edible part – 75.5%; Color of peel – bright red; Fruit shape – sphere (round); Characters of pulp - sweet, good taste and flavor, firm (Vu and Nguyen, 2001).

Although there are many cultivars cultivated in Vietnam, there are only some varieties cultivated in the study areas (Table 5.6).

Table 5.6 Litchi cultivars in the studied areas

District	Variety
Thanhha	Thieu Thanhha, Sau Yue hong, Hung long
Chilinh	Thieu Thanhha, Sau Yue hong, Hunglong, hybrid Thanhha

Source: farmer interview, 2003

Among the varieties, two districts grew some varieties only and Thieu Thanhha is considered as a major cultivar in both districts. Thieu Thanhha is the cultivar with good quality growing in most areas in Vietnam for commercial purpose. Sau Yue Hong, Hunglong, hybrid Thanhha are able to harvest earlier than Thieu Thanhha, but the quality is not so good as Thieu Thanhha.

Besides factors to decide to litchi yield, including cultivation and caring technique, cultivar is a very important factor relating to yield (Tran, 1999). Nowadays there are many litchi cultivars to be grown in the world. In Australia there are over 40 cultivars of litchi. Cultivars currently being planted in areas of northern Queensland on the Atherton Tablelands and coastline, some major cultivars can include Kwai May Pink, Fay Zee Siu and Souey Tung (Menzel, 2002). However litchi cultivars could be also divided by topography of cultivated area. In Thailand, there are two groups of litchi cultivars, lowland and upland litchi. The lowland cultivars (almost 20 cultivars) are grown in lowland areas and require moderately low temperatures and a drought period for flowering. The cultivars of upland zone (about 10 cultivars) require lower temperatures for flowering and are grown in the northern region. The main cultivars are Haak Yip, Tai So and Wai Chee (Anupunt and Sukhvibul, 2003). Moreover in the country with the most populous population, China, there are over 200 cultivars are grown, only about eight of them are commercially important cultivars. In Guangdong, and Fujian Provinces, some major cultivars are grown such as the cultivars Baila, Baitangying, Heiye, Feizixiao, Gwiwei, Nuomici, Huaizhi, Guiwei, Nuomici and Lanzhu (Xuming, 2001).



## 5.2 Characteristics of litchi orchards in the surveyed households

### 5.2.1 Litchi-based cropping systems

Vietnam is a country that is narrow area and dense population, mountain and hill account for three fourth total area. Because most populations live in plain, urban and city area, this has been resulting in strong pressure of population on its narrow limitation of area. So remaining areas, mountain and hill have lower pressure and these have more chances to develop and expand area of litchi trees.

Table 5.7 Litchi-based cropping systems in the studied areas

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Lowland litchi orchards:
Litchi – kumquat
Litchi – longan
Litchi – watermelon
Litchi – vegetables
Litchi - rice
Litchi – annual crops such as soybean, groundnut, etc
Upland litchi orchards:
Litchi – persimmon
Litchi – custard apple
Litchi – pineapple
Litchi – longan
Litchi – annual crops such as soybean, groundnut, etc

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Source: farmer interview, 2003

Besides plain provinces, including Haiduong, Hatay, litchi has been growing and expanding in mountainous and hilly areas such as Bacgiang, Thainguyen, Quangninh. So litchi cultivation could be divided into two systems, those are upland and lowland. The litchi orchards were cultivated according to the model of bed planting system in lowland and terrace planting system in upland. If consideration of the litchi-based cropping systems, most litchi orchards were mono-cropped, however there were some

households to intercropping with other crops. This intercropping was relatively different between upland and lowland litchi orchards (Table 5.7).

These differences in litchi based cropping systems are caused by differences of soil, weather, elevation, and socio-economic conditions (Table 4.1). Persimmon, custard apple, and pineapple seem more favorable for fruiting and living conditions in upland zone. On the contrary, watermelon, kumquat, and vegetables are more suitable to plant and grow in lowland area (Vu, 1996). Existence of these litchi-based cropping systems has a great significance in term of the cultivation. Besides creation of more income for household, some of them play a role as a mulching material to maintain the moisture for litchi growth. Moreover intercropping make favorable environment for beneficial organisms to grow and restrain development of the insect pest, reduce pressure of the insect pest, avoid establishing and appearing specialized insect pests on the litchi orchards (Nghe and Ngo, 1991). However for economic target, these inter-cropping systems exist only in a given time that the litchi trees close their crown. These times can be 5 years or 7 years or longer depending on type of intercropped crop, caring condition and other factors.

### **5.2.2 Farm size**

One of decisive factors to develop and successfully invest is the farm size. When the farm size is too small, investment is more difficult and inefficient (Nguyen, 1999a). In order to understand the distribution in two districts, the farm size was divided into 4 groups with the size of less than 0.5 ha, from 0.5 ha to less than 1 ha, from 1 ha to less than 1.5 ha, and more than and equal to 1.5 ha. The findings were shown in Table 5.8. Most litchi farm households in the study area own the litchi area of less than 1.5 ha. There was 76.9% and 72.5% of households in Thanhha and Chilinh districts, respectively, holding the farm size of less than 1.0 ha. 23.1% and 22.5% of households in Thanhha and Chilinh districts, respectively, owed the farm size of from more than and equal to 1.0 ha.

There is a little difference between the farm size of two districts, the farm size of Thanhha households existed only threshold of less than 1.5 ha/household. Meanwhile

that of Chiling was 5.0% of the households. The difference was due to the difference in terms of population and area (Table 4.2). Chiling is the district with larger area and population less than Thanhha district, so the difference is obvious.

Table 5.8 Distribution of litchi farm size

District	Thanhha		Chiling	
	Percent of household	Number of household	Percent of household	Number of household
<0.5 ha	35.90	13	35.00	5
0.5 ha to <1.0 ha	41.03	17	37.50	14
1.0 ha to <1.5 ha	23.07	9	22.50	19
>=1.5 ha	n.a.	n.a.	5.00	2
Total	100	39	100	40

Source: farmer interview, 2003

In terms of farm scale, most farms in both districts were smaller than country scale. In Vietnam, farm that is considered as small farms if the area of the farm is less than 1 ha, medium farm is from 1.0 ha to less than 3.0 ha, and large farm is equal or more than 3 ha (Vu, 2001). So if basing this standard, Thanhha district had 76.9% farms belonging to small farms, and 23.1% farms belonging to medium farms, without large farms. Like Thanhha district, Chiling district had 72.5% farms belonging to small farms, and 27.5% farms belonging to medium farms, without large farms. So most surveyed farms in both districts were small farms, this would have effects on investment, and caring. However the investment and caring of the litchi orchard are depending much on household labor, and influences from different careers in the household. If household income comes mainly from the litchi, these influences are very small and on the contrary. In terms of influences from the labor, it is necessary to use from 1 to 1.5 agricultural labors/ha for rice cultivation, but it is from 4 to 6 labors for fruit cultivation, excluding the labor for post-harvest (Vu, 2001). So average number of household labor in two districts in the surveyed farm (Table 4.5) was always insufficient to do every job in the litchi orchard. So if there were any change in the

household income from the litchi, the labor would not be enough for taking care of the litchi.

### 5.2.3 Tree age and tree density

The age is very important to affect on yield and investment level. If the age is too young or too old, the yield would be low and investment would not achieve a high performance (Nguyen, 1999a). In the surveyed area, average age of the litchi trees in each household was quite different. The findings were shown in Table 5.9.

Table 5.9 Age and density of litchi trees per household in the two districts

Item	District	n	Average	Min	Max	SD
Tree age (years)	Thanhha	39	8.15	3.86	16.94	2.49
	Chilinh	40	9.13	3.90	18.72	2.85
Tree density (trees/ha)	Thanhha	39	256.0	138.89	416.67	64.33
	Chilinh	40	303.9	133.7	529.1	81.1

Source: farmer interview, 2003

Tree age varied from 3.9 years up to 16.9 years with an average of 8.2 years in Thanhha district. Meanwhile this variation was from 3.9 years up to 18.7 years with an average figure of 9.1 years in Chilinh district. These average ages are considered ideally for business orchards (Nghe and Ngo, 1991). The age in Chilinh litchi orchards was more ideal than that of Thanhha district for fruiting and high yield. There was a difference between the tree age of two districts by new cultivation of the litchi trees in Thanhha district in several recent years, especially in year 2002. In Chilinh most litchi orchards were in stabilization several years ago.

In order to understand more about the tree age, distribution of the group of tree age was established in both districts. The result was shown in Figure 5.1. The figure showed that the average tree age of most farms in both districts concentrated mainly in the group of from 5 to 10 years with 31 farms in Thanhha district and 26 farms in Chilinh district. The group less than or equal to 5 years was 4 farms in Thanhha district

and 2 farms in Chilinh district. The group of from 10 to 15 years was quite different in both districts, meanwhile Thanhha district had 2 farms only in this group, Chilinh district had up to 11 farms. Because of these farms, average tree age in Chilinh district was higher than that in Thanhha district. The group of more than 15 years had 2 farms in Thanhha district and 1 farm only in Chilinh district.

Number of farm

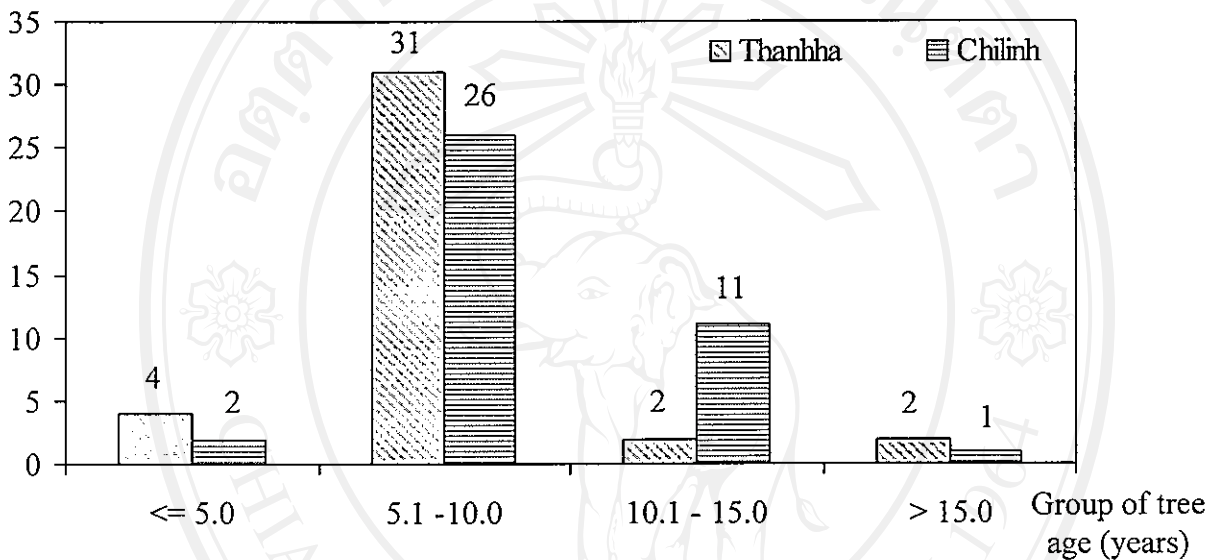


Figure 5.1 Distribution of the group of tree age and number of farm in the two systems

When establishment of the orchard, tree density will be an important factor affecting on litchi's growth, productivity and insect pest management's practices (Le *et al.*, 2000). If density is too dense or too sparse, productivity will be able to reduce. There was also difference between two districts. Meanwhile these were 256 trees/ha with the range from 138.9 trees/ha to 416.7 trees/ha in Thanhha district, these densities were approximately 303.9 trees/ha in variation between 133.7 trees/ha and 529.1 trees/ha in Chilinh district. Main reasons for the difference in density are as follows:

- In recent years, when illegal movement of paddy land transference into the litchi land, litchi farmers have to grow rice crop under canopy of the litchi trees.
- Some Thanhha's litchi farmers need to have more spaces in litchi orchard to grow more subsidiary and vegetable crops such as cabbage, garlic, and onions in order to supply for next market – Haiduong City.

The tree density was quite different between two districts; this was expressed more clearly in Figure 5.2. The findings showed that the distribution of farms in both districts was quite different.

Number of farm

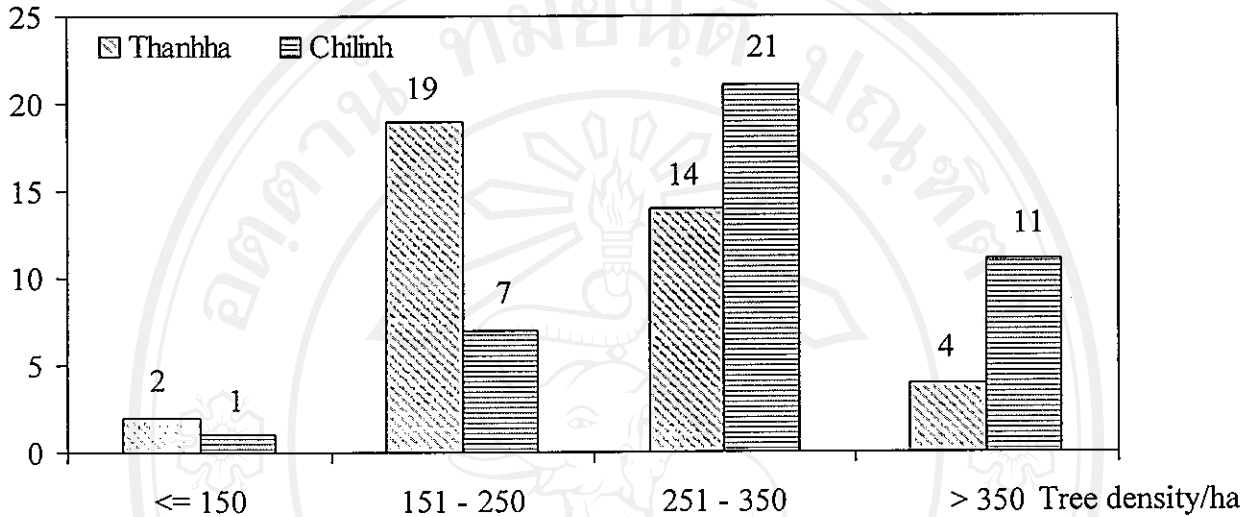


Figure 5.2 Distribution of tree density and number of farm in the two systems

Meanwhile the order of farm number in Thanhha district was in 151 – 250 trees/ha with 19 farms – the most number of farms. The second was from 251 – 350 tree density /ha with 14 farms, the third was more than 350 tree density/ha with 4 farms, and last was 2 farms with density less than or equal to 150 trees/ha. The order in Chiling district was 21 farms with the density around 251 to 350 trees/ha – the most number of farms. The second was 11 farms with the density of more than 350 trees/ha, the third was 7 farms with the density around 151 - 250 trees/ha, and the last was 1 farm with the density of less than or equal to 150 trees/ha. All of these distributions made the tree density between two districts quite different. The average density was 256 trees/ha in Thanhha district and 304 trees/ha in Chiling district.

In terms of tree density, traditionally, orchards planted at low densities from 100 to 200 trees/ha, and the trees thinned out when they began to crowd each other. Intercropping can be carried out among the rows to make use of the land during the early life of the orchard. Modern orchards are planted at closer spacing of 6 m x 8 m or

4 m x 6 m or 7 m x 3 m, equivalent to 200 to 460 trees/ha. Many countries such as southern China are now adopting high-density plantings with 300 to 1,500 trees/ha (Menzel, 2002). Tree density is maybe 156 trees/ha or 8 m x 8 m, 138 trees/ha or 8 m x 9 m, and 100 trees/ha or 10 m x 10 m (Le *et al.*, 2000). The densities are also maybe 278 trees/ha at period the trees unclosed the canopy and 139 trees/ha when trees closed the crown (Tran, 1999). Besides these spaces, litchi trees take from 8 years to 10 years to close their canopy. In order to increase intensity of land use, the litchi farmers sometime grow more one tree among the four litchi trees or higher density. When the litchi trees have already closed their canopy, intercropped tree among the four trees would be chopped down (Nghe and Ngo, 1991). In China most litchi farmers prefer to plant at a higher density (2.5-3m x 3.5-4m) initially and thin the plants to a permanent spacing (6m x 6m or 300 trees/hectare) as the tree crowns expand and overlap (Xuming, 2001).

In general, high-density orchards are becoming popular in Vietnam and the Region. But this also requires the litchi farmers to get more knowledge and experience to manage and take care efficiently the orchard, especially in insect pest management. Because of high density, environment for insect residence and damage is better than lower density. However high density would be expected to increase the returns to growers, especially in the early years. There is evidence that these orchards can have double the returns of traditional low-density plantings. Considerable experience has been developed in some countries such as China. These closer plantings would be expected to increase the returns for both small and large landholders. However high-density plantings require some method of canopy management to control tree size, with close attention to water and nutrient management (Papademetriou and Frank, 2001).

#### **5.2.4 Growth of the litchi tree**

Litchi is an evergreen spreading tree, which attains the height of about 10-12 m at its full growth and development. Productivity of the litchi tree is related closely with growth. If the tree has reasonable height and canopy width, the productivity could be higher than the tree with unreasonable ones (Tran, 1999). From the destination of this point, the litchi's height and canopy were measured in both districts, the findings were

shown in Table 5.10. There were completely differences in height and canopy width between the districts. The height of the litchi trees varied from 3.3 to 5.0 m with an average of 3.8 m in Thanhha, meanwhile this is from 3.0 up to 5.2 m with an average height of 4.0 m in Chilinh, 19 cm higher than Thanhha's one. On the contrary and as a rule, average canopy width is 5.5 m in Thanhha, higher 24 cm than Chilinh's one, 5.3 meters.

Table 5.10 Height and canopy width of 10-year litchi trees in the two districts

Item	Height		Canopy width	
	Thanhha	Chilinh	Thanhha	Chilinh
	.....m.....			
Average	3.77	3.96	5.54	5.30
Min	3.25	2.95	4.35	4.05
Max	4.95	5.15	6.45	6.40
SD	0.43	0.66	0.47	0.54
n	40	40	40	40

Source: farmer interview, 2003

The main reason for the difference in the height and the canopy between Thanhha and Chilinh districts is by the difference in tree density (Table 5.9) and cultivation practices (Nghe and Ngo, 1991). When the litchi orchard is cultivated with high density, the litchi tree must compete together about light resulting in the development of the height. If looking at the height from the angle of insect pest management, the higher the tree is, the more difficult the management is by monitoring, spraying, hand removal, etc.

The height and canopy width, besides depending on the tree density, they also depend much on the variety. If different varieties are grown in the same area, they will maybe obtain the difference in the growth. Two varieties of Thieu Thanhha and Phuho grown in Phuho plantation – Phutho province, have the different canopy width and height. In the case of same age, 14 years old, Thieu Thanhha's height and canopy were



only  $3.63 \pm 0.16$  m and  $5.57 \pm 0.23$  m, respectively. Meanwhile Cultivar Phuho's ones were  $4.72 \pm 0.21$  m and  $5.03 \pm 0.30$  m (Pham, 1998).

Generally the height and canopy width have many effects on the productivity and activities of insect pest management, especially in intensive zones of litchi cultivation. A reasonable height and canopy width would give a reasonable high productivity and be easier in inset pest management.

### 5.2.5 Productivity of the litchi farms

Productivity is decisive factor to the orchard's success, when the productivity is high, it is success, and on the contrary. In order to increase production effectiveness of the litchi trees, litchi farmers have been striving to intensify to achieve the highest gross output as well as income. From the study findings were shown in Table 5.11.

Table 5.11 Litchi fruit gross output and productivity in the two districts, 2002

Item	Productivity (tons/ha)	
	Thanhha	Chilinh
Average	7.14	7.42
Min	3.68	3.64
Max	13.89	17.09
SD	1.86	2.83

Source: farmer interview, 2003

It is easy to see that per ha productivity was a little difference in the surveyed households in both districts. In Thanhha district productivity ranged from 3.7 tons/ha up to 13.9 tons/ha with an average of 7.1 tons/ha, meanwhile this was from 3.6 tons/ha to 17.1 tons/ha with an average of 7.4 tons/ha in Chilinh district. It was clear that average productivity in Chilinh was higher 0.3 tons/ha than Thanhha district.

There was a difference in productivity between the two districts by two main reasons as follows:

- Average age and density of the tree in Chilinh was higher than that of Thanhha district (Table 5.9) and litchi season of the year 2002 in Chilinh district was considered as more favorable season in terms of weather condition for flowering and fruiting than that of Thanhha district.

In Asia Pacific area, average yields in the Region are about 4 tons/ha, although some orchards in Australia, China and elsewhere can produce 15 tons/ha, under close spacing and intensive tree management (Menzel, 2002). Generally per ha and per tree average productivity of the litchi in Vietnam was very low over other countries in the region such as China, 2.50 tons/ha in 1998 (Xuming, 2001), Thailand, 2.54 tons/ha in 1999 (Sethpakdee, 2001). In 1998 per ha average productivity was 1.25 tons in Lucngan, Bacgiang and 0.3 – 0.4 tons in Chilinh, Haiduong. In some intensified modern, yield can reach 5 tons/ha (Le *et al.*, 2000).

In general, productivity in the study area was higher than the average of country in year 2001, 2.59 tons/ha (Vu *et al.*, 2003). As a matter of fact, with favorable natural conditions, professional skill in the litchi cultivation as well as litchi age made its yield exceed over the average of the country.

### **5.3 Practices in litchi orchard management**

Besides the cultivar, weather condition, practices in litchi orchard management are considered as key factors for success or loss of litchi orchard, especially in insect pest management. In each different growth phase of the tree, including young phase, first 4 – 6 years and business phase, inputs and technical measures must be applied suitably to make more condition for the tree to develop and create yield. The key factors for this include pruning, watering, fertilizing, harvesting, spraying, etc.

#### **5.3.1 Labor utilization**

Utilization of labor in the litchi orchard is not similar to annual crops such as vegetables, rice, because the litchi is perennial tree. So caring is quite different among the different phases of the growth. In the young phase of the growth, the tree requires labor investment different from business phase of the growth. When the litchi orchard is

newly established, most investments focus mainly on landing and seedling. In business orchard, then these investments would focus more on caring of the orchard such as fertilizing, pruning, insect management, irrigation, etc. So study on labor utilization in the litchi orchard will understand about the distribution of activities, including land and weeding, fertilizing, pruning, insect management, watering, and harvesting.

### 5.3.1.1 Ground management

Ground management is permanent activity in the litchi orchards consisting of plough, harrow, and weeding. Ploughing and harrowing have effect on turning over the soil, killing the weed, making the soil airy, keeping moisture, avoiding film creation, promoting fertilizer break, creating new root layer, and nutrient absorption of root (Tran, 1999).

Table 5.12 Labor use for taking care of litchi orchard in the two districts

Cultivation practice	Household labor		Total labor	
	Thanhha	Chilinh	Thanhha	Chilinh
	manday/ha	manday /ha	manday/ha	manday/ha
Ground management	81.9	92.0	89.5 ± 11.9	94.6 ± 13.2
Fertilizing	28.6	28.7	28.9 ± 1.4	29.1 ± 1.7
Watering	6.9	11.5	7.0 ± 2.6	12.5 ± 3.2
Harvesting	54.8	82.7	72.5 ± 9.3	94.4 ± 10.5
Total	172.2	214.9	197.9 ± 25.2	230.6 ± 28.6

Source: farmer interview, 2003

Note: total labor = household labor + hired labor

In the surveyed farms, the farmers employed mainly household labor to turn over land and kill weed. There was up 81.9 or 47.6% household labors employed in the litchi orchards in Thanhha district (Table 5.12). Like Thanhha, Chilinh farmers also employed 92.0 or 42.8% household labors in the litchi orchard. In total labors (household labor and hired labor) over all activities listed, labors employed in activity

ground management accounted for 45.2% and 41.0% in Thanhha and Chiling district, respectively. This was activity, requiring labor the most over other activities.

Litchi farmers ploughed, harrowed and weeded the orchards from two to three times yearly. First times takes place after harvest to recover growth, promote autumn shoots and buds. How deep the plough and harrow are depending on how deep or shallow the root is. Generally the plough and harrow are around 10 – 15 cm depth to avoid effects on root and the tree growth. Second times after firm autumn buds, plough and harrow makes soil in deeper layer to be turned over, chop off young root to grow vertically, restrain growth of winter buds, more advantageous for differentiation of flower sprout. Generally the plough and harrow are about 15 – 25 cm depth. The last times, before blooming around one month, plough and harrow promote growth of new root, resulting to health growth of flower and fruit. The depth should be around 10 cm to avoid effects adversely on the root.

Significance of the land and weeding was not only in making more condition for the litchi tree's growth, but also in deterring the damages of the pest. Many insect pests reside in soil environment such as nematodes, pupae of litchi looper and some of them hibernate in the bushes and weed such as litchi stink bug, stem borer, so when land and weeding had effects on these insect pests (Nghe and Ngo, 1991).

### **5.3.1.2 Fertilizing**

Like “land and weeding”, the litchi farmers in the surveyed farm employed mainly household labors to apply (Table 5.12). Household labors employed to apply fertilizer were 28.6 or 16.6% and 28.7 or 13.4% over other activities used household labors in Thanhha and Chiling districts, respectively. In total labors over all activities listed, labors employed in activity “fertilizing” accounted for 14.6% and 12.6% in Thanhha and Chiling district, respectively.

In general, fertilizing for business litchi orchards is more difficult than that for young un-bearing litchi orchards. Because fertilizer had effect on vegetative growth, differentiation of flower buds, and rate of fruit set (Nghe and Ngo, 1991). In the study

areas, fertilizer was put down from two to three times annually, sometimes seven to eight times. The grower added that disregarding number of fertilizing times is numerous or few, roughly fertilizing must be around inducement of flower, fruit, and bud. Those are some key periods to put down the fertilizer. Dose of fertilizer for each must base on phenological periods, real situation and amount of harvest fruit.

Besides having effects positively on the tree's growth and development, if uncaredful fertilizer would be considered as factor attracting the insect pests to damage on the tree by vegetative overgrowth. When applying fertilizer, it should be careful to control dose to assure balance growth, flowering, fruiting, and avoiding unexpected damages from the insect pests.

### **5.3.1.3 Watering**

Water situation in the orchard has effect on growth, flowering, and fruit set. Duration of growth stages, each stage requires a different volume of water. In fact, the litchi farmers in both districts employed labors to water the litchi orchard mainly in period of autumn bud growth. Other periods are obtained from rain. The litchi farmers in Thanhha and Chiling districts just employed 6.9 and 11.5 household labors to water, respectively (Table 5.12). In total labors over all activities listed, labors employed in activity "watering" were 7.0 mandays or 3.6% and 12.5 mandays or 5.4% in Thanhha and Chiling districts, respectively.

Litchi being an evergreen plant, the maintenance of optimum soil moisture is critical for growth, development and fruit production. If the rainfall is evenly distributed litchi is grown successfully and supplementary water requirement depends upon cultivar and evaporation demand. Water requirement ranges from 600-800 mm a year. Irrigation at the intervals of 2-3 days during the initial stage of plant establishment is considered essential. Further, the young plants should be irrigated during dry periods and winter months at intervals of 3-5 days. Supplementary watering during the first few years will assist tree establishment. The timing and quantity of water applied varies with tree size, soil, weather and time of year (Singh and Babita, 2001).

Irrigation is critical at the fruit development stage to get better yield and quality of fruits. Interestingly, differential management of water in the vegetative phase and reproductive phase is also suggested. To achieve faster growth of the plant no water stress should be permitted, while in the reproductive phase water stress is beneficial at the time of fruit bud differentiation. Irrigation will give more effectiveness for hill grown trees. The irrigation for litchi orchards should focus in the following phases (Le *et al.*, 2000):

- When panicle emergence: irrigation if shortage of moisture and slow panicle emergence, small flower cluster.
- When growing fruit: keeping adequate moisture to promote fruit's growth. If soil is drought limited fruit's growth and cracked by heavy rain.
- Promotion of autumn bud: making the shoots big, strong those impact positively on fruit season next year.

In short, water is a necessary demand for the litchi, however it should be attention that misuse of watering can lead vegetative growth overwhelm reproductive growth. So flowering will be reduced and followed by reduction of yield.

#### **5.3.1.4 Harvesting**

Harvesting is one of activities requiring the most labors. Depending on yield, labor for harvesting is required quite different. The findings showed that (Table 5.12) most labors used were household labors. There were 54.8 or 31.8% and 82.7 or 38.5% of total household labors employed in Thanhha and Chiling districts, respectively. In total labors over all activities listed, labors employed in activity "harvesting" accounted for 36.6% and 40.9% in Thanhha and Chiling districts, respectively.

Harvesting season in Vietnam begin from late April with early-ripened varieties up to early July for late ripened varieties, but harvesting concentrates mainly in late May to late June with some major varieties such as "Thieu Thanhha", "Duong phen". In the study area, most farmers grow mainly "Thieu Thanhha" cultivar and very few trees

of early and late varieties. After picking down, fruits were graded visually by size and color by hand. Nice color, medium and big size, and attractive shape would be selected to sell directly to wholesalers to export to other provinces or foreign markets with a higher price, from 4,500 to 5,000 VND/kg. The rest fruits were sold to domestic consumers with a lower price, from 3,500 to 4,000 VND/kg or dried to sell in other times (around 4 kg of fresh fruits equivalent to 1 kg of dried fruits). After grading, the fruits arranged and put into bamboo baskets to transport to market.

Generally litchi fruit are able to harvest at about 55 - 60 days after full bloom but it varies with the variety and environment. Fruits are harvested early in the morning before they are warmed up. Once litchis are picked, they start to dry out and become brown in color. After picking, fruits are sorted visually on mechanical conveyors to remove small, poorly colored or damaged specimens (Menzel, 2002). Normally existing time of the fruits on the tree from beginning ripen to in-between ripen and rot is around one to two weeks. Fruit color is an important indicator of fruit maturity. During maturation, the peel undergoes color changes from green to yellowish green and to bright red 7-10 days later. When the peel color changes into dark red from bright red, the fruit is over-matured with reduced storability as well as sugar content. It is recommended to harvest the fruit when their peel is 80% fully red. At this stage of maturity, the fruit is of good quality (Xuming, 2001).

#### **5.3.1.5 Insect pest management**

Changing cultivation practices from extensive farming into intensive farming brought about a series of other changes such as emergence of new pests, supplement of chemical fertilizers, etc (Ha and Duong, 2001). From this fact, devastation of the pests become more seriously and most cases, the pests could not be controlled by traditional methods alone. So pesticides have applied broadly and popularly. It is considered as an effective tool in managing pests commonly and insects in particular. However there were also many other methods to be applied with insecticide to control the insect pest. The findings showed that distribution of labor use among these methods were different in each system and in both districts (Table 5.13).

Table 5.13 Labor use for managing insect pests in the two districts

Practice	Thanhha			Chilinh		
	Number of farm	Applied area (ha)	Manday/ha	Number of farm	Applied area (ha)	Manday/ha
Spraying	39	26.6	47.0±11.3	40	31.2	52.4±12.1
Pruning	32	23.0	23.3± 5.1	25	20.3	25.0± 5.9
Removal	22	15.0	9.3± 4.1	21	17.5	5.8± 2.3

Source: farmer interview, 2003

In activity “spraying”, Thanhha farmers employed only 47.0 mandays/ha, but Chilinh farmers must employ up to 52.4 mandays/ha - a quite difference in spraying between two districts. However in activity “Removal”, Thanhha farmers employed number of manday per farm higher than Chilinh farmers. This was shown by 9.3 mandays/ha in Thanhha compared with 5.8 mandays/ha in Chilinh in practice “Removal”. However in the practice “Pruning”, number of manday per ha was not much difference between two districts, this was 23.3 mandays/ha in Thanhha compared with 25.0 mandays/ha in Chilinh.

So a farm applies spraying only, the labor use for this farm in Thanhha district was only 47.0 mandays/ha, meanwhile this was 52.4 mandays/ha in Chilinh district. If a farm applies spraying in combination with pruning, the labor use was 70.3 mandays/ha in Thanhha district and 77.4 mandays/ha in Chilinh district. In the case of the combination of three methods in one farm, spraying, pruning, and removal, the labor use was 79.6 mandays/ha in Thanhha district and 83.2 mandays/ha in Chilinh district. So labor use for insect pest management in Chilinh district was always higher than that in Thanhha district. The main reason for this caused by the difference in number of application times (Table 6.10) and damaging level of the insect pests (Figure 6.1).

These differences in labor use were result of the differences causing by many factors such as insect pest’s pressure, in insect pest management practices, etc, and tree density. The tree density in Thanhha district was 256 trees/ha, meanwhile this was 304 trees/ha (Table 5.9). When density is low, activities in litchi management in general and



insect pest management in particular are easier and more advantageous, and vice versa. So “spraying” and “pruning” in Thanhha district consumed less labor than that in Chiling district. In terms of “removal”, this is an activity easy to do, however it consumes a big amount of labor if applied regularly such as spraying. In two systems, the growers applied a different amount of labor. Number of labor applied in Thanhha district was higher than that in Chiling district, because the orchards in Thanhha district is more advantage for applying (next to house) and the grower had a tradition in applying the removal to manage the insect pests in the orchard.

### 5.3.2 Fertilizers

Nowadays, agricultural production related closely to fertilizers, because purpose of the agricultural production is to create more yields to get more income per area unit. Most types of agricultural production land are exploiting strongly to intensify, so nutrient resources in soil are becoming exhausted and supplement of nutrients for better growth of the crop is necessary ever.

Table 5.14 Chemical fertilizer application to litchi orchards in the two districts

Item	N		P <sub>2</sub> O <sub>5</sub>		K <sub>2</sub> O	
	Thanhha	Chiling	Thanhha	Chiling	Thanhha	Chiling
	.....tons/ha.....					
Average	0.19	0.21	0.21	0.20	0.24	0.23
Min	0.06	0.08	0.04	0.09	0.05	0.09
Max	0.45	0.49	0.52	0.49	0.59	0.57
SD	0.08	0.11	0.09	0.09	0.10	0.12

Source: farmer interview, 2003

By importance of the fertilizer in relating to tree’s growth and yield, as well as its influences on cultivation practices, so chemical fertilizer application to litchi orchards in the surveyed farms in two districts was studied (Table 5.14). Litchi farmers in both districts apply chemical fertilizers to put down for the litchi. The chemical

fertilizers applied are urea (46% nitrogen), superphosphate Lamthao (18.5%  $P_2O_5$ ), and potassium sulphate (58%  $K_2O$ ) or in the N:P:K formula of ready mixed 5:7:6; 11:4:14.

Litchi farmers apply N, P, and K for the litchi in both of separate and ready mixed fertilizer. Dosages applied were not much different between two districts.

Nitrogen: N is considered as a factor promoting leafy and branching growth and development. Nitrogenous formulas applied were urea (46% nitrogen) or in the formula of ready mixed 5:7:6; 11:4:14. Dosages applied were quite different between two districts. In Thanhha litchi farmers applied in range of 0.06 tons up to 0.45 tons/ha with an average dosage of 0.19 tons/ha, meanwhile that of Chilinh district varied from 0.08 tons to 0.49 tons/ha with an average of 0.21 tons/ha. The variation of the nitrogenous applied was very large with a standard deviation of 0.08 tons/ha and 0.11 tons/ha in Thanhha and Chilinh districts, respectively.

Phosphorous: phosphorous support for root, flower bud's growth, development and fruit set. Phosphorous formulas applied were superphosphate Lamthao (18.5%  $P_2O_5$ ) or the ready mixed formula (above). The litchi farmers in both districts applied phosphorus in different ranges. Dosages applied varied from 0.04 tons/ha to 0.52 tons/ha with a mean dosage of 0.21 tons/ha in Thanhha district. Meanwhile those were from 0.09 tons to 0.49 tons/ha with an average dosage of 0.20 tons/ha in Chilinh district. However most litchi farmers applied in ranges of  $0.21 \pm 0.09$  tons/ha, and  $0.20 \pm 0.09$  tons/ha in Thanhha and Chilinh districts, respectively.

Potassium: Like macronutrient elements such as nitrogen and phosphorus, potassium contributes to process of fruit growth and transportation of nutrients from leaves, root, trunk, branch to fruit. Potassium formulas applied were potassium sulphate (58%  $K_2O$ ) or the ready mixed formula (above). Average amounts of 0.24 tons and 0.23 tons/ha applied to the litchi orchards in Thanhha and Chilinh districts, respectively. However variations of potassium amounts were quite different between two districts. This was from 0.05 tons to 0.59 tons/ha with a standard deviation of 0.10 tons/ha in Thanhha district and from 0.09 tons to 0.57 tons/ha with a standard deviation of 0.12 tons/ha in Chilinh district.

Litchi requires soil nutrients and water for its satisfactory growth. Nitrogen (N) is the major nutrient and occupies an important position in the fertilizer program. The other major nutrients are phosphorus (P), potassium (K), calcium (Ca) and magnesium (Mg). The micronutrients like iron (Fe), boron (B), copper (Cu), zinc (Zn) and manganese (Mn) are required in very small amounts. When the concentration of a nutrient reaches abnormally low or high levels in a plant, characteristic symptoms appear in the leaves, stems, flowers or fruit. Normally, growth and yield are reduced long before visible symptoms appear. Litchi can be put down fertilizer soon after transplanting around one month. When young tree, number of fertilizing times should be divided into from 5 to 6 times and use a small amount of fertilizer to put down. When the litchi bears fruit (fourth year), amount of fertilizers put down must base on the tree age, growth situation. Fertilizers should be applied 3 times/year: 1) after harvesting, apply around 50% N; 33% P; and 25% K. 2) Before panicle emergence around 1 month, apply 25% N; 33% P; and 25% K. 3) From panicle emergence to the second physiological fruit dropping, apply the rest amounts. (Le *et al.*, 2000. Tran, 1999).

Chemical fertilizers such as N, P, and K can use separately or in the formulation of ready mixed fertilizer N:P:K. formulation N:P:K applied suitably to the litchi can be 5:7:6; 11:4:14; or 5:10:3 (Le *et al.*, 2000). Fertilization for non-bearing young trees follows the principle of 'slight but frequent' to encourage the development of each flush and thus fast canopy expansion. Usually two growths of autumn flushes are encouraged to develop into the fruiting branches for the coming year. Late autumn flushes and winter flushes are negative to flower differentiation, and farmers use chemical and physical means to suppress growth (Xuming, 2001).

In general litchi farmers in both districts are aware of the importance of fertilizer application to the litchi's growth, development, and fruiting. Two systems had the difference in amount of fertilizers put down. This reflected a fact that the cultivation practice was quite different between two districts. The difference in the amount of fertilizer applied is by difference in soil conditions, tree age, tree density, and intensive level.