

CHAPTER 4

FARMING SYSTEMS IN THE STUDY AREA

This chapter describes the study area and its socio-economic characteristics obtained from the field survey. Comparisons between different types of farming systems are also made.

4.1 Land characteristics and bio-physical conditions of the study area

The Fang watershed is located in the north of Chiang Mai province. It is 70 kilometers long and covers a total area 2,135.7 square kilometers or 213,570 hectare (DEQP, 1994) in the 3 districts of Chai Prakan, Fang and Mae Ai. This represents 9.69 percent of the land area belonging to Chiang Mai province and 0.38 percent of the total land area of Thailand. The Fang watershed is situated between 19°31'13.025 and 20°8'9.130 north and 99°1'2.009 and 99°27'12.723 east with an elevation of between 492 and 1,920 meters above sea level. This district is bordered by:

- a) The north is contiguous with the Kok River in Shan State, Myanmar and Mae Chan District in Chiang Rai province, Thailand.
- b) The south is contiguous with 2 districts in Chiang Mai province; Chiang Dao and Phrao.
- c) The east is contiguous with the Kok River located in Mae Suai, Muang and Mae Chan district, Chiang Rai province.
- d) The west is contiguous with Ping River in Chiang Dao districts, Chiang Mai province and the Salween River in Shan State, Myanmar.

The Fang watershed is a large plain consisting of lowland area surrounded by mountains. To the north is the Daen Loa mountain range running south west. The Pee Pannam range is to the northeast running down to the Doi Wiangpa range in Chiprakarn

district, Chiang Mai province. The Fang watershed is home to the Fang River which flows from Chaiprakarn to Fang and Mae Ai districts where it meets the Kok River flowing in from Myanmar at Sob Fang. The Fang River is rich in natural resources which are suitable for agriculture (Santasup and Verunrat, 2011). The main transportation routes to the Fang watershed are the highway no. 107, 109, 1089, 1204, 1249, 1314, 1340 and 1347 (Onpraphai et al., 2011). The Fang watershed has well-known tourist spots such as Doi Angkhang and Angkhang Agricultural Station, Pha Hom Pok National Park and Doi Wiang Pha. It also has the Chiang Mai Agricultural Resource and Development station, Fang branch. This station engages in research and development of various crop varieties for local and national agricultural development.

4.2 Climate and soil conditions

Santasup and Verunrat (2011) defined the general climate of the Fang watershed as follows:

- a) The rainy season is South-West monsoonal. These winds come from the Bay of Bengal and the Gulf of Thailand carrying moisture; rain falling between June and October. The heaviest rainfall is in August with an average rainfall of 1,500 mm. per year.
- b) The winter season is Northeastern monsoonal and occurs from November to February each year. It is cold with dense fog and the temperature falls to -4 degree Celsius.
- c) The dry season is between March and May with the highest temperatures in April reaching 39-40 degrees Celsius. In the Fang watershed, the rainy and winter seasons are longer than the dry season.

The topographic condition is a watershed with a cool climate surrounded by villages. Based on the Angkhang meteorology station located in the Fang watershed, the average temperature is between 14.28 and 22.68 C⁰, depending on the season (Figure 4.1). It is suitable for growing temperate plants such as vegetables and fruit trees. There is a period of long heavy rain usually occurring between February and November each year.

It is at its heaviest between July and October, with a smaller quantity between April and June which provides enough water for cultivation throughout the year (Figure 4.2).

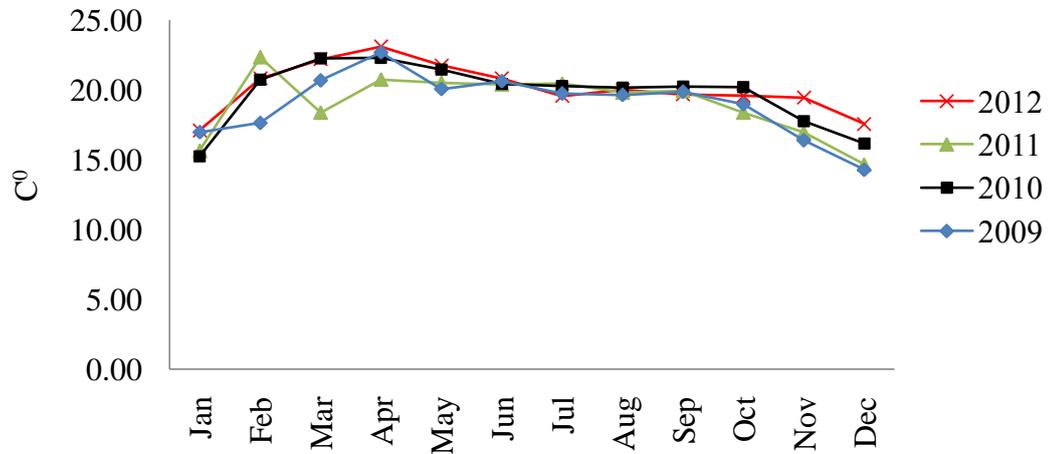


Figure 4.1 Average temperatures in the Fang watershed (Angkhang station)

Source: Chiang Mai Meteorological Center, 2013

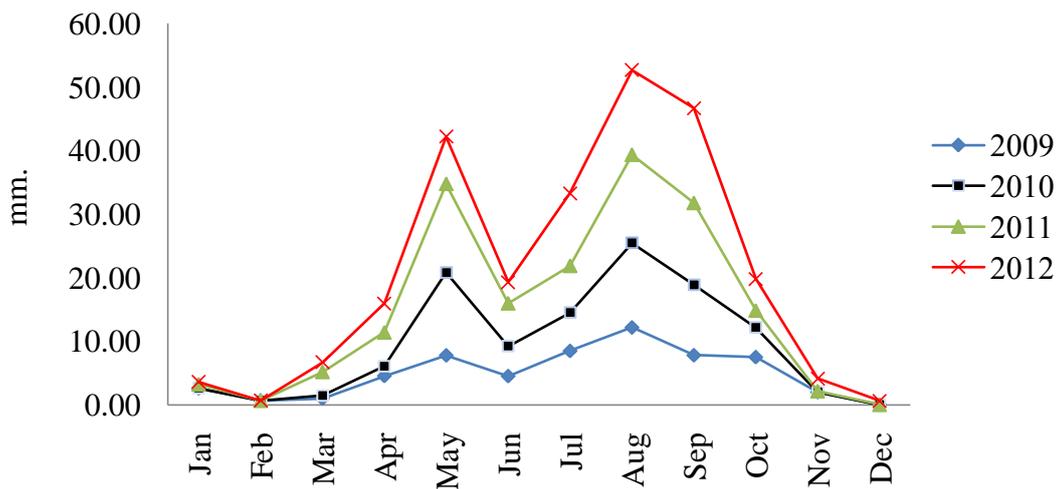


Figure 4.2 Average rainfall in the Fang watershed (Angkhang station)

Source: Chiang Mai Meteorological Center, 2013

4.3 Land cover and land utilization

4.3.1 Land cover and land use activities

Onpraphai et al., (2011) classified the types and forms of land utilization in the Fang watershed by using an analysis of remote sensing techniques. It was found that aside from having forest areas, there were large areas of agricultural cultivation. The main crops were citrus, lychees and rice (Figure 4.3). As a whole, there were 6 groups of land utilization in the Fang watershed as follows:

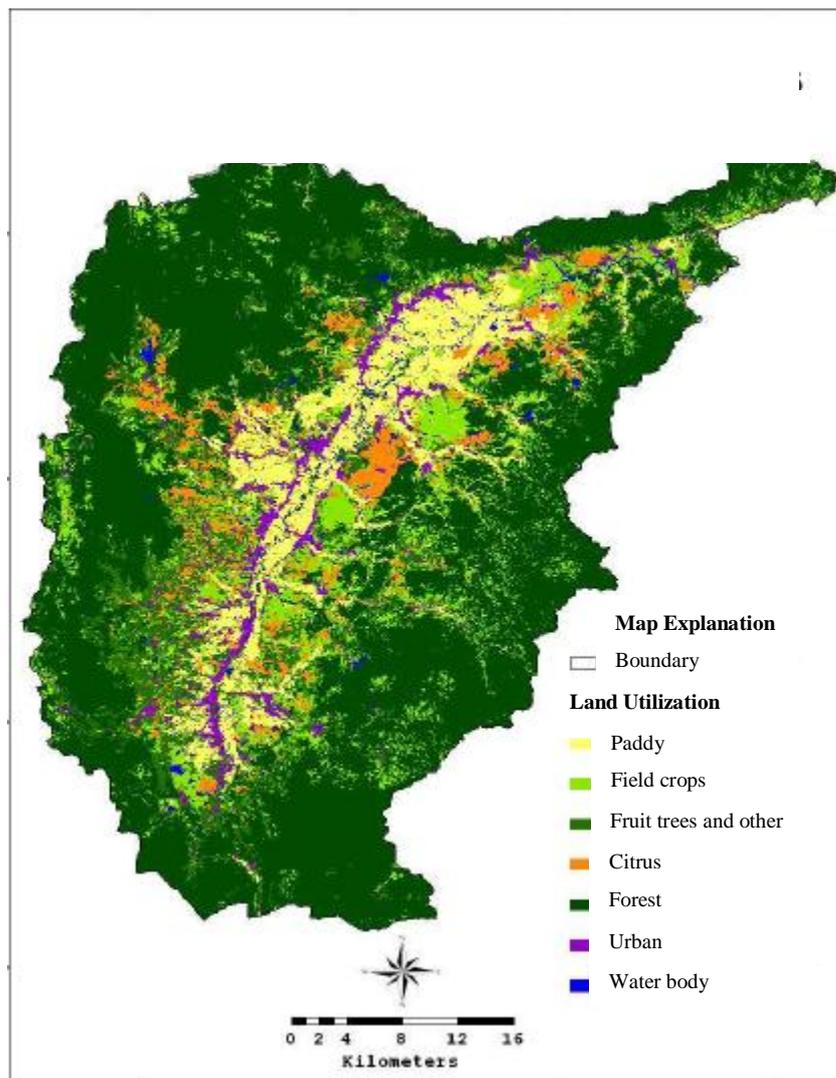


Figure 4.3 Land utilization in the Fang watershed crop year 2008/2009

Source: Onpraphai et al., (2011)

- a) Paddy: These are found in large lowland areas near natural water resources in the middle part of the Fang watershed and in small flat plains in the valleys. There are paddy dikes for water storage and farmers plant rice in May and June (Thailand Rice Foundation, 2010). After the harvest during December and January, the paddy is changed and other crops are grown such as garlic, sweet corn and onions but some farmers grow a second rice crop.
- b) Field crops: They are mainly grown in the upland areas and the growing system is not complicated. They mainly rely on rain and the main crops grown are maize and upland rice. Garlic and onions are grown in the paddy after the rice is harvested.
- c) Fruit trees and other arboreal crops: This is systematic land utilization. Trees are grown in lines with appropriate spacing for effective care-taking and harvesting. The fruit trees or perennials include citrus, lychees, longans and mangos. Lychees were grown for a long time but after 1997, they started to be replaced with citrus. After 2008, the orange groves were replaced by other crops such as mangos, papayas and rubber (Chiang Mai Agricultural Office. 2013).
- d) Forest: This is a long term type of natural land utilization and there are diverse types of trees. The Area Conservation Office 16 (2007) classified forest base by type and elevation as follow:
 1. Mixed Deciduous Forest: This is widely found at an altitude of 600 to 800 meters. The tree types found there are teak, jampa, Burmese ebony, ma khaa mong (*Afzelia xylocarpa*), rosewood and laurel. Below the forest canopy are grasses, sedges and various types of bamboo.
 2. Dry Dipterocarp Forest: This is found at an altitude below 1,000 meters. The following trees were found: siamese sal, ingyin, dipterocarpaceae (*Dipterocarpus obtusifolius*), eng, ambal and phayomtree (*Sharea roxburghii*). Under the forest canopy at this elevation are various types of grass.
 3. Evergreen Hill Forest: This is found at an altitude above 1,000 meters. This kind of forest is more spaced out than wet evergreen forest since the trees of the former are smaller than those of the latter. The following trees were

found in this forest: birch, rosaceae (*Prunus cerasoides*), forest talauma spp., forest champak, pine and oak. Under the forest canopy at this elevation are fern, moss, peperomia and various types of grass.

- e) Urban: This is the land utilization for settlement. There are various activities for which the villagers must depend on each other such as the construction of houses, schools, temples, shops and factories (Jumnong, 2002). Generally, the community areas are located in the flat plain, and there are various activities such as fruit tree growing, vegetable growing and animal husbandry.
- f) Water Body: These are located near a natural water source such as a river, canal, stream or pond. An alternative water source includes those built by man such as a dam, reservoir, pond or a check dam. Farmers may also dig a small pond for agricultural purposes.

4.3.2 Land utilization

The Fang watershed covers an area of 213,570 hectares. Using the Land utilization classification for the crop year 2001/2002, the division of land was as follows: 20,008 hectare (paddy); 26,425 hectares (field crop); 32,496 hectares (trees) 121,570 hectares (forest); 6,832 hectares (urban) and 2,779 hectares (water body). For the crop year 2008/2009, the following was found: 16,159 hectares (paddy); 36,026 hectares (field crop); 33,592 hectares (trees); 111,514 hectares (forest); 10,973 hectares (urban) and 1,846 hectares (water body). It was found that the largest decrease in land utilization was in the water body (33.56 %). This was followed by paddy (19.24%), and forest (8.27%), respectively. However, there was an increase in land utilization for urban (60.61%), followed by field crops (36.33%) and trees (3.37%) respectively (Onpraphai et al., 2011).

4.3.3 Land use change in the Fang watershed

The land use change in the 6 types above could be observed by the comparison of land in 2001 and 2008 by change detection. It was found that most of land utilization (84.78%) was still used in same form as before. The land utilization which changed the mostly forest (3.65% of the total area) to crop fields (7,677 hectares) followed by trees which changed to fields (3.43% or 7,205 hectares) (Onpraphai et al., 2011).

4.3.4 Land use change for citrus production

Before 2001/2002, the total area used for orange growing was 10,412 hectare but Onpraphai et al., (2011) found that that in 2001/2002, this area had been reduced to 5,424 hectares. There had been a 4,988 hectare change in land use to crop fields, forest, paddy and alternative fruit trees. By 2008/2009, this had increased substantially to 10,209 hectares as 4,785 hectares had been converted from crop fields, forest, paddy and alternative fruit trees (Onpraphai et al., 2011). This results agreed with the data from Chiang Mai Agricultural Office (2013); it was found that the citrus production area and harvest area then decreased continually until it reached 4,935 and 4,042 hectares in 2012 (Figure 4.4). Citrus had a higher variation than the average with the total area and yield reducing rapidly after 2008 until 2012 (Figure 4.5 and Figure 4.6).

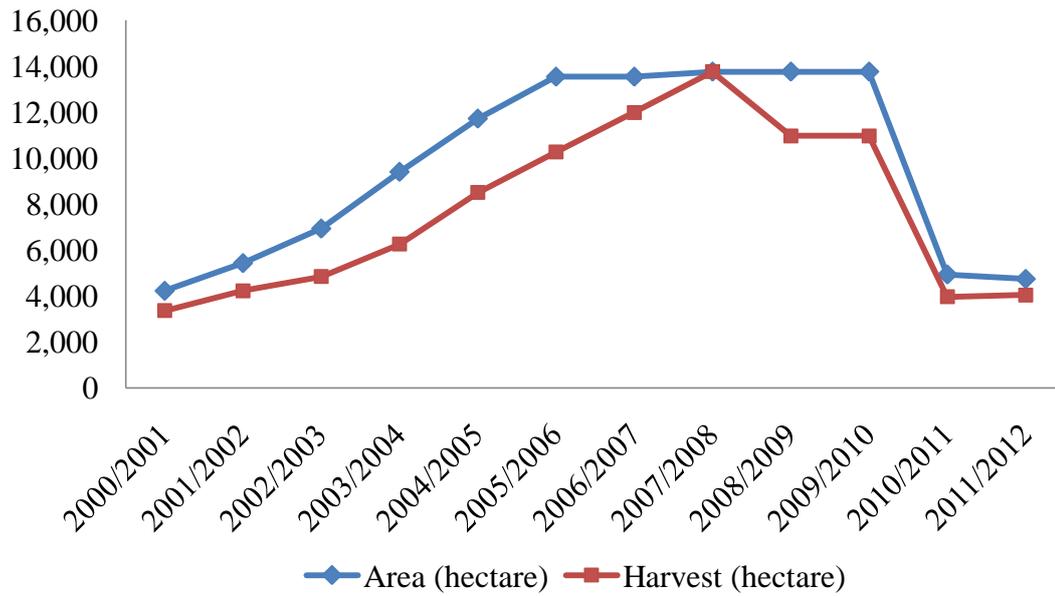


Figure 4.4 Citrus production area in the Fang watershed

Source: Chiang Mai Agricultural Office, 2013

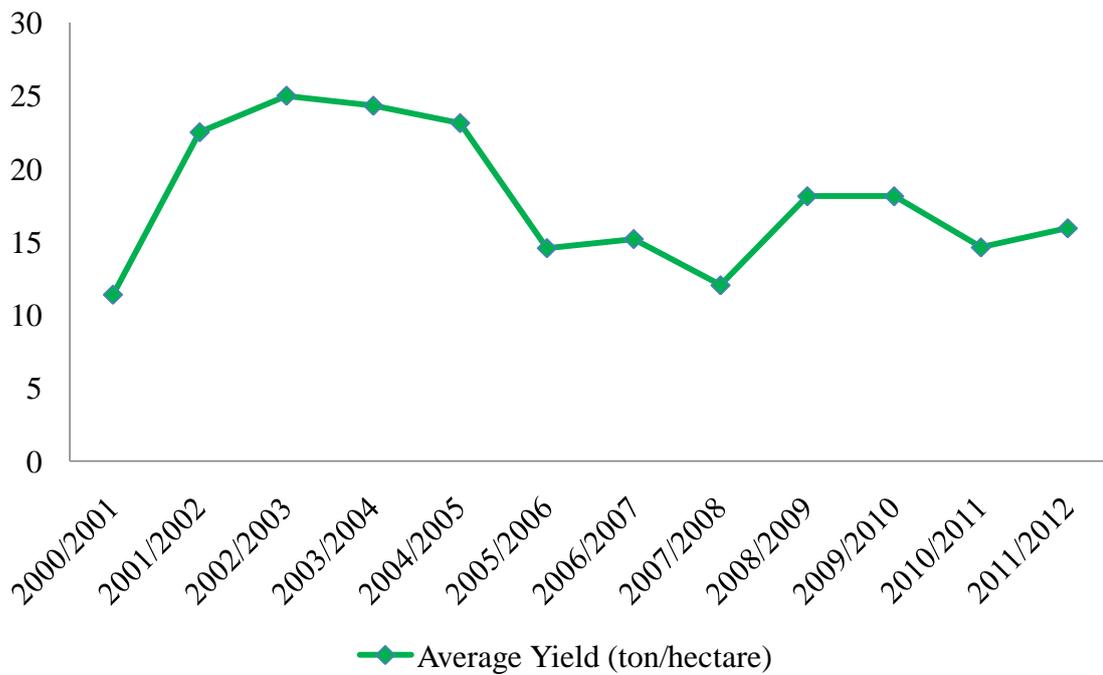


Figure 4.5 Average yield of citrus production in the Fang watershed

Source: Chiang Mai Agricultural Office, 2013

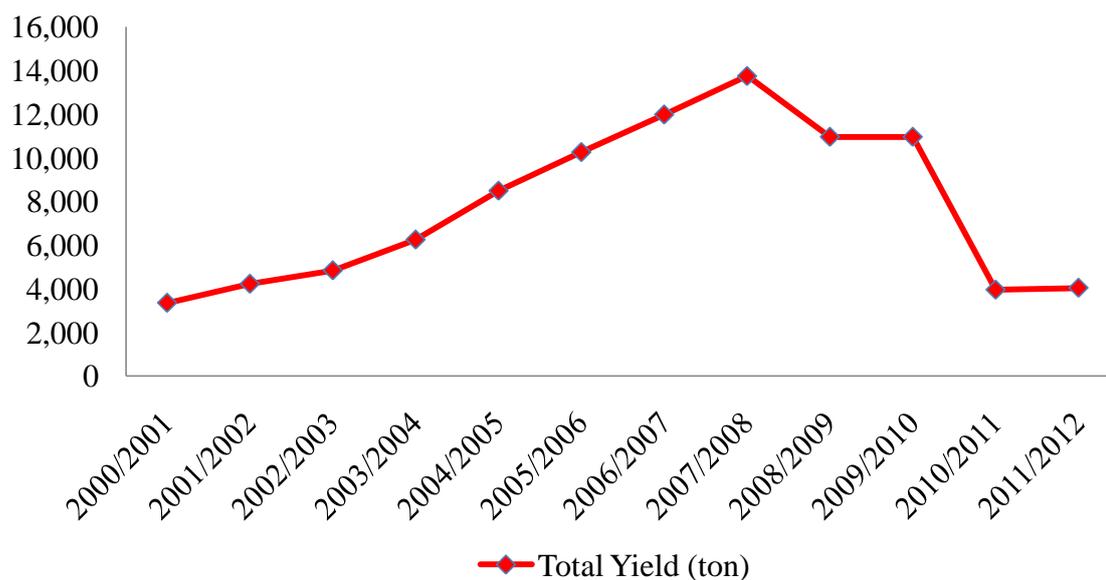


Figure 4.6 Total yield of citrus production in the Fang watershed

Source: Chiang Mai Agricultural Office, 2013

4.3.5 Suitability assessment of the citrus production area

At present, much of the orange production area in the Fang watershed is unsuitable for the topographic conditions there. This includes both upland and lowland orange production areas. For the former, the farmers grow citrus on steep slopes which are at risk of soil erosion. There is the application of chemical pesticides and insecticides at an inappropriate rate. This has resulted in toxic contamination and rapid soil deterioration. There is also a high possibility of finding toxins in the water sources and in the plains below. The topsoil in the lowland Fang watershed is easily flooded and this might have a negative effect on orange production. Onpraphai et al. (2011) has conducted a study and found that only 4 percent of the Fang watershed has an area suitable for orange growing and only 39.5 percent was found to be moderately suitable. Fifty percent was found to have a low level of suitability and 6.5 percent was inappropriate (Table 4.1). The areas being most appropriate for orange production (8,477 hectares) were mostly in the Fang and Mae Ai districts, particularly on the slope areas. The topsoil there had good drainage because it was a loamy sandy soil which made it suitable for growing citrus. There was also the Kok and the Fang rivers flowing through the Fang watershed

as well as many other water sources. It was found that there were lower risk factors of drought and flood. For the crop year 2008/2009, it was found that out of 10,209 hectares of orange production, a highly suitable area measured 2,202 hectares, the moderate level measured 7,141 hectares, the low level area measured 862 hectares and the inappropriate area covered 4 hectares (Table 4.2).

Table 4.1 Suitability level of areas for citrus production in the Fang watershed

Suitability	Area (hectare)	Percentage (%)
suitable	8,477	4.0
moderate	83,041	39.5
low level	105,024	50.0
unsuitable	13,568	6.5
Total	210,111	100.0

Source: Onpraphai et al., 2011

Table 4.2 Suitability level of citrus production in the crop year 2008/2009

Suitability	Area (hectare)	Percentage (%)
High	2,202	1.0
Medium	7,141	3.5
Low	862	0.4
Inappropriate	4	0.0
Other areas	199,902	95.1
Total	210,111	100.0

Source: Onpraphai et al., 2011

4.4 Cropping systems and the main crops grown

The people in the Fang watershed have been engaged in agriculture for a long time due to suitability of the topography and climate there. In the past, people grew rice as a staple food. At present however, they also grow various good quality vegetables and fruit trees. Various varieties of fruit trees have been introduced and propagated in the Fang watershed which gives the Fang watershed a good reputation for agricultural produce. Rice is the staple crop of the Fang watershed and the cultivation period is determined by the climatic conditions between July and November each year. The majority of the study area is irrigated and has enough water for planting second or third crop such as garlic, onions and sweet corn.

Most of the perennial crops are citrus, longans and lychees. The orange production is planted in upland and lowland irrigated areas because of the available water supply. Meanwhile, longans are grown in the irrigated areas but only need water in the period of branch sprouting and fruiting. They are harvested one time a year but they can be stimulated to produce a second crop by using potassium chlorate. If they are stimulated, the harvest occurs between June and July and off-season between October and November. Lychees use less water and often grow in rainfed upland and can be harvested between May and June (Figure 4.7).

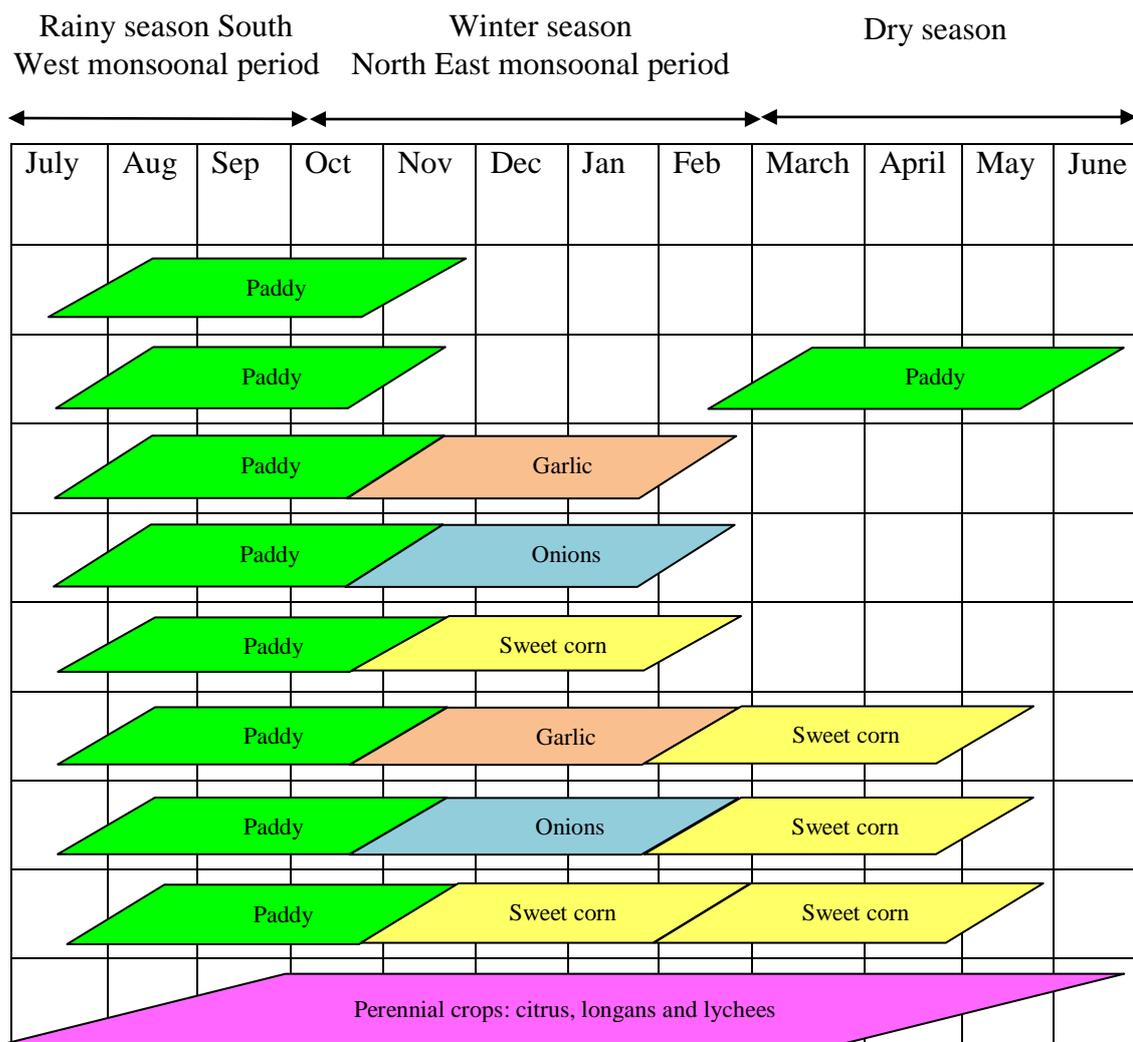


Figure 4.7 Seasonal cropping calendars of the main crops grown in the study area

Source: Survey, 2012

The study selected alternative crops for evaluation in the model from inside and outside the Fang watershed. The alternative crops chosen from inside the Fang watershed were annual crops of paddy, garlic, onion and sweet corn. For the perennial crops, this study chose longan and lychee which were major crops in the Fang watershed before citrus was grown in this area. There are still minor crops of longan and lychee grown although they are not as popular as citrus. For the crops from outside the Fang watershed, the study considered alternative crops which are environmentally

friendly as well as providing yield and revenue equal or greater to the major crops grown in the Fang watershed. The production of these alternative crops would have the additional benefit of not affecting the farmer's health by avoiding chemical use. The alternative crops selected were tea and coffee.

4.5 Diseases and the resulting effects associated with citrus production

4.5.1 Problems with Citrus Production

The field survey showed that the orange orchards in the Fang watershed have been facing worsening problems. This situation particularly applies to small farms as they have less capital. Since citrus give high yields throughout the year, they need more nutrients and care-taking than other types of plants. If the farmers lack production knowledge or the environment is unsuitable, it would have negative effects on the citrus such as fruit size, plant diseases and crop health. The orange is able to absorb food synthesized from leaves and store food internally. The farmers should harvest them during the harvest season; otherwise if they leave them on the tree in order to obtain a better price, the citrus will deteriorate (Figure 4.8). If there are additional factors such as the citrus are grown in a paddy by using a graft, it is possible that the air ventilation and nutrition in the soil are not good. This will result in a poor quality crop.



Figure 4.8 Citrus productions in a lowland area showing healthy and unhealthy crops

Source: Survey, 2012

4.5.2 Effects of diseases and insects on citrus production

Citrus diseases and insects have resulted in lower yields as part of the crop and could not be harvested. This means that many farmers do not have sufficient capital to purchase what is needed for the following year. Based on interviews, it was found that farmers believed that orange orchards could only be rehabilitated if they used fertilizers and other chemicals. This means that they borrow money from the bank to purchase what they think they required, putting many of them into more debt. It is difficult to rehabilitate orange orchards and it needs a large investment to do it. Small farms in particular find this difficult (Onpraphai et al., 2011). This leads to many farmers abandoning orange trees and growing other crops (Figure 4.9).



Figure 4.9 Abandoned citrus production and the transition to a new crop

Source: Survey, 2012

4.6 Socio-economic conditions of the study area

The Fang watershed covers 3 districts: Chai Prakan, Fang and Mae Ai. This area has 19 districts (256 villages) with a population of 103,973 with an average density of 73.44 people per square kilometer. Eighty percent of the population engages in agriculture (Table 4.3). The Chiang Mai Community Development Provincial Office (2013) found that of the 51,824 households interviewed, 97.43 percent had an income from farming or from other sources. Of the 30,573 households which replied to the question regarding their average income, 98.34 percent reported an income of over 23,000 baht per year (766.77 US dollars). Of the people with an income, 78.81 percent reported that they had savings (Table 4.4).

Table 4.3 Population in the Fang watershed

Provinces	Tambons	Villages	Population
Chai Prakan	4	44	15,077
Fang	8	128	53,792
Mae Ai	7	93	35,104
Total	19	265	103,973

Source: Chiang Mai Community Development Provincial Office, 2013

Table 4.4 Socio-economics of households in the Fang watershed

Characteristics	Household interviewed	No. of household %
In employment	51,824	97.43
Households with an average income >23,000 baht/year	30,573	98.34
Having household savings (baht)	30,573	78.81

Source: Chiang Mai Community Development Provincial Office, 2013

4.7 The characteristics of the sampled households

4.7.1 The socio-economic characteristics of citrus-based farming.

This study used a sample group of 149 households (Table 4.5). It was classified into:

- a) Small farms using chemicals or SFC (53 households).
- b) Small farms using chemicals and bioextract or SFCB (50 households).
- c) Large farms using chemicals or LFC (24 households).
- d) Large farms using chemicals and bioextract or LFCB (22 households).

Table 4.5 Data collection of study area

RMU type	Total households* (HH)	10% of total household (HH)	Sample of household survey (HH)	No. of households/years of citrus production				
				1-2 years	3-5 years	6-9 years	10-12 years	Total
SFC	580	58	53	5	14	20	24	63
SFCB	472	47	50	8	7	26	21	62
LFC	258	26	24	10	9	21	18	58
LFCB	219	22	22	4	5	13	13	35
Total	1,529	153	149	27	35	80	76	218

Source: *Chiang Mai Agricultural Office, Sep 30, 2012

The location of the samples of the citrus production areas in this study are shown in Figure 4.10. It was found that most of the respondents were male (87.58%), married (96.08%) and were lowland Thai (98.04%). They had an average age of 50 years old, elementary school graduates (74.51%) and Buddhists (98.04%) (Table 4.6). The respondents had 2 agricultural/non-agricultural workers per household on average. For the larger agricultural land holdings including the larger citrus growing areas, it was

found that the large farms using chemicals occupied an average land area of 22.8 hectares (142.5 rai) with 21.05 hectares (131.54 rai) used for citrus per household. The small farms using chemicals and bioextract occupied a smaller land area averaging 2.21 hectares (13.80 rai) and 1.06 hectares (6.64 rai) per household respectively (Table 4.7).

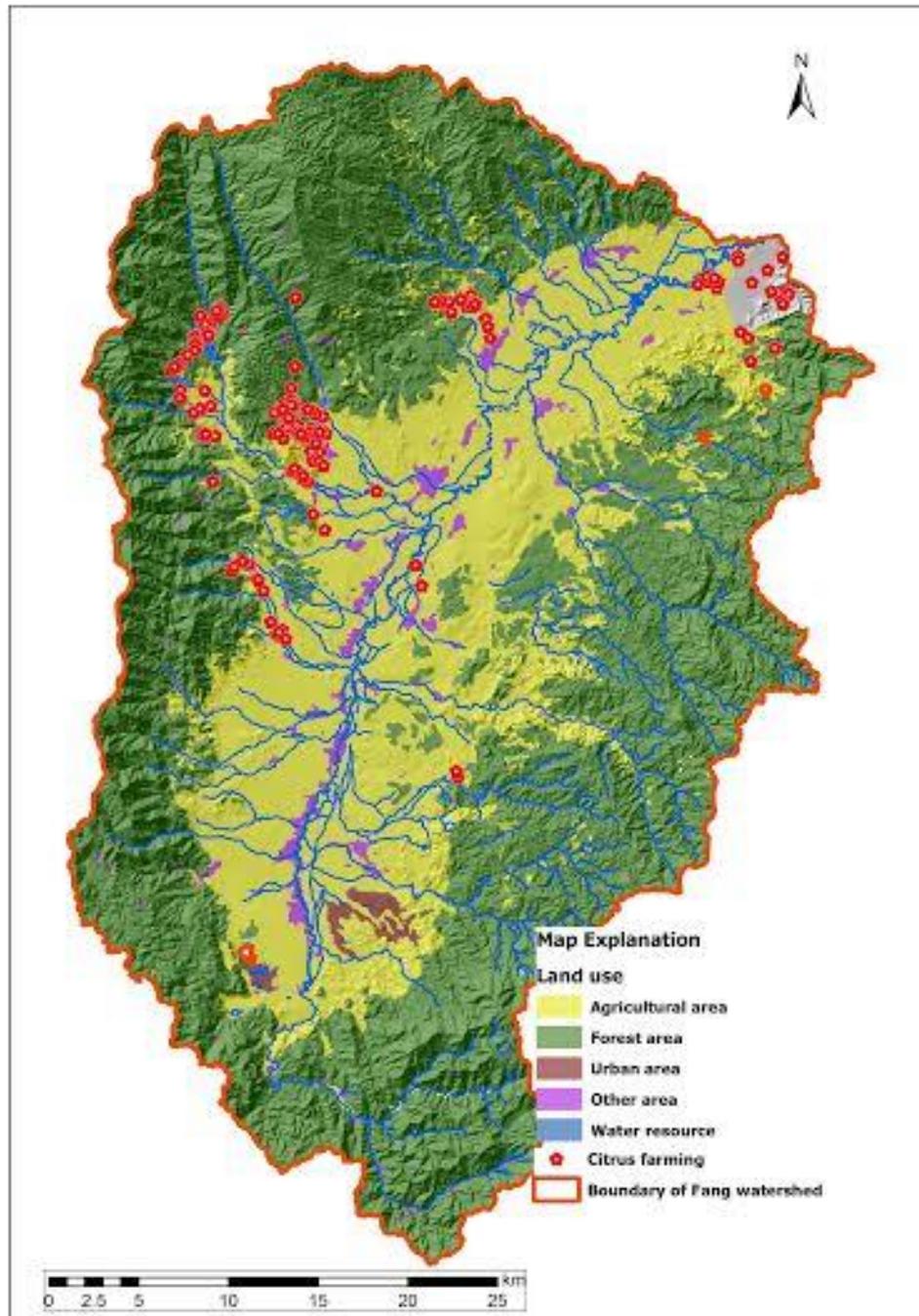


Figure 4.10 Location of the samples of citrus production area in the Fang watershed

Table 4.6 Socio characteristics of respondents

Specification	RMU type				Total
	SFC	SFCB	LFC	LFCB	
Sample size (household)	53	52	26	22	153
Sex					
Male	50 (94.33)	39 (75.00)	25 (96.15)	20 (90.91)	134 (87.58)
Female	3 (5.66)	13 (25.00)	1 (3.85)	2 (9.09)	19 (12.42)
Status					
Single	-	2 (3.85)	-	-	2 (1.31)
Married	52 (98.00)	47 (90.38)	26 (100.00)	22 (100.00)	147 (96.08)
Divorced	-	2 (3.85)	-	-	3 (1.96)
Widowed	1 (2.00)	1 (1.92)	-	-	1 (0.65)
Ethnicity					
Lowland Thai	53 (100.00)	50 (96.15)	26 (100.00)	21 (95.45)	150 (98.04)
Chinese	-	2 (3.85)	-	1 (4.55)	3 (1.96)
Age (year)					
Minimum	28	32	24	25	24
Maximum	63	59	81	65	81
Average	50.26	49.81	56.29	50.15	51.06
Education					
Illiterate	1 (1.89)	-	-	1 (4.55)	2 (1.31)
Grade school	40 (75.47)	39 (75.00)	22 (84.62)	13 (59.09)	114 (74.51)
Senior high school	4 (7.55)	8 (15.38)	1 (3.85)	5 (22.72)	18 (11.77)
Junior high school	7 (13.20)	5 (9.62)	2 (7.68)	3 (13.64)	17 (11.11)
Bachelor	1 (1.89)	-	1 (3.85)	-	2 (1.31)
Religion					
Buddhism	52 (98.11)	52 (100.00)	24 (92.31)	22 (100.00)	150 (98.04)
Islam	1 (1.89)	-	2 (7.69)	-	3 (1.96)

Note: numbers in parentheses are percentages

Table 4.7 Economic characteristics of respondents

Specification	RMU type				Total
	SFC	SFCB	LFC	LFCB	
Family members (persons)					
Minimum	2	2	2	3	2
Maximum	8	8	10	7	10
Average	4.26	3.77	4.96	4.60	4.25
Average agricultural labor (persons)	2.07	2.04	2.08	1.75	2.02
Average off-farm labor (persons)	2.19	1.73	2.88	2.85	2.23
Land holding (rai)					
Minimum	6.5	3	30	30	3
Maximum	49	43	500	200	500
Average	15.20	13.80	142.50	40.63	40.63
Average citrus crop (rai)					
Minimum	2	1	30	30	1
Maximum	20	18	500	200	500
Average	8.86	6.64	131.54	28.60	31.83

4.7.2 Source of loans for citrus-based farming

The sample households were questioned as to the purpose of their loans: production, production and consumption, merchants and production, consumption and merchants. The study found that the total amount of loans was 97.36 million baht from 7 sources. Financial organizations provided 93.66 percent and non-banking sources provided the rest. The loans from commercial banks were evaluated at 50.50 million baht and the Bank for Agriculture and Agricultural Co-operatives provided 39.33 million baht. The Agricultural Co-operatives and villages funds provided 0.75 and 0.6 million baht respectively. The larger farms using chemicals usually borrowed from the commercial banks whereas the smaller farms obtained most of their loans from the Bank for Agriculture and Agricultural Co-operatives, especially as 43.61 percent of loans from these sources were for small farms using chemicals.

The non-banking sources such as agricultural merchants, loans from relatives and loans against future crops had a total borrowing of 6,040,000, 110,000 and 20,000 baht respectively. The average interest rate was at least 12 percent per year which was at a higher rate than the financial organizations at 7 to 8.5 percent. The study found that the average loan per household was higher in large farms using chemicals at 2.23 million baht. The second highest were large farms using chemicals and bioextract with loans of 476,364 baht. The third highest were small farms using chemicals at 333,962 baht and finally, the small farm using chemicals and bioextract had loans of 214,038 baht (Table 4.8).

Table 4.8 Source of loans for household investment

Source	SFC (53 HH)	SFCB (52 HH)	LFC (26 HH)	LFCB (22 HH)	Watershed (153 HH)
Bank for Agriculture and Agricultural Co-operatives (average interest rate 7 %)					
Production	6,670,000	4,380,000	4,000,000	8,330,000	23,380,000
Production and Consumption	10,480,000	2,620,000	1,850,000	400,000	15,350,000
Merchant		40,000			40,000
Production , Consumption and Merchant		230,000	330,000		560,000
Total	17,150,000	7,270,000	6,180,000	8,730,000	39,330,000
Agricultural co-operatives (average interest rate 8.5 %)					
Production	240,000		200,000	200,000	640,000
Production and Consumption	105,000	10,000			115,000
Total	345,000	10,000	200,000	200,000	755,000
Commercials bank (average interest rate 8 %)					
Production			10,000,000		10,000,000
Production and Consumption				1,500,000	1,500,000
Merchant		3,500,000	25,000,000		28,500,000
Production , Consumption and Merchant			10,500,000		10,500,000
Total	-	3,500,000	45,500,000	1,500,000	50,500,000
Villages fund (average interest rate 12 %)					
Production	30,000	230,000	50,000		310,000
Production and Consumption	115,000	110,000	20,000	50,000	295,000
Total	145,000	340,000	70,000	50,000	605,000
Agricultural merchant for production (average interest rate 12 %)	40,000		6,000,000		6,040,000
Relative loan for production (average interest rate 12 %)		10,000	100,000		110,000
General loan for production (average interest rate 12 %)	20,000				20,000
Total	17,700,000	11,130,000	58,050,000	10,480,000	97,360,000
Average per household	333,962	214,038	2,232,692	476,364	636,340

Source: survey, 2012

4.7.3 Characteristics of citrus production in the Fang watershed

Sai Nam Pueng citrus are the most common variety of citrus produced in the Fang watershed. In 2009, the Fang watershed had a total area of 85,939 rai (13,750 hectares) for established and new trees, 68,525 rai (10,964 hectares) of which could be harvested. In 2011, however, this decreased to 4,935 and 3,954 hectares (30,841 and 24,713 rai, or a 64.11 and 63.94 percent reduction respectively). The results are shown in Figure 4.11. This was because the farms with the largest *Sai Nam Pueng* orchards during this time were the large farms (LFC) which used chemicals. In 2009, the large farms had a total area of 27,881, of which 22,231 rai (4,461, 3,557 hectares) could be harvested but this decreased to 10,000 and 8,018 rai (1,600 and 1,283 hectares) in 2011.

The small farms (SFCB) using chemicals and bioextract covered the smallest total land area compared with the other farm types. In 2009, they had a total area of 9,550 rai, of which 7,615 rai (1,528, 1,218 hectares) could be harvested but this decreased to 3,427 and 2,746 rai (548 and 439 hectares) in 2011 respectively (Figure 4.12). It was found that there were clear changes in yields and prices. The average yield of all the farm types decreased continually from 2009 to 2011. The average total yields in the Fang watershed decreased from 2,332 kilograms per rai in 2009 to 1,975 kilograms per rai in 2011, a 16.28 percent reduction as shown in Figure 4.13. Although there was a decrease in yields, this was compensated by an increase in price. In 2009, the average price of *Sai Nam Pueng* in the Fang watershed was 16.38 baht per kilogram but this increased to 25.91 baht in 2011, an increase of 58.14 percent. The large farms using chemicals could sell their crop at a higher price than the other farm types. Their price increased from 20.11 baht per kilogram in 2009 to 31.46 baht per kilogram in 2011, a 56.44 percent increase as shown in Figure 4.14. The increase in price was compensated for the lower yield which led to an increase in income for the farmers. The price and revenue increased every year between 2009 and 2011. The only exceptions were the small farms using chemicals which had a decrease in revenue per rai between 2010 and 2011 (Figure 4.15).

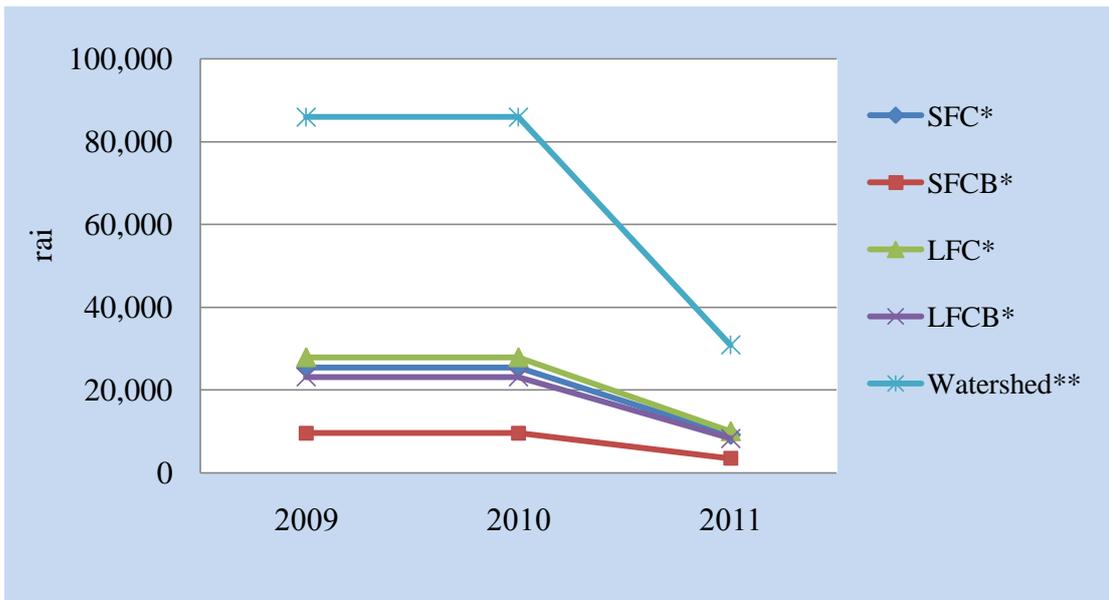


Figure 4.11 Citrus production areas

Source: * Survey, 2012 ** Chiang Mai Agricultural Office, 2013

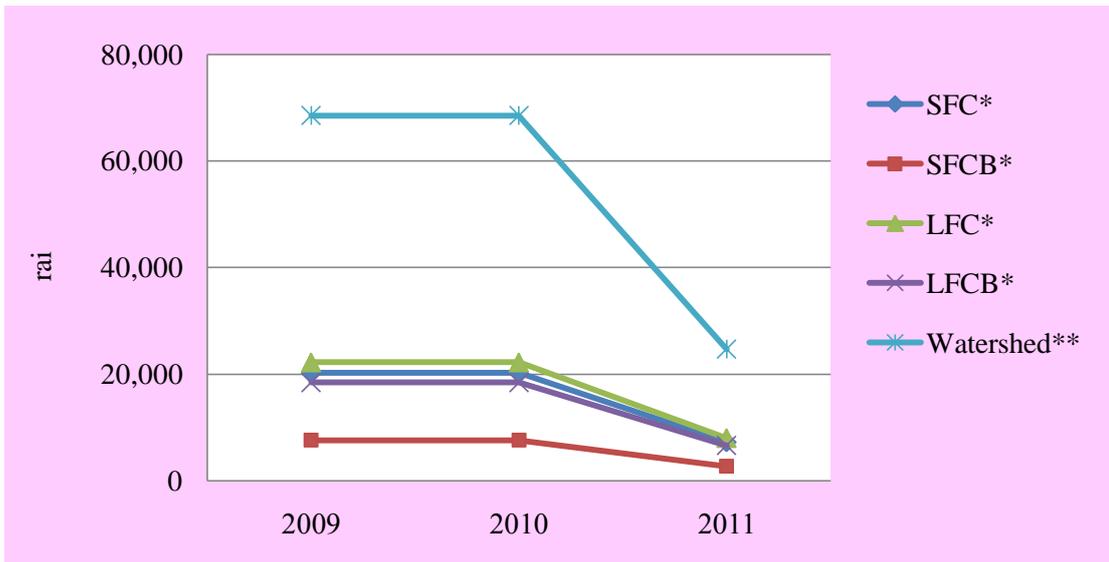


Figure 4.12 Harvested area of citrus production

Source: * Survey, 2012 ** Chiang Mai Agricultural Office, 2013

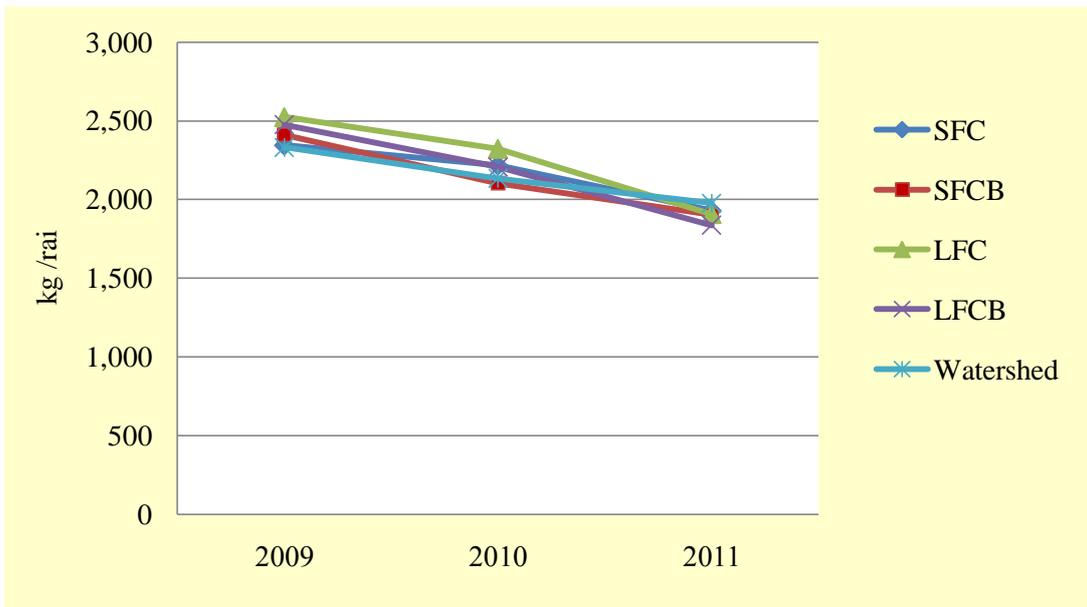


Figure 4.13 Average yield of citrus production

Source: Survey, 2012

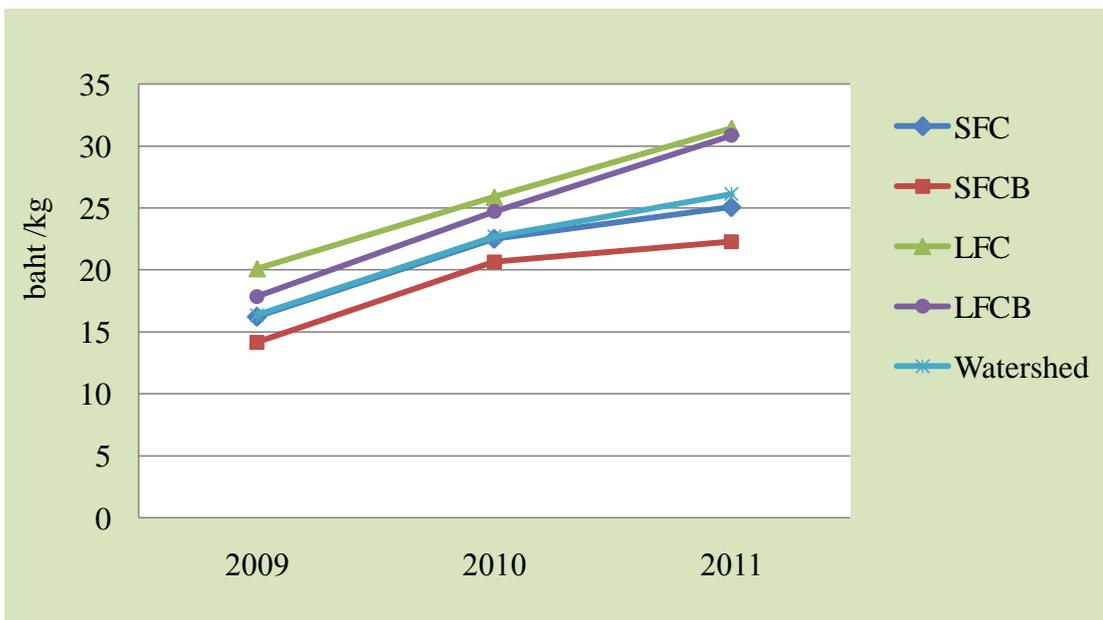


Figure 4.14 Average price per kilo from citrus production

Source: Survey, 2012

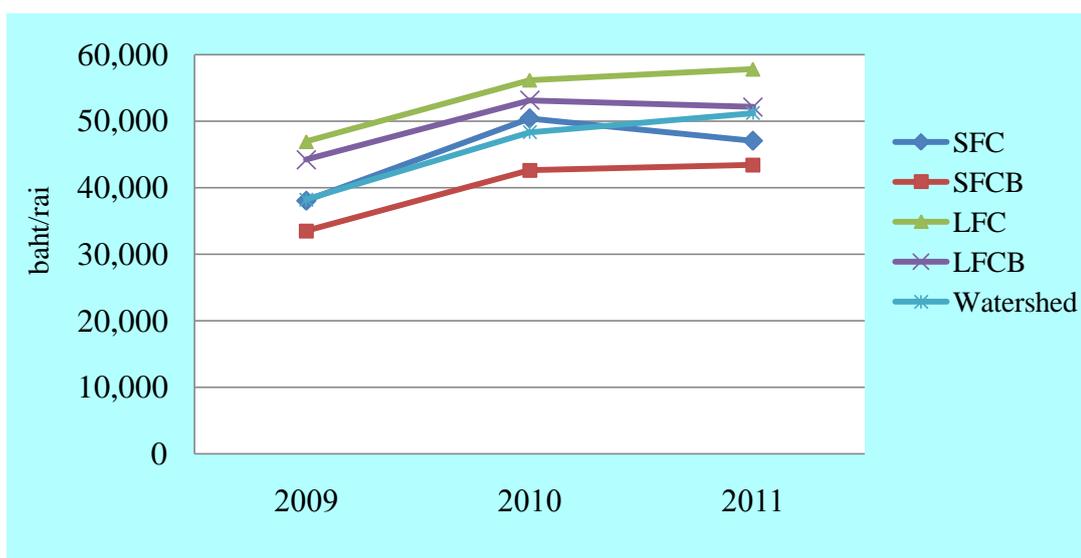


Figure 4.15 Average revenue from citrus production

Source: Survey, 2012

4.7.4 Production cost and returns from citrus production

4.7.4.1 Production cost of citrus

The largest item of variable production cost at both the farm level and the watershed was the cost of chemicals over the 12 year lifespan of the orange tree. This low lifespan can be attributed to the greening disease. When the citrus were 1 to 2 years old, fuel and production material costs exceeded the cost of chemicals. When the orange trees were 3 to 12 years old, wages, fuel and fixed costs were lower than the cost of chemicals (Figure 4.16 to Figure 4.20). However, if we breakdown the variable cost of orange production over 12 years for every farm type, we find that small farms using chemicals and large farms using chemicals and bioextract had the highest average cost for chemicals per rai. Between 6 and 9 years, the average cost per rai was 30,389 and 31,903 baht, 58.36 percent and 69.36 percent of their total production costs respectively as show in Figure 4.16 and Figure 4.19. Meanwhile, the large farms using chemicals had the highest average chemical cost per rai when the citrus were 3 to 5 years old or

60.45 percent of their total production costs at 26,299 baht per rai (Figure 4.18). For the small farms using chemicals and bioextract and for production at the watershed level, there was little difference in the average chemicals costs from 3 to 12 years (Figure 4.17 and Figure 4.20)

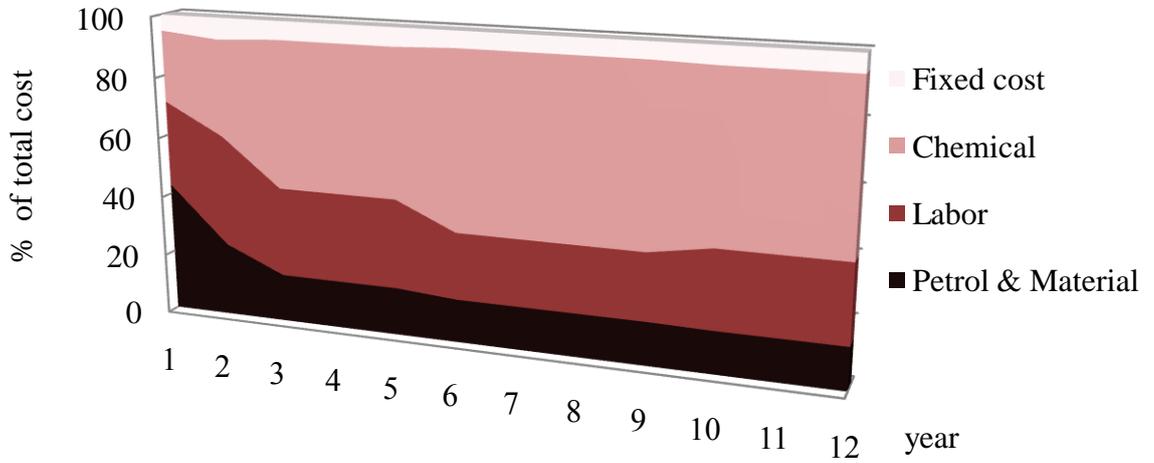


Figure 4.16 Average production cost per rai for the small farm using chemicals (SFC)

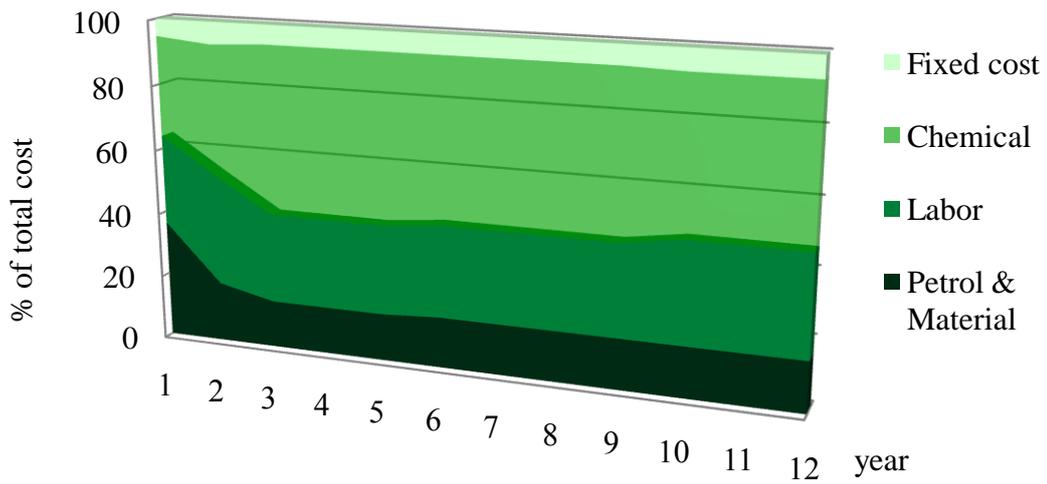


Figure 4.17 Average production cost per rai for the small farm using chemicals and bioextract (SFCB)

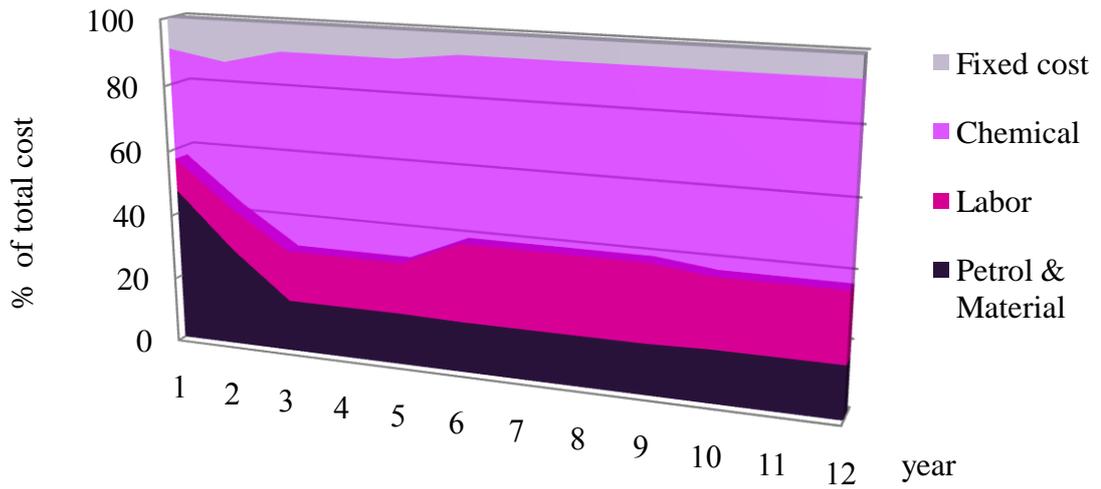


Figure 4.18 Average production cost per rai for the large farm using chemicals (LFC)

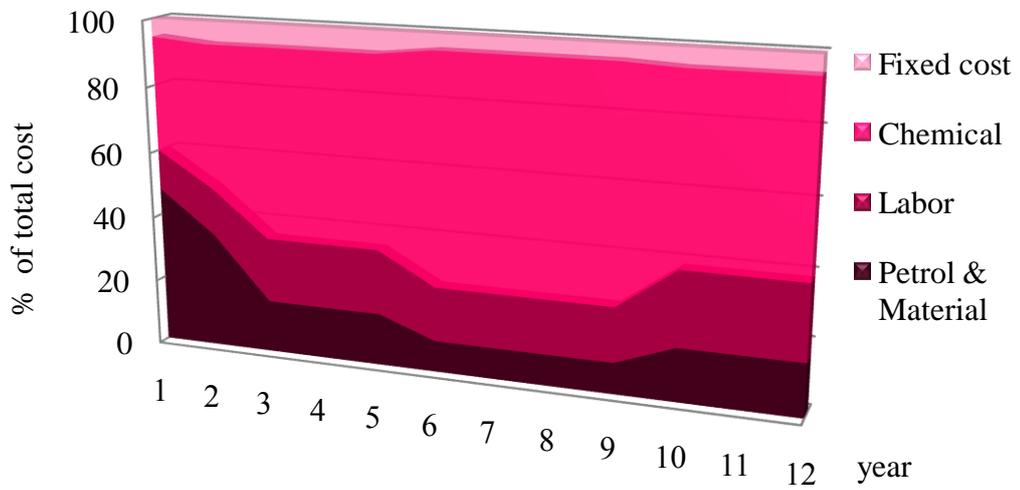


Figure 4.19 Average production cost per rai for the large farm using chemicals and bioextract (LFCB)

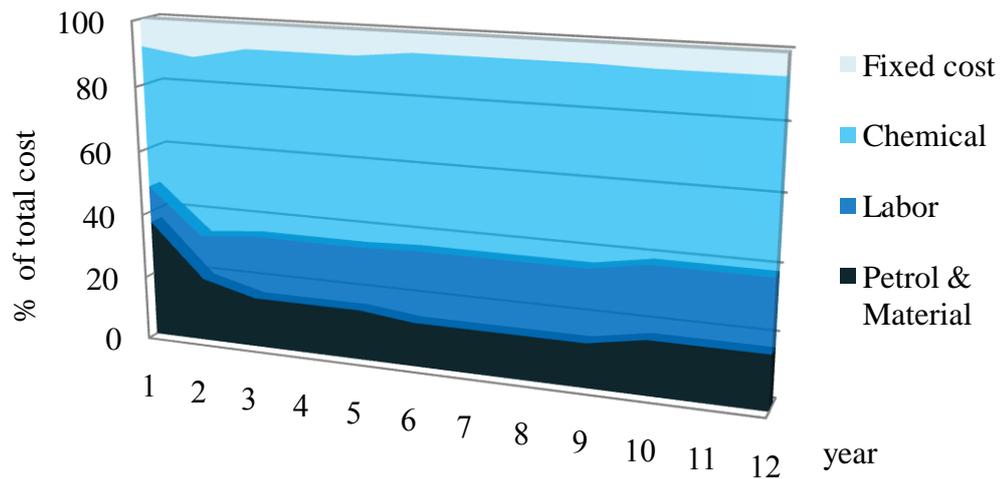


Figure 4.20 Average production cost per rai at the watershed level

4.7.4.2 Total costs and total revenue from citrus production

A citrus tree begins to bear fruit when it is 3 years old. Based on the results of this study, it was found that the citrus production of all farm types and the production at the watershed level could earn a higher total revenue and a higher total cost per rai when the citrus were 6 to 9 years old, followed by 9 to 12 and 3 to 5 years old respectively (Figure 4.21 to Figure 4.25). At 6-9 years old, the citrus from the large farms using chemicals could earn more total revenue and had a higher total cost than for other farm types at 31,942 and 68,192 baht per rai per year (Figure 4.23). This was followed by the large farms using chemicals and bioextract at 31,903 and 66,588 baht per rai per year (Figure 4.24). The small farms using chemicals and the small farms using chemicals and bioextract could earn an average revenue of 52,164 and 48,229 baht per rai respectively. This gives an average total cost per rai of 30,389 and 34,377 baht respectively (Figure 4.21 and Figure 4.22). The citrus production at the watershed level was found to have a total revenue and total cost of 53,324 and 33,303 baht per rai respectively (Figure 4.25).

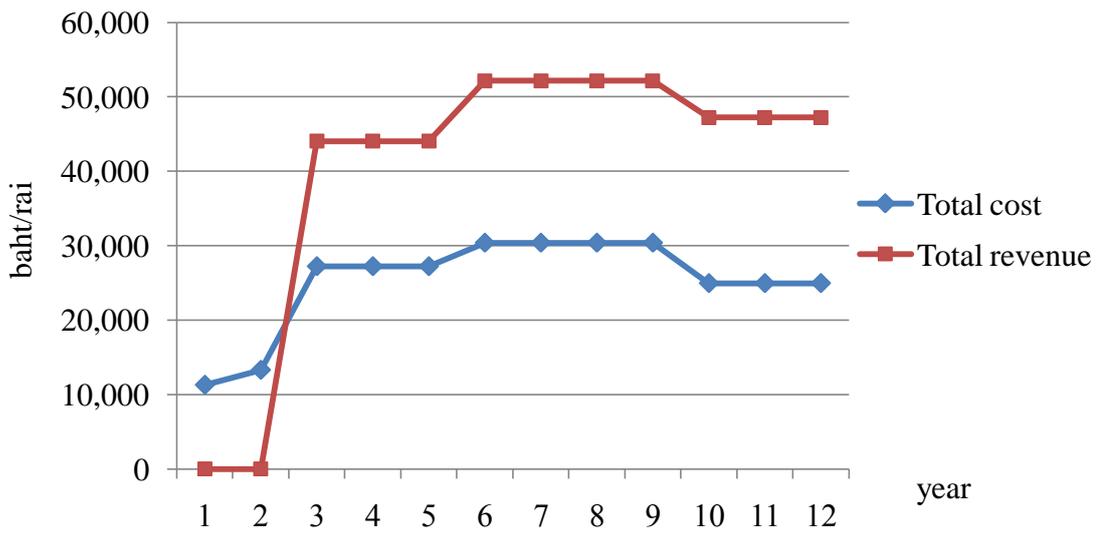


Figure 4.21 Total cost and total revenue from citrus production for the small farm using chemicals (SFC)

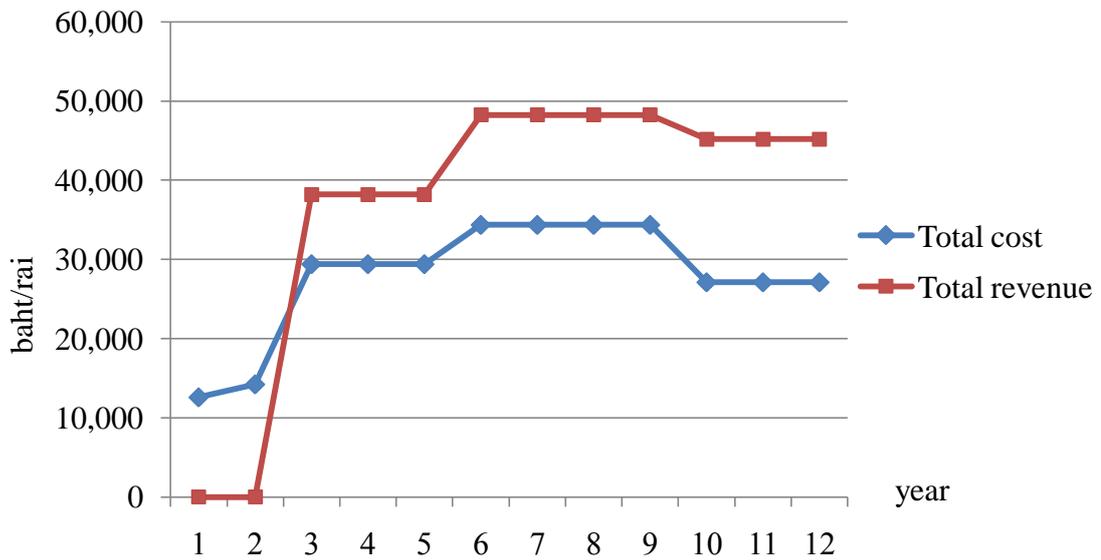


Figure 4.22 Total cost and total revenue from citrus production for the small farm using chemicals and bioextract (SFCB)

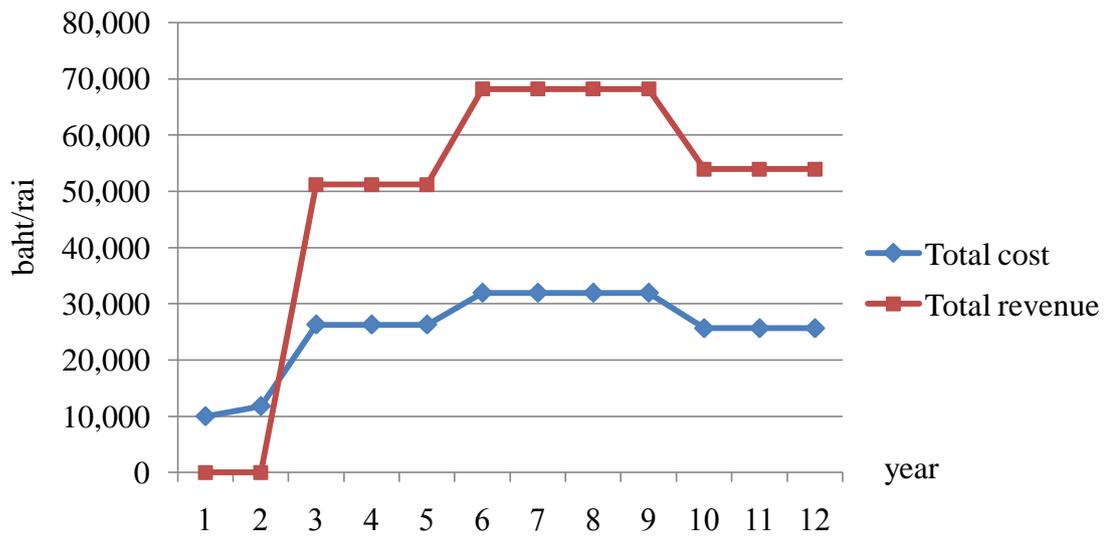


Figure 4.23 Total cost and total revenue from citrus production for the large farm using chemicals (LFC)

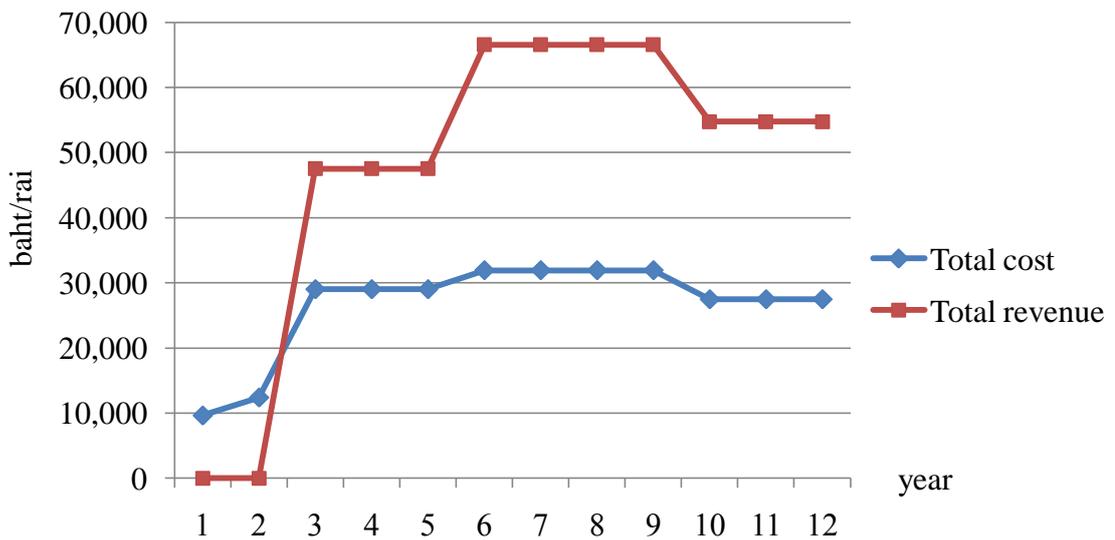


Figure 4.24 Total cost and total revenue from citrus production for the large farm using chemicals and bioextract (LFCB)

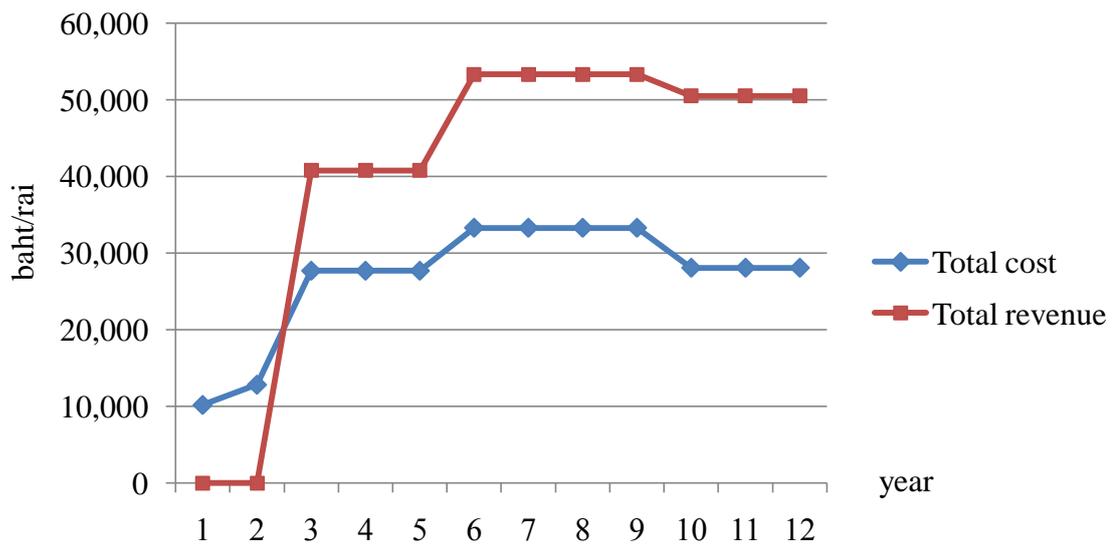


Figure 4.25 Existing total cost and total revenue from citrus production at the watershed level