Chapter IV

Climatic Conditions and Coffee Production in DakLak and Ea Ktur

In this chapter, the issues of climatic conditions, coffee area distribution among the districts and overview procedures for coffee farm practices are introduced to show the panoramic view of coffee production of DakLak province. In addition, the characteristics of climate, soil types, socioeconomic of the study site (Ea Ktur) are briefly described in order to figure out the advantages and disadvantages of the farms in coffee production.

4.1 Characteristics of DakLak province

4.1.1 Topography

DakLak, with the total area of about 19,830 square kilometers is the largest province of Vietnam. It is situated between $11^0$30'–$13^0$25' N and $107^0$30'–$109^0$3' E, adjacent to Gia Lai province to the north, Lam Dong province and Binh Duong provinces to the south, Khanh Hoa and Phu Yen provinces to the east, and Cambodia to the west. Its relative flat terrain averages 600 meters above sea level. There are many mountain ranges and hills concentrating in DakLak's northeast and southeast regions, of which the highest is Chu-Yang-Sin mountain. The high mountains in the south and the southeast of the territory occupy about 35 percent of the natural area (Phong, 1998).

Soil of DakLak was classified into 8 groups: alluvial soils (Fluvisols), gley soils (Gleysols), peat soils (Histosols), black soils (Luvisols), red soils (Ferralsols), grey soils (Acrisols), alit humus soils (Alisols) on high mountain and eroded soils (Leptosols). Of which basaltic soil (Rhodic Ferralsols) with an area of 713,508 hectares is suitable for planting perennial crops such as coffee, rubber, cashew, black pepper, fruit trees from different varieties (Tri, 1997).

The plateau, on which Buon Ma Thuot, a capital of DakLak, and its surrounding areas, occupies 53.5 percent of the total area and has a mean elevation of 450 m above sea level. This plateau is considered as the most typical climate region of DakLak. There are three main river systems: the Ba river that runs to the eastern sea, the Serepoc river running up back to the Mekong river and the Dong Nai river in the southwest of DakLak. These rivers are the main sources to supply water for living and production in the whole province (Phong, 1998).

4.1.2 Climate

Table 2. The five-year average of meteorological data of DakLak (1997- 2001)

Month	Mean temp. (^{o}C)	Precipitation (mm)	RH (%)	Evaporation (mm)	Wind speed (m/s)
Jan.	21.1	3.1	78	123	6.5
Feb.	22.7	2.3	74	159	5.6
Mar.	24.7	19.9	71	177	4.4
Apr.	26.1	80.1	73	162	3.2
May	25.8	168.5	81	90	2.1
Jun.	24.8	227.3	85	63	1.9
Jul.	24.3	264.2	87	54	1.7
Aug.	24.2	322.8	87	51	1.8
Sep.	23.9	283.7	88	45	1.5
Oct.	23.5	176.7	87	63	2.5
Nov.	22.5	84.9	85	81	3.9
Dec.	21.2	21.3	82	93	5.4

Source: Ea Kmat Meteorological Station, 2002.

Note: Temp: Temperature, RH: relative humidity

Due to its location, both the tropical climate and the cool climate of the highlands influence DakLak.

Sunshine in this province is abundant with average yearly sunlight of over 2,000 hours and the average annual rainfall is about 1,650 mm, the lowest monthly rainfall is February and the highest one is August. DakLak has two distinct seasons, dry season and rainy season. During the dry season, which begins in November and ends in the following April, the violent northeast winds blow ranging from 3.2 to 6.5 m/s and the high evaporation from 81 to 177 mm creates serious dryness and drought. This causes constraints on the development of agriculture production. Therefore, the task of hydraulic conservancy, storing water for the dry season, plays an important role in the economic development, in the livelihood of the residents, and in coffee production in DakLak province (Table 2).

The climate varies according the topography elevation: the area below 300 m is hot all months of year, the area between 400 m and 800 m is hot and humid and the area over 800 m has a fresh climate. This characteristic can create favorable condition for crops and animal husbandry in each climatic area (Ea Kmat Meteorological Station, 2002).

4.1.3 **Land use**

Among 8 soil groups, basaltic soil is the most important soil distributed in the two plateaus of Buon Ma Thuot and Dak Nong, and suitable for many kinds of crops. About 11 percent of the existing land resources are of unused land, 58 percent of forest land, and more than 28 percent of agricultural land, of which 10 percent and 18 percent total land are annual crops and perennial crops, respectively (Figure 4).

Alluvial soils occupy 60,000 hectares mainly in Lak and Krong Ana districts, the low land of Dak Mil and Ea Soup districts. The soils in these areas are suitable for short-term cash crops.

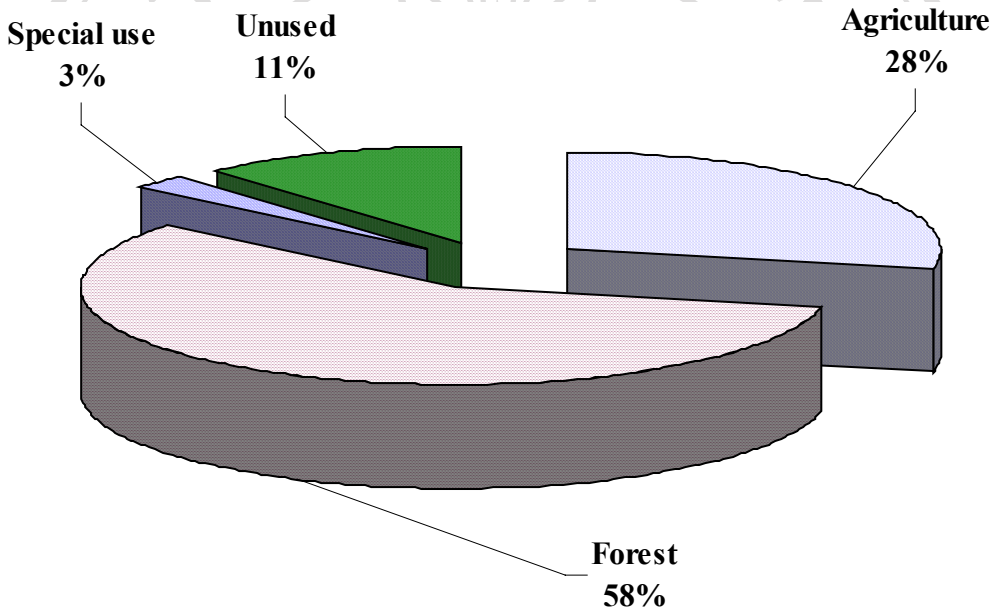


Figure 4. The status of land use in DakLak
Source: DakLak Statistical Department, 2001.

4.2 Coffee production in DakLak

4.2.1 Coffee area distribution in the province

Most of coffee area of province was planted on basaltic soil, which is the best soil for coffee cultivation in Vietnam. The total coffee area of the province is about 260,000 hectares distributed to 19 districts with the area ranging from 0.03 percent to 13.77 percent of total coffee area of the province (Table 3). Yield varied widely, the

lowest one of 3,168 kg of fresh cherries per hectare was in M'Drak, the highest one of 14,690 kg was in Buon Ma Thuot. The differences from coffee yield among the districts were caused by many factors, but in some districts like Krong Bong, Lak, M'Drak and Ea Kar, the yield-limiting factors were mainly unsuitable climate and soil conditions. The study site belongs to Krong Ana district, which had the average coffee yield of more than 13,000 kg of fresh beans per hectare. In spite of having different yield, but the procedure for coffee production on farm is the same among the districts (Sung, 1997).

Table 3. The distribution of coffee area to 19 districts of DakLak

District	Percentage of total coffee area of DakLak	Rank
Cu M'gar	13.77	1
Krong Buk	13.49	2
Dak R'lap	10.32	3
Krong Nang	7.74	4
Krong Ana	7.73	5
Dak Mil	7.55	6
Ea H'leo	6.77	7
Krong Pak	6.34	8
Dak Song	6.03	9
Buon Ma Thuot	4.42	10
Dak Nong	4.12	11
Ea Kar	4.04	12
M'Drak	2.38	13
Cu Jut	1.61	14
Krong No	1.60	15
Buon Don	1.18	16
Krong Bong	0.48	17
Lak	0.40	18
Ea Sup	0.03	19

Source: DakLak Statistical Department, 2001.

4.2.2 Overview basic procedures of coffee, durian and black pepper cultivation in DakLak province

Irrigation, fertilization, pruning, weeding and maintaining basin, pests control, and harvesting are the chief works of farm management practices in one year of production of coffee, durian and black pepper cultivation in DakLak.

For coffee cultivation

Figure 5 indicates the management practices of coffee production in DakLak.

Watering: Watering needs to be consistent with the climate condition. Depending on the specific climate condition of a certain year that irrigation can start early or later, but normally about 40 - 50 days after finishing harvest, the coffee is irrigated in order to break dormancy of flowers and induce blossom.

Fertilization: Coffee responds to nitrogen, phosphorus, potassium, and minor elements in tropical settings. Most fertilizers are applied in rainy season, from May to October. However, many farms now are fertilized one or two times in dry season simultaneously with irrigation.

Pruning: The main purposes of pruning are to control the tree not to be over bearing, to prevent alternate bearing, and to eliminate all disease infested and unproductive branches. This work can be carried out year-round, but mainly concentrated on two periods, after finishing harvest and at beginning of rainy season.

Weeding and maintaining basin: Coffee is very sensitive to competition from any kind of weeds, both in the wet and dry seasons, a huge reduction in yield can be expected free growing uncontrolled weeds in the coffee farms. However, for coffee in productive stage of the province, weed is not a problem in coffee production because coffee coverage prevents weeds from growing. Now weeding activity is always

combined with maintaining basin in each coffee hill to protect soil surface from erosion in the wet season.

Pests and diseases control: This work requires the knowledge of the growers in identifying characteristic of each kind of pest or disease and level of damage to make a good decision for controlling. Year-round monitor of insect pest and disease levels on farm is very important for better decision-making.

Harvesting: In the province, coffee harvest is obtained by hand picking the ripen-berries at intervals of several weeks, often this work starts in October and ends in December or early January. After collecting the berries, the berry coffee usually is processed by two common methods of dry or wet processing to become green beans for market.

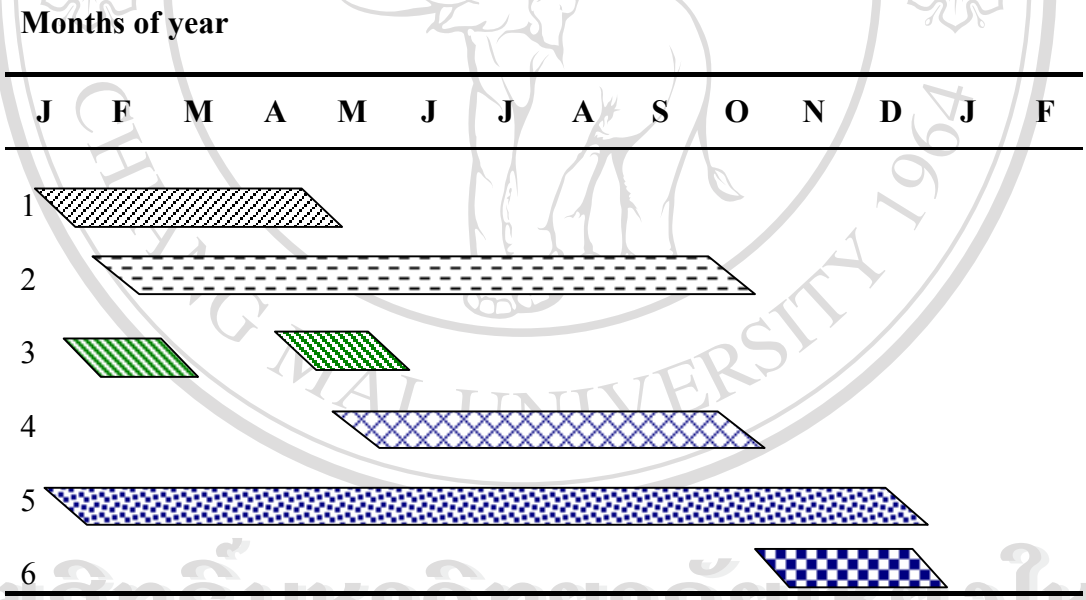


Figure 5. Seasonal calendar of coffee production in DakLak

Source: Survey, 2002.

Note: 1: Irrigating, 2: Fertilizing, 3: Pruning, 4: Weeding and maintaining basin, 5: Pests and diseases control, and 6: Harvesting.

For durian cultivation

Durian needs less water during dry season. Depending on the variety that irrigation can start early or later to induce flowering. In rainy season nitrogen, phosphorus and potassium (K_2SO_4 is better than KCl) are applied 2 times in May and July. However, many farms now are fertilized one time in dry season simultaneously with irrigation. Pruning can be carried out year-round, but mainly concentrated on two periods, after finishing harvest and in September. Pests and diseases management requires the knowledge of the growers in identifying characteristic of each kind of pest or disease and level of damage to make a good decision for controlling. Year-round monitor of insect pest and disease levels on farm is very important for better decision-making.

For black pepper cultivation

Black pepper needs to be irrigated during dry season in DakLak province. But before harvesting (from January to March) black pepper requires less water for maintaining its body performance and berries. About one month after harvesting (in August or May), water should be applied to induce even flowering. An attention should be paid is mulch in dry season, because pepper plant has a shallow root system. Pepper plant reacts very well to organic fertilizer, nitrogen, phosphorus, potassium, and magnesium. Most fertilizers are applied three times at the given months of May, July and September and one or two times in dry season simultaneously with irrigation. Pepper plants are pruned to get stronger plants, to reduce wild growth of the runners, to keep the plants at a certain height, to stimulate the growth of lateral fruit-bearing branches. This work can be carried out year-round, but mainly to be done after finishing harvest. Year-round monitor of insect pest and disease levels on farm is very important for better decision-making. In the province, after flowering, it takes about 9 months before the ripe berries can be picked. Harvesting often takes a period of 2 to 3 months.

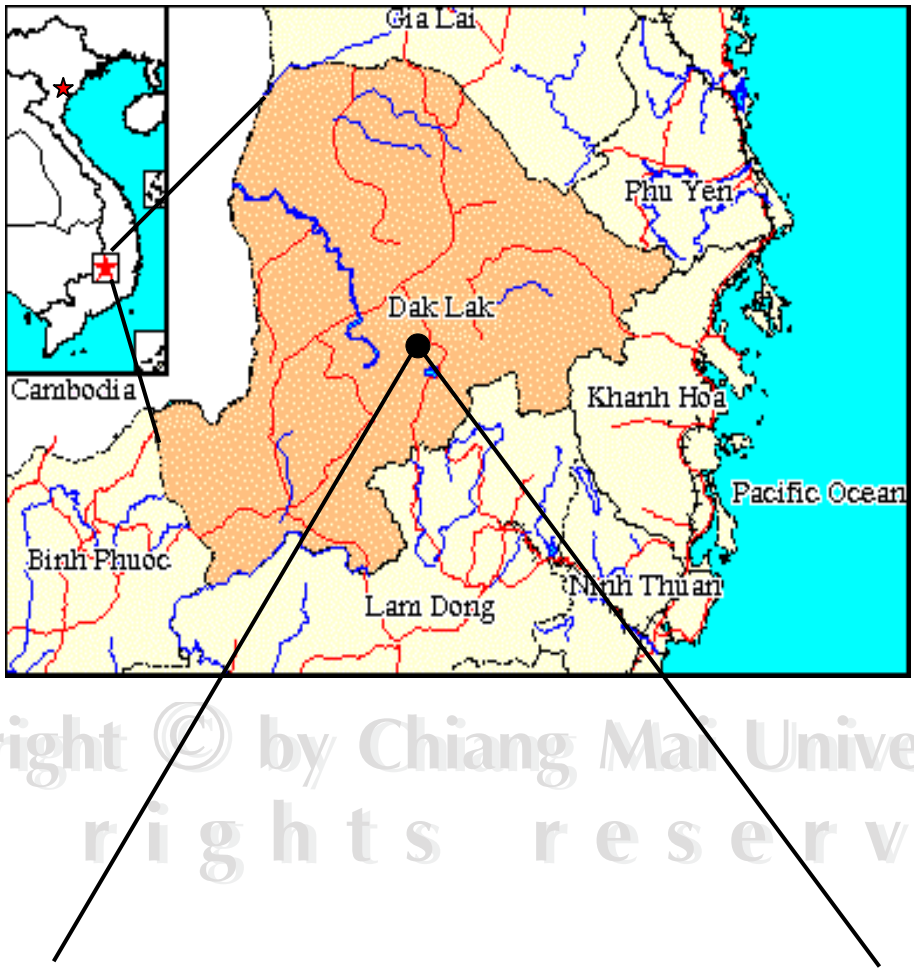
4.3 Description of the survey area

4.3.1 Geographical location

The study site, Ea Ktur village, is one of 12 villages of Krong Ana district, DakLak province, and located along the left-hand side of the national road 27 on the northeast direction. It is about 17 km far away from Buon Ma Thuot, a heart of Dakkak, and bordered by Hoa Dong village in the north, Ea Bhuk in the south, Cu Ewi in the east, Ea Tieu of Krong Ana and Hoa Thang of Buon Ma Thuot in the west (Figure 6).

4.3.2 Topography

Topography of Ea Ktur is gully and roll, with gradient ranging from 15 - 20 percent. Its elevation is about 450m above sea level and is covered by long-term crops.



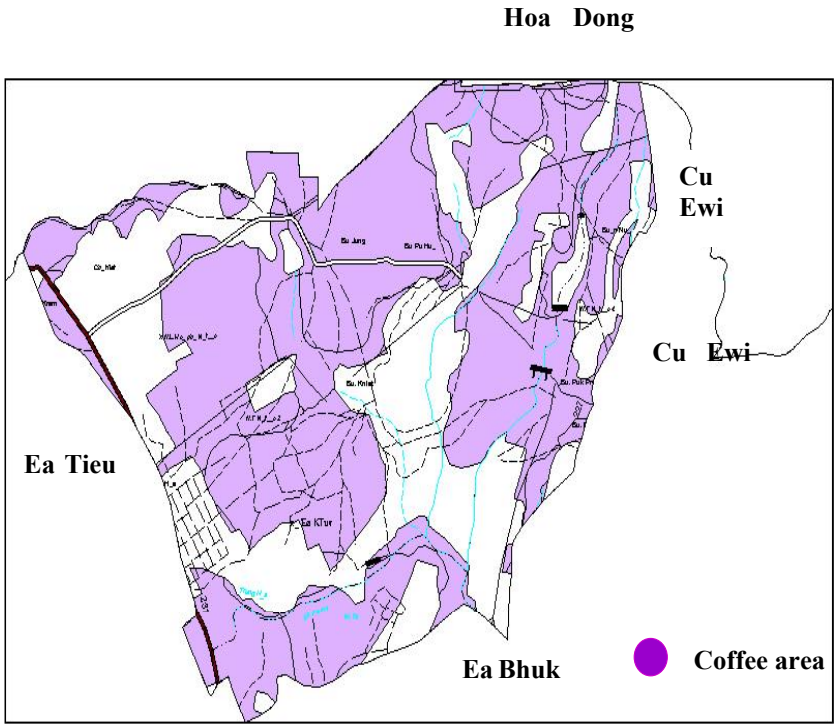


Figure 6. Study site map (Ea Ktur village)

4.3.3 Climatic conditions

Table 4. Five year average meteorological data of Ea Ktur (1997-2001)

Month	Mean temp.(°C)	Precipitation (mm)	RH (%)	Evaporation (mm)	Wind speed (m/s)
Jan.	21.4	2.3	75	128	6.2
Feb.	22.6	0	73	163	6.6
Mar.	24.9	8.4	72	182	4.2
Apr.	26.3	30.7	74	165	3.5
May	25.1	152.7	80	87	2.0
Jun.	24.6	256.8	84	61	1.8
Jul.	24.7	273.2	88	58	1.7

Aug.	24.2	323.5	90	50	1.8
Sep.	23.3	297.4	87	46	1.6
Oct.	23.6	194.6	87	68	2.3
Nov.	22.5	58.9	85	87	4.1
Dec.	20.9	18.6	80	98	5.7

Source: Ea Kmat Meteorological Station, 2002.

Note: Temp.: temperature, RH: relative humidity

Because of its geographical location, Ea Ktur is affected by the climate regime of Buon Ma Thuot plateau with two separated seasons, the dry one from November to late April with strong monsoon coming from the northeast and the rainy season normally starts in May and ends in late October, with a peak in August. The annual precipitation of the area is over 1,600mm, but unevenly distributed among the months, more than 93 percent of total is concentrated within the 6 months of wet season. Meanwhile, the dry season has high evaporation of 87 - 182 mm per month, and strong wind speed ranging from 3.5 - 6.6 meters per second that causes a big problem in agricultural production, especially coffee production, in the area. However, there is no large gap of air temperature among the months. The hottest month is April with average air temperature of 26.3^{o}C, the coldest one is December with average air temperature of 20.9^{o}C (Table 4). The annual sunlight is 1,700 - 2,400 hours, averaging 2,050 hours.

4.3.4 Land use

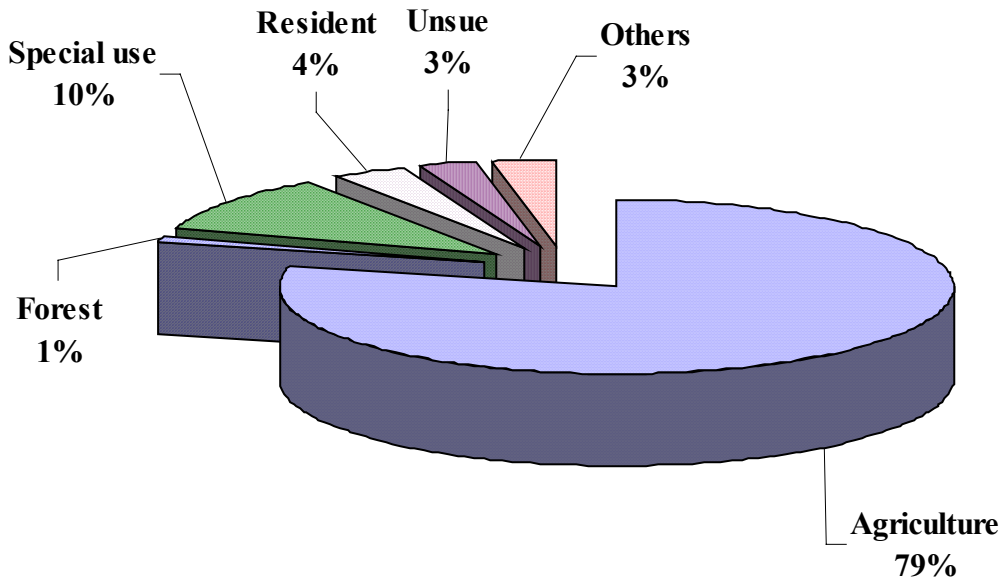


Figure 7. The status of land use in Ea Ktur village

Source: DakLak Land Management Department, 2001.

The total area of the site is 4,195 hectares of which agricultural land occupied 79 percent of total area. Land used for agriculture was mainly devoted to perennial crops with the area of 3,038.2 hectares or 72.4 percent of total area. Forest was 1 percent, but under afforestation, there was no natural forest in the study site. Special lands such as construction land, road land, and burial land occupies about 10 percent (Figure 7). Total area of lakes, ponds, reservoirs and streams is 3 percent; these are the vital sources to supply water for irrigation and life of the local.

Soil types of Ea Ktur

There are three soil types in Ea Ktur. Acid gley soils (Dystric Gleysols) is 125.9 hectares, or equivalent to 3 percent of total area, and distributed in the south of village. Yellowish brown soils (Xanthic Ferralsols) is equal to 3.4 percent, which is distributed on the northern village. Reddish brown soils (Rhodic Ferralsols), the most important soil type, occupied 91.7 percent of total area, distributed in the village-

wide. This is the soil type with physical and chemical properties that are very suitable for long-term crops especially coffee crop (Table 5).

Table 5. Soil types of the village

Soil name	FAO-UNESCO name	Area (ha)	Percentage of total area
Reddish-brown soils	Rhodic Ferralsols	3,846.8	91.7
Acid gley soils	Dystric Fluvisols	125.9	3.0
Yellowish-brown soils	Xanthic Ferralsols	142.6	3.4
Others	-	79.7	1.9

Source: Loan *et al.*, 1989.

Loan *et al.* (1989) classified properties of basaltic soil or reddish-brown soil (Rhodic Ferralsols) profiles in Ea Ktur and showed that the soil developed on basaltic parent rock. With soil depth was more than 120 cm, soil bulk density ranged from 0.97 g/cm^3 in the top layer to 1.10 g/cm^3 in bottom layer of the profile. The soil particle-size of over 0.25mm varied from 57.6 to 62.2 percent (Table 6).

The soil reaction was acidic in the whole profile, pH_{KCl} ranges 4.3 - 4.6, total organic mater, nitrogenous contents were at medium level. Total phosphorus was high, but the available contents of phosphorus (P_2O_5) and potassium (K_2O) were quite low, 14.5 milligrams of P_2O_5 per 100-gram of soil and 12.2 milligrams of K_2O per 100-gram of soil in 40cm surface layer (Table 7). So the application of nutrients played very important roles in growth, development and yield of crops.

Table 6. Physical properties of basaltic soil (Rhodic Ferralsols) in Ea Ktur

Soil depth (cm)	Bulk density (g/cm^3)	Porosity (percent)	Aggregate (percent)	
			> 0.25mm	< 0.25mm
0 - 40	0.97	59.12	62.2	37.8
40 - 80	1.05	56.25	59.2	40.8

80 - 120	1.10	54.73	57.6	42.4

Source: Loan *et al*., 1989.

Table 7. The chemical properties of basaltic soil (Rhodic Ferralsols) in DakLak

Soil depth (cm)	pH KCl	Total (%)				Available (mg/100g)		Ex. cations (meq/100g)	
		O.M	N	P_2O_5	K_2O	P_2O_5	K_2O	Ca^{++}	Mg^{++}
0 - 40	4.5	3.88	0.21	0.19	0.06	14.5	12.2	1.93	1.72
40 - 80	4.3	2.64	0.15	0.16	0.04	10.5	8.1	1.85	1.54
80 -120	4.6	1.65	0.08	0.16	0.03	6.6	6.2	2.01	1.68

Source: Loan *et al.,* 1989.

Note: O.M: organic matter, Ex. cations: exchangeable cations

In general, relying on the soil properties identified, especially physical properties, the soil scientists and coffee researchers came with a conclusion that soil in Ea Ktur could meet the requirements of several long term crops, but it is very suitable with robusta coffee.

Cropping Systems

Figure 8 shows that coffee is the key crop of cropping system of the village, with total area of 3,020.8 hectares or equivalent to 91.26 percent of agricultural land area (3,310.2 hectares), of which 2,271.6 hectares under mono-coffee, 749.2 hectares of intercropping farms. In the past, designing coffee farm exposed under sun was a desire of coffee growers who thought that sun coffee farms produced higher yield and easier management than intercropping farms. However, in recent years, this perception has changed, many growers would like to develop their coffee farms under intercropping

coffee with other tree crops in order to reduce external and internal risks in production, to stabilize income.

Besides coffee, there were some other crops such as rubber, black pepper, and fruit trees planted in the studied area, with the area of less than 2 percent for each crop. The food crops of lowland and upland rice, which occupied 8.23 percent, and gave average yields of 5.30 tons and 0.95 ton per hectare respectively.

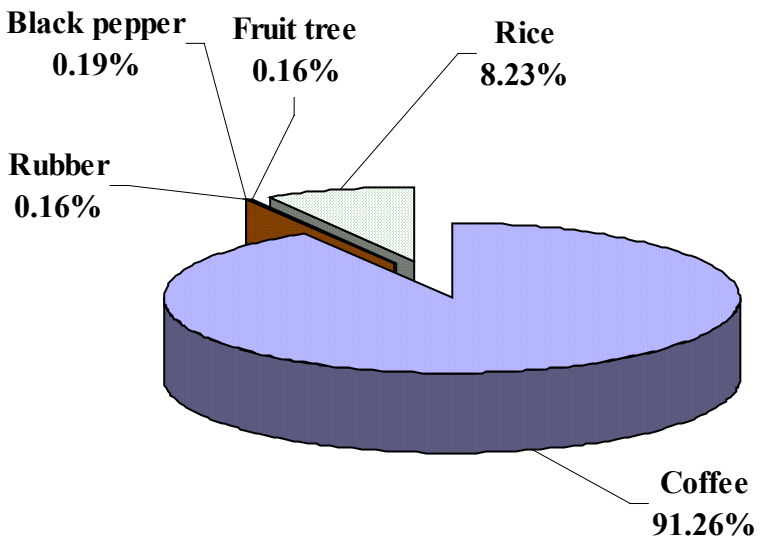


Figure 8. Cropping area in Ea Ktur
Source: DakLak Land Management Department, 2001.

Coffee yields of the village ranged quite widely among the farms in the same coffee-based farming system as well as between the coffee systems. In most of the area (70.3 percent) of the mono-coffee system gave the coffee yield less than 16 tons of fresh weight per hectare. 28.6 percent farm produced less than 14 tons of coffee per year. Meanwhile, the area with the yield over 18 tons occupied only 4.5 percent of total coffee area of mono-coffee system. For the coffee intercropping system, the coffee yield less than 14 tons per hectare was found out in 82.8 percent area (Table 8).

The figures showed the importance of understanding farmers' practices in both the monoculture and intercropping coffee-based farming systems.

Table 8. Coffee yield distribution in the study site

Yield	Mono-coffee farm	Coffee intercropping farm
(ton/ha)	--- Percentage of area---	
> 18	4.5	0.0
16 - 18	25.2	0.0
14 - 16	41.7	17.2
< 14	28.6	82.8

Source: Ea Ktur People's Committee, 2002.

4.4 History of coffee development in the study site

Coffee had planted with small area in the study site since in the1950s. Until 1975 a total coffee area remained at about 200 hectares, with an average annual yield of 6 tons of fresh berries per hectare. The rapid development of coffee started in the 1980s, with a total coffee area planted of around 800 hectares. All coffee farms were uniformly designed under one technical standard, and belonged to the state-run enterprises or joint-venture enterprises. The largest coffee area development of about 1,500 hectares has been recorded since 1990, with a peak in 1990 and 1991. In this period, coffee farms were developed under monoculture as well as intercropping systems, and mainly belonged to the households. The coffee development has positively contributed to develop socioeconomic of the studied village, but it has also begun causing the problems for environment such as water shortage in dry season, air and water contamination, and soil degradation (Ea Ktur People's Committee, 2002).

4.5 Farmers' socioeconomic background

All farmers interviewed in this study belonged to a majority group, called "Kinh", which occupied about 95 percent of total population of the village. The respondents' age ranged from 20-65 years old. 87.0 percent (120 persons) of interviewees were in-group of 30-59 years old. The 40-49 year old farmers were the biggest group, with 16 persons, 16 persons and 22 persons belonged to coffee monoculture system (P1), coffee-durian intercropping system (P2) and coffee-black pepper intercropping system (P3), respectively (Table 9).

Table 9. Average age of the interviewed farmers

Age	Overall	P1	P2	P3
(year)	--- Number of farmers---			
20–29	13	2	5	6
30–39	40	11	15	14
40–49	54	16	16	22
50–59	26	14	8	4
60-65	5	3	2	0

Source: Survey, 2002.

Note: P1(n=46): mono-coffee system, P2 (n=46): coffee-durian intercropping system, $P_{3\ (n=46)}$: coffee-black pepper intercropping system

Most of the farmers had formal education, the majority were only educated to secondary school and high school, with 60 farmers and 48 farmers of total 138 respondents respectively. 9 persons were at diploma level, and especially, there were 16 farmers, approximately 12 percent, have graduated from universities. The educational level of the respondents was evenly distributed among the coffee system growers. However, the owners of intercropping farms of coffee - black pepper (P3) were got a little bit higher education level than those of mono-coffee and coffee-durian systems (P1 and P2) (Table 10). Maybe, higher education level has helped them to be easy accessibility to advanced information and technologies as well as predicted the risks that could be able to take place whenever in production. Therefore,

they have designed their farms in form of intercropping coffee-based farming systems as a solution to reduce risks.

Table 10. Educational level of the interviewed farmers

Education level	Overall	P1	P2	P3
	--- Number of farmers---			
Primary school	5	2	2	1
Secondary school	60	24	20	16
High school	48	15	15	18
Diploma	9	3	4	2
University	16	2	5	9

Source: Survey, 2002.

Note: P1(n=46): mono-coffee system, P2 (n=46): coffee-durian intercropping system, P3 (n=46): coffee-black pepper intercropping system

Table 11. Total member and average family size of the households (persons)

Variable	Overall		P1		P2		P3	
	Total	Mean	Total	Mean	Total	Mean	Total	Mean
Family size	897	6.5	313	6.8	294	6.4	290	6.3
Male	469	3.4	161	3.5	166	3.6	142	3.1
Female	428	3.1	152	3.3	128	2.8	148	3.2

Source: Survey, 2002.

Note: P1(n=46): mono-coffee system, P2 (n=46): coffee-durian intercropping system, P3 (n=46): coffee-black pepper intercropping system

Total members of surveyed households were 897 people of which 428 were female, the rest was male. On average, farmers had medium families of around 6 to 7 individuals with a maximum of 10 members and minimum of 4 persons. In the specific coffee system, the male numbers were a bit higher than female ones, with ratio of female to male was approximately 1 (Table 11). All interviewees have been working in coffee for more than 10 years, even 20-year experience. Many of them were very familiar with coffee cultivation from their childhood. 24 farmers, 29 farmers and 21 farmers of P1, P2 and P3 respectively, had 11 to15-year experience, the rest farmers had at least 16-year working (Table 12).

Table 12. Years of experience in coffee production of interviewed farmers

Range	**P1**	**P2**	**P3**
(year)	**--- Number of farmers ---**		
10 - 15	24	29	21
16 - 20	15	13	9
> 20	7	4	16

Source: Survey, 2002.

Note: P1(n=46): mono-coffee system, P2 (n=46): coffee-durian intercropping system, P3 (n=46): coffee-black pepper intercropping system

According to data from community council and village leaders, 80 percent of farmers have their own coffee farms, and the rest has made a 50-year contract of owning coffee farms with state-run enterprises. These farmers have several rights related to their farms and profit, except the right of transferring their farms to other owners and converting coffee farms to other crops. In this case, they have to get permission from the enterprise.

Most of the households in the village relied on agricultural production to earn for living. Most of the family income came from the agricultural products, especially primary products. So agricultural production has been playing very important roles in development of socioeconomic of the local. Coffee, the key cash tree, contributed from 50 to 90 percent of total family income. The data in the Table 13 shows the

contribution of coffee production to total family income of the interviewed farmers. About 65.2 percent of total farmers said that over 90 percent their family income gained from coffee production, 25.4 percent reported 71-90 percent and the rest answered from 51 - 70 percent. Most of farmers in a certain coffee system reported that over 70 percent of their family income earned from coffee production, which was the crucial source for their living standard. Therefore, they have spent not only so much money but also their time, technologies and knowledge in production in order to obtain sustainable and high coffee yield.

Table 13. Contribution of coffee production to income of surveyed households

Percentage of income	Overall	P1	P2	P3
	--- Percentage of farmers ---			
51-70	9.4	6.5	13.0	8.7
71-90	25.4	21.7	30.4	23.9
> 90	65.2	71.7	56.5	67.4

Source: Survey, 2002.

Note: P_1 (n=46): mono-coffee system, P_2 (n=46): coffee-durian intercropping system, P_3 (n=46): coffee-black pepper intercropping system

4.6 Constraints in coffee production of the study area

In order to identify the constraints in coffee production of the village, the randomly collected samples of the coffee growers and informants were interviewed with only a question of what the problems in coffee production of the village? The answers are listed in the Table 14. All the interviewees said that coffee price fluctuation was adversely affected to production, because in the years of low coffee price, cost of production was over gross return. Next was coffee yield decreasing yeraly in the past five years. Thirdly, low income from coffee product in recent years, because of low coffee price. Finally, the credit accessibility was not so important

factor affecting to coffee production of the farmers, due to several state-run credit services were available to provide money to coffee producers.

Although a total ten constraints were found out, but they could be grouped into 3 factors. First was a market factor, coffee price fluctuation. Second was a technological factor, technical knowledge, and last one was credit accessibility. For the second factors, technical knowledge consisted of the others. Because technical knowledge encompassed of all farm management skills, which were able to affect to water-use efficiency and fertilizer-use efficiency, unsuitable pest management. In addition, heavy dependence on external inputs, less knowledge on designing other intercropping coffee-based farming systems were also the results of the second factor. As a consequence, these adversely affected to the productivity of the farms, leading to decline in coffee yield. Therefore, the income from farm decreased.

Table 14. Constraints in coffee production of the study area

Constraint	Respondents (n=400)		Ranking order
	Number	Percentage	
Coffee price fluctuation	400	100.0	1
Yield decrease	346	86.5	2
Low income from farm	320	80.0	3
Less knowledge on designing other CBFSs	314	78.5	4
Soil degradation	280	70.0	5
Low water use efficiency	280	70.0	5
Low fertilizer use efficiency	280	70.0	5
Pests outbreak	254	63.5	6
Heavy dependence on external inputs	189	47.3	7
Credit accessibility	50	12.5	8

Source: Survey, 2002.