CHAPTER 5

CHARACTERIZATION OF

INTEGRATED COFFEE-BASED FARMING SYSTEMS

5.1 General characteristics of interviewed farmers

Based on survey's result in 2008 of 119 samples from three villages (Catur, Belantih, and Pengejaran), there are three systems of integrated coffee-based farming systems in the study area: 1) coffee (*Coffea arabica)* integrated with tangerine (*Citrus nobilis Lour*) and livestock (cow and pig) with 79 samples (CTL), 2) coffee (*Coffea arabica*) integrated with clove (*Syzygium aromaticum*) and livestock (cow and pig) with 30 samples (CCL), and 3) coffee (*Coffea arabica*) integrated with livestock (cow and pig) with 10 samples (CL). The distribution of surveyed farmers in each village and farming system is shown in Table 5.1.

Table 5.1 Number of surveyed farmers in three integrated coffee-based farming systems

Village	CTL	CCL	CL
Catur	39 (49.4%)	25 (83.3%)	2 (20%)
Pengejaran	17 (21.5%)	5 (16.7%)	0
Belantih	23 (29.1%)	0	8 (80%)
total	79 (100%)	30 (100%)	10 (100%)

Source: primary data, 2008

The total land use for integrated coffee-based farming systems in the study area were varied from 0.5 ha to more than 3 ha per farm, but most of them have less

than 3 ha (see Table 5.2). Wintgens (2004, p.825) categorized the range of land used for arabica coffee less than three hectares as small-scale operation, so based on this referrence, most of farmers in this study were categorized as small-scale farmers.

Table 5.2 Land holding of surveyed farmers in the study area

Land area (ha)	**CTL**	**CCL**	**CL**	**Total**
0 – 3	76	27	9	112
>3	3	3	1	7
total	79	30	10	119
Average (ha)	1.02	1.24	1.35	

Source: primary data, 2008.

Regarding the age of interviewed farmers, among the three systems, 43.7% of farmers were in the age between 25 to 39 years old, 31.9% were between 40 to 54 years old, 16.8% were in the age of 55 to 64 years old, and 7.6% were in the age more than 64 years old (see Table 5.3). In Indonesia, the productive age determined by age less than 64 years old (Center Bureau of Statistics, 2007), so, the result shows that more than 80% of interviewed farmers are productive farmers. All of interviewed farmers were household heads, and they were the main decision makers in their households.

Concerning the education level of farmers in the three systems, averagely 4.2% of farmers were non educated, 65.5% were farmers with primary school education level, 28.6% with high school education level, and only 1.7% with post-

high school education level (see Table 5.4). This is indicated that most of farmers are literate.

Table 5.3 Age of surveyed farmers in the study area

Age (years)	CTL	CCL	CL	Total
25 to 39	38	9	5	52 (43.7%)
40 to 54	20	13	5	38 (31.9%)
55 to 64	14	6	0	20 (16.8%)
> 64	7	2	0	9 (7.6%)
Total	79	30	10	119

Source: Primary data, 2008

Table 5.4 Education level of surveyed farmers in the study area

Level of education (years)	CTL	CCL	CL	Total
< 6	5	-	-	5 (4.2%)
6 – 9	48	24	6	78 (65.5%)
9 – 12	24	6	4	34 (28.6%)
> 12	2	-	-	2 (1.7%)
Total	79	30	10	119

Source: primary data, 2008

Based on survey on family members of farmers, it was found that most sample farmers (92.43%) among the three systems have four members or less. Only 7.57% of farmers who have family member more than four people in their household (see Table 5.5). This is because of the implementation of “Program Keluarga Berencana (KB)”

(family planning program policy) in Indonesia that encouraged family to have two children at most starting from 1990s. Bali is one province that acknowledge succeed in implementing this program. In relation with the family labor availability, this condition turned into threat in doing farming systems, as family labor availability is low, it implied high requirement on hired labor, especially for those who have land more than one hectare. As consequent, this indicated higher cost in farming systems.

Table 5.5 Members of household of interviewed farmers in the study area

No.of members (persons)	CTL	CCL	CL	Total
2 - 4	74	26	10	110 (92.43%)
> 4	5	4	0	9 (7.57%)
Total	79	30	10	119

Source: primary data, 2008

5.2 Characteristics of coffee-based farming systems

Farming techniques application on the study area of Kintamani is relatively uniform. Currently, arabica coffee farmers almost 100% do organic farming by applying organic manure for their coffee, and produce the manure by themselves inside the farm (cow dung). Pesticides have never applied on coffee farming. Population of coffee ranges from 333 to 1,646 plants per hectare. Single stem system commonly applied by the farmers to prune their coffee bush, they cut their coffee at 180 cm height in order to facilitate harvesting. On this system, cherries bearing was depend on the branching management; the better branch pruning management is the more stable and the higher cherries production. Among the three systems, the shade

trees were also included as a part of the system, such as *Erythrina* and *Leucaena.* Farmers valued the shade trees more in term of its ecological function and less to its economic function. Most farmers designed their farms without specific spacing between trees, but usually they planted shade trees as hedgerow, in the edge of farm boundary, and in the sloping land. Most interviewed farmers have been practicing coffee farming systems for more than ten years. Based on survey on age of coffee trees among the three systems, it was found that the average age of coffee trees in CTL was 15.6 years old, in CCL was 15.8 years old, and in CL was 15.3 years old. There is no significant difference of coffee trees' age among the three systems.

In terms of number of trees, in CTL, where farmers integrated coffee with tangerine, the number of coffee plants varied. The minimum number of coffee trees from the survey was 667 trees in one hectare of land, mixed with 400 tangerine trees. The maximum reached 1,067 trees of coffee with 633 trees of tangerine per hectare. So, on average, in CTL, farmers cultivated 979 coffee trees integrated with 582 tangerine trees. This is a little bit different from CCL, where farmers integrated their coffee with clove. In CCL, the number of coffee trees ranged from 333 to 1015 trees per hectare, where averagely, farmers cultivated 903 trees of coffee integrated with 200 trees of clove. In CL, where farmers cultivated only coffee, the number of trees are ranging significantly from CTL and CCL. In CL, there are 1,000 to 1,676 trees of coffee per hectare, where averagely, farmers cultivated 1,377 trees of coffee per hectare (see Table 5.6).

Regarding the livestock integrated in the systems, there were two kinds of livestock possessed: cow and pig. The result from the survey shows that there is one

case of outlier in CTL in terms of cow rising, where one farmer has 14 cows. But, averagely, farmers in CTL possess more than two cows. This is typically the same with those in CCL and CL. For pig possessions, most farmers in the three systems did not raise pig (CTL 80%, in CCL 40%, and in CL 80%) while some rise between 1 to 4 pigs in their farms. The average pigs owned less than one in every system (see Table 5.7).

Table 5.6 Number of trees in integrated coffee-based farming systems

Items	Number of trees per hectare			
	Min	Max	Mean	SD (Standard Deviation)
CTL (n=79)				
Coffee tree	667	1067	979.79	54.17
Tangerine tree	400	633	582.44	45.44
CCL (n=30)				
Coffee tree	333	1015	903.5	151.17
Clove tree	200	200	200	0
CL (n=10)				
Coffee tree	1000	1646	1377.1	155.33

Source: primary data, 2008

Table 5.7 Number of livestock in integrated coffee-based farming systems

Items	Number of livestock			
	Min	Max	Mean	SD
Cows				
CTL	0	14	2.9	1.87
CCL	1	5	2.7	1.01
CL	2	4	2.9	0.87
Pigs				
CTL	0	4	0.25	0.67
CCL	0	4	0.76	0.89
CL	0	1	0.20	0.42

Sources: primary data, 2008

In term of time allocation for farm management, such as: fertilizing, pest control, weeding, and pruning, most farmers allocated the same time in the three different patterns of integrated coffee-based farming systems. A slight difference appears only in harvesting time, where coffee harvesting usually start from July until September, tangerine harvesting time is from May to August, and clove harvesting time is from June to August annually. Cropping calendar is shown in table 5.8.

Table 5.8 Cropping calendar of integrated coffee-based farming systems

Activities	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Fertilizing												
Pest control												
Weeding												
Pruning												
Harvesting							<==coffee==>					
					<===tangerine===>							
						<==clove==>						

Source: survey, 2008

5.2.1 Integrated coffee with tangerine and livestock farming systems (CTL)

Generally, among the three integrated coffee-based farming systems observed in the study area, integration of coffee with tangerine and livestock (CTL) is the well-known pattern. Farmers were integrating their coffee with tangerine, due to the specialty (sweet taste) of Kintamani tangerine which is famous in the provincial level and the low-fluctuated price from year to year of tangerine which is good for stabilizing the farm income besides the fluctuated price of arabica coffee. Moreover,

the tangerine has been introduced to farmers in the study area before arabica coffee. So, they were having more experiences and they are likely to adopt this system.

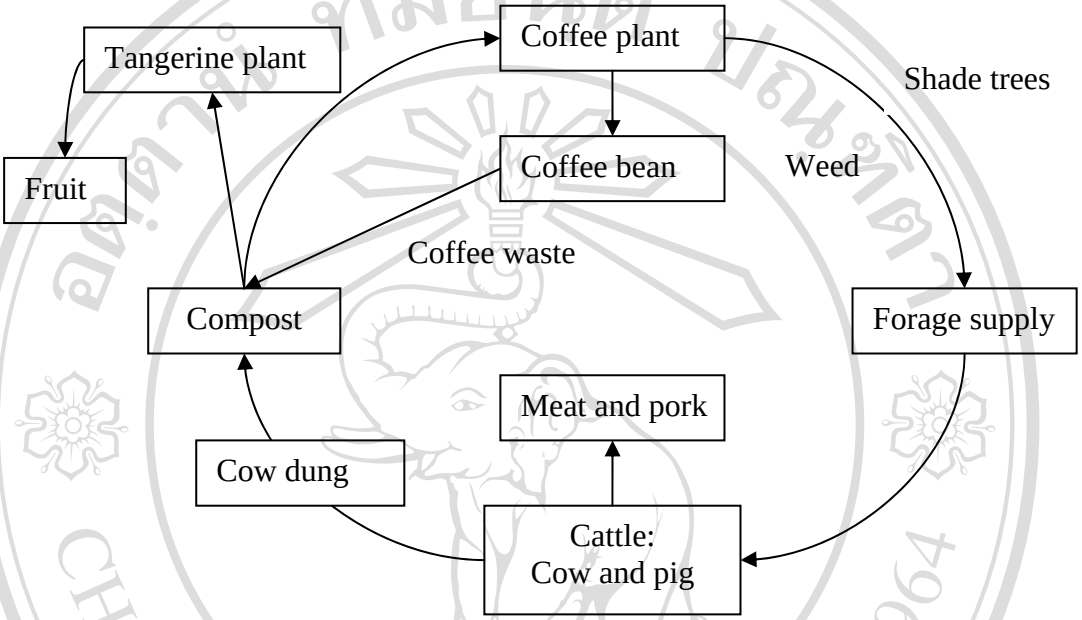
In CTL where arabica coffee integrated with tangerine and livestock, most farmer planted shade trees as a hedgerow in the edge of the land (see figure 5.1) and livestock were kept surrounding the farm. Commonly, the space between coffee and tangerine is 2.5 m x 2.5 m.

Figure 5.1 Pattern of CTL

Based on the survey, the forage supply for cattle were gained from weed and shade trees wastes from the farm and cattle waste were returned as manure. As mentioned earlier, most of irrigation systems in the study area are highly dependent on rainfall. No additional irrigation was applied in their coffee-based farming system since water is the scarce resource. To reduce the water loss from the soils, they applied mulching and utilized the shade trees in their farm.

The main product of coffee plant and tangerine plant are coffee bean and tangerine fruit for sell or consumption. Livestock (cow and pig) are kept for emergency cash and religious ceremony, such as: “pawiwahan” (wedding), “ngaben” (death ceremony), “odalan” (temple celebration), etc. Commonly, the integration in

this system categorized as traditional plain integration (Antari, 2006), where there were utilization of local resources as input in the systems and re-cycling of waste (output) to be input (see Figure 5.2).



Sources: adapted from Antari (2006)

Figure 5.2 Traditional plain integration of CTL

Furthermore, the marketing systems of 79 farmers in CTL were also varied. Based on the survey results, there are four ways of selling farmers' crops and livestock: a) only sell to *Subak* (farmers group) (8.9%); b) sell to traditional market nearby and *Subak* (59.5%); c) sell at farm and *Subak* (29.1%); and d) sell at farm, traditional market, and *Subak* (2.5%). Detailed are shown in Table 5.9.

Table 5.9 Marketing place of integrated coffee-tangerine-livestock farming systems

Place of marketing	Number of farmers	Percentage
Only sell to *subak*	7	8.9%
Sell at traditional market and *subak*	47	(59.5%)
Sell at farm and *subak*	23	(29.1%)
Sell at farm, traditional market, and *subak*	2	(2.5%)
Total farmers	79	(100%)

Source: computed from survey, 2008

5.2.2 Integrated coffee with clove and livestock farming systems (CCL)

Clove is a high-value perennial and widespread spice crop found in Indonesia, except in the study area. The integration of clove with coffee in the study area was introduced in 1980's when provincial government encouraged farmers to develop the clove as an alternative perennial crop, besides arabica coffee. The first harvest of clove was in six year after plantation, which is longer than the coffee. This was one of consideration that made farmers rather hard to adopt this system. Another consideration was due to lack of knowledge and experience in clove farming. So, only a few farmers adopted this system in the study area.

In CCL where arabica coffee integrated with clove and livestock, most farmers placed shade trees as a hedgerow in the edge of the land and placed clove in the center. Livestock were kept surrounding the farm. There was no specific spacing in the system, but most farmers applied the pattern as shown in figure 5.3.

The same as CTL, the farmers in CCL were not applied chemical into their farm since local government encouraged them in 2003. They only applied the organic fertilizer (cattle manure) to their farm twice a year: March (during coffee flowering)

and October (after the harvesting of both crops). Commonly, the space between coffees is 2.5 m x 2.5 m, and space between coffee and clove are 6 m x 6 m.

Figure 5.3 Pattern of CCL

Based on the survey, the forage supply for cattle were gained from weed and shade trees wastes from the farm and cattle waste were returned as manure. Like in CTL, there is no additional irrigation in CCL. To reduce the water loss from the soils, they applied mulching and utilized the shade trees in their farm.

The main product of coffee plant and clove plant are coffee bean and clove flower buds for sell or herbal needs and cattle for emergency cash and religious ceremony (similar with CTL). Commonly, the integration in this system categorized as traditional plain integration where there were utilization of local resources as input in the systems and re-cycling of waste (output) to be input (see Figure 5.4).

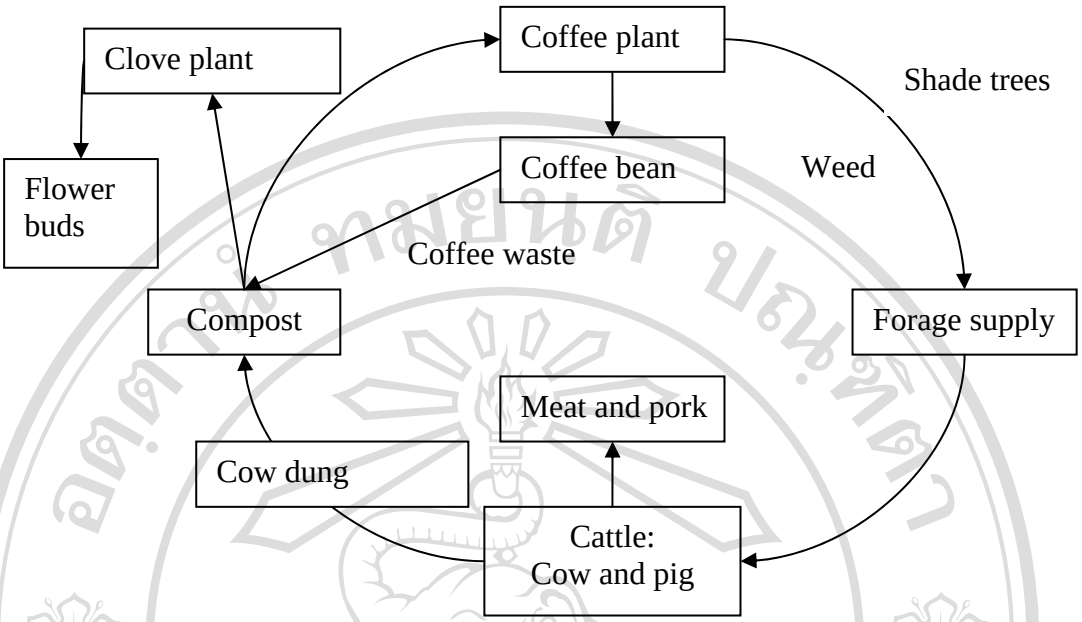


Figure 5.4 Traditional plain integration of CCL

Furthermore, the survey regarding the marketing systems of 30 farmers in CCL found that the farmers sold their crops and livestock in three ways: a) sell to a traditional market nearby and *Subak* (90%); b) sell at farm and *Subak* (3.3%); and c) sell at farm, traditional market, and *Subak* (6.7%) (See Table 5.10). *Subak* here refers to *Subak abian* which is an organization of farmers that cultivate plantation crops commodity, such as: coffee, cocoa, etc.

Table 5.10 Place of marketing of integrated coffee-clove-livestock farming systems

Place of marketing	**Number of farmers**	**Percentage**
Sell at traditional market and subak	27	90%
Sell at farm and subak	1	3.3%
Sell at farm, traditional market, and subak	2	6.7%
Total farmers	30	100%

Source: computed from survey, 2008

5.2.3 Integrated coffee and livestock farming systems (CL)

In CL where arabica coffee integrated with livestock, most farmers placed shade trees as a hedgerow in the edge of the land and in the center. Livestock were kept surrounding the farm. There was no specific spacing in the system, but most farmers applied the pattern as shown in figure 5.5. The same as CTL and CCL, the farmers in this system were not applied chemical into their farm since local government encouraged them in 2003. They only applied the organic fertilizer (cattle manure) to their farm twice a year: March (when coffee is flowering) and October (after the harvesting). Commonly, the space between coffees is 2.5 m x 2.5 m, and space between coffee and shade trees are 6 m x 6 m.

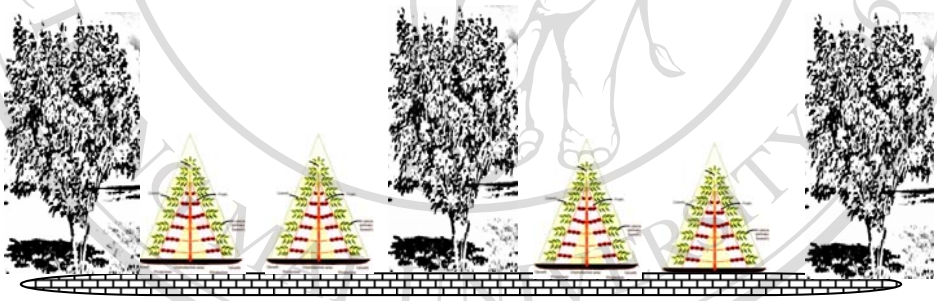


Figure 5.5 Pattern of CL

Based on the survey, the forage supply for cattle were gained from weed and shade trees wastes from the farm and cattle waste were returned as manure. As mentioned earlier, coffee production in the study area is highly dependent on rainfall. To reduce the water loss from the soils, they applied mulching and utilized the shade trees in their farm.

The main product of CL system is coffee bean and cattle for emergency cash. Besides that, the waste from processed coffee was recycled to be fertilizer. The same as CTL, commonly, the integration in this system categorized as traditional plain integration where there were utilization of local resources as input in the systems and re-cycling of waste (output) to be input (see Figure 5.6).

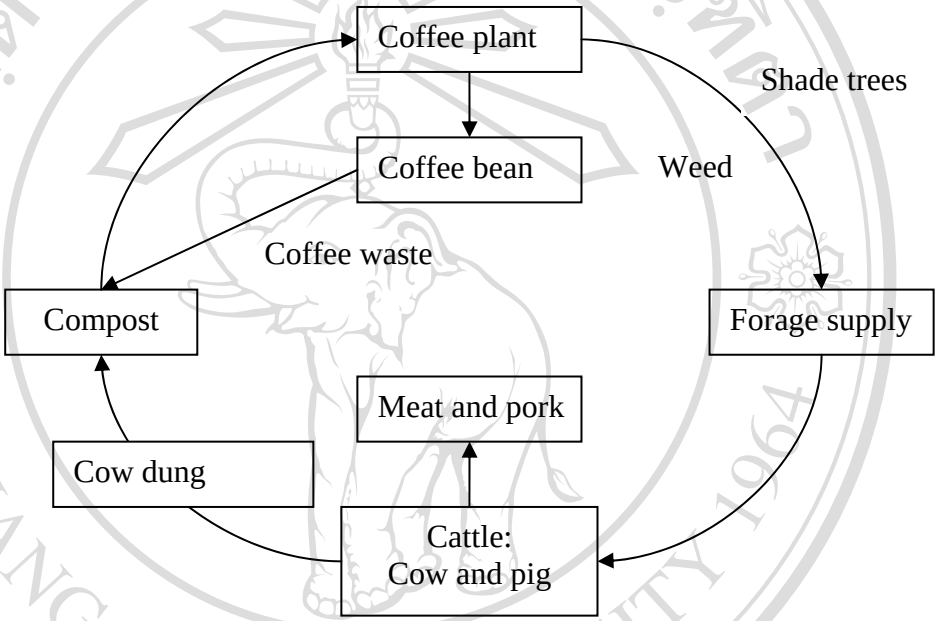


Figure 5.6 Traditional plain integration of CL

Similar with other two systems, the survey regarding the marketing also conducted for CL, and from the result it was observed that among 10 farmers of CL there are two ways of farmers to sell their crops and livestock: a) sell to traditional market nearby and *Subak* (90%); and b) sell at farm and *Subak* (10%). Detailed are shown in Table 5.11.

Table 5.11 Place of marketing of integrated coffee-livestock farming systems

Place of marketing	Number of farmers	Percentage
Sell at traditional market and subak	9	90%
Sell at farm and subak	1	10%
Total farmers	10	100%

Source: computed from survey, 2008

5.3 Overview of arabica coffee cultivation

5.3.1 Production aspect

Most of Balinese arabica coffee farmers grow S795 and USDA 762 varieties as recommended by the government. The two varieties are belonged to typical group, which are also widely grown by the planters to produce Toraja coffee in South Sulawesi and Java coffee in East Java. The two varieties are expected to perform unique distinctive characteristics under the study area, as a special quality sign or "tipicite" of the product.

In Kintamani sub district, especially in the three villages under the study area, farmers have been cultivating arabica coffee since the early of 1980. The seed that they used are developed from "Kembang Sari", the experiment center for arabica coffee development that belongs to estate crops agency of Bali province, that have been operating since 1971. From here, farmers get the knowledge about how to propagate their coffee seeds, and sometimes they have training program and field visit about the arabica coffee extension program. This plantation experimental field is located in Satera village, Kintamani sub district, 8 km from the study area. The total

area of experimental field is 10 hectares; consist of one hectare for seed development, and nine hectares for productive arabica coffee plants development. Environmental factors affecting the growth of coffee greatly are among others: the altitude, the rainfall, sunlight, wind and soil, such as: (a) the altitude range between 700 – 2,000 m a.s.l; (2) rainfall between 1,500 – 2,500 mm per year; (3) dry month averagely 3 – 4 months; (4) average temperature 15 – 25 degree celcius; (5) pH of the soil 5.5 – 6.5.

Generally, coffee needs a lot of sunlight in the beginning of the dry season or in the end of the wet season. The sunlight stimulates the growth of the flowers. The wind plays a very important role in spreading the pollen, especially in case of self-sterile coffee. Generally, coffee needs loose, fertile and rich soil.

Planting

Usually coffee seeds were planted in the beginning or in the middle of the wet season, because the newly-planted coffee seeds cannot stand drought. One year before the coffee trees are planted, some protective crops such as Leucaena, Erythrina, were planted first in order to protect the young trees from direct sunlight. Another function of the shade trees is that increasing the absorption of nitrogen from the air through their root nodules. Land preparation for planting arabica coffee started three months before. The hole for placing the seed usually varied; depend on the design of the farm. There are four sizes of hole: 50 x 50 x 50 cm, 60 x 60 x 60 cm, 75 x 75 x 75 cm, and 1 x 1 x 1 m for heavy soil.

Then, two or four weeks before planting, manure was mixed with the soil approximately 15 to 20 kg per hole. For the shade trees, the height of shade trees was two times from coffee plant. This is to give the optimum shade to the coffee plants.

When coffee plant and shade trees grow up, the shade trees can be reduced to be 1:2 or 1: 4. This is meant that one shade tree can shade two or four coffee plants.

Fertilizing

In the study area, farmers do fertilizing twice a year with organic fertilizers such as manure or compost in the beginning (October) and the end of the wet season (March), by putting in the soil at a depth of 10 -20 centimeters and spreading them around the crops, with average amount of 100 cubiq meter/ha/year.

Pests, diseases, and weeds control

In the case of pest attack, such as coffee cherry borer and branch borer (*xyloborus moliberus*) – which infected young and ripe cherries, also branch and small stem, farmers were controlling by manual: collected the infected cherries, or technically re-arrange the space between shade trees and coffee plants. Regarding coffee disease, there was no case reported in the study area.

Weed control in maintaining coffee system is aiming to limit the growth of grasses where they are great consumers of nitrogen, the most important nutritive element in coffee growing. Since farmers integrated their coffee, this is already one way to control the weed. Another way to control the weed is by weeding. Based on survey, farmers in the study area done weeding twice a year (on February and December) to clean the weed surrounding the coffee plants.

Pruning

Coffee trees can grow as high as 12 m with irregular and dense branching. This condition may make the trees susceptible to diseases, less fruitful and difficult to be harvested. Therefore, farmers do regular pruning. There are two stages of pruning:

foliage pruning and primary branches pruning. For foliage pruning, farmers usually do pruning at the early of rainy season (October). For primary branches pruning, farmers do this usually at the end of rainy season, around March.

Harvest and post-harvest

Arabica coffee tree starts producing at the age of 2.5 - 3 years, depending on the environment and the types. Production life of coffee can last for 20 years, and after that, farmers should re-new the coffee plant by rejuvenation, rehabilitation, etc. Coffee cherries that ready to be harvested were those which already red while green cherries are avoided to harvest. To process coffee bean from coffee cherries, there are two ways that farmers applied: wet processing and dry processing. For wet processing, coffee cherries were sortage, and open the fur, and fermented for 36 hours. After that, washing and cleaning for eliminate the juice left in the bean. Finally, farmers dried the coffee bean until the water content attained 12%. For dry processing, the coffee bean processed from green cherries and last harvesting. The coffee cherries directly dried until reach water content 13 %. Then, the dried cherries opened by Huller machine. For marketing systems, some farmers sold their crops through *Subak Abian*, nearest local market, and middle-man. For the processing and packaging of roasted coffee and coffee powder, it is only available at cooperative named Mulih Sari in Belantih village.

5.3.2 Social economic aspect

The establishment of large-scale coffee plantations will employ a lot of labors, from the preparation, construction and post-construction processes. Therefore, such

establishment will have positive impact on the plasma and the communities living around the plantation. The development of such plantations will teach an intensive and advanced farming system to the communities living around them in practical a method that is learning by doing.

Arabica coffee farmers in Kintamani are mostly strongly organized through Subak abian, namely a traditional structure of farmer organization on upland areas in Bali. Subak abian plays its important role not only on agriculture activities, but also on religious ones. In arabica growing area of Kintamani, there are fifty eight subak abian at the moment.

5.3.3 Other aspect

Arabica coffee from the study area has uniqeness: tangerine flavor and special acidity. Based on the uniqeness of arabica coffee from the study area, so, government of Bali has been trying to register for intellectual property rights for protecting the uniqeness with geographical indication (GI). Geographycal indication is one way of protection for goods because of their uniqeness, such as: originated area, specific quality, quality related with geographical condition or the human resources. Geographical indication (GI) protection is multilaterally acknowledge by WTO countries member (148 countries) including Indonesia, so Indonesia has been trying to ratify the TRIP's IG agreement in to State Act No. 15 Year 2001 regarding trademark, which detailed in Government Act No. 51 Year 2007 regarding geographycal indication. As an implementation, government of Bali province through Estate crop agency of Bali province have registered the Kintamani arabica coffee to

get sertification for GI to the Ministry of Law and Human Rights of Indonesia (Estate crops agency of Bali province, 2007).

5.4 Overview of tangerine cultivation

In the study area, farmers have been cultivating tangerine (*Citrus nobilis* Lour) for a long time. Farmers obtained the seeds from "Kembang Sari", and some are comes from their own experiment. The spacing of tangerine is varied from one location to the other location. Tangerine plantation spacing in low land (wet land) is relatively larger than those in upland, because 40% from wet land used for drainage and road. In Java, it usually used spacing 7 x 7 meter or 8 x 8 meter. But recommended tree spacing for tangerine in upland is 6 x 6 meter. But, in the study area, the spacing is 4.5 x 4.5 meter, less than recommended. The number of tangerine tree varied from 400 to 633 trees per hectare. The larger tree spacing generally reduces the density of trees per hectare. Moreover, since tangerine is integrated with coffee, where it also useful as shade tree, the larger the spacing, it will reduce the shade intensity to coffee trees, and could affect to the decline of coffee yield.

Tangerine plants prefer sandy to clay loam soil with a pH 5.5 – 7.5 (Mukhopadhyay, 2004). As a part of integrated crops with coffee, farmers maintain their tangerine the same time with coffee in terms of fertilizing; pest, disease, and weed controlling; pruning; trimming; except harvesting. In the study area, in the past, CVPD was the main disease or tangerine found in the study area. But, nowadays, there is no case found. Overall, pest and disease attack can be eliminated by continuous observation to orange tree.

In order to reduce the trees (tangerine) heavy load and damage during harvest season, shaves made out of wood or bamboo were assembled. The shaves are formed in squares and are suitable with the large stem that needs the grip. The larger the tree bigger the larger the shave needed.

5.5 Overview of clove cultivation

Clove (*Syzigium aromaticum*) is well known as spice to use in traditional herbal medicine. Clove is better grown in the soil type of latosol, mediteran, and andosol with pH optimum ranging from 5.5 to 6.5. The optimum rainfall is 1,500 – 2,500 mm annually with dry month less than two months, the temperature ranging between 25 to 34 ºC, and relative humidity is 80 to 90%.

Planting

The size of hole for planting the clove is ranging between 60 to 80 centimeter (in length and depth). Two weeks to one month before planting, farmers put cow manure 5 – 10 kg per hole. There is no specific tree spacing of clove in the study area, depend on the landscape, but common spacing is 6 m x 6 m, with 200 trees per hectare.

Fertilizing

The aim of fertilizing is to fix the plant growth and improve the yield. Kind of fertilizer that farmers applied to the clove is organic fertilizer from cow manure. The time allocation for fertilizing is the same with coffee.

Pest, disease, and weed control

In the study area, the most known of pest attacked is *penggerek* (in local language) is the small bug infected the branch of clove, while the disease is *die back* (the decease of stem). For controlling the pest and disease, usually farmers do manually, such as cut out the infected branch, or pruning.

Harvesting

The main output from clove tree is clove flower bud. The optimum of clove flower bud harvested content water 60 – 70%, and the best time to harvest is 6 month after the flower pit shown, when flower become yellow to red colour. Clove flower bud picked by hand, in the case where clove tree is high, farmers used stairs or bamboo stick to chop. Farmers processed naturally and traditionally the clove flower bud. Before put up for sale, farmers dried the clove flower buds under direct sunlight around 3 to 4 days until the water content reached 10 to 12%, and its colour change into red brown.

5.6 Overview of livestock rearing

In general, kind of livestock that farmers rearing in the study area are pigs and cows, where averagely each farmer possessed two cows. The integration systems between crops and livestock were not a new introduced system, but in the study area, there were growing trend of adoption of this system since the economic crisis happened in 1999. The reason that farmers integrated livestock into their coffee-based farming systems, were not only because livestock can generating more income,

and the source of cash income in the emergency situation, but also it can increased fertility of land by return of its dung and urine, and reducing cost for weed control.

In financial aspect, the income from livestock was determined by the total amount of the livestock weight and selling price of the pig and cow per body weight. The total body weight increase is determined by increase of body weight per day (ADG = average daily growth). ADG can be reached between 0,8kg/day and 1.2 kg/day with average ADG value of 0.9 kg/day. The price of the fattening cattle is Rp. 4,000 per kg of live weight, while for pigs, the price is Rp. 9,000 per kg of live weight.

In the term of investment cost, there are some components to be considered, such as: fodder, cowshed, feeder cattle, and equipment. Fodder here refers to the yard or cultivated land where in this case, farmers get fodder from the shade trees and waste from crops, and also weeds surrounding their land or state forest nearby. They kept their cattle in the cage (cowshed), and feed it two times a day. The cost for cowshed was varies according to affordability of farmers. The amount of the cost for cowshed is analyzed according to design of the area per square meter. Depending on the price of the materials in each area, this is about Rp. 70,000/m², ranging from Rp. 50,000 to Rp. 90,000/m². Materials for the post and roof vary according to the available fund. However, the basement must be provided so as to fulfill the strength requirement. The type of cattle that farmers rearing is local Bali cattle (*Bos javanicus* sp) with price ranging from Rp 3,000 to Rp 3,500 / kg of body weight.

Other components that being considered are: medicines and health control, transportation, labor, and water supply. In regard to medicines and health control, the

livestock agency of Bali province has program vaccination which is arranged regularly, once every three months and also they will have regularly monitoring once in six month for evaluation and discussion of the development of cattle in the study area. The cost for labor is counted as 120 man-days in one year term. However, most of farmers in the study area were employing family members to rearing livestock, so that averagely there were no real cost for labor in livestock. For some cases, it was found out that the cost of labor for rearing livestock is Rp 15,000 / man-days. In the case of water supply for livestock, water supply is limitation in the study area. However, farmers gathering water for livestock from their home or nearby ponds with limited amount, or sometimes they were borrowed water from nearby field.