

## Chapter VII

### Conclusion and Recommendation

#### 7.1 Conclusion

##### 7.1.1 Farm management

Four major management practices of irrigation, soil nutrient management, pest management and pruning were the main yield-limiting factors of coffee production in the village. So in production, the farmers focused on the technologies to increase efficiency of each practice in order to sustain the advantages and minimize the disadvantages for sustainable coffee production.

Water was supplied with an average amount of about 610m<sup>3</sup>, 590m<sup>3</sup> and 575m<sup>3</sup> per hectare per time to coffee monoculture (P1), coffee-durian intercropping (P2) and coffee-black pepper intercropping (P3) farms, respectively. The interval between two times of irrigation was 22.5 days for coffee monoculture farms, 24.5 days for coffee-durian intercropping ones and 26.0 days for coffee-black pepper intercropping ones. All kinds of organic matters were used as the mulching materials to cover soil surface in dry season for raising water use efficiency of the crop in each system.

The most efficient and simplest soil erosion control methods of individual earthen basins and basins in combining with earthen bunds on-farm was made to prevent nutrients losses from soil surface erosion on-farm.

Chemical fertilizers were the main sources that provided nutrients to crop trees, applied with amount of 336 kg N, 115 kg P<sub>2</sub>O<sub>5</sub> and 332.5 kg K<sub>2</sub>O to one hectare of coffee monoculture farms. In the coffee-durian intercropping system (P2), the amounts of about 290.3 kg N, 96.5 kg P<sub>2</sub>O<sub>5</sub>, and 295.5 kg K<sub>2</sub>O were provided to one hectare per year. For the coffee-black pepper system (P3), total amount of chemical fertilizers of 261.3 kg N, 76.2 kg P<sub>2</sub>O<sub>5</sub>, and 268.5 kg K<sub>2</sub>O were used. These amounts were divided into small parts to apply in several months of a seasonal production.

Nitrogenous fertilizer was applied to farm in February, March, May/June, July/August, September and October. Phosphorus was added to farm in May/June and July/August. And potassium was mixed with nitrogen to applied four (4) times in May/June, July/August, September and October of wet season.

The farmers of intercropping systems paid more attention to supply nutrients in forms of organic matters and organic fertilizer than ones of monoculture farms did. Bio-fertilizer was applied about 800 kg per hectare per year to coffee-black pepper farms. The monoculture farms and coffee-durian farms were not provided so much, about 300 kg and 430 kg per hectare, respectively. FYM were applied amounts of 735 kg to monoculture farm and 787 kg to coffee-durian farm, and 822 kg to coffee-black pepper farm in average. And the amount of coffee pulp/husk returned to the farms depended on each farm but averaged about 1,500 kg, 2,800 kg and 3,800 kg for coffee monoculture, coffee-durian intercropping and coffee-black pepper intercropping farms respectively.

In the village, insecticides were widely used to control insect pests. But different coffee-based farming systems applied different methods in pest management. The monoculture farmers mainly relied on the insecticides to control insect pests with an average of 5.2 liters. The coffee-durian farms, the insecticide applied was less than monoculture, an average of 3.2 liters. And 2.0 liters was the amount applied on the farms of coffee-black pepper.

The coffee intercropping farmers have practiced several methods such as intensive monitoring of pest dynamic, adequately providing nutrients for the crop trees, manual controlling, conserving natural enemies on-farm by using bio-insecticides, using selective insecticides, treating only infested trees. Meanwhile, monocropping farmers mainly relied on insecticides to control pests rather than manage pests.

Pruning played very important roles in controlling of growth, development, pest management, plant nutrient management and coffee yield. The farmers of coffee-black pepper system paid more attention in pruning with an average of 2.4 times a

year. For the farms of monoculture system and coffee-durian system, the number of pruning averaged 2.2 times. Pruning was mainly carried out first time in January, second time in April or June of a seasonal production. The farmers followed pruning by removing all weak, dead and unproductive branches. The all kinds of suckers (orthotropic shoots) developed from the main stem and primary branches, were removed to concentrate nutrient on blossoming process and the branches, bearing in following season.

### **7.1.2 Potential of intercropping coffee-based farming systems**

Coffee cultivation under intercropping systems generated several benefits to the growers in terms of ecological and economical aspect. The intercrop species reduced the damage from extreme factors of climate on the performance and yield of tree crops in the system. Moderating microclimate such as reduction in on-farm air temperature, and wind speed, to create a favorable condition for processes of cross-pollination and photosynthesis of the crop trees that was one of the several advantages of the coffee- durian (P2) and coffee- black pepper (P3) farms. In addition soil surface underneath of the canopies of coffee and others was dried more slowly than soil exposed to the sun and harsh wind in the mono-farms. Therefore, intercropping coffee-based farming systems in the forms of coffee-durian, and coffee-black pepper played very significant roles in protecting the water resources for sustainable coffee production of the province.

Organic matters from on-farm sources were incorporated to farm as much as possible in order to maintain soil productivity. Application of organic matter in form of crop residues, coffee leaf, coffee pulp/husk was a potential to replace a part of chemical fertilizers, to increase the chemical fertilizer-use efficiency, and to stabilize crop yields. Mulching coffee farm with any kinds of organic matters improved soil-water conservation regime and uptake of nutrients significantly. That was an indicator of sustainable coffee production

The intercropping farms provided favorable habitat for many species of natural enemies that kept pest insects of farm in check. So it was not necessary to use so

much insecticide to prevent the tree crops from hand of insects, that protected the health of farmers as well as environment.

The coffee production in the forms of coffee-durian, and coffee-black pepper brought income diversification to the farmers. Besides main product, coffee yield, the secondary products such as durian fruit in coffee-durian farms and black pepper yield of coffee-black pepper farms were the considerable incomes contributed to the total farm income of farmers. On the other hand, the diversity and wide range of income in the several months of a year from farm products were brought free of debt to the producers, particularly small farm-holders who were often suffered from credit shortage in the lean period. Apart from that, the intercropping farms had a crucial role to play in reducing risks for the farmers in the case of bad harvest of coffee or low price of main product in the market.

The coffee intercropping farms brought to the producers additional farm income (gross return). Thus an average gross margin of the 46 farms, belonging to mono-coffee system, was US\$ 1,379.9 per hectare per year. This factor calculated to the farms of coffee-durian was US\$ 1,956.5 and US\$ 2,162.9 for coffee-black pepper farms.

Based on the farm management and best economic performance, five farms were identified from monoculture system (No. 8, 28, 14, 11 and 38), six farms from coffee-durian system (No. 1, 25, 15, 36, 11 and 30) and four farms from coffee-black pepper system (No. 29, 3, 24 and 39).

## 7.2 Recommendation

Although, the scope of the study was small, only one village, the study results should be considered to be criteria for sustaining coffee production through intercropping based-coffee systems. In the village, the result can be applied to coffee-producing farms, where there exist the similar coffee systems as of study site.

Generally, the coffee growers, especially smallholders, should be encouraged to convert their mono-farms into intercropping one by replacing as many coffee trees by

fruit trees. For those, who would like to develop new coffee plantations, should be consulted to design them in form of intercropping farms.

However, to guarantee for success of production, some demonstration models, which were chosen, should be conducted in three coffee systems on larger scales in order to have some adjustments for suitable with field production. The results of models should be used to demonstrate for learning processes among the farmers.

On the other hand, some recommendations should be paid attention for further studies as follows:

To study deeper farmers' perception on the causes and effects of coffee intercropping systems, this can lead to a more concrete recommendations for both research and extension activities.

For the two intercropping coffee-based farming systems above should study on the different crop densities on various soil types to point out the best systems for a certain region.

In addition, farming system research on soil-water-tree interaction should be conducted in order to find out the methods to minimize degradation of natural resources for long term production.

Study on larger scales with various coffee-based farming systems, ie. coffee with one or more tree species planted in the same piece of land should be carried out.