

Chapter 8

Discussion, Conclusions and Recommendations

As coffee will remain the vital component of agricultural sector for poverty reduction in the rural areas in DakLak province. Various promotional strategies lay out, included introducing extension system focus on transferring of improved technological packages on coffee production has been effective in achieving this crucial objective i.e., incremental increase in coffee productivity over the past few years. Nevertheless, through these strategies, it is felt that there is a tendency that sustainability of coffee production is being jeopardized, mainly by farmers' unsuitable farming practices. As the result of case study conducted at Cu Sue commune, the research deal with three main sub-topics consisted of discussion, conclusions, and recommendations.

8.1 Discussion

8.1.1 Change in farmers' practices on coffee production

Mechanization on coffee production has been considered as one of the factors that have facilitated the expansion of the area under coffee. Main production facilities and equipment invested by farmers on coffee production included tractor, pump, irrigation, tubes, and wells. Just in recent years, farmers were able to purchase hand tractor and other farm equipment, locally made or imported. All these equipment aim using for coffee production like hand tractor is mainly used to transport inputs to the field, and bring back cherries and fresh coffee beans to houses or traders.

Most farmers consider coffee as one of the highest profitable crops, coffee production in the study area has been carried out intensive practices by using a large amount of inputs likes fertilizers, pesticides, and water resources etc. The overuse of these inputs caused by misspecification of types, incorrect application time, and

insufficient or over dosage. All these could be linked to unsustainable agricultural development due to soil degradation, negative impact on ecological conditions and finally added to increase the production cost. Phat (2001) stated that in 1998, DakLak province applied about 600 thousand tons of agro-chemical for pest and disease control on coffee, if these amount is continuously using for many years, the surplus of those agro-chemical would remain on crops, soil, water resources and finally would be hazardous to human beings. In order to gain more efficient from the use of agro-chemical without leaving detrimental impacts on ecosystem and health, it is suggested that the decision should be made in a judicious manner. This basically emphasizes the need for an implementation of an integrated pest management (IPM).

Table 17, Table 18 and Table 28 shows that the cost for pest and disease control of the non-contact farmer was higher than the contact farmers. However, there was still higher percentage of the non-contact farmers at 45.5 percent faced with pest and disease outbreak on their coffee gardens compared with the contact farmers 12.9 percent (in Table 28). This can be explained, a part, as inefficient application of pesticides and insecticides of the non-contact farmers, misperception on pests and diseases or wrong control time. Griffiths (1972), cited in Hillocks *et al.* (1999) found that spraying at the wrong time or weak mixture can even exacerbate the diseases for coffee. Knowledge on pesticide and insecticide utilize are very important, especially timing of pesticide applications depends on the persistence of the chemical used. Weather condition, particularly rainfall, is also important in determining when pathogens spread, infected crops or the stage of plant may be susceptible to infection. The higher pest and disease outbreak recorded on coffee gardens of the non-contact farmers could be related to pruning practices, the contact farmers spent more labour and more concerning on this practice with 100 percent of the contact farmers pruned their coffee gardens compared with 74 percent of the non-contact farmers. This practice opens up the coffee canopy and allows air circular within the canopy thus resulting in reduced surface wetness and reduced relative humidity leading to reduction of conidial production and dispersal of pathogen. Phiri *et al.* (2001) encouraged coffee farmers in Malawi to regularly prune their coffee gardens as they found that pruned coffee plantations had significantly ($p \leq 0.05$) lower diseases

severity than the other ones that were not pruned. Similar to the report by Strand (2000) that farmers could modify the microclimate to affect a plant's habitability for pests and diseases, for example, through pruning to reduce humidity within the plant canopy and reduce the likelihood of infection from plant pathogen.

As a serious overexploitation of surface and ground water is taking place at the research area in particular and in DakLak province in general at the moment, water resource in the near future is likely to worsen. More coffee farms enter into the maturity period, the demand for irrigated water will grow likewise. The exploitation of water resource has a potential to the quality and quantity of water available for agricultural and domestic use of the communities in this area. Combining with the change from forestland to agricultural land, the change from rainfed annual upland crops to coffee, which requires irrigation in dry season, makes water become increasingly scarce in the whole province and study area.

Bau (2002) said that with total coffee area within the whole province currently has 264,000 ha. Each year need about 691 million cubic meters of water for agricultural production whilst the total water resource could be exploited from the lakes, and ponds reach about 290 million cubic meters a year. So every year, DakLak province has to exploit about 400 million cubic meters water from the rivers, streams and ground water resources. If there is no training or regulations on ground water abstraction and no measures are taken for encouraging farmers to use water more efficiency and a more profitable manner. The utilization of ground water continues to be unsustainable. One of the options to improve the effective water usage is to encourage farmers to invest for other profitable crops with less water consuming on the areas where are not suitable for coffee cultivation. Extension and irrigation officers should play important role in facilitating and guiding that there is an emerging need for effective management of the water resource.

The changes in coffee production and its impact at the study site are similar to the study of Nestel (1995) in Mexico that the amount of energy and land devoted to the production of coffee is associated with the economic behavior of the commodity

in the international market by incorporating new land into coffee production and introducing technological innovations to increase yield, may in turn negative effect the regional landscape and ecology.

8.1.2 Economic consideration

Gross margin of two groups of farmers were significantly different at one percent level (t-test), the contact farmer group earned \$1841 compared to \$1337 of the non-contact farmers. The difference in gross margin between two groups was resulted from higher yield, and higher return of intercropped products for the contact farmers. Of which, the total gross return from coffee was calculated from coffee yield multiplied by the unit price for both groups.

It should be noted that this amount of increased gross return for the contact farmers could be tangible benefits. Others intangible benefit from contact to the extension programs often leads to underestimated by farmers. Nagel (1997) said that one of the important tasks of the extension agents is to extend human resource development, providing managerial and organizational skills that will enable farmers to solve their own problems in the long run. From this notable idea, it is therefore hoped that the handover of important yardsticks relative to economic standpoint would help enhance farmers' perception, attitude and capability. Those active farmers could be able to help the underprivileged groups with less access to the formal extension programs for women farmers, rural youth, and small-scale farmers in remote areas.

8.1.3 Potential of intercropping coffee-based farming system

As the natural habitat of coffee is the understorey of rainforest, therefore coffee cultivated under intercropping systems not only generates several profits to the growers in terms of ecological aspect but also economic aspect. For ecological aspect, intercropping contributes to the reduction of the damage of extreme climatic conditions on the performance of tree and coffee yield in the system. Moderating

meteorological conditions, such as air temperature, relative humidity, wind speed, and the amount of radiant solar energy arrive at the evaporating surface to create a favorable condition for processes of cross-pollination and photosynthesis process. Aside from that, soil surface underneath of the canopies of coffee and others dry more slowly than soil exposed to the sun and harsh wind in the mono-farms. Therefore, intercropping coffee based farming systems in the form of coffee-fruit trees, coffee-black pepper plays very significant roles in properly using and protecting the water resources for sustainable agriculture production. Gliessman (1998) found other contribution of ecological aspect that intercropping farm would be able to generate the habitat diversity for many species of natural enemies that kept insects of farm in check. So it is not necessary to use so much pesticide to prevent the crops from the pest and disease outbreak.

In term of economic aspect, coffee production in the form of intercropping system brought income diversification to the farmers. This was proved by the products harvested from the farm of the contact farmers and a certain group of the non-contact farmer who followed this practice. Besides the main product, coffee yield, the secondary products from fruit, annual crops, pepper were considered the source of incomes contributed to the total income for farmers. The diversity and wide range of income in the months of a year from farm products have brought free of debt to the producers, particularly small farm holders who were often suffered from credit shortage in the peak periods.

Apart from that, the intercropping farms play a crucial role in reducing risk for the farmers in case of bad harvest of coffee or low price of main product in the world market. The loss of one product would be compensated by others in the system, this will keep the farmers in avoiding from falling down to the bottom. Herzog (1994) stated that the diverse intercropping on coffee-based farming system would yield various secondary products, such as fruits, timber, firewood that diversify the diet and stabilize the income of small-scale coffee farmers during spells of low coffee prices in the world market.

8.1.4 Consequences of coffee production

Lack of farmers' knowledge lead to low efficiency and unsustainable farming practices of coffee growers were the main constraints faced by farmers on coffee production at the moments. Farmers not only applied over chemical fertilizers, pesticides, but also applied imbalance of nutrients as coffee required. Consequently, there were signs of increasing environmental stress, which creates a potential threat to the whole ecosystem including the reduction in water retention capacity of the upper watershed. Thus, this has caused changes on quantity, quality, and seasonal distribution of available water resources, changes in bio-diversity as well as for agricultural production and domestic use in the downstream communities else.

There is very strong linkage between land use changes and water resource management issues. To meet the high demand of water for irrigating coffee due to the rapid expansion of coffee areas, farmers had to dig a large number of shallow wells to extract ground water resource. This activity will seriously deteriorate the ground water resource and lead to negative impacts on the environment. However, there is currently no other option for individual farmers to maintain their yield and avoid facing the high production risk.

When the price of coffee increased in the 1990's, coffee production became a very profitable enterprise for farmers and the coffee areas expanded likewise. First, a large forest area has been destroyed by migrants, who move to settle in this area and clear forest to get land for upland cultivation of annual upland crops like upland rice, beans and maize, then those farmers had earned sufficient money from this cultivation, they changed the cropping pattern from former upland rain-fed by investing on planting coffee parcels. This process, that is still prevalent today, has played a major role in the transformation of the physical and socio-economic landscape of the area.

8.1.5 Improving agricultural extension

8.1.5.1 Extension approaches

Extension in the study area plays a major role in the flow of information transferring. Through their impact was quantified in the study, of which, the main source of information has come from the extension agents, at 100 percent for the contact farmers and 3 percent for the non-contact farmers. The mode of information flow from the extension was predetermined by farmers' training, demonstration, training, visit system and mass media. The other sources involvement was largely determined by the contact farmers, it indicated from the non-contact farmers point of view about 34 percent of them who has obtained the new information from the contact farmers, it seems that the contact farmers have participated along with the extension agents in the transferring process. Therefore, updating the contact farmers' knowledge and enhancing their technical skills in the participatory extension methods and then decentralising these activities at the field level would bring about the desirable impacts. Farmers' preferences of the extension approaches seem to be those approaches they were familiar, such as farmer-led approach, demonstration and training and visit system, like individual farm visit that created awareness of the problems on coffee production, farmer-led approach seems to be met the farmers' basal oriented, and the demonstration provides the sharing cost etc. However, lecture usually covers wide range of topics that are often theory-oriented, which may be difficult for farmers to fully understand the management strategies in relation to the complex technologies on coffee production.

8.1.5.2 Strengthening research-extension-farmer linkage

The lack of a close working relationship between national agricultural research, extension organization, and different categories of farmers, is one of the most difficult institutional problems confronting ministries of agriculture in many developing countries so that research and extension have become top-down approach (Swanson, 1997). However, in order to meet the demand driven, research and

extension personnel should occur while carrying out jointly on-farm trials, demonstration or meetings where farmers would have the opportunity to articulate different problems and concerns. The value of both formal and informal farmers' feedback depends on whether research and extension staff are listening to what farmers and their representatives propose. Röling and Pretty (1997) stated that if new technologies recommended from the extension agents appropriate and fit a particular farmers' condition or their need then they stand a good chance of being adopted. But if they do not fit and if farmers are unable to make changes, then they have only the one choice. They have to adopt to the technology, or reject it entirely. That is why Hussain (1994) stated that the closed links between extension and research to ensure the relevance of the extension messages to farmers' needs is essential to promote for agricultural and rural development.

8.1.5.3 Farmer's capacity building

Lack of knowledge of the non-contact farmers about new technologies was considered as being one of the difficulties in most of the rural areas in DakLak province. A fundamental problem facing extension programs is how to increase the rate of diffusion of improved practices among the majority of farmers who are currently not being served. At the study area, 70.7 percent of the non-contact farmers was inadequate of technical knowledge so that strengthening the extension system at the commune level and increase the number of technical training for farmers, especially, the technical aspects like pruning, fertilization, pest and disease management on coffee production were essential solutions to support for sustainable agricultural and rural development. The training of farmers was not only in the traditional fields like crop and animal production but also should pay more attention on other fields related to integrated rural development, farm management, water management, post-harvesting, and market.

With currently low efficiencies in coffee production and unsustainable production practices of many farmers in the study area, making farmers better manage of their own resources will be an important strategy for a sustainable agricultural

development in the study area and DakLak province. With large area under coffee, a change from the currently inefficient and unsuitable production practices to a more economic efficiency and environmental friendly one will lead to a significant increase in farmers' income and environmental benefits. This implies that expanding and strengthening for the contact farmers on coffee production should have a high priority.

It was revealed from the survey that the number of farmers benefiting from the extension service was very limited. On average, only 23.8 percent farmers had participated in the extension programs. The contact farmers were considered as one of the frequent sources of information provided to the non-contact farmers. The link to farmers are extremely needed to ensure that extension service is relevant to and focused on farmers' priority needs and their problems. Given the large discrepancy in economic efficiency in their farming practices on coffee production between the contact farmers and the non-contact farmers, a "farmer-to-farmers extension" in the study area might be very beneficial by introducing the contact farmer model who were trained by the extension staff with their successful adoption to other farmers under similar socio-economic condition. The production efficiency among farmers could increase coffee yield significantly. Grisley (1994) found in Uganda on successful adoption of new bean varieties transferred from the contact farmers to marginal farmers through farmer-to-farmer dissemination process. In contrast to Dejene (1989) proved in Ethiopia the adoption of recommended practices among the non-contact farmers after receiving advise from the contact farmers or looking at their demonstration plots was insignificant. This is partly due to the contact farmers' limited ability to transmit complex innovations so that it is necessary to update the contact farmers' skill through short-term trainings.

8.2 Conclusion

An enormous development challenges for DakLak province at present is to strive for fighting the pervasive poverty, which is still afflicting the majority of the population, particularly the agricultural households. Coffee production is one of the most dominant and profitable agricultural venture for those households. Its productivity is affected by many internal and external factors. Aside from climatic condition, irrigation, fertilizers etc., farmers' technical knowledge is the most important factor to change better farmers' practices and increase coffee productivity. The lack of knowledge in inputs application does not only decrease productivity, but also causes negative impacts. The operation of extension system is one of the aspects that made the rural economy improvement during the past few years so there is appeared that the establishment of extension had positive impacts on coffee production.

The results indicated that the extension agents in the area site play a major role in the flow of information. The mode of this information flow from the extension is predominated by lecture in classroom, extension's individual visits to farms' home, field, field day workshop, demonstration, and mass media. The intervention of extension is necessary to support farmers to be better in farm management. Extension services not only provided farmers with technical knowledge on coffee production but also on other aspects like how to access to credit, market etc. Using t-test found the statistically significant difference from the average yield of two groups of farmers at one percent level. The contact farmer produced 0.5 ton dry coffee bean ha⁻¹ higher than the non-contact farmers whilst the farm sustainable return was about \$425 higher for the contact farmer than the non-contact farmer. This higher return was not only derived from higher yield for the contact farmers but also came from intercropping products, less dependent on external inputs, and efficiency use of available farm resources like manure in stead of chemical fertilizers. Aside from that, the yield stability is recorded higher for the contact farmer than the non-contact farmer. Hopefully, the impact can be measured in term of net income for the contact farmers

as higher price selling their products through marketing's channels introduced by the extension agents.

It was empirical revealed from the survey that the high percentage of the non-contact farmers not only applied imbalance fertilizers but also at very high rate and over used of other inputs like chemical, and water resources. Too much phosphorous was applied with little or no other element compared to the extension's recommendations.

The value of index acceptability analysis (I_a) of five recommended practices was recorded 47.4 percent, 0.86 percent, 83.7 percent, 36 percent, and 29.7 percent on fertilization, grafting, pruning, pest and disease management, and irrigation respectively. This indicates how the contact farmers followed and accepted these improved technologies. It illustrates that the adoption of technological components was not uniform, pruning was the highest adoption by the contact farmers, followed second fertilization, third pest and disease management, fourth irrigation, and the last one grafting. The certain techniques resulted at humble number of farmers' adoption, such as grafting. It indicates that farmers were still testing this technique that has not yet convinced it should be adopted in the larger-scale.

The overall-priority vectors value of five different extension approaches were 0.243, 0.163, 0.302, 0.089, 0.217 for demonstration, classroom, farmer-led approach, mass media, and T & V approach respectively. It indicates that the farmer-led extension approach was one of the most preferable one of farmers, followed second by demonstration, third by T & V approach, fourth by classroom, and last one by mass media. The criteria for selecting the efficiency of the extension approach tend to be address farmers needs, problem solving oriented from farmers, and participatory. The lecture and mass media approaches were less preferred by farmers it seems these two methods usually covers wide range of topics and less feedback that are often theory-oriented, which may be difficult for those farmers who are less knowledge to fully understand and follow the complex techniques within their own sites.

The production function was estimated based on Cobb-Douglas model. Coffee yield was used as the dependent variable, and other factors, such as nitrogen, potassium, phosphorous, irrigation, pesticide and insecticide, labor, extension, manure, and pruning as independent variables. The relationship between dependent and independent variables was estimated. Of which, all variables except phosphorous, irrigation, pest and disease management had positive effect on coffee yield at different statistically impact from one to ten percent levels. In particular, extension had positive coefficient (0.11) and statistically significant at one percent level. It means that the contact farmers had higher output 13.7 percent than the non-contact farmers, followed by nitrogen, pruning, manure, and potassium variables that had positive sign with statistically significant effect on coffee yield also. Phosphorous, pest and disease control, and irrigation inputs had negative coefficients seem to be non-optimal or overused of these inputs. In addition, the multiple regression analysis was run for the contact farmer group to estimate how the efficient use of individual input to the coffee yield. With the positive coefficient values and statistically significant at five percent and one percent level for the irrigation and extension variables respectively, the result proved that the contact farmer group used the water and irrigation technique were more efficient than the non-contact farmers, and the coffee yield was recorded higher for the contact farmers, who had access to the extension programs earlier or longer time compared with the farmers had just access to the extension programs.

The contact farmers' ability to cooperate with the extension services indicates scope for their full and active participation in technology development. The findings prove that extension system in DakLak province could usefully be reformed by the incorporation of the farmer' first paradigm. This implies revision of the extension system away from transfer of technology towards the provision of appropriate assistance and cooperation in farmer-led approach in agricultural and rural development. This would enable the extension agent to be more responsive to differing circumstances and the link with the contact farmer would be strengthened as a partnership with mutually corresponding goals determined by the farmers' priorities. A new emphasis on relevant training for the participatory development of appropriate technologies would encourage primacy of fieldwork, reinforce the need for farmer

contact by staff, and make the system more workable in complex situation. The technical outcomes would reflect differences in local priorities and conditions as recognized by the farmers.

8.3 Recommendations

From these field survey results, it is worth making the relevant recommendations as follows, which are particularly drawn from the foregoing discussions that are targeted to all the relevant stakeholders, i.e., individual farmers, extension, researchers, local leader, and policy maker.

8.3.1 Organic coffee production

It has been evident that the coffee production in certain aspects leads to unsustainable development, it is, however, for more sustainable coffee industry development in mountainous DakLak province and winning higher market favor, the challenges are still ahead. Being aware of all above-mentioned problems, a long-term strategy for improving coffee quality, production cost reduction, diversifying crops and products. It is essential to promote more and more efficiency technology transfer through extension service in associating with appropriate technologies that could be applied at average and small-scale farms with minimum investment and environmental problems. The establishment of sustainable agro-systems based mainly on making use of organic resources from shade trees, cover crop, green manure, plant residues, animal waste, coffee husk and pulp, bio-organic fertilizers, IPM, and various other organic supplements should pay more attention on coffee production. Application of organic matters in the form of crop residues, coffee leaf, coffee pulp was potential resources to replace a part of chemical fertilizers aiming promote the efficiency of chemical fertilizer used such as, mulching coffee farm with husks and cow's buffalo's, pig's dung could improves soil water conservation regime and easily uptake of nutrients.

Nutrients imbalance application and water resource used are considered as constraints causing inefficiency in the use of inputs. Farmers should apply these inputs followed the recommended rate by reducing phosphorous, water resource, pesticide and insecticides. The amount of potassium, manure level should increase up equal or a little bit higher to the recommended level.

8.3.2 Components of improved technology

The index acceptability (I_a) analysis found a large number of farmers who still apply recommended technologies on a small portion of their own land. This would be attributed to many factors, such as inadequate practical knowledge, input, or reluctant to extension agents' advises. An adding survey in the following year may be valuable in assessing the adoption, or some modification may be necessary to promote adoption ratio. All improved technologies should pay more attention in equal. It is, however, the grafting technique should be introduced on large-scale to the old coffee systems regions or unproductive gardens in stead of young coffee systems or productive sites, especially practical training programs should pay more attention at the field.

8.3.3 Incorporated indigenous' knowledge components

It is essential to be concerned on the "indigenous knowledge" for maintaining the local knowledge that can be contributed to sustainability of coffee farming system in the mountainous DakLak province. It is a valuable and underused resource, which should be studied, collected, and incorporated into development activities.

8.3.4 Farmers' participation

As farmers play a key role in the process of technology dissemination on extension work but there is currently inadequate of farmers' participation in the extension programs on planning and research setting. The participation of farmers on extension programs are extremely needed to ensure that extension service is relevant

to and focuses on farmers' priority needs and their problems. All these emphasize the need for promoting the participation of farmers in planning, implementing the extension programs.

8.3.5 Farmer-to-farmer extension

As the result proved that the contact farmers have been participated on dissemination the improved coffee technology process to other farmers. It is essential to more fully understand the farmer-to-farmer dissemination method to limit the loss of information in their transferring process, create more situations to increase interaction among farmers for exchanging technological information.

8.3.6 Priority female on the extension programs

As women are noticeably absent at present. Necessary efforts should be made to motivate woman farmers to participate in the extension programs, especial, priority and promote the small and poor farmers groups, where extension activities should be oriented to the development of people rather than farms or commodities. Extension programs should be expanded to cover more on the non-contact farmers, particular farmer-led and gender based approach

8.3.7 Information sources and extension approach

Because of open societies, information concerning on coffee production is not disseminated by one source but the spontaneous extension process. At study site, farmers get information from the contact farmers, salesman, and through mass media etc., are also very important sources. Those sources, however, farmers are not interested in approaching because they frequently lacked of target group or location specificity and information was not up-to-date. It had better therefore, to transfer the technological information through those channels should be based on farmers' needs and regional specify within different languages, especially ethnic minorities languages, for instance, in DakLak province Ede and M'nong.

8.4 Suggestions for further research

How to improve the learning approach of those farmers who are illiterate in order to improve farmers' capacity on coffee production

How could one design the up-scaling of good coffee production practices in the heterogeneous farm community

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