# CHAPTER 4

# The GCSC Driving Factors of Highland Arabica Coffee

In GCSC development, the knowledge about production and marketing environment of highland Arabica coffee is necessary for planning, design, and simulation of cluster of green supply chain. The contents of this chapter are divided into four main topics including the appropriate physical conditions and community context of the sample areas, cluster of Arabica coffee in the sample areas, the adoption of environmentally friendly practices by farmers in the supply chain, and the economic environmental factors in the supply chain of highland Arabica coffee.

## 4.1 Appropriate physical conditions and community context of the sample areas

This research has defined its scope to cover two areas namely Pamiang in Doi Saket District and Pang Ma-O in Chiang Dao District, Chiang Mai Province. The physical characteristics and the community context of the sample areas are briefly presented below.

### 4.1.1 The physical characteristics and community context of Pamiang area

Most of the Pamiang area is mountainous rainforest terrain at elevations ranging from 600 to 2,000 meters above MSL with predominant portion or 32.53% of the total area lying at the altitudes of 1,100 to 1,200 meters as shown in Figure 2. The average temperature is approximately 19 degree Celsius and the average annual rainfall is about 1,700 milliliters (HRDI, 2007). Roughly 98% of the population in this area are native Thai and the rest are Yao and Tai ethnic groups. Their occupation is farming and the most commonly grown crops are coffee and tea accounting for 61.20 % and 24.80 % of the cultivated land, respectively. Various types of farmers' group are established in this area such as cooperative, coffee growers' group, etc.

### 4.1.2 The physical characteristics and community context of Pang Ma-O area

The Pang Ma-O area is located at the edge of a forest, headwater of the Ping River. The geography as shown in Figure 1 features the complex mountain range with the heights around 400 to 1,500 meters above MSL and also the fertile area. The average temperature is approximately 21.9 degree Celsius and the average annual rainfall is about 1,724 milliliters (HRDI, 2009). The population is about 65 households. This community is strengthened by group formation to help one another in many aspects. Moreover, people in the community are involved in the conservation of forest and their leaders became recipients of numerous awards like Green Globe Award from the Petroleum Authority of Thailand (PTT) in 2003 and 2009.

The main occupation of the people in this area is tea and coffee cultivation. With virtually no secondary occupation, most local villagers thus earn income from single source which gives them the potential threat of income instability.

Although the area based contexts of both Pang Ma-O and Pamiang areas showed that Arabica coffee cultivation is the most crucial occupation bringing about income for the people in these areas, the main problems of Arabica coffee farmers are quality of coffee that does not meet the market demand, the lack of knowledge of accurate green management, and the limitation of external markets. Therefore, the development of GCSC is one significant alternative to help the Arabica coffee farmers in Pang Ma-O and Pamiang areas.



### 4.1.3 Suitability of the two selected areas for GCSC development

In the analysis of the suitability from physical and environmental perspectives to determine whether Pamiang and Pang Ma-O areas have the potentials for Arabica coffee cultivation in environmentally friendly orientation and consequently for the GCSC development, the suitable varietal and environmental criteria defined by HRDI (2012) for producing good quality coffee are used for the evaluation as follows:

| | |
|---|---|
| Coffee varieties | Resistant to rust, with dwarf shrub, short spacing internodes, high and regular yielding. |

| | |
|---|---|
| Soil texture | Fertile loam, with deep topsoil, well drained, with soil pH between 5.5 and 6.5. |
| Growing altitudes | Higher than 800 meters above MSL. |
| Temperature | Average temperature between 15 and 25 degree Celsius. |
| Rainfall | Average annual rainfall more than 1,500 mm. |
| Relative humidity | More than 60%. |

The physical and environmental assessment provides a convincing indication that both Pamiang and Pang Ma-O areas are suitable in all dimensions for growing coffee in environmentally friendly system.

## 4.2 Historical background of coffee and clusters in the sample areas

This section presents the historical background of Arabica coffee in the sample areas, and cluster analysis of Arabica coffee stakeholders at present to understand the interaction among actors in the supply chain of highland Arabica such as coffee farmers in Pamiang and Pang Ma-O areas, Pamiang and Pang Ma-O Sub-district Administrative Organizations, Chiang Mai University, Maejo University, saving groups, farmers' groups/community enterprises, Pamiang RPDC, Pang Ma-O PREC, RPF, etc., by using cluster diagram.

### 4.2.1 Arabica coffee in Pamiang area



In the past, the main occupation of farmers in Pamiang area was tea farming in plantation nature. In 1978, Prince Bhisadej Rajani introduced Arabica coffee to Pamiang farmers by distributing the plant stocks for their cultivation, but, during that time, the farmers did not have much interest. While getting occupied with tea farming, the farmers faced declining tea prices. Income from tea plantations was not enough to meet household expenses thus worsening the livelihood of the farmers. In 1981, His Majesty the King visited people in this area and learnt about the problems of these farmers. He then graciously bestowed his money for establishing the Pa Miang Royal Project Development Center (Pamiang RPDC) in Pang Bong village, Thepsadej Sub-district, Doi Saket District, Chiang Mai

Province which was intended to be the crop production technology transfer center for the farmers in this area such as in shiitake mushroom and Arabica coffee cultivation . In 1992, Her Royal Highness Princess Maha Chakri Sirindhorn gave the new name to this sub-district bringing the change from Pa Miang to Thepsadej Sub-district (RPF, 2012). With this graciousness, the extent of Arabica coffee plantations in this area has increased. At present, Arabica coffee growers account for 71.16% of the total Pamiang farmers and the rest are tea cultivators (HRDI, 2014).

### 4.2.2 Arabica Coffee in Pang Ma-O area

Arabica coffee growing in Pang Ma-O began in 1986 as promoted by the Thai-Australia Highland Agricultural and Social Development Project. The farmers were supported for coffee plants and encouraged to grow Arabica coffee. At that time, the farmers did not have knowledge regarding coffee plantation and production techniques to obtain quality coffee; meanwhile the price of Arabica coffee declined. Many farmers abandoned their coffee plantations and cut coffee trees down. In 2006, the Royal Project Foundation (RPF) encouraged the Petroleum Authority of Thailand (PTT) to help restore soil fertility by planting vetiver, in cooperation with people in the local community following the vetiver planting project to celebrate the auspicious occasion of His Majesty the King's 60 years on the Throne. Furthermore, RPF has assigned the Highland Research and Development Institute (HRDI) to develop agriculture, as well as grow vetiver in upper Ping watershed covering Pang Ma-O area to enable the people to have a better living. In 2007, HRDI established a center for the extension of the royal project's achievements in upper Ping watershed at Ban Pang Ma-O (Pang Ma-O RPEC) for vocational rehabilitation of Arabica coffee growers in the area through provision of Arabica coffee plants and necessary inputs to farmers, arranging training and workshops, undertaking research and development programs on coffee production, quality of coffee, and coffee marketing. At present, Arabica coffee and tea cultivation become a major source of revenue for local farmers (HRDI, 2014).

The history of Arabica coffee growing in both areas shows the importance of coffee plantations as the main source of farmers' income which affects the lifestyle and well-being of farmers. Yet, production and marketing research and development of Arabica coffee to achieve sustainability remain inadequate for further enhancement of the well-

being of coffee farmers. Thus, this research recognizes the importance of sustainability for the coffee farmers and focuses on the research and development of cluster in the environmentally friendly coffee supply chain which is built by the collaboration among the farmers and the coordination between farmers and other stakeholders in the supply chain. The research scope underlines the green production, green waste management, and green transportation, as well as the value sharing in supply chain for creating the sustainability in economic, social, and environmental terms. However, before developing cluster in a supply chain, the interactions of all actors in highland Arabica coffee supply chain has to be analyzed for creating the partnerships and forming the green Arabica coffee clusters in the sample areas.

### 4.2.3 Arabica coffee clusters in the sample areas

The analysis of Arabica coffee clusters in the sample areas deals with interaction and collaboration among all actors in highland Arabica coffee supply chain. This research has separated the actors into 5 groups namely coffee farmers in Pamiang and Pang Ma-O areas which are defined to be the focal node, suppliers, academic and research institutes, government and relevant agencies, and consumers. The results by coffee growing areas are as follows:

1) Arabica coffee cluster in Pamiang area

In Pamiang area, the roles of and the interactions among actors in the cluster of Arabica coffee supply chain are shown in Figure 4.1.

*Coffee farmers in Pamiang area*

As stated above, in this research, coffee farmers are defined to be the main unit of analysis regarding cluster relationship. Pamiang farmers were found to grow coffee in the integrated cropping systems either between Arabica coffee and other crops such as tea, macadamia, etc., or between Arabica coffee and the forests. These systems virtually resemble shade-grown rather than mono-cultural coffee plantation and thus accommodating the conservation of natural resources and biodiversity in the ecosystem.

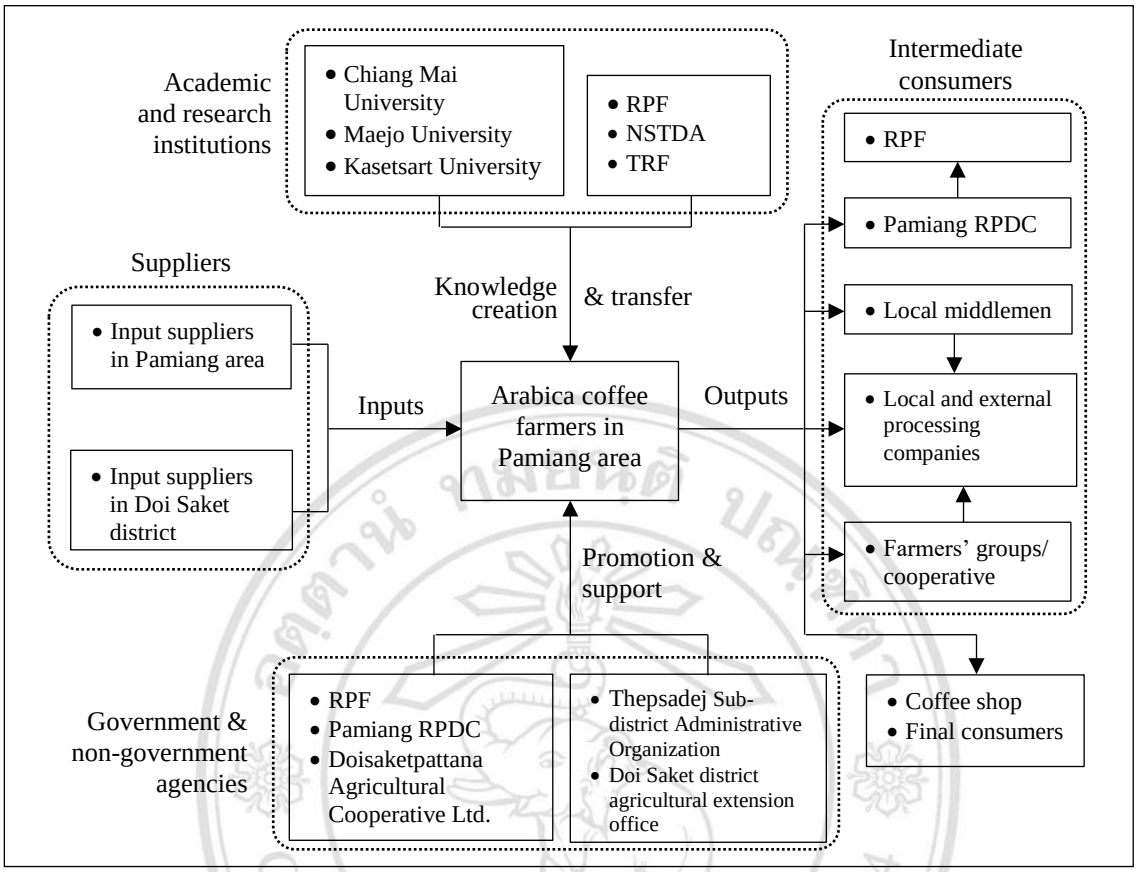


Figure 4.1 Cluster mapping of Arabica coffee stakeholders in Pamiang area

Source: Author's analyzing.

However, a large proportion of coffee farmers (75.63 %) in Pamiang area were also found to use such external input as chemical fertilizers at relatively high degree. The chemicals used in coffee production could result in the destruction of soil and water resources, and also high cost of production in the long term. In terms of coffee outputs, the farmers generally sell their products in three forms such as coffee cherries, parchment coffee, and roasted coffee which account for 21.01%, 76.47%, and 2.52%, of the total output respectively. As for distribution, there are five main coffee marketing channels for the farmers. The first channel is selling the mixed grade parchment coffee to the RPF via the Pamiang RPDC. The second channel is selling the products to farmers' groups or the Doisaketpattana Agricultural Cooperative Ltd. in the form of mixed grade parchment coffee. The third channel is selling coffee cherries and parchment coffee to local middlemen. The fourth channel is selling directly to coffee processing companies like the Hillkoff Coffee Ltd. that contacts the farmers to buy parchment coffee. And the last channel is selling the products to coffee shops and final consumers in the form of roasted

coffee which is processed and sold using individual local brands. Considering the agencies supporting coffee farmers in Pamiang area, there are many organizations involved such as Thepsadej Sub-district Administrative Organization, Doi Saket District Agricultural Extension Office, RPF, Pamiang RPDC, the Doisaketpattana Agricultural Cooperative Ltd., Chiang Mai University, Maejo University, Kasetsart University, the Thailand Research Fund (TRF), the National Science and Technology Development Agency (NSTDA), etc. The details of the assistance and cooperation will be discussed in the next section.

*Suppliers in Pamiang area*

The suppliers of production inputs to coffee farmers in Pamiang area are divided into two groups, local suppliers and external suppliers. The results of analysis are presented following the main input categories used in coffee production. The first input category is the young coffee plants. Coffee seedlings are mostly purchasable from the local suppliers that are local farmers specializing in producing coffee seedlings for distribution to other farmers. Moreover, the RPF has also provided young coffee trees to farmers. At present, some farmers propagate the planting stocks by selecting the best and robust beans from their own coffee trees for use as seeds and thus become able to reduce their dependence on external seedlings.

The second input category is fertilizers and chemicals. The study result revealed that sources of fertilizers and chemicals are mostly located outside the local area such as in Doi Saket and Sansai Districts. Coffee farmers generally do not plan buying fertilizers and agro-chemicals in advance but will buy them from market whenever their input inventory gets nearly depleted, using their own vehicles for transportation. However, some suppliers have offered farmers in Pamiang area fertilizers and other agro-chemicals at lower prices than those of external market if the purchase is made up to a defined volume. Some farmers having more capital and large coffee plantation would greatly benefit from these suppliers' offer because they can pay less for the bulk purchase and they can save the transportation cost. The capital poor coffee farmers of course cannot take advantage of such attractive marketing deal.

The third input category is capital. Capital input of farmers comes from three sources, namely, personal funding, bank loans especially from the Bank for Agriculture and Agricultural Cooperatives (BACC), saving group loans. Thus, the suppliers involved in farmer financial market are the BACC acting as external supplier and the saving groups playing the role as internal supplier. Both groups of credit supplier similarly serve to help farmers by providing low interest loans.

The fourth input category is labor. The result of analysis indicated that labors for Arabica coffee farming and farm maintenance are mostly household labors except in some large farms where some farmhands about 1 – 2 persons are hired to care for the coffee trees. However, hired labors are usually necessary during the harvest period because most coffee fruits are ripe at the same time entitling household labors even with additional exchange labors to become inadequate for the harvesting tasks. Most hired labors come from areas outside local community and they are selected for their labor skills and experience in preventing any damages to coffee fruits and trees during the harvesting process. The wages are paid in two types: the daily wage about 300-500 baht per day per person, and wage paid by the weight of the harvested crop about 5-6 baht per kilogram of coffee cherries.

The fifth input category is coffee bean peeling machine which is the major equipment for processing coffee cherries into parchment coffee. The peeling machines in Pamiang area are provided by RPF and installed at various points in the area for coffee growers to share the use with the agreements on different rules and regulations regarding the use and the maintenance of the machines. In addition, some farmers have bought their own coffee peeling machines to facilitate the processing of parchment coffee.



From the information above regarding suppliers, it is evident that coffee farmers in Pamiang had small extent of business dealing with input suppliers. This is because, from the perspective of suppliers, supplying various production inputs to different small farmers is not only difficult to arrange but also costly for both procurement and distribution of input materials. Thus, the collaboration among coffee farmers to form themselves into a buying group to make business relation with input suppliers is an interesting point as this can help economize many costs for the suppliers.

*Academic and research institutes working in Pamiang area*

The academic and research institutions that have involvements or activities in Pamiang area can be distinguished into two groups: higher learning institute (such as Chiang Mai University, Maejo University, and Kasetsart University, etc.) and research and development institute (such as RPF, TRF, NSTDA, etc.). They have involved in some form or another interacting with people in Pamiang in such ways as knowledge provision, technology transfer, plant diseases and pests consultation, conducting research and development programs to improve coffee varieties, quality and productivity, as well as coffee marketing. Coffee farmers in Pamiang area have continuously received the training. However, most of the research and development, activities especially on the part of educational institutes are in the nature of project funded on the basis of fiscal year. The continuity and sustainability of research attempts invariably become vulnerable once the project ends. This is a crucial point for cluster development by building partnerships between coffee farmers and the research community.

*Government and related agencies in Pamiang area*

The government agencies and private organizations that have frequently come to provide assistance and support to farmers in Pamiang area are the Thepsadej Sub-district Administrative Organization, Doi Saket District Agricultural Extension Office, Cooperative Promotion Department, RPF, Pamiang RPDC, and Doisaketpattana Agricultural Cooperative Ltd., etc. Farmers in general and coffee growers in particular have benefited from the functioning of the above said agencies in the natures of agro-tourism development plan that allows tourists to learn and experience about coffee plantation and processing, promotion of farmers' groups, establishment of savings groups to be internal financial source for farmers, production input support, production technique and development education, and promotion of coffee products through community enterprise. This study found a well cooperation between Pamiang farmers and these government and private agencies due to the latter's continuation in giving various supports and assistance.

*Buyers in Pamiang area (the Pamiang RPDC)*

The buyers in this analysis are the intermediate consumers who purchase coffee products, accounting for 97.48% of total output, for further processing. The largest buyer in Pamiang area was found to be RPF. Farmers sell their coffee output in the form of mixed grade parchment coffee and take the coffee price set by RPF. After harvesting the coffee cherries and processing into parchment coffee, the farmers pack their parchment coffee in plastic mesh bags containing 30 kilograms and tag the information about the farmer's name, plantation source, weight of product and delivery date. These products are transported to the assembler, the Pamiang RPDC, that in turn delivers the compiled bulk to coffee plant of RPF for further processing. The cooperation between the farmers and Pamiang RPDC playing the role as the assembler and between the farmers and RPF playing the role as the processor are made by informal and verbal agreement for farmers to deliver the parchment coffee at the determined quantity and price. The verbal agreement is taken because the farmers have many channels to sell their products such as Doisaketpattana Agricultural Cooperative Ltd. and other processing companies that come into direct contact with coffee farmers. In the latter case, there are two types of business deal namely the verbal agreement if the processing companies are regular buyers and the contract farming agreement in which the processing companies are committed to provide financial and some input supports to farmers for the production and primary processing and the farmers have to deliver their coffee products to them. With respect to the channel of selling through middlemen, the study result indicated that there is no trade arrangement between coffee farmers and middlemen.



2) Arabica coffee cluster in Pang Ma-O area

The interactions among actors in cluster supply chain of Arabica coffee in Pang Ma-O are shown in Figure 4.2.

*Coffee farmers in Pang Ma-O area*

Coffee farmers in Pang Ma-O area have planted Arabica coffee in the integrated cropping systems together with other crops (such as tea, macadamia, etc.) and in forest, in the same way as in Pamiang area. However, the chemical used in Pang Ma-O area is relatively lower as a result of the community agreements on forest and watershed conservation. The

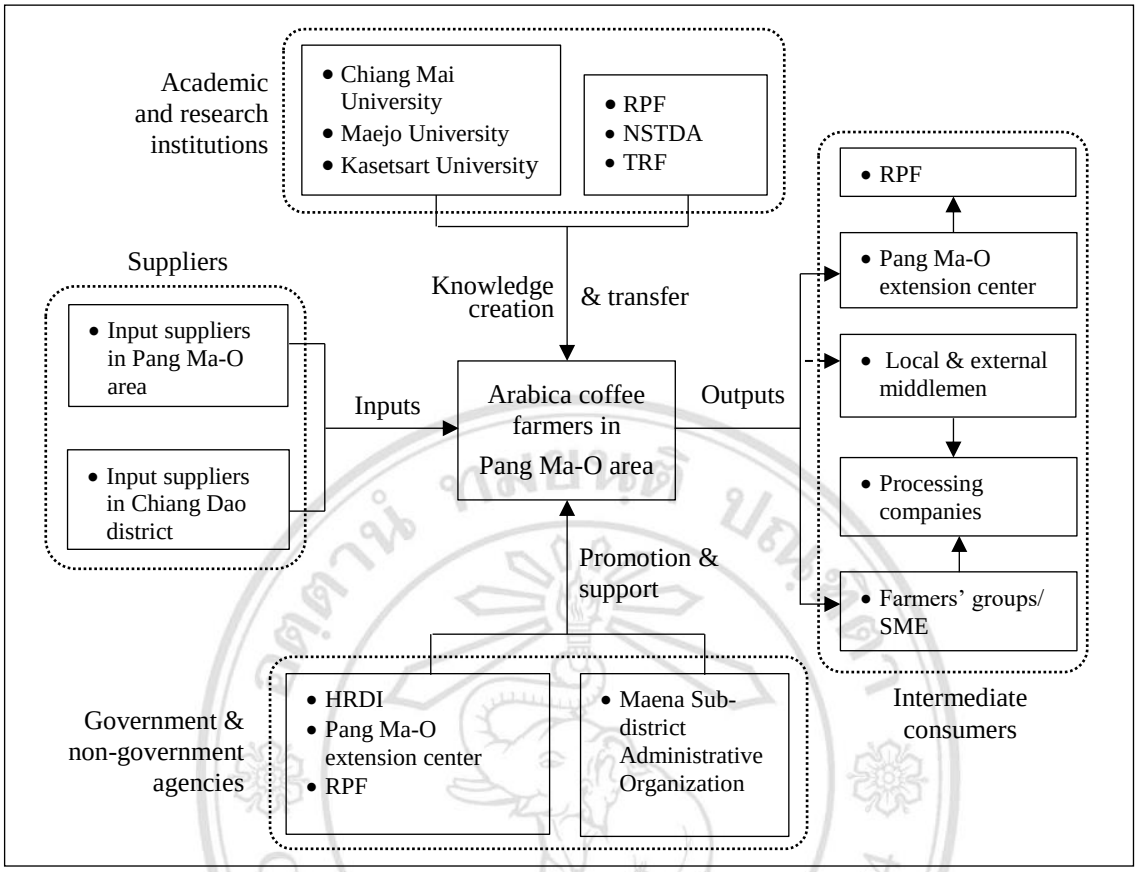


Figure 4.2 Cluster mapping of Arabica coffee stakeholders in Pang Ma-O area

Source: Author's analyzing.

farmers, therefore, recognize the importance of the environment and work together to reduce the use of chemicals to prevent pollution in soil and water resources. From their strength in environmental conservation, Pang Ma-O people won the Green Globe Award in 2003 and 2009. This award is the project of the PTT that aims to support and encourage the natural resources and environmental conservation efforts of individuals and groups, by recognizing them as the award recipients and as the models for others to follow. When it comes to selling coffee outputs, the farmers in Pang Ma-O area have sold them as coffee cherries and/or parchment coffee through three channels: selling the mixed grade parchment coffee to the RPF via the Pang Ma-O RPEC, selling the same type of product to the community enterprise in Pang Ma-O, and selling both coffee cherries and parchment coffee to the middlemen. In terms of the relevant agencies, the organizations promoting and supporting the farmers consist of Maena Sub-district Administrative Organization, Chiang Dao District Agricultural Extension Office, Cooperative Promotion Department, RPF, HRDI and Pang Ma-O RPEC. Meanwhile, the academic and research

and development institutes giving the knowledge to the farmers are Chiang Mai University, Maejo University, and Kasetsart University, RPF, TRF, NSTDA, etc.

*Suppliers in Pang Ma-O area*

The suppliers of production inputs to coffee farmers in Pang Ma-O area are distinguished into two groups; local and non-local suppliers. In the case of young coffee plants, the suppliers are primarily the local producers of coffee seedlings including those coffee farmers who also venture into coffee tree propagation and the Pang Ma-O RPEC. In terms of fertilizers and chemicals, because of the community agreements on forest and watershed conservation in Pang Ma-O area, there is little use and purchase of chemical fertilizers and other agro-chemicals. Most coffee farmers use manure and organic fertilizers instead. The sources to buy manure and organic fertilizers are in Chiang Dao district town and the farmers use their own cars to transport them. However, some farmers who have no own vehicles for carrying these inputs have to rely on the Pang Ma-O RPEC as supplier of the organic fertilizers.

In view of the capital used, the study found the main sources of coffee farming finance to include farmer's personal fund, bank loans especially from the Bank for Agriculture and Agricultural Cooperatives (BACC), and borrowing from saving groups. Both the BACC and saving groups have a mandate to support farmers by giving them the low-interest loan.

The major labor used in Arabica coffee production and harvesting in Pang Ma-O area is household labor. However, those farmers having large cultivated area have to hire the labors from outside the village for harvesting especially during the period of simultaneous ripeness of outputs. The wages are paid in two ways, namely, daily wage around 300-500 baht per person per day and wage paid on the basis of weight of coffee cherries at about 5-6 baht per kilogram.

For the coffee bean peeling machines, the result showed that these are provided by HRDI and installed at various points in the village for farmers to share the use and the cost of maintenance at 1 baht per kilogram according to the mutual agreement.

The information regarding input suppliers mentioned above showed that some farmers in Pang Ma-O area face the problem of low access to non-local suppliers. The main reason is the difficult road communication. Moreover, many farmers in Pang Ma-O area do not have their own vehicles thus they have to depend on Pang Ma-O RPEC for some input supply. This finding points out that the connection between coffee farmers and the suppliers is a crucial issue for the increase in input accessibility of the farmers in Pang Ma-O area.

*Academic and research institutes working in Pang Ma-O area*

The research community working in Pang Ma-O area includes the educational institutes (such as Chiang Mai University, Maejo University, Kasetsart University, etc.) and research and development agencies (such as RPF, HRDI, TRF, etc.) that are involved in knowledge and technology transfer, consultation about plant diseases and pests, research and development of coffee quality, managing the environment from coffee production, and development of coffee marketing. However, their research and development activities in Pang Ma-O area lack the continuation and sustainability leading to the difficulty in cluster development. In addition, in 2015, the Earth Net Foundation (known as Greennet) came into promoting and supporting farmers in Pang Ma-O area to produce organic Arabica coffee. At present, there are 5 farmers participating in this project to be the prototype for other farmers in this area.

*Government and related agencies in Pang Ma-O area*

The government agencies and private organizations that have encouraged and supported the farmers in Pang Ma-O area consist of Maena Sub-district Administrative Organization, Chiang Dao District Agricultural Extension Office, RPF, HRDI and Pang Ma-O RPEC. They have played roles and performed their functions helping create the community plan about environmental conservation to facilitate environmentally friendly farming; encouraging the farmers to set up the community enterprises for the purposes of production, marketing, and access to capital; establishing the savings groups as a means for agricultural finance; supporting production inputs; and transferring the knowledge concerning production techniques and development. The farmers in Pang Ma-O area cooperate well with these entities.

*Buyers in Pang Ma-O area (the Pang Ma-O RPEC)*

In the past, the farmers' group in Pang Ma-O area was quite strong while the coffee outputs were of high quality and in high market demand. Thus, the farmers' group had more bargaining power than middlemen. Then, the coffee products were sold by auction. Later, the farmers' group became weak resulted from the timidity of the group leader, as well as the intervention by local middlemen. Some farmers sought to sell their product by themselves bringing about the reduction in the bargaining power and the lower price given by the middlemen. Thus, at present, the Pang Ma-O RPEC encourages the farmers by promoting and educating them to produce quality products, and gathers the coffee products from farmers for delivery to RPF. In 2015, the RPF is the largest buyer in this area. The coffee product sold to RPF is in the form of mixed grade parchment coffee at the price set by RPF.

Packing of mixed grade parchment coffee is done in the same way as in Pamiang area. The products are packed in plastic mesh bags containing 30 kilograms and tagged with the information about the farmer's name, plantation source, weight of product and delivery date. After that, the Pang Ma-O RPEC playing the role as the assembler gathers them to the coffee plant of RPF for further processing.

The collaboration between the farmers, the RPF, and the Pang Ma-O RPEC is by verbal agreement. The Pang Ma-O RPEC generally makes a survey to estimate the farmers' potential supply of parchment coffee to the RPF and compiles the actual products paying the price as set by the RPF. Moreover, another important buyer in Pang Ma-O area is the Pang Ma-O coffee community enterprise. This enterprise buys parchment coffee from farmers for processing into roasted coffee products to be sold under PMO brand. However, the enterprise does not do the processing itself but has to rely on the RPF for the processing service because of its limited capital for investment in processing facility and its lack of expertise in coffee roasting. Coffee farmers and the Pang Ma-O coffee community enterprise appear to have good business relation especially in terms of the farmers' supplying parchment coffee to the enterprise due to the fact that 40% of Pang Ma-O coffee farmers under study are also members of this community enterprise.

### 4.2.4 Strengths and weaknesses in GCSC development in sample areas

The results of cluster analysis point out the strengths facilitating the development of green supply chain of Arabica coffee in the sample areas to consist of the suitability of physical factors (such as the land elevation, soil texture, temperature, and rainfall); coffee farmers' experience, knowledge about production techniques and technologies, awareness of environmental value; and the cooperation and relation among stakeholders. These factors increase the chance for GCSC development in the sample areas.

However, weaknesses were also found to exist in relation to the continuity and sustainability of the collaboration among coffee farmers and the cooperation between the farmers and the relevant agencies which may hamper the GCSC development.

In general, cooperation is the key success factor for green cluster establishment and in bringing about the sustainability. Furthermore, the priority coffee farmers giving to agricultural production in environmentally friendly nature can be a strength contributing to sustainable development.

GCSC development in the sample areas is possible to materialize if coffee farmers in Pamiang and Pang Ma-O are willing to adopt green practices and build cluster relation. At this stage, it is imperative to analyze and understand the extent of green practices which are in turn conditioned by many economic and environmental factors, and which determine the strengths and weaknesses for cluster development as well. Therefore, in this research, coffee farmers' adoption of green practices is analyzed under three feasible economic activities such as green production, green waste management, and green transportation. The results are presented in the following section.



## 4.3 The adoption of green practices by coffee farmers

As mentioned above, GCSC development in the sample areas would occur when coffee farmers in Pamiang and Pang Ma-O areas adopt green practices and form cluster relation. Thus, the analysis on coffee farmers' adoption of green practices is the necessary tool to understand the key factors having impacts on the behavior changes from the conventional to the environmentally friendly activities in the Arabica coffee supply chain.

This research defines the green practices in three ways such as 1) the green production consisting of chemical use reduction, 2) the green waste management particularly wastewater and waste disposals, and 3) the green transportation containing alternative energy use. The reasons for selecting these three main activities are the facts that they in conventional ways have brought about the highest proportion of the greenhouse gas emissions, and that with the practice of these green activities, the farmers are able to claim or label their outputs as for environmental friendliness easily. Therefore, the adoption of environmentally friendly practices by the farmers is stated in terms of binary choice dependent variables (1 = adopt and 0 = otherwise) in this study and is divided into three aspects including the adoption of green production (GPA), the adoption of green waste management (GWA), and the adoption of green transportation (GTA).

Totally 188 samples of farmer in the Pamiang and Pang Ma-O areas were collected for analyzing. The binary logit model and the maximum likelihood estimation method were used for estimating the factors affecting farmers' adoption. The summary statistics of the variables used in the binary logit model are presented in Table 4.1.

Summary statistics of variables that determine the green practice adoption by coffee farmers were calculated (Table 4.1) including the variables of gender of the sampled farmer (GEN), number of years in school of the farmers (EDU), farming experience of the farmers (EXP), the attitude of farmers toward green supply chain practices (ATT), farm size (FZ), input cost concern of the farmers (CI), and the information accessibility of and utilization by the coffee farmers (IA). The value of farmer's adoption of green production, green waste management, green transportation, gender of the farmers, and the input cost concern is either 0 or 1. The number of years in school of the farmers ranges from 6 years, Prathom 4, to 18 years, bachelor degree, and the average is 8.63 years. The average farming experience of the farmers and farm size are roughly11.39 years and 8.85 rai, respectively. In terms of the attitude of the farmer toward green supply chain practices, on average, the farmers have the positive attitudes about the environmentally friendly practice, considering 30.01 out of 50 scores. In view of information accessibility of and utilization by the farmers, the average score is around 2.80 indicating that the farmers perceive the production and market information and take advantage of it in their production and marketing about 41 to 60 percent.

Table 4.1 Summary statistics of variables used in the binary logit model of green practice adoption by coffee farmers

| Variables | Definitions | Mean | S.D. | Min | Max |
|---|---|---|---|---|---|
| GPA | Farmer's adoption of green production (willing to adopt=1, otherwise=0) | - | - | 0.00 | 1.00 |
| GWA | Farmer's adoption of green waste management (willing to adopt=1, otherwise=0) | - | - | 0.00 | 1.00 |
| GTA | Farmer's adoption of green transportation (willing to adopt=1, otherwise=0) | - | - | 0.00 | 1.00 |
| GEN | Gender of farmer (male = 1 female =0) | - | - | 0.00 | 1.00 |
| EDU | Number of years in school of the farmers (Years) | 8.63 | 2.57 | 6.00 | 18.00 |
| EXP | Farming experience of the farmers (Years) | 11.39 | 4.55 | 5.00 | 29.00 |
| ATT | Attitude of farmers toward green supply chain practices (Scores) | 30.01 | 8.78 | 11.00 | 48.00 |
| FS | Farm size (Rai) | 8.85 | 7.09 | 1.00 | 30.00 |
| CI | Input cost concern of the farmers (1 = if think that cutting cost is important, 0 = otherwise) | - | - | 0.00 | 1.00 |
| IA | Information accessibility of and utilization by the coffee farmers (1-5 Linkert scales) | 2.80 | 1.16 | 1.00 | 5.00 |

Source: Calculation.

For the correlation between the independent variables used in the binary logit model of the green practice adoption by coffee farmers (Table 4.2), the results show that the concern about input cost (CI) is positively correlated with the number of years in school of the farmers (EDU) and with the positive attitude of the farmers toward green supply chain practices (ATT) at the 0.01 statistically significant level, implying that the farmers who have concern about the input cost and have higher education level, also have the positive thinking about the green supply chain practices. Moreover, the information accessibility of and utilization by the coffee farmers and the number of years in school of the farmers, as well as the farming experience of the farmers and the concern about input cost of the farmers are positively associated with each other significantly at 0.01 and 0.05 levels, respectively. However, the correlation values of all independent variables do not exceed 0.7 meaning that there is no multicollinearity in the model.

Table 4.2 Correlation between the variables used in the binary logit model of the green practice adoption by coffee farmers

| Variables | GEN | EDU | EXP | ATT | FS | CI | IA |
|---|---|---|---|---|---|---|---|
| GEN | 1.0000 | | | | | | |
| EDU | 0.0461 | 1.0000 | | | | | |
| EXP | 0.0282 | 0.0987 | 1.0000 | | | | |
| ATT | 0.0222 | -0.0297 | -0.0832 | 1.0000 | | | |
| FS | 0.0393 | -0.0234 | 0.0426 | 0.1169 | 1.0000 | | |
| CI | -0.0844 | 0.1852** | 0.0575 | 0.1725** | 0.0978 | 1.0000 | |
| IA | 0.0818 | 0.2438*** | 0.2934*** | -0.0082 | 0.0166 | 0.3150** | 1.0000 |

Source: Calculation.

Note: ** denotes .05 statistically significant level.

The results on the factor affecting farmers' adoption of green practice from application of the binary logit model are presented separately for the three ways of green practice as in the following sub-sections.

### 4.3.1 The adoption of green production

The green production practice of the farmers in this research is reflected by the reduction of chemical use in their coffee cultivation. The farmers who adopt this practice have to change their behavior toward lower use of chemical input and utilize the organic or the environmentally friendly materials instead. The estimation of the farmers' adoption of green production in the sample areas is reported in Table 4.3.



Table 4.3 shows the goodness of fit of the model with the McFadden's R-square of 0.4526 and 82.9787 percent of correct prediction. The estimations are interpreted by the significant variables as follows:

**Education (EDU)**: The educational achievement of a farmer reflects his/her ability to learn and understand the environmentally friendly practices. This research defines the EDU as the number of years in school of the farmers. The result in Table 4.3 indicates that the educational level of farmers has the strong positive relationship with green production adoption at 99% confident level. The increase in the education level results in the rise of the adoption probability of the green production around 0.1036. Thus, the

farmers who have higher level of education are more likely to adopt the green production practices. This finding conforms to those in the studies by Herath and Takeya (2003), Sidibe (2005), and Mzoughi (2011) who concluded that the educational level of farmers reflects the ability of farmers to learn and understand the environmentally friendly practices and positively affects the adoption of the green practices.

Table 4.3 Binary logit model analysis of green production adoption by Arabica coffee growers

| Variable | Estimate | | Marginal effect | |
|---|---|---|---|---|
| | coefficient | t-value | coefficient | t-value |
| Constant | -10.0978*** | -5.9730 | -2.5144*** | -6.0150 |
| GEN | 0.1024 | 0.2380 | 0.0255 | 0.2380 |
| EDU | 0.4162*** | 3.8880 | 0.1036*** | 3.8570 |
| EXP | 0.1294** | 2.2170 | 0.0322** | 2.2110 |
| ATT | 0.0041 | 0.1680 | 0.0010 | 0.1680 |
| FS | -0.0078 | -0.2480 | -0.0019 | -0.2480 |
| CI | 2.5631*** | 3.9910 | 0.5170*** | 6.0920 |
| IA | 1.0376*** | 4.6950 | 0.2584*** | 4.6870 |
| Number of observations | 188 | | | |
| Restricted log likelihood | -130.2159 | | | |
| McFadden's R-square | 0.4526 | | | |
| Percent correctly predicted | 82.9787 | | | |

Source: Calculation.

Note: *, **, *** denote .10, .05 and .01 statistically significant levels, respectively.

**Experience (EXP)**: Experience working in coffee plantations of farmers demonstrates the skills of farmers gained from practice (Feder et al., 1985). The estimation in Table 4.4 reveals that the increase in the farmers' experiences brings about the increase in the chance of green production practices by 0.0322 at 95% confidence interval. This result shows the same direction impact as in the research by Thanh and Yapwattanaphun (2015) who mentioned that the experiences of farmers have positive impact on technology adoption because the available knowledge and skills of farmers lead to the adaptation and application of new technologies.

The evidence of this situation is confirmed by the findings with respect to Arabica coffee clusters in Pamiang and Pang Ma-O areas as mentioned in Sections 4.2.3 and 4.2.4, as well. Coffee farmers, especially those in Pamiang area, have learned from their persisted practices following their belief that the use of chemical fertilizers would bring about high coffee yield. Later, they have seen the changes in the ecosystem, such as water pollution and soil degradation from the use of chemical fertilizers, over the time of cultivation. The interview with the farmers about the use of chemical fertilizers disclosed that the farmers who used to apply chemical fertilizers to nourish their coffee trees had to use them more and more because the soil nutrients were depleted. In addition, the high use of fertilizers leads to the high cost of production. So, the farmers who have more experience in coffee growing have recognized the benefit of the change from chemical to organic fertilizer and thus they incline to adopt the environmentally friendly practices.

**Input cost concern (CI)**: The input cost concern is determined as the dummy variable being equal to 1 if the farmer thinks that cutting cost is important and 0 in case of otherwise. This research used the binary value of input cost instead of the actual cost due to the capital used by each farmer being different bringing about the difference in suffering from the input cost. When the input costs increase, farmers having enough financial resource will face less serious problem compared to those otherwise. Thus, the use of the binary data which judges the input cost concern being important or not is suitable for the analysis. The result shown in Table 4.3 indicates that the concern of input cost in terms of the importance of cutting cost has the positive influence on the green production adoption by coffee farmers at 0.01 statistically significant level, and with the marginal effect of 0.5170. This finding implies that the farmers who focus on reducing input costs are likely to adopt the green practices.



**Information accessibility and utilization (IA)**: Farmers' access to information and their utilization demonstrate the implementation of new technology by practice. In general, those farmers having a high level of accessibility to information and taking advantage of the technology tend to accept the new ways of doing anything (Sheikhet al., 2003). The Likert scales from 1 to 5, from poor to excellent, are used for letting the farmers assess the levels of their receiving the production and market information and taking advantage of it. The results show that the information accessibility of and utilization by farmers has

a positive effect on the green production adoption approximately 0.2584 at 0.01 statistically significant level.

The information accessibility of and utilization by coffee farmers create the incentive for farmers' adoption easily from the positive thinking and the outcomes of actual practice. In Pamiang and Pang Ma-O areas, coffee farmers have accessed the information themselves as well as received it from many sources such as local authorities, the District Agricultural Extension Office, the RPF, the HRDI, the Pamiang PRDC, the Pang Ma-O RPEC, the research and development agencies and educational institutes. When this information is utilized and the farmers have seen the empirical outcomes from doing, they would adopt the new practices easily.

### 4.3.2 The adoption of green waste management

The green waste management deals with the disposal of wastes in the form of pulps and peels of coffee cherries from the pulping process, and wastewater from the fermentation process to produce parchment coffee. These wastes bring about pollutions and degradation of the ecosystem in the long term. Thus, the green waste management is an approach to reduce these problems.

Table 4.4 shows the estimations of the green waste management adoption by the farmers. The McFadden's R-square equal to 0.2827, and the percent correctly predicted at 78.1915, indicate the goodness of fit of the model.

The significant variables affecting the green waste management adoption are interpreted as follows:



**Input cost concern (CI)**: As mentioned previously, the more concern about the input cost, the higher the chance for farmers to accept the green practices. Table 4.4 displays the significantly positive impact on the green waste management adoption with the marginal effect coefficient of 0.2917.

In parchment coffee production process in both Pamiang and Pang Ma-O areas, large amount of wastes in the form of pulps and peals is generated from coffee cherries pulping process as well as enormous volume of wastewater from the fermentation and washing

processes. These wastes give rise to both air and water pollutions. The farmers in both areas do not have the systems of waste disposal from the production. The wastes from peels of coffee cherries are dropped on the coffee plantations or piled around residential areas causing foul smell and GHG emissions. The coffee peels, in fact, can be used to make compost. Composting agricultural wastes, in this case coffee cherries peels and pulps, not only reduces pollutions but also helps decrease the cost of fertilizers. Thus, the way of green waste management by making compost from wastes is the choice of the farmers having concern about production cost.

Table 4.4 Binary logit model analysis of the green waste management adoption by Arabica coffee growers

| Variable | Estimate | | Marginal effect | |
|---|---|---|---|---|
| | coefficient | t-value | coefficient | t-value |
| Constant | -5.5444*** | -4.4510 | -1.1922*** | -4.4420 |
| GEN | 0.5835 | 1.5320 | 0.1279 | 1.5240 |
| EDU | 0.1393 | 1.6020 | 0.0300 | 1.6160 |
| EXP | 0.0305 | 0.6270 | 0.0066 | 0.6270 |
| ATT | 0.0344 | 1.5850 | 0.0074 | 1.5930 |
| FS | -0.0260 | -0.9240 | -0.0056 | -0.9260 |
| CI | 1.2723*** | 3.0070 | 0.2917*** | 2.9690 |
| IA | 0.9594*** | 4.6730 | 0.2063*** | 4.9370 |
| Number of observations | 188 | | | |
| Restricted log likelihood | -124.6265 | | | |
| McFadden's R-square | 0.2827 | | | |
| Percent correctly predicted | 78.1915 | | | |

Source: Calculation.

Note: *, **, *** denote .10, .05 and .01 statistically significance levels, respectively.

**Information accessibility and utilization (IA)**: There is a significantly positive sign of the information accessibility of and utilization by coffee farmers, as shown in Table 4.4, at 99% confidence interval. The estimated result implies that those farmers who receive more production and market information and take more advantage of it in their production and marketing are likely to accept green waste management practice to a higher degree, according to the 0.2063 value of the marginal effect.

As mentioned above, coffee farmers in Pamiang and Pang Ma-O areas do not have the waste disposal systems. They manage the wastes by littering them around their plantations or their residences. So, in promoting the practice of the green waste disposals, information and demonstration should be given to farmers about how to manage the wastes for the purpose of practical learning which can increase farmers' adoption of green waste management.

### 4.3.3 The adoption of green transportation

The practice of green transportation in this research focuses on the use of alternative fuels for transporting inputs and coffee products, as well as shared transportation method. The change from using the conventional to alternative fuels results in lower transportation cost and also reduces the GHG emission which causes global warming. In addition, the shared transportation method helps decrease the fuel consumption, save the cost, and lessen the air pollution.

The results from using the binary logit model are provided in Table 4.5. The McFadden's R-square and Percent correctly predicted equal to 0.2541 and 74.4681, respectively show the goodness of fit of the model.

The significant variables affecting the green transportation adoption by coffee farmers are discussed below.

**Green attitude (ATT)**: This research defines the green attitude as the positive attitude of the farmers toward green supply chain practices by determining the variable of environmentally friendly attitudes via ten questions to be assessed by the farmers themselves using Likert scales from 1 to 5, from least agree to most agree. The result in Table 4.5 shows that the green attitude of the farmers has a positive impact on the adoption of green practices at 0.10 statistically significant level. The rise in the positive thinking of the farmers concerning the environment leads to the increase in the chance of their adoption of green transportation practice by 0.0096. This finding is in accord with the studies of Burton et al. (1999), Burton et al. (2003), Läpple (2010), Läpple and Rensburg (2011) which showed that the farmers who are interested in environmental issues tend to be more accepting of organic farming.

Table 4.5 Binary logit model analysis of the green transportation adoption by Arabica coffee growers

| Variable | Estimate | | Marginal effect | |
|---|---|---|---|---|
| | coefficient | t-value | coefficient | t-value |
| Constant | -5.2551*** | -4.6350 | -1.3120*** | -4.6170 |
| GEN | 0.0129 | 0.0360 | 0.0032 | 0.0360 |
| EDU | 0.0850 | 1.1450 | 0.0212 | 1.1450 |
| EXP | 0.0153 | 0.3630 | 0.0038 | 0.3630 |
| ATT | 0.0384* | 1.8230 | 0.0096* | 1.8240 |
| FS | -0.0213 | -0.8460 | -0.0053 | -0.8460 |
| CI | 0.9204** | 2.1240 | 0.2251** | 2.2350 |
| IA | 0.9895*** | 5.1780 | 0.2470*** | 5.1910 |
| Number of observations | 188 | | | |
| Restricted log likelihood | -130.2691 | | | |
| McFadden's R-square | 0.2541 | | | |
| Percent correctly predicted | 74.4681 | | | |

Source: Calculation.

Note: *** denote .10 statistically significance levels.

From the findings above, when considering the context of the farmers in Pamiang and Pang Ma-O areas, coffee farmers in both areas apparently give priority to forest and watershed conservation as seen from the community agreement on land use and the reduction of chemical use to raise the environmental friendly awareness of the farmers. Thus, the positive attitude of farmers about the environmental friendliness measured by ATT remained at high level can lead to the opportunity of green practice adoption. This context is the key driver for strengthening the green supply chain promotion in the sample areas.

**Input cost concern (CI)**: Table 4.5 reveals the concern about the input cost that has significant positive impact on the adoption of green transportation at 0.05 significant level. The marginal effect coefficient of this variable is equal to 0.2251, meaning that the farmers who pay attention to lowering input cost tend to adopt green transportation.

**Information accessibility and utilization (IA)**: The information accessibility of and utilization by coffee farmers, as shown in Table 4.5, positively influence the use of green

transportation at 99% confident level. The marginal effect shown as 0.2470 implies that the farmers who receive the information and utilize it for achieving their production and marketing goals at high level tend to implement the green transportation practices.

From the above results regarding the adoption of three green practices, it can be seen that there are common factors that affect the farmers' adoption in all dimensions (green production, green waste management, and green transportation) namely the input cost concern and the information accessibility and utilization. Thus, presenting information and demonstrating the utilization as well as the cost saving outcomes to the farmers are the important means to achieving the success in GCSC development.

## 4.4 Economic conditions in the highland Arabica coffee supply chain

Analysis of the economic factors in the highland Arabica coffee supply chain was undertaken with the application of modified GEM model, which has extended the concept of Padmore and Gibson (1998) by adding the Porter's five forces and green relation concepts. The results of the analysis are divided into two stages: the first stage is to analyze the relative importance weights of the sub-indicators using the Analytic Hierarchy Process (AHP) of Saaty (1980, 1990), and the second stage is to analyze the economic and environmental factors in the highland Arabica coffee supply chain.

### 4.4.1 The results of relative importance weights of the indicators of the economic environment

The relative importance weights of 37 sub-indicators were determined through the analytical hierarchy approach (AHP) participated by 14 representative coffee farmers in Pamiang and Pang Ma-O areas, four staff members of Pamiang RPDC and Pang Ma-O RPEC, one staff member of RPF, and one staff member of HRDI, thus including totally 20 individuals. The results, shown in Table 4.6, revealed the priority of sub-indicators based on the respective weights given by coffee farmers and other stakeholders. For example, the prior important sub-indicators of resource which is one of the main indicators are production techniques in the case of Pamiang area, and natural resources in the case of Pang Ma-O area. Due to frequent extension assistance and supports from relevant agencies, the farmers in Pamiang area adopted some external production

techniques to increase their coffee productivity. Meanwhile, the farmers in Pang Ma-O area, because of the community regulations on environment conservation, had natural resources as their priority.

Table 4.6 Weights and priorities of sub-indicators of economic condition using AHP

| Indicator | Sub-indicator | Pamiang area | | Pang Ma-O area | |
|---|---|---|---|---|---|
| | | Weight | Priority | Weight | Priority |
| *Grounding dimension*: | | | | | |
| Resources | Natural resources | 0.11 | 5 | 0.38 | 1 |
| | Capital | 0.19 | 3 | 0.20 | 2 |
| | Human resource | 0.18 | 4 | 0.19 | 3 |
| | Techniques | 0.31 | 1 | 0.11 | 5 |
| | Technology information | 0.21 | 2 | 0.13 | 4 |
| Infrastructures | Transport and Communication | 0.15 | 3 | 0.09 | 5 |
| | Business environment | 0.14 | 4 | 0.17 | 3 |
| | Policy | 0.14 | 4 | 0.14 | 4 |
| | Associations | 0.25 | 2 | 0.30 | 2 |
| | R&D institutes and university | 0.32 | 1 | 0.31 | 1 |
| *Enterprise dimension*: | | | | | |
| Suppliers and Related agencies | Supplier strength | 0.13 | 4 | 0.17 | 2 |
| | Quality of suppliers | 0.25 | 1 | 0.23 | 1 |
| | Cooperation with suppliers | 0.11 | 6 | 0.14 | 6 |
| | Related agencies' strength | 0.15 | 3 | 0.16 | 4 |
| | Quality of related agencies | 0.12 | 5 | 0.15 | 5 |
| | Cooperation with related agencies | 0.24 | 2 | 0.17 | 2 |
| Structure and Strategies | Unanimous in group | 0.32 | 2 | 0.43 | 1 |
| | Ownership | 0.41 | 1 | 0.32 | 2 |
| | Production and strategies plans | 0.27 | 3 | 0.25 | 3 |
| Competition | Bargaining power of suppliers | 0.15 | 4 | 0.14 | 4 |
| | Bargaining power of buyers | 0.18 | 3 | 0.21 | 3 |
| | Intensity of rivalry | 0.30 | 1 | 0.29 | 1 |
| | Threat of substitute products | 0.25 | 2 | 0.23 | 2 |
| | Threat of new entrants | 0.12 | 5 | 0.13 | 5 |
| Green relation | Green production management | 0.30 | 3 | 0.47 | 1 |
| | Green transportation | 0.38 | 1 | 0.19 | 3 |
| | Green disposal of waste | 0.32 | 2 | 0.34 | 2 |

Table 4.6 (Continued)

| Indicator | Sub-indicator | Pamiang area | | Pang Ma-O area | |
|---|---|---|---|---|---|
| | | Weight | Priority | Weight | Priority |
| *Market dimension*: | | | | | |
| Local markets | Scale of local markets | 0.16 | 4 | 0.15 | 4 |
| | Local market share | 0.21 | 2 | 0.18 | 3 |
| | Growth and opportunity | 0.32 | 1 | 0.31 | 1 |
| | Local market boundary | 0.18 | 3 | 0.13 | 5 |
| | Specific demand | 0.13 | 5 | 0.23 | 2 |
| External markets | Distances to external markets | 0.13 | 5 | 0.13 | 4 |
| | Scale and growth rate | 0.29 | 1 | 0.35 | 1 |
| | External market share | 0.19 | 3 | 0.12 | 5 |
| | Final consumers | 0.14 | 4 | 0.17 | 3 |
| | Entry to external markets | 0.25 | 2 | 0.23 | 2 |

Source: Calculation.

Note: Weights and priorities of sub-indicators are calculated by using AHP method and shown in appendix B.

The weights of the sub-indicators from Table 4.6 were used to analyze economic factors of the Arabica coffee supply chain in Pamiang and Pang Ma-O areas by using the GEM Model.

### 4.4.2 Analysis of the economic factors of the Arabica coffee supply chain in Pamiang area

In the analysis of the economic factors in the Arabica coffee supply chain in Pamiang area, the 119 farmer samples are allowed to evaluate each sub-indicator from the current situations. The scores range from 1-10, from the least to the most. The economic factors or main indicators analyzed are separated into three dimensions consisting of *Grounding* indicating the supply side determinants such as the available resources and infrastructure, *Enterprise* focusing on structural determinants such as suppliers and relevant industries, firm structures and strategies, rivalry, and green relation, and *Market* stressing on the demand side determinants such as local market and the ability to access the external market. Each of the main indicators includes sub-indicators to assess. The results of the evaluation by the entire farmer samples in Pamiang area are averaged (details are shown in Appendix B) and weighted by the relative importance weight of each sub-indicator

received from Table 4.6, then, averaged again by using geometric mean method as shown in Equation (3.7) and (3.8) in chapter 3, $w_{ir} = \sqrt[n]{\Pi_{i=1}^{n} a_{ijr}}$ and $w_i = \sqrt[R]{\Pi_{r=1}^{R} w_{ir}}$ .The criterions for interpreting the scores are presented in Chapter 3 and the calculated scores of each main indicator are shown in Table 4.7.

Table 4.7 Economic factors in the Arabica coffee supply chain in Pamiang

| Indicator | Sub-indicator | Average of sub-indicator [a] | Weight [b] | Score [c] |
|---|---|---|---|---|
| *Grounding dimension:* | | | | |
| Resources | Natural resources | 5.94 | 0.11 | |
| | Capital | 6.49 | 0.19 | |
| | Human resource | 5.58 | 0.18 | 6.399 |
| | Technique & Technology | 6.92 | 0.31 | |
| | Information | 6.50 | 0.21 | |
| Infrastructures | Transport & Communication | 7.05 | 0.15 | |
| | Business environment | 6.80 | 0.14 | |
| | Policy | 5.99 | 0.14 | 6.594 |
| | Associations | 6.34 | 0.25 | |
| | R&D institutes & University | 6.75 | 0.32 | |
| *Enterprise dimension*: | | | | |
| Suppliers & Related agencies | Supplier strength | 5.84 | 0.13 | |
| | Quality of suppliers | 6.04 | 0.25 | |
| | Cooperation with suppliers | 5.79 | 0.11 | |
| | Related agencies strength | 6.19 | 0.15 | 5.974 |
| | Quality of related agencies | 5.94 | 0.12 | |
| | Cooperation with related agencies | 5.94 | 0.24 | |
| Structure & Strategies | Unanimous in group | 6.45 | 0.32 | |
| | Ownership | 6.19 | 0.41 | 6.070 |
| | Production & Strategies plan | 5.44 | 0.27 | |
| Competition | Bargaining power of suppliers | 5.11 | 0.15 | |
| | Bargaining power of buyers | 5.94 | 0.18 | |
| | Intensity of rivalry | 6.24 | 0.3 | 5.897 |
| | Threat of substitute products | 6.09 | 0.25 | |
| | Threat of new entrants | 5.54 | 0.12 | |

Table 4.7 (Continued)

| Indicator | Sub-indicator | Average of sub-indicator [a] | Weight [b] | Score [c] |
|---|---|---|---|---|
| Green relation | Green production management | 4.61 | 0.3 | 4.633 |
| | Green transportation | 4.81 | 0.38 | |
| | Green disposal of waste | 4.45 | 0.32 | |
| *Market dimension*: | | | | |
| Local markets | Scale of local markets | 6.12 | 0.16 | 6.152 |
| | Local market share | 6.39 | 0.21 | |
| | Growth & Opportunity | 6.34 | 0.32 | |
| | Buyer boundaries | 5.89 | 0.18 | |
| | Specific demand | 5.69 | 0.13 | |
| External markets | Distances to external markets | 5.97 | 0.13 | 5.465 |
| | Scale & Growth rate | 5.79 | 0.29 | |
| | External market share | 5.40 | 0.19 | |
| | Characteristics of final consumers | 4.91 | 0.14 | |
| | Entry to external markets | 5.18 | 0.25 | |

Source: Calculation.

Note: [a] Average of sub-indicators are calculated by using mean of scores of all farmers as shown in appendix B.

[b] Weights of sub-indicators are received from Table 4.4.

[c] Scores of indicators are calculated by using geometric mean as represented in equations (3.7) - (3.8) in chapter 3, and shown in appendix B. The criterions of score interpretations are also shown in chapter 3.

1) Grounding dimension

The grounding dimension indicates the supply side determinants such as the available resources and infrastructure. The available resources include the sub-indicators of natural resources (the appropriate geographic and climate conditions), capital (the adequacy of capital), human resources (the training and skill improvement of the farmers), technique and technology (the knowledge and accessibility of the farmers to production techniques and technologies), and information (the accessibility to information of the farmers). The results from the analysis of resource indicator in Pamiang area (Table 4.7) with the mean score of 6.399 can be interpreted that the available resources in Pamiang area is a strength for cluster development because of the physical suitability in terms of soil fertility, the height of the area, and the abundance of forest and natural water resources.

Infrastructure, the other main indicator, consists of five sub-indicators such as transport and communication (convenience to community access and transportation), business environment (regulation, socio-economic situation, technology supporting coffee production), policy (policy promoting coffee cultivation), associations (existence of farmers' groups in local community) and R&D institutes and universities (knowledge supports from R&D institutes and universities). Its score is 6.594 providing the interpretation that infrastructure is the strength for cluster development due to the convenient transportation giving easy access to the area, the supports from community organization, especially the Thepsadej Sub-district Administrative Organization in promoting coffee product and agro-tourism in the area, as well as providing funding sources to coffee farmers. In addition, the farmers in Pamiang area have received supports and assistance from various government agencies and academic institutes transferring the useful information and knowledge regarding production and marketing.

2) Enterprise dimension

The perspective of enterprise focuses on structural determinants such as suppliers and relevant industries (ability of suppliers to provide inputs on farmers' orders), firm structures and strategies, rivalry, and green relation.

A result in Table 4.7 is the calculated score of 5.974 for the part of indicator of suppliers and related industries which consists of six sub-indicators including the strength of its suppliers, quality of suppliers, cooperation with suppliers, the strength of the relevant agencies, quality of the relevant agencies, and cooperation with the relevant agencies. This means the factor of suppliers and related industries is neither the strength facilitating nor the weakness obstructing cluster development in Pamiang area. Some farmers in this area are able to produce inputs such as coffee seedlings themselves through their selecting quality seeds from their coffee plantations for producing seedlings to replace old coffee trees or expand the cultivation area. Moreover, on the issue of the cooperation with suppliers and related organizations, it was found from the interview with farmers that the farmers do not have commitment or loyalty to buy inputs from any particular suppliers. They would buy production inputs from any suppliers who offer them a lower price or other favorable deals. In terms of the cooperation with the concerned authorities, it was found that although many organizations have frequently provided coffee farmers

extension services and other supports, the cooperation between the concerned authorities and the farmers is not sustainable due to the desultoriness of the projects supporting the farmers.

The structure and strategies indicator, which consists of three sub-indicators including the homogenous group, ownership, and production and strategic plan, received a score of 6.070 indicating that this factor is the strength for cluster development, especially the homogeneity in the group that allows the easier development and management of new technologies (DAS, 1998) and leads practices of the farmers in the same ways. Meanwhile, the group unity can be achieved with strong leadership. In Pamiang area, the community leaders such as the sub-district headman, the village headman, the Chief Executive of Thepsadej Sub-district Administrative Organization, and the farmer leaders are very strong. Most coffee farmers trust them and thus generally listen to their advice and follow their practices in the same direction. This can become a key to success in cluster development.

For the factor of competition as a main indicator, this research applies the five forces competition model of Porter (1980) for determining the sub-indicators focusing on competitive advantages in terms of the bargaining power of suppliers, the bargaining power of buyers, the intensity of rivalry, the threat of substitute products, and the threat of new entrants. The analysis resulted in the score of 5.897 of competition indicator meaning that this factor does not facilitate or hinder the cluster development in Pamiang area. In bargaining power with supplier aspect, the farmers have high bargaining power when many suppliers simultaneously offered the inputs at the same time. This event does not often happen. The farmers in Pamiang area, in general, purchase inputs at the sources themselves.



For bargaining power with buyers, in the case of the farmers' selling their coffee products to the RPF or Doisaketpattana Agricultural Cooperative Ltd., the selling price is determined by the buyers based on the market price and sometimes it may be higher than the market price. Thus, the farmers do not have advantage or disadvantage from trading, although they do not have the power to negotiate with buyers. However, in the case of selling coffee products to the middlemen, the selling price depends on the middlemen. The farmers would be in disadvantage position if the middlemen force the price down.

In terms of the intensity of rivalry because of the demand for parchment coffee in the domestic market is still greater than the supply, the competition is not severe. However, following the operation of AEC in 2015, Thailand has reduced the import duties of green coffee beans down to 0% bringing about the increased imports of green coffee beans from neighboring countries. The impact of this situation on coffee farmers in Pamiang area may not obviously appear because the excess demand in the market still exists. But, whenever the excess supply takes place in the market, the competition will become more intense.

For the factor of green relation, which comprises three sub-indicators namely green production management, green transportation, and green waste disposal, the score is 4.633 leading to the interpretation that environmental friendliness is neither the strength nor the weakness for cluster development. The information from interviewing the farmers in Pamiang area indicated that the farmers here give high priority to environmental conservation as far as they pursue coffee farming without deforestation. However, farmers' heavy use of chemical fertilizers renders the doubt concerning green relation in this area. Moreover, the results in Table 4.5 indicated that the green relation factor which is the environmental friendliness indicator has the lowest score because of the association with chemical use and waste disposal. The use of chemical fertilizers and the waste disposal, especially waste from coffee peels, pulps, and wastewater, result in the degradation of soil quality and pollution in natural water sources. Preliminary data from the survey on sample farmers in Pamiang area showed that approximately 70% of the sample farmers had no management of waste from coffee husks, while releasing the wastewater from coffee fermentation and wash into the natural water without treatment. Consequently, when analyzing the actual situation and context, the indicator of green relation is likely to be the weakest of the GCSC development in the future.

3) Market dimension

The market dimension addresses such demand side determinants as local market and the ability to access external market. In this research, therefore, the analysis of market dimension is split into local market and external market indicators.

The local market indicator includes as sub-indicators the scale of local markets, the local market share, the growth and opportunity, the buyer boundaries, and the specific demand. The study result showed that the local market indicator has the score of 6.152 indicating that the local market is the strength for cluster development. The major buyers in the local market of Pamiang area are the RPF, the Doisaketpattana Agricultural Cooperative Ltd., and the middlemen. Moreover, some farmers in Pamiang area produce not only coffee cherries and parchment coffee to sell to the processors, but also green coffee and roasted coffee to sell to coffee shops under their own brand. The scale of coffee processing in Pamiang area consists of small households and medium industries. This information revealed that the local market for coffee farmers in Pamiang area is quite large. The farmers have various choices to sell their coffee products. In addition, the reputation of Pamiang coffee is well known and accepted in local and external markets. So, this indicator is the strength facilitating cluster development.

In terms of the ability to access external markets, the sub-indicators are the distance to external markets, the scale and growth rate, the external market share, the characteristics of final consumers, and the entry to external markets. The result presents the score of 5.465 for interpreting that the external market is not the measure of both the strengths and the weaknesses for cluster development. This may be due to the above mentioned matter. The local market potential is sufficient to support the productivity of farmers in the area, so the major goal of farmers in Pamiang is not selling coffee products outside the local area.



### 4.4.3 Analysis of the economic factors in the Arabica coffee supply chain in Pang Ma-O

Analysis of the economic environments in Pang Ma-O uses the same method as in the case of Pamiang. The 69 samples of farmers were involved in scoring each sub-indicator as assessment of the current situation with scores ranging from 1 to 10, from the lowest to the highest. The results of the analysis of the main indicators are shown in Table 4.8.

The interpretation of each indicator is as in the following:

Table 4.8 Economic factors in the Arabica coffee supply chain in Pang Ma-O

| Indicator | Sub-indicator | Average of sub-indicator [a] | Weight [b] | Score [c] |
|---|---|---|---|---|
| *Grounding dimension:* | | | | |
| Resources | Natural resources | 7.28 | 0.38 | |
| | Capital | 5.91 | 0.20 | |
| | Human resource | 6.99 | 0.19 | 6.654 |
| | Technique & Technology | 6.22 | 0.11 | |
| | Information | 5.81 | 0.13 | |
| Infrastructures | Transport & Communication | 4.39 | 0.09 | |
| | Business environment | 5.33 | 0.17 | |
| | Policy | 4.80 | 0.14 | 5.399 |
| | Associations | 5.58 | 0.30 | |
| | R&D institutes & University | 5.80 | 0.31 | |
| *Enterprise dimension*: | | | | |
| Suppliers & Related agencies | Supplier strength | 5.13 | 0.17 | |
| | Quality of suppliers | 6.00 | 0.23 | |
| | Cooperation with suppliers | 5.29 | 0.14 | |
| | Related agencies strength | 6.23 | 0.16 | 5.887 |
| | Quality of related agencies | 7.10 | 0.15 | |
| | Cooperation with related agencies | 5.59 | 0.17 | |
| Structure & Strategies | Unanimous in group | 7.38 | 0.43 | |
| | Ownership | 7.09 | 0.32 | 7.009 |
| | Production & Strategies plan | 6.28 | 0.25 | |
| Competition | Bargaining power of suppliers | 4.90 | 0.14 | |
| | Bargaining power of buyers | 4.80 | 0.21 | |
| | Intensity of rivalry | 5.51 | 0.29 | 5.523 |
| | Threat of substitute products | 6.48 | 0.23 | |
| | Threat of new entrants | 5.71 | 0.13 | |
| Green relation | Green production management | 7.78 | 0.47 | 7.112 |
| | Green transportation | 5.81 | 0.19 | |
| | Green disposal of waste | 6.91 | 0.34 | |

Table 4.8 (Continued)

| Indicator | Sub-indicator | Average of sub-indicator [a] | Weight [b] | Score [c] |
|---|---|---|---|---|
| *Market dimension*: | | | | |
| Local markets | Scale of local markets | 5.99 | 0.15 | |
| | Local market share | 5.81 | 0.18 | |
| | Growth & Opportunity | 6.52 | 0.31 | 6.349 |
| | Buyer boundaries | 6.10 | 0.13 | |
| | Specific demand | 6.91 | 0.23 | |
| External markets | Distances to external markets | 3.91 | 0.13 | |
| | Scale & Growth rate | 4.70 | 0.35 | |
| | External market share | 4.33 | 0.12 | 4.663 |
| | Characteristics of final consumers | 5.20 | 0.17 | |
| | Entry to external markets | 4.81 | 0.23 | |

Source: Calculation.

Note: [a] Average of sub-indicators are calculated by using mean of scores of each farmers as shown in appendix B.

[b] Weights of sub-indicators are received from Table 4.4.

[c] Scores of indicators are calculated by using geometric mean as represented in equations (3.7) - (3.8) in chapter 3, and shown in appendix B. The criterions of score interpretation are also shown in chapter 3.

1) Grounding dimension

The grounding dimension analysis obtained the score of 6.654 for the available resources indicator meaning that this factor is the strength for cluster development. In fact the survey of natural resources and interviews with community leaders in the Pang Ma-O area also provided the results that the resources in this area are quite abundant in terms of soil, water and forests. This is most probably due to the strength of Pang Ma-O community in environmental conservation and forest protection. Pang Ma-O villagers had jointly established the rules demarcating land for agricultural use and forest area for community's utilization to prevent the encroachment into forests for expanding agricultural areas. Moreover, Pang Ma-O area also has been declared as being in Chiang Dao Wildlife Sanctuary and Class 1A watershed where related invasive and destructive activities are strictly prohibited resulting in the advantage of having abundant natural resources which can facilitate the GCSC development.

For other sub-indicators of available resources, this study found that the farmers in Pang Ma-O area are able to access capital from institutional funding sources such as the village fund, cooperative, and BAAC, as well as from such private internal source as savings' group which is a self and mutual help community organization. In addition, the farmers in Pang Ma-O area are encouraged and supported by the HRDI in the field of training and farm skills development, and transferring coffee production knowledge, techniques and technologies. These factors support the strength of resources.

The infrastructure indicator received the score of 5.399 reflecting that all its sub-indicators combined including transport and communication, business environment, policy, associations, and R&D institutes and universities, is neither supporting nor hindering cluster development. This result is compatible with the fact that Pang Ma-O is located in the remote and hilly area. Although Pang Ma-O can be accessed without much difficulty by rural road, other means of distant communication are quite difficult for use like wireless phone whose signals do not reach certain parts of the area bringing about the obstacle for coffee farmers to contact external market. However, Pang Ma-O area is under the supervision of Pang Ma-O RPEC which is in turn overseen by HRDI that has its field staff working to assist farmers in various matters including the communication between farmers and external market resulting in lesser extent of communication problems.

For the factor of educational and R&D institutes, although Chiang Mai University, Maejo University, HRDI, RPF, etc., are recognized for having transferred knowledge and technologies to Pang Ma-O farmers, their research and development activities in this geographic area are not so frequent compared to their works elsewhere probably due to the matter of transportation and communication as discussed above. Therefore, this factor is not a strength or weakness for the development of cluster.



1.2) Enterprise dimension

For the enterprise dimension, the score of suppliers and related industries indicator is 5.887 which can be interpreted that this factor is not a strength or weakness for cluster development in Pang Ma-O area. This is because some farmers in Pang Ma-O are able to procure production inputs themselves without commitment or obligation to any particular

suppliers, while some rely on the Pang Ma-O RPEC for the supply of such inputs such as fertilizers, coffee seedlings. The farmers, thus, did not consider this indicator as strength or weakness.

The firm structure and strategies indicator received the score of 7.009 indicating the strength of the structure of production and strategies in supporting the development of cluster. The sub-indicator having the highest score is the homogeneity of coffee farmers. Although the farmers have the problems of integration and separation to sell their products, there is possibility for them to create unity as the result of their common goal of environmental conservation. Unity is likely to lead to the same direction of practices in coffee production by farmers which is the key to cluster development.

The competition indicator has the score of 5.523 implying that rivalry is neither a supporting nor constraining factor for cluster development in Pang Ma-O area. Considering the competition following the five forces model, the analysis found in the case of bargaining power with suppliers that most farmers in this area buy inputs at the input sources at market price. Thus, both farmers and suppliers do not have bargaining power. In terms of the bargaining power with buyers, in the case of selling coffee output to the RPF, the price is set by RPF based on average price in the market which is fair for farmers. But if farmers sell their produce to middlemen, the given price is more or less depending on the quality of output. So, the middlemen have more bargaining power than the farmers. However, the coffee product sold to middlemen is in very small proportion compared with selling to RPF. Thus, bargaining power is not the weakness or strength. In addition, the intensity of competition at present is not much because the demand in the market is still greater than the supply. Although Pang Ma-O coffee can be substituted by other forms or origins of mass coffee products, with the excess demand for Pang Ma-O coffee, the competition is not the problem for cluster development.

The environmentally friendly relation indicator - consisting of three sub-indicators defined as green production management, green transportation, and green waste disposal - got the score of 7.112 representing the strength of the green relation in the cluster's development. This is because the farmers in Pang Ma-O area have given priority to watershed and forest conservation and consequently produce coffee products with concern about environmental friendliness

This issue would allow the highly feasibility to cluster development. However, the waste management and transportation is the important issues having to develop to build the sustainable environment in the long term.

However, green waste management and green transportation need to be further encouraged as having important implication for building the sustainable environment in the long term.

1.3) Market dimension

In the market dimension, the local market indicator, including the scale of local markets, the local market share, the growth and opportunity, the buyer boundaries, and the specific demand, has the score of 6.349 indicating the strength of local markets in cluster development. The cooperation among the farmers to sell the coffee product to the RPF, and the establishment of the community enterprise are the strength of the local market indicator as well. In terms of the ability to access external markets, the score is 4.663 underlying the interpretation that the external market is not the strength contributing to or the weakness hindering cluster development. This is because most farmers have sold their coffee products in the local market. Thus, the target market of the farmers in Pang Ma-O area is not those outside the local area.

### 4.4.4 The comparison of the economic environments in the sample areas

The eight indicators of three dimensions of the economic environments are compared using the radar graph (Figure 4.3). The results showed that in Pamiang area as the whole, the available resources particularly the technical and technological progress, and the existing infrastructure with convenient and fast transport and communications are the strength that can be used to create GCSC of Arabica coffee. Considering the weaknesses in the cluster development, the green relation in production, transportation and waste disposal is the major weakness hindering development.

As an overview of Pang Ma-O area, the environmental friendliness factor has the highest score followed by the structure and strategies. These are the strength that can be used to develop the GCSC of Arabica coffee. However, the indicator of the external market is

considered a major weakness compared to other indicators which affects the cluster development.

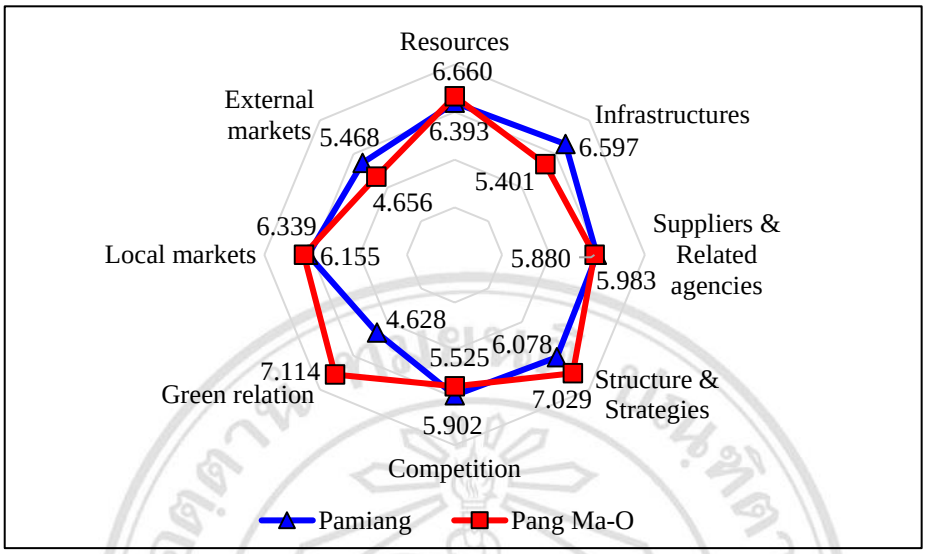


Figure 4.3 Economic factors in the Arabica coffee supply chain in Pamiang and Pang Ma-O

Source: Author's analysis.

Moreover, the calculated GEM score, which generally has the total score of 1,000 points, reflects the maximum competitiveness in an industry (Padmore and Gibson, 1998). The results from the present calculation show the GEM scores of Pamiang and Pang Ma-O areas equal to 449.01 and 355.25, respectively. These findings reveal the competitiveness of two sample areas to be lower than the average score (500 points), pointing out that if the GEM indicators in Arabica coffee cluster are not developed, the two sample areas will gradually incur the loss of their market share to competitors.



## 4.5 Summary and discussion

In GCSC development, the knowledge about production and marketing environments of highland Arabica coffee is necessary for planning, designing and simulating cluster of green supply chain. The results from the analysis of production and marketing environments of highland Arabica coffee that imply the GCSC driving factors can be concluded and discussed as follows:

1) The results on the appropriate physical domain and community context of the sample areas reveal that Pamiang and Pang Ma-O areas are suitable in the

aspects of land elevation, soil fertility, abundant water resource, temperature, average rainfall per year, and relative humidity.

2) The results from current cluster analysis of Arabica coffee point out the specific strengths of current cluster in facilitating the development of green supply chain of Arabica coffee in the sample areas. The strengths come from the suitable physical factors, farmers' experience as well as knowledge regarding coffee production techniques and technologies, farmers' awareness of environmental value, and the cooperation among coffee farmers. However, the collaboration among the farmers and the cooperation between the farmers and the relevant agencies are the weakness of the GCSC development due to the doubtful continuity and sustainability.

3) To understand the underlying factors for coffee farmers to adopt green practices in production, waste management, and transportation for realizing an environmentally friendly supply chain, the logit model was used as the analytical tool. The results revealed the significant factors that have strong positive effect on farmers' adoption of all three green practices to include the concern of farmers about input cost and the information accessibility of and utilization by the farmers. Thus, the provision of relevant information to farmers as well as the demonstration on how to use green practices and the cost saving outcomes from the practices will be an important means to achieving the success in GCSC development.

4) In addition, the analysis of external environmental factors with the use of modified GEM model revealed that the available resources indicator particularly the technical and technological progress element, and the existing infrastructure with convenient and fast transport and communications are the strengths that can be used to create GCSC of Arabica coffee in Pamiang area, while the green relation in production, transportation and waste disposal is the major weakness of cluster development. With respect to Pang Ma-O area, the environmental friendliness and the structure and strategies are the strengths that can be used to develop the GCSC of Arabica coffee here. However, the external market factor is considered a major weakness

compared to other indicators which affect the cluster development. Moreover, the calculated GEM scores to judge the competitiveness of the two sample areas point out that if the indicators in Arabica coffee cluster are not developed, the two sample areas will gradually incur the loss of market share to competitors.

The findings in Chapter 4 bring about two questions for discussion as follows:

**1) Are the farmers ready to go green and cluster?**

The GCSC development is successful, whether or not, depends on the readiness of the farmers to participate in the environmentally friendly practices and cooperation. The findings mentioned above indicate the main drivers for and barriers against the farmers to go green as follows:

**1.1) Driving factors to form the GCSC**

**Geography, natural resource availability, and cultivation form**: Pamiang and Pang Ma-O areas have the appropriate geographic conditions for producing quality Arabica coffee such as the altitude, the fertility of soil, the abundance of water, temperature, average rainfall per year, and relative humidity. Moreover, the shade grown cultivation which is the pattern of growing coffee plants under the shade of trees mostly used in both areas results in the positive ecological impacts from the shade trees such as biodiversity conservation that serves as a means for natural pest control against coffee pests, enrichment of the soil and, strengthening plant roots systems, prevention of soil degradation and erosion, retaining of rainfall, lowering temperatures for the coffee trees, reduction of greenhouse gas emission, etc. The studies by Gobbi (2000), Perfecto et al. (2005), Gordon et al. (2007), and Philpott and Bichier (2012) mentioned that there are higher habitats for a great number of migratory and resident organisms in the shaded polyculture than unshaded monoculture. The denser coffee shade grown, the more environmental benefits. In addition, shade-grown coffee benefits the farmers in terms of potential livelihood by reducing production costs of the farmers because of the lower chemical input requirement of shade-grown cultivation (Albertin and Nair, 2004), increasing farmers' productivity over the long-term resulted from longer lifespan of the

coffee trees grown under shaded relative to unshaded cultivations (Bote and Struik, 2011), and providing the higher quality of shade grown coffee products than sunlight grown coffee products, as the study by Muschler (2001) showed that shade grown coffee generally had better body and acidity than coffee from unshaded plantations. Thus, the appropriate geography, natural resource availability, and shade grown cultivation are the fundamental facilitators for supporting the readiness of the farmers to GCSC.

**Strong partnerships**: The findings of the current cluster analysis point out the relationships among the partners such as the farmers, other stakeholders in the supply chain, and the relevant institutes are very strong. The agencies supporting the farmers in Pamiang and Pang Ma-O areas, such as the Sub-district Administrative Organization, the District Agricultural Extension Office, the RPF, agricultural cooperatives, Chiang Mai University, Maejo University, Kasetsart University, the Thailand Research Fund (TRF), the National Science and Technology Development Agency (NSTDA), etc., provide the facilities, knowledge, and policies useful for green and cluster development. For example, in Pang Ma-O area, the Maena Sub-district Administrative Organization, Chiang Dao District Agricultural Extension Office, the RPF, the HRDI and the Pang Ma-O RPEC jointly created the community plan about environmental conservation facilitating environmentally friendly farming; encouraging the farmers to set up the community enterprises for the purposes of production, marketing, and access to capital; establishing the savings groups to finance farmers' borrowing; supporting production inputs; and transferring the production technical knowledge and development. The farmers in Pang Ma-O area cooperated well with these entities.



Meanwhile, in Pamiang area, there are various organizations such as Thepsadej sub-district Administrative Organization, Doi Saket District Agricultural Extension Office, Cooperative Promotion Department, RPF, Pamiang RPDC, and Doisaketpattana Agricultural Cooperative Ltd., etc., working in support of the community plans and activities to benefit the farmers such as agro-tourism that allows tourists to learn and get experience in coffee plantation and processing, farmers' groups, establishment of savings groups to be both saving and lending source for farmers, production input assistance, production technique and development education, and promotion of coffee products

through the operation of community enterprise. Coffee farmers in Pamiang area cooperate well with these agencies because of the continuation of their promotion and supports.

These partnerships are the key factors to support and encourage the GCSC. They could be formed to facilitate and promote local development through the creation of development strategies, the strengthening of local competitiveness, the promotion of innovation, and providing cluster benefits (Porter, 1990). According to Lambert (2006), partners bear the closely integrated and mutually beneficial relationships in optimizing the performance of supply chain. They play the roles as the networks connecting individuals and organizations in functional areas (e.g. research, production, logistics or marketing) for quick response development (Andonova, 2010, Bjarstig and Sandstrom, 2017). However, there are many different styles of relationship among the partners and their performances over time would be changed depending on the trust conditions (Cannon et al., 2010, Abdullah and Musa, 2014). Consequently, for achieving the GCSC, the trust-based partnership formation is important and brings about the sustainable development.

**Farmer readiness**: The findings on farmers' adoption reveal the readiness of the farmers to go green. The factors strongly and positively affecting the adoption of three green practices consist of the input cost concern and the information accessibility of and utilization by farmers. In Pamiang and Pang Ma-O areas, the farmers have accessed the information themselves as well as received from many organizations such as local authorities, the District Agricultural Extension Office, the RPF, the HRDI, the Pamiang PRDC, the Pang Ma-O RPEC, the research and development institutes and universities. When pertinent information is utilized and the farmers have seen the empirical outcomes from doing, they would adopt the new practices easily. Collentine et al. (2004) stated that the farmers who have the limitations to access, record and utilize the information may suffer from the increase of the costs of time and resource procurement in developing and decision making in agricultural practices.

Moreover, in parchment coffee processing, farmers in both Pamiang and Pang Ma-O areas have generated large amount of wastes from the coffee cherries peels and pulps from the pulping process, as well as enormous wastewater from fermentation and washing processes. These wastes result in the air and water pollutions. Coffee farmers in both areas

do not have the systems of production waste disposal. The wastes from peels of coffee cherries are dropped on the coffee plantations or piled around residential areas causing a foul smell and GHG emissions. The coffee peels, in fact, can be used to make compost. The composting from agricultural waste, coffee cherries peels and pulps, not only reduces the pollution but also decreases the cost of fertilizers. Accordingly, the way of green waste management by composting from waste is the choice of the farmers having the concern about input cost.

Thus, presenting information about the advantage of green practices and cluster, and demonstrating the utilization and outcomes to the farmers are the important means to achieving the success in GCSC development.

**Green relations**: Because Pamiang and Pang Ma-O villages are located in forest and watershed areas, the local farmers recognize the importance of environment and work together to reduce the use of chemicals to prevent the pollution of soil and water resources especially in Pang Ma-O area where there exist the community agreements on forest and watershed conservation. Moreover, both villages are located in the responsible areas of the RPF and the HRDI which work to promote the reduction of chemical use and to bring about the awareness and practices of environmental friendliness. So, this factor is a crucial driver for green and cluster development in highland Arabica coffee.

### 1.2) Barriers to the GCSC

**Weakness related to farmers' collaboration**: The study results indicate that the collaboration among the farmers and the cooperation between the farmers and the relevant agencies are the weakness of the GCSC development in the light of questionable continuity and sustainability of various development project and activities. In general, cooperation is a key success factor of green cluster establishment and brings about the sustainability (Tseng, 2011, Tseng and Chiu, 2013). Consequently, the demonstration of the importance and outcomes of the cooperation to farmers would lead to the occurrence of development. Furthermore, the giving of priority to environmental friendliness, which is the strength of farmers, creates the sustainable development.

**Discontinuous actions**: The findings from cluster analysis show the discontinuous actions to be the key obstacle to the sustainability of GCSC development. In both Pamiang and Pang Ma-O areas, there are many government, private, and academic institutes working in the provision and transfer of technologies and knowledge but they are not doing continuously to lead to the sustainability of GCSC development. Most of research and development activities especially those undertaken by educational institutes are in the nature of projects funded for operating in specific fiscal year or years. The continuity and sustainability of research works come to an end at the completion of the projects. This point is a crucial issue as the green and cluster development depends pretty much on the building of partnerships between the farmers and research entities.

**2) How to prepare the farmers into GCSC**

The preparation of the farmers to participate in the GCSC is suggested to make as in the following directions.

**2.1) Building the trust among the farmers and other stakeholders in the supply chain**

As mentioned above, the trust is an important factor fostering commitment among supply chain partners and increasing the chance of success in the supply chain performance. Trust is pointed out as the wealth for long-term partnerships (Cannon et al., 2010).

Although there exist farmers' groups or farmers' clusters in Pamiang and Pang Ma-O areas, the collaboration and unity of the groups are low. Some farmers do not trust one another and do their activities separately, such as purchasing inputs, harvesting coffee cherries, producing parchment coffee, and selling coffee output on their own acts bringing about price intervention by middlemen and high costs of production and transportation. Furthermore, the easy entry of fertilizer merchants to advertise the benefits of fertilizers and lead the farmers to believe that the use of fertilizer provide the high coffee yield may change the latter's pattern of cultivation from environmentally concerned plantation to chemical growing in the future. Thus, the building of the trust among the farmers and other stakeholders in the supply chain is the priority of the GCSC development.

How to build trust is a question. The findings on factor affecting the farmers' adoption of green practices as presented in Section 4.3 indicate that the variable of input cost concern has a significantly positive effect on the green adoption. The higher concern about the cost, the more adoption of the green practices. Therefore, the way to build the trust should be through the calculative processes which estimate the costs and rewards associated with staying in current and alternative situations (Newman and Briggeman, 2016). If the current costs are higher, trust building process will take place.

**2.2) Establishing the collaboration**

When the trusts among the farmers and relevant actors are built, the collaborations among them occur. There are three types of collaboration: the horizontal collaboration that occurs when two or more unrelated or competing organizations at the same level cooperate to share their private information or resources together, the vertical collaboration that takes place when two or more organizations at different levels share their responsibilities, resources and performance information to serve relatively similar end consumers, and lateral collaboration that aims to gain more flexibility by combining and sharing capabilities in both vertical and horizontal manners (Simatupang and Sridharan, 2002, Barratt, 2004, Mangan et al., 2008).

The present research findings point out that the collaborations among the farmers and the relevant agencies in Pamiang and Pang Ma-O areas are weak in terms of continuity and sustainability. Moreover, despite the concern about production cost, chemical use, transportation, and agricultural wastes from the production still remain the issue. Thus, two possible ways to establish the collaborations among the farmers and relevant actors in both areas consist of the horizontal collaboration among the farmers for sharing information, joint production and transportation, and joint waste disposal management, and the vertical collaboration among the farmers, the Pamiang RPDC and Pang Ma-O RPEC, and RPF with the revenue sharing contracts.

**2.3) Choosing the strong leader**

Leader is the important person who leads the group or cluster members to do in the same patterns and achieve their goals. Once the cluster has been established, the cluster leader

is selected (Nicolini et al., 2001). In Pamiang and Pang Ma-O areas, the findings indicate that although there are the farmers' groups in these areas, they are weak from the timid nature of their leaders. Thus, selection of a strong leader is necessary for strengthening the GCSC.

**2.4) Providing the correct information regarding GCSC**

The information accessibility of the farmers in Pamiang and Pang Ma-O areas is the key factor for adopting the new practices. The findings show that those farmers who have more ability to access the information tend to positively adopt the environmentally friendly practices. Therefore, providing correct information regarding the approaches and outcomes of the green and cluster practices is useful for farmers to consider accepting green practices and participating in the GCSC.

**2.5) Simulating the GCSC**

The best ways to demonstrate the GCSC to Pamiang and Pang Ma-O coffee farmers are learning by doing approach and providing them the empirical knowledge because these ways can bring about the obvious outputs and outcomes.

Nicolini et al. (2001) proposed four criterions guiding the formation of GCSC including integrity of processes concerning the meaningful and measurable output, interdependence of activities covering a range of operations that are relatively interdependent one with the other, leadership that has the potential for effective leadership, and coordination among the players involved in a cluster, and incomplete clustering regarding the change of the partners who can fulfill the activities in the cluster at any time.

Moreover, the demonstration of green practices, such as green production, green waste management and green transportation, is the pathway to build the trust and achieve the GCSC. The summary of driving factors and approaches to achieve the GCSC of Arabica coffee is shown in Figure 4.4.

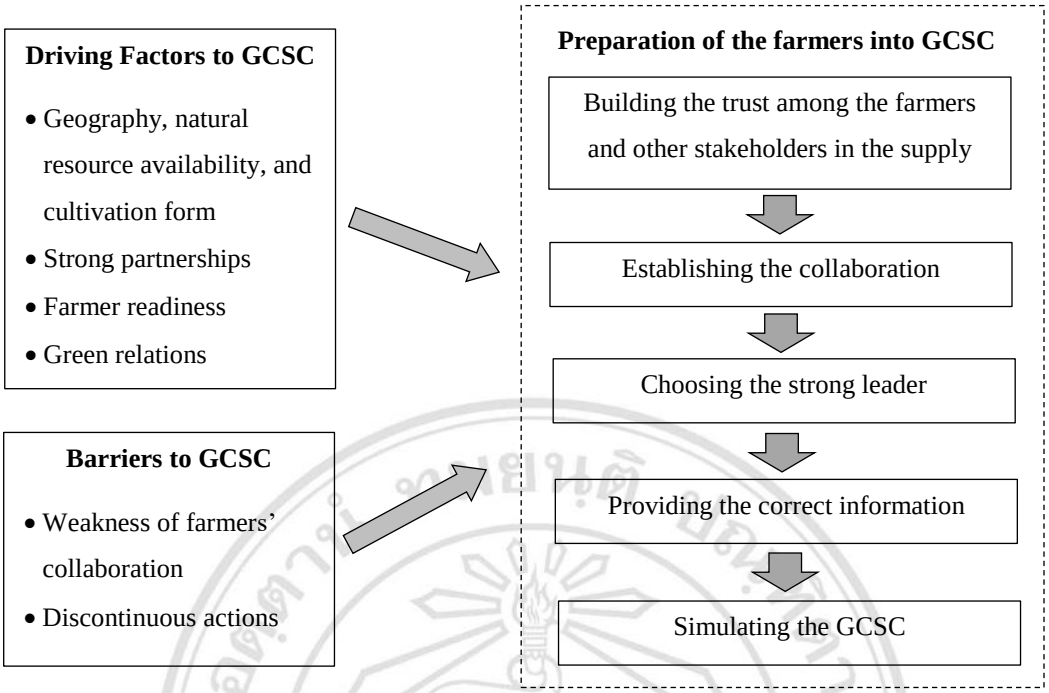


Figure 4.4 Driving factors and pathways to GCSC