TECHNICAL BULLETIN

Vol. 1 No. 1
ISSN 2243-8483

Supply Chain Improvement of Arabica Coffee in the Cordillera Region

Rodelio G. Idago and Renita SM. Dela Cruz

Department of Agriculture
Philippine Center for Postharvest Development and Mechanization
2011

ISSN: 2243-8483

Bibliographic Citation:
R.G. Idago and R.SM. dela Cruz. 2011.
Supply Chain Improvement of Arabica Coffee
in the Cordillera Region. Philippine Center for Postharvest
Development and Mechanization. Science City of Muñoz, Nueva Ecija. 36p.
PHilMech Technical Bulletin No. 1

About the cover:
The cover shows coffee depulping using a small-scale PHilMech-designed pulpers
appropriate for depulping fully-ripened coffee berries.

Cover photo by R.G. Idago

Supply Chain Improvement of Arabica Coffee in the Cordillera Region

Rodelio G. Idago and Renita SM. Dela Cruz

Department of Agriculture
PHILIPPINE CENTER FOR POSTHARVEST DEVELOPMENT AND MECHANIZATION
CLSU, Compound, Science City of Muñoz, Nueva Ecija

ABSTRACT

The study had two phases. Phase 1 assessed the existing supply chains of Arabica coffee in the Cordillera in 2009 while Phase II subsequently designed and pilot-tested postharvest-related interventions to improve the status of the current supply chain. The result of the study revealed that the current Arabica supply chain is hampered, among others, by: (a) insufficient supply of green coffee beans for processing because of backyard type and low level of production, and (b) poor quality of green coffee beans produced at the farm level because of poor postharvest practices and antiquated postharvest facilities.

Improvement in the supply chain was concentrated on the postharvest operations of coffee and was designed to improve and meet the quality of the green coffee beans demanded by the processors. The physical system is a set of matched postharvest facilities tailor-fitted to the unique socioeconomic and farm attributes characterizing the coffee growing areas in Cordillera. It was pilot tested in the province of Benguet, the highest producer of Arabica coffee among the provinces of the Cordillera region, under the operation and management of existing coffee farmers' organizations.

With the postharvest system intervention, the quality of green coffee beans produced by the farmers significantly improved resulting to increase in income due to improvement in grade and reduction in labor cost. On the side of the processors, transaction cost of procuring raw material was reduced because of direct transaction with organized coffee farmers while having access to better quality of raw materials for processing. However, problems on insufficiency of supply could only be partly addressed by the postharvest system and has to be resolved through production-focused interventions. In general, through the developed postharvest intervention, the farmers' and the processors' nodes were enhanced contributing to the improvement of the supply chain of the Arabica industry in the Cordillera region.

INTRODUCTION

The Philippines used to be one of the top 10 producers and exporters of coffee in the 1970's. However, problems related to unstable world market price of coffee beans, quota restrictions and high cost of production reduced the once booming domestic coffee industry into almost backyard type of production (Bayanihan, 2007). As a consequence, in the 1980's up to the present, the Philippines has to import PhP 2.5 billion worth of coffee a year or about 32 percent of its domestic consumption (Department of Agriculture (DA), 2006).

However, there was a recent surge in the demand for coffee as a beverage especially when the widely perceived negative effects of coffee like high blood pressure, were disproved, and that significant positive health benefits were uncovered such as the coffee properties of preventing Type 2 diabetes, reducing the risk of colon cancer, prevention of Parkinson's Disease (coffeescience.org; undated). Consequently, there was a revival and rehabilitation of the coffee industry.

BAS (2007) reported that the country's production of green coffee bean in 2005 was about 52,924 MT while domestic consumption was about 78,072 MT indicating that the country is a net importer of coffee. On the other hand, the country exports specialty coffee particularly Arabica and Liberica.

Previous programs of the Department of Agriculture (DA) identified coffee as one among the priority crops to be developed in the next 10 years. A Coffee Development Program was then developed which aimed to make the Philippine coffee industry self-sufficient within the next ten years, increase income opportunities for producers and entrepreneurs, and increase export of specialty coffee by 2015 (DA, 2006).

Among the several strategies and activities undertaken to meet the objectives of the program are: provision of postharvest and processing facilities in selected production clusters, improvement of distribution efficiency, improvement of value-adding activities and development of specialty products such as organic coffee and high quality Benguet Arabica (Maghirang, 2006). DA (2006) reported that organic Liberica and Arabica coffee are becoming popular in the country with Figaro and Serenity Coffee promoting and marketing them. The Philippines has a comparative advantage in the production of Arabica coffee thus the rehabilitation of the areas where this variety is grown, particularly the Cordillera region, is given a major priority.

The DA's move towards the development of specialty coffee requires a more in-depth examination of the Arabica coffee industry to ensure that the quality of product demanded by the market is produced in reliable and consistent manner. This project was in line with the objective of the Coffee Development Program to improve value-adding activities at the upstream end and improve production-market linkage by building up capabilities to process the quality of coffee demanded by the specific market.

OBJECTIVES OF THE PROJECT

In general, the project aimed to improve the supply chain of Arabica coffee industry in the Cordillera Region through provision of appropriate postharvest technologies. Specifically, the project sought to:

1. provide an overview of the coffee industry and map out the Arabica coffee supply chain;
2. analyze the performance of the Arabica coffee supply chain in terms of efficiency, flexibility and responsiveness;
3. identify areas for improvement in the aspect of postharvest;
4. pilot test identified postharvest intervention designed to address the postharvest inefficiencies of the supply chain, and;
5. provide policy recommendations to improve the coffee industry in general, and the specific supply chain in particular.

REVIEW OF LITERATURE

Supply Chain Analysis and Supply Chain Management

Supply chain analysis is the examination of how the flow of information, inventory, processes, and cash are managed from the supplier to the customer, including the final process of disposal (Fawcett, Ellram and Ogden, 2007). The analysis identifies the needs of the end-customer and the capabilities that must exist in the chain to meet the needs of the customer. Each supply chain has its own unique set of market demands and operating challenges.

Hugos (2006) defined supply chain management (SCM) as the coordination of production, inventory, location, and transportation among participants in a supply chain to attain the best mix of responsiveness and efficiency for the customer being served. SCM embraces a systems approach to understanding and managing the various activities required to coordinate the flow of products and services to best serve the customer. It views the supply chain and the organizations in it as a single entity.

The effective management of supply chain requires simultaneous improvements in both customer service levels and the internal operating efficiencies of the firms in the supply chain. Among others, customer service can be gauged through order fill rates, on-time delivery rates, and rate of product returned by customers while internal efficiency of the organizations in a supply chain is measured by the rate of return on investments and reduced operating and sales expenses, among others.

Coffee Production

<u>World production</u>

Based on the last three years, 2007 to 2009, the average world's production of green coffee beans is 8.245 million MT (FAOSTAT, 2009). The production in Brazil (30.26 percent), Vietnam (14.13 percent), Colombia (9.43 percent) and Indonesia (8.32 percent) constituted 62 percent of the world's total coffee production. The total volume produced in the Philippines during the same period was only 1.2 percent. Brazil remains the largest coffee exporting nation but in recent years the green coffee market had been flooded by large quantities of Robusta beans from Vietnam (Scofield, undated).

Production in the Philippines

Coffee planted in Mindanao and Luzon constituted 67 percent and 24 percent of the total coffee areas, respectively (BAS, 2007). Moreover, Mindanao provinces also produced the highest, 75 percent, while the provinces in Luzon only produced 19 percent of the total volume of green coffee beans.

In terms of volume of production (MT), the ten highest coffee-producing provinces in 2006 were Sultan Kudarat (20,759), Compostela Valley (12,450), Davao City (8,288), Cavite (7,515), Davao del Sur (5,231), Bukidnon (4,954), Sulu (4,839). Kalinga (4,065), Maguindanao (3,649) and Iloilo (3,382). These 10 provinces contributed 72 percent of the total volume of coffee harvested in the country.

The four major types of coffee grown in the Philippines are Arabica, Excelsa, Liberica and Robusta. In terms of the percentage volume of total coffee produced in 2005 to 2006, Robusta had the highest volume (71 %), followed by Arabica (20 %), Excelsa (8 %), Liberica and other types of coffee (1%).

Coffee Trade

World trading

Robusta coffee is preferred by large industrial companies, such as multinational roasters and instant coffee producers, because of lower cost. Kraft, Nestle, Procter & Gamble, and Sara Lee are four single roaster companies buying more than 50 percent of all annual production (Stein, 2002). The preference of the "Big Four" coffee companies for cheap Robusta was believed to be a major contributing factor to the crash in coffee prices.

Philippine trading

Coffee is traded in several forms, namely: raw coffee, roasted, extracts and essences and coffee husks and skins. DA-AMAS (2006) reported that in 2005, the country exported USD 6.464 million worth of the four forms of coffee. In terms of value, the coffee extracts and essences contributed about 98 percent of the total value of exported coffee. On the other hand, the Philippines imported USD 51.292 million worth of coffee, with raw coffee getting the highest percentage (55 %) of the total value of coffee importation. The figures indicate the huge potential of coffee in the local market to substitute for the importation. Based on this data, the demand gap is about 25,222 MT annually.

The two major markets of Philippine coffee in 2005 were Japan and South Korea with 44 percent and 27 percent, respectively, of the total export volume. The export to these countries accounted for 71 percent of the total coffee exportation. The three big coffee exporters are the Cordillera organic exports, Goldshine pharmaceuticals and Serenity Coffee Corporations (DA-AMAS, 2006). Their total volume of exportation was worth USD 67,153 or P3.4 million in 2005 with the Kingdom of Saudi Arabia, Japan and Canada as points of destination.

DA-AMAS (2006) also reported that based on price, the Philippine coffee is competitive in the local market and has a bright export market at a price of about P100/kg (USD 1.89/kg at 2005 exchange rate of P53/USD). Based on 2005 statistics, Arabica type of coffee had the highest farm gate price of P61.21/kg while Robusta and Excelsa had P39.61/kg and P35.24/kg, respectively. On the other hand, the wholesale prices of the aforementioned types of coffee, on the same year, were P41.47/kg and P40.11/kg for Robusta and Excelsa, respectively.

Coffee Types

The two main cultivated species of coffee are Coffea canephora and Coffea arabica. Arabica coffee is considered to be more suitable for drinking than Robusta (C. canephora). Compared to

Arabica, Robusta tends to be bitter and have less flavor and for this reason, about three fourths of coffee cultivated worldwide is Arabica (http://www.ico.org). However, Robusta is less susceptible to disease than Arabica and can be cultivated in environments where Arabica will not thrive. Moreover, Robusta coffee contains about 40 to 50 percent more caffeine than Arabica. Hence, it is used as an inexpensive substitute for Arabica. It has also been reported that good quality robustas are used to prepare some espresso blends to provide better foam head and to lower cost.

Flavor Characteristics as Influenced by Coffee Processing

The method employed in processing coffee is usually the single most important contributor to the flavor profile of coffee while the next major contributors are the microclimate and soil. Thus, every region has its own proper processing technique that should help attain the flavor profile desired by the producer and consumer. For example, dry processing in Guatemala is not acceptable due to their high humidity. Only their lowest grade coffees are dried without pulping. On the other hand, in Brazil, dry processing gives the kind of flavor that is almost essential in any good espresso blend.

There are three major techniques in processing coffee, namely: dry process, wet process and the pulped natural process. The dry process, also called the natural method, is commonly used in production areas where rainfall is scarce and long periods of sunshine are available to properly dry coffee. Coffeeresearch.org reported that coffee from Indonesia, Ethiopia, Brazil and Yemen are processed using the dry method. Coffee produced from this method is reported to be heavy in body, sweet, smooth and complex.

Wet processing is a relatively new method to remove the four layers surrounding the coffee beans. This method produces coffee that is cleaner, brighter and fruitier. Coffee growing areas, where their coffee produced is valued for its perceived acidity, prefer the wet process.

The pulped natural method consists of pulping coffee but omitting the fermentation stage to remove the silver skin. This type of processing can be adapted in coffee growing areas where the humidity is low and the coffee covered in the sweet mucilage can be dried rapidly without fermenting. Brazil introduced and made this method famous and produces some of the best pulped natural coffee in the world (coffeeresearch.org). The 20 winners of the Gourmet Cup competition in Brazil in 2000 have been reported to process their coffees using the pulped natural method.

Coffee Postharvest Operations

Information on coffee postharvest operations were largely taken from the literature on coffeeresearch.org.

<u>Harvesting</u>

Coffee is harvested when the berries are bright red, glossy and firm. Berries are either harvested by (a) selective picking of mature berries, (b) stripping which gather both unripe and overripe berries and (c) mechanical harvesting using machines. To maximize the harvesting of ripe coffee berries, selective picking by hand is recommended especially in areas where there is enough labor.

Brazilian farmers harvest when 75 percent of the coffee crop is already ripe. They found that stripping is feasible and cost effective due to the uniform maturation of Brazilian coffees. Harvesting the same coffee tree several times is less cost effective than separating and discarding the unripe overripe berries.

<u>Separation of good coffee berries</u>

After harvesting, good ripe berries are separated from the overriped and undeveloped berries. Overriped and undeveloped coffee berries as well as sticks and leaves, float in water. On the other hand, ripe and green coffee berries sink. The coffee floaters are usually used for internal consumption. The coffee sinkers are dried using the natural process of preparing coffee or can be depulped to facilitate drying.

Depulping coffee

After harvesting and separation of inferior quality berries, the pulp of the good coffee berries is removed, usually by pulping machine. In big mills, the beans are separated by weight as they are conveyed through water channels, the lighter beans floating on the water surface while the heavier, ripe beans sink to the bottom. The beans are further separated by size. The depulped berries are dried or fermented then dried and sorted.

Fermentation

After pulping, the beans covered with the slippery mucilage can be directly dried as pulped natural coffee or can be fermented in fermentation tanks. Depending on a combination of factors, such as the amount of coffee, climate, altitude, water temperature and humidity, the pulped beans remain in the fermentation tanks for 12 to 48 hours. During this time the slick layer of mucilage is dissolved by naturally occurring enzymes. The best way of determining the end of fermentation is to feel if the beans are still encased in mucilage. The beans feel rough when fermentation is completed. Longer fermentation time creates an off flavor. After rinsing, the beans are dried to about 12 percent moisture for storage.

Coffee drying

Coffee is dried from approximately 60 percent to 11 to 12 percent moisture content. The dry beans, also known as 'parchment', are stored until further processing. Typically, Brazil coffee is sun-dried on drying pavements and then transferred to mechanical dryer. While sun drying, coffee is shifted every 30 to 40 minutes. Sun drying coffee on pavements takes six to seven days for washed coffee, eight to nine days for pulped naturals (semi-washed), and 12 to 14 days for natural (dry-processed) coffee. Sun drying is typically done until the beans reached a moisture content of 15 percent and are then transferred to mechanical dryers. There are six stages in drying coffee, namely: (1) skin drying with 55 to 45 percent moisture; (2) white stage drying with 44 to 33 percent moisture; (3) soft black stage with 32 to 22 percent moisture; (4) medium black stage with 21 to 16 percent moisture; (5) hard black stage with 15to 12 percent moisture, and; (6) fully dry coffee and conditioning with 11 to 10 percent moisture (Kamau, 1980 cited by cofeeresearch.org).

It is recommended that sun drying at stage 3 is mandatory for coffee quality. Drying temperature should be between 40-450C or a bean temperature of 350C so that coffee quality will not be seriously compromised. Stages 5 and 6 (15-11% moisture) require a drying time of six hours in a mechanical dryer using a drying temperature of 40^{0} - 45^{0}C. Higher drying temperature will kill the germ and the flavor potential of coffee is ruined.

Drying coffee in a mechanical dryer accelerates the slowest part of the coffee drying process (15-11% moisture) and helps prevent further unnecessary fermentation. In areas where relative humidity is high, the entire drying process will have to be done in a mechanical dryer. Some grain dryers can be converted as coffee dryers. However, these types of dryers are not as efficient as the new horizontal barrel dryers used in Brazil. These new coffee dryers are designed to mix the coffee beans evenly and ensure uniform drying.

Most coffee from Africa is sun dried using drying tables. The pulped and/or fermented coffee is spread thinly on raised surface which allows the air to pass on all sides. The beans are mixed by hand which facilitates more uniform drying and fermentation is less likely to happen.

Removal of parchment layer

The final steps involve the removal of the parchment layer or polishing to remove the final traces of parchment, then grading and sorting. At this final stage, the coffee is known as 'green bean'. The green bean is then blended, roasted and ground by the final customer.

Sorting dried coffee beans

Coffee beans are frequently sorted in terms of color to remove the defective beans that were not removed during the initial separation of good from inferior berries before pulping and after pulping. Dried coffee beans can be sorted manually or mechanically. Coffee beans are sorted by hand where coffee growers handled relatively small volume of harvest or where manual labor is inexpensive.

Mechanically, coffee beans can be sorted using a color sorting machine or color separator and density sorter. The more specific color sorting machines detect and eliminate beans that are white, unripe, broken, insect damaged and black. On the other hand, density sorter separates broken, small, undeveloped and otherwise defective beans.

Storing coffee beans

Just like any other dried grains, coffee must be stored in dry and cool conditions. Exposure to high temperature and relative humidity will hasten quality deterioration. In Brazil, burlap bags are used to store coffee beans because they allow air flow. It is claimed that burlap bags preserve coffee longer than plastic or paper bags (coffeeresearch.org). Mitchell (1988) and Van der Vossen (1980) as cited by coffeeresearch.org found out that coffee seeds can be safely stored for two years at a temperature and relative humidity conditions of 15^0C and 41 percent respectively, in an airtight polyethylene bag.

Storage of roasted coffee bean

Preservation of the inherent coffee quality is maintained at relatively longer period of time when whole bean is stored. Whole coffee beans that have been opened and exposed to the environment should not be kept for more than a week. Nitrogen gas can be used to preserve the whole beans for an extended period of time.

On the other hand, the freshness of ground coffee is readily lost (in a matter of minutes) since the protective cellular structure has been broken and oxidation takes place at a faster rate. Moreover, coffee that has been roasted very darkly is even more susceptible to oxidation and should be kept for an even shorter period of time.

Grading coffee beans

Coffee is classified according to the number of defects, screen size and cup quality. The degree of defect is supposed to indicate a general idea of cup quality. Two green coffee classification methods are commonly used, namely: the Specialty Coffee Association of America (SCAA) Green Coffee Classification Method which is the excellent method for specialty green coffee beans and the Brazilian/New York Green Coffee Classification Method which is more precise but more time consuming.

The website of coffeeresearch.org gives a detailed information of the coffee bean classification.

CONCEPTUAL FRAMEWORK

The project employed the supply chain management (SCM) framework. The SCM concept is a holistic approach of designing and managing value-added processes across organizational boundaries to produce, distribute and market the product required by the end customer. From a practical viewpoint, SCM is associated with better information exchange, shared resources and win-win relationships among the members of the chain (Fawcett, Ellram and Ogden, 2007). The SCM requires a multidisciplinary group to look at the multifaceted aspects involved in production, distribution and marketing.

The study is anchored in Resource-based Theory that “emphasizes the management of internal resources to establish a hard-to-imitate advantage” (Dierickx and Cool, 1989 as cited by Fawcett, Ellram and Ogden, 2007). The Resource-based Theory calls for strategic management that focuses on building organizational capabilities and processes that enable an organization to deliver distinctive products and services. The concept of a firm’s core competencies is an important aspect linked to the theory which refers to the resources that differentiate the firm from the rest. Arabica coffee thrives well in the highlands with low temperatures. The presence of favorable growing conditions (i.e., high elevation and low temperature) as well as the organic way of production and inherent varietal qualities of Arabica coffee differentiate the kind of coffee produced by the small-scale coffee growers in the Cordilleras.

The project aimed to align supply chain with market demands for specialty coffee. Thus, the postharvest processes and/or technologies that will preserve and/or enhance the quality of specialty coffee were introduced. At the same time, individual and organizational capabilities were enhanced through trainings to further hone the competencies of the producers in attaining and delivering the products required by the market.

Improvement of the supply chain was done by identifying the weakest or problematic node of the chain. The weakest node was separated from the chain and corresponding improvement through appropriate postharvest technologies to meet the demand of the market was introduced (Figure 1). The improved node was returned back to the chain to evaluate its performance based on efficiency, responsiveness and flexibility.

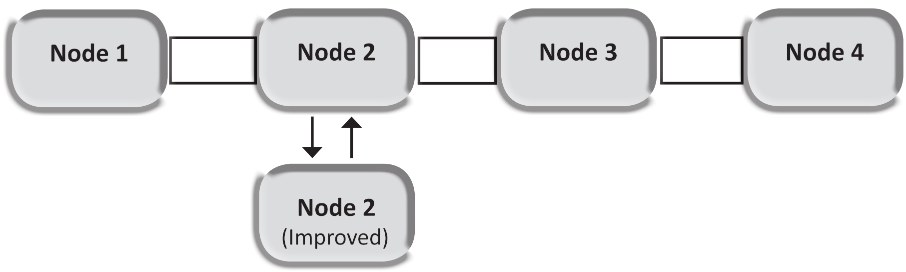


Figure 1. Conceptual model of improving the supply chain through improvement of the weakest node of the chain.

Improvement (or changes) between the current and improved chain were gauged by looking at the efficiency or performance indicators such as quality improvement, reduction in losses and incremental income among the affected players of the chain. The effect of the postharvest technology intervention on quality, quantity and income can be illustrated by looking at the factors influencing these indicators and how these factors are influenced by technology intervention. This can be illustrated as:

Qlty = fn (MC, PB, z1)
where Qlty = quality of green coffee beans (GCB)
MC = correct moisture content
PB = percent broken
z1= vector of qlty other than MC and PB

$\partial Qlty/\partial PB<0$, indicates that lesser percent broken improves the quality of GCB. Introduction of postharvest technology designed to eliminate or reduce the extent of broken beans will improve the quality of GCB produced.

$\partial Qlty/\partial MC>0$, higher moisture content of the GCB than the required MC means lower quality. Provision of moisture meter that would accurately measure the MC would assure that GCB is properly dried, hence attaining the quality required by the market.

Qty = fn (L, z2)
where Qty = quantity of product
L = losses
z2= vector of qty other than losses

$\partial Qty/\partial L<0$, which means that reducing quantity and quality losses would increase the quantity of product available in the supply chain.

To see the effect on income, it can be illustrated that,

R = fn (P, Q)
where R = revenue or gross income
P = unit price of product
Q = quantity of product

$\partial R/\partial P>0$, $\partial R/\partial Qty>0$, which means that increase in quantity and increase in price would increase the revenue or gross income, but $\partial P/\partial Qlty>0$, $\partial Qty/\partial losses<0$, indicates that price is a function of quality, better quality translate to higher price, while reduction in losses implies more product to be sold in the market, all translated to higher revenue.

With the arguments laid, it was hypothesized that the technology intervention would improve quality, increase the quantity or supply of product, increase the revenue or income, hence improving the particular nodes or participants of, if not the whole, supply chain of the Arabica industry.

METHODOLOGY

Scope and Delimitation of the Project

Supply chains mapped out were the chains prominent in Benguet, the highest Arabica producing province of the Cordillera region. The project addressed the postharvest requirements of the supply chain up to the production of green coffee beans. Two of the highest coffee growing municipalities of Benguet with cohesive farmers organization or cooperative were considered as cooperators for the piloting of the farmer-based coffee processing centers, which is the postharvest intervention designed to address the postharvest inefficiencies of the current supply chain.

Data Gathering Procedure

Primary data were obtained using surveys, focus group discussion (FGD), key informant interviews (KII), tracing methods and direct observation to (a) map out the chain, (b) monitor and document all practices at each stage of the chain, (c) determine and quantify all costs and margins associated with such practices, and (d) determine and quantify the changes in product volume and quality along the chain.

On the other hand, secondary data were utilized to determine information on production, consumption, quality and grading of product, and major issues and constraints affecting the Arabica coffee industry based on the results/proceedings of various coffee forums.

Sampling and Selection of Respondents

The supply chain participants that were included in the study were as follows:

1. Coffee farmers - respondents from this node or participants of the chain represent 30 percent of the members of the farmers organization or cooperative.
2. Processors - Of the prominent processors operating within Cordillera, fifty percent were taken as respondents representing the processors node. This comprised of the specialty coffee processors and city assembler/processors.
3. Cooperative - farmers association or cooperative engaged in processing and marketing coffee. These cooperatives have coffee as either their OTOP (one-town-one-product) or priority commercial crop.

4. Coffee shops - at least one of the coffee shops supplied by the selected processors.

Methods of Analyses

The analytical tools used in the project are presented below. Information from the survey was processed with the aid of the SPSS (Statistical Package for Social Sciences) computer software.

Descriptive analysis

This was used to describe the socioeconomic characteristics and farm profile of the respondents. Quantitative data such as farm size, yield, qualitative and quantitative losses were presented using mean values. For qualitative data such as harvest durations, cropping management, tools and methods used, etc., frequency distribution were used.

t-test

This was used to determine if there were significant differences between observed efficiency indicators such as percent broken, costs, capacity and person-days per activity.

Financial analyses

To determine the conditions to viably operate the processing system, financial analyses were performed. This was done through sensitivity analyses and uses indicators such as payback period, internal rate of return (IRR) and benefit-cost ratio (BCR). On the part of the technology adoptors, partial budget analysis was used to determine and quantify the benefits and costs associated in adopting the new technology versus the traditional method.

RESULTS AND DISCUSSION

The project had two phases. Phase I involved the supply chain analysis of Arabica coffee in the Cordillera region while Phase II identified and pilot tested interventions that would solve the identified problems on postharvest operations.

Supply Chain Analysis of Arabica Coffee in the Cordillera Region

Major Coffee Routes

The study found that Benguet province is the major source of Arabica coffee in the region (Figure 2). Although Mt. Province and parts of Kalinga and Ifugao have their respective productions of Arabica, these provinces still have to source out part of their requirements from Benguet because of their limited production. This is also true for other nearby provinces who are using Arabica for blending. From interviews of some of the biggest assemblers and processors in Benguet (i.e. Umali and Garcia) it was estimated that about 40 percent of the traded Arabica coffee in Benguet is consumed within the region. Thirty percent goes to Metro Manila areas and the remaining 30 percent goes to other provinces which included Cavite. Cavite being known as one of the major sources of Robusta coffee have more advanced facilities such as high capacity mechanized roasters. Hence, some of the processors in Benguet avail of the roasting services provided by some processors in Cavite like Gourmet. Other processors in Benguet like Garcia avail of the roasting services from the processors in Manila.

Baguio City and La Trinidad serve as the major buying stations of GCB because of their year-round operations. The GCB that are not sold to processors of specialty coffee in the province are either sold in Baguio or La Trinidad. These buying stations also sell roasted ground coffee in retail or wholesale markets. Aside from Arabica, they also sell other varieties of roasted coffee such as Robusta, Excelsa and Liberica for blending.

Some processors of specialty coffee (i.e., Serenity, Gourmet) had already started exporting

Arabica coffee. However, these export markets were not sustained because of problems on limited supply and poor quality of GCB, among others.

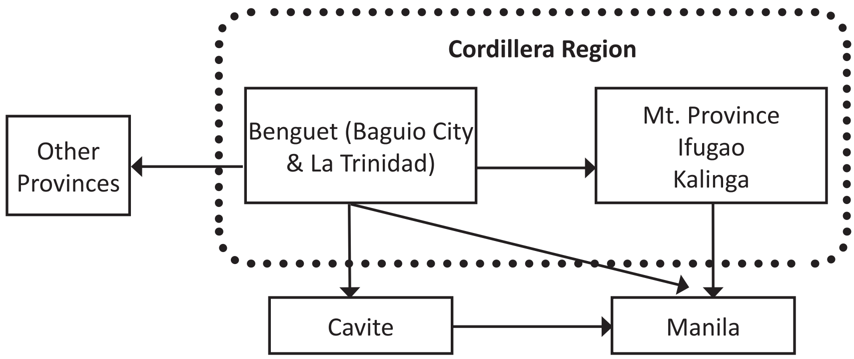


Figure 2. Major routes of green coffee bean and roasted coffee .

Existing Supply Chains of Arabica in Cordillera

Three predominant chains operating in Cordillera were identified by the project. These chains include:(1) Specialty coffee processors chain, (2) City assembler/processors chain and (3) Cooperative/processors chain. These major chains interact with each other through the flow of product, flow of information and flow of payments. Their mode of operations are described below.

<u>Specialty coffee processors chain</u>

This chain is dominated by various specialty coffee processors whose markets are Manila, Cavite, Baguio and other major cities. Some of these processors even attempted to penetrate the export market but were not sustained because they cannot provide the minimum volume and quality requirement demanded by the export market . These processors normally employ agents that purchase GCB within the major coffee growing areas and establish temporary buying stations within the coffee growing municipalities.

They are very particular (and most of the time very strict) with the quality of coffee that procure and normally follow the grading system used by the Specialty Coffee Association of America (SCAA), the widely accepted grading system for coffee worldwide. Processors under this chain require a minimum grade of “class 3” coffee for their processing operation. Although they are strict with coffee grades, they buy at relatively higher price compared to city assembler and cooperative processors.

<u>City assembler/processors chain</u>

This chain usually caters to any walk-in farmers who would be selling their GCB. They are not limited to buying only quality beans. Lower grades of coffee are bought at relatively lower price. They do not require minimum volume to engage in buying transaction, however, weights less than 50kg are discounted in price compared to other sellers who will be bringing bigger volume. Processors under these chain buy their coffee at relatively lower price compared to specialty coffee processors.

<u>Cooperative/processors chain</u>

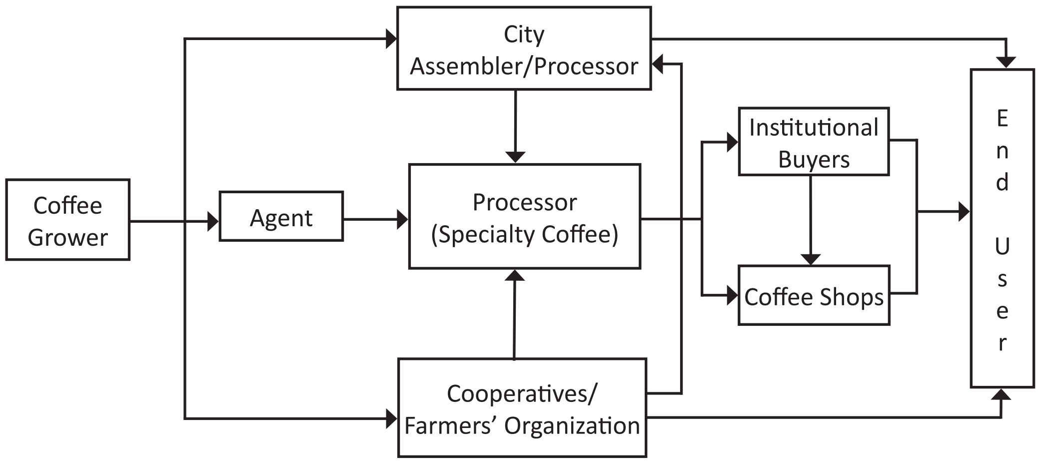
Cooperatives are engaged in buying GCB and process relatively smaller volume of roasted ground coffee. Their markets are usually limited within the locality where they operate. GCB requirements are obtained from farmer-members. These farmer- members have their share at the cooperative and accordingly treated as shareholders of the cooperative. They receive various incentives from the cooperative i.e., loan assistance, free trainings and rebates.

Major Players, Specific Activities and Services Rendered by Each Player

The major players of the supply chain include the facility manufacturers, coffee growers, agents, municipal and city assemblers, processors, coffee shops and institutional buyers and household consumers.

a. Coffee facility manufactures and suppliers - manufacture, import and sell coffee facilities i.e. moisture meter, hullers, pulpers, roasters and coffee makers.
b. Coffee farmers - manage the farm, perform harvesting, depulping, drying, hulling to produce and sell green beans.
c. Agents - go from farm to farm directly transacting with individual farmers to buy and sell GCB to processors or city assembler.
d. City assemblers and/or processors - with established stalls and/or buying stations within the trading centers in Benguet; buy GCB from walk-in sellers and process roasted ground coffee; sometimes supply the GCB requirements of other processors.
e. Specialty coffee processors - process roasted ground coffee, obtain GCB requirement from farmers, city assembler or cooperative. Strict in grading coffee and maintains quality standard of product. Supply coffee shops, restaurants, hotels and even wet market.
f. Institutional buyers - include coffee shops, restaurants and hotels and buys roasted coffee from city assembler/processor and specialty coffee processors. Sells packed roasted coffee or ready to drink coffee in cups.
g. household consumers - buy roasted ground coffee in packs or ready to drink preparation from coffee shops.

Figure 3 shows the product flow and the services and/or activities undertaken by the supply chain participants.



Services/Activities of Supply Chain Members

• Plants and manages coffee farm • Performs -Harvesting -Pulping -Drying -Hulling • Sells parchment or GCB to agent, processor, city assembler • Process roasted ground coffee for home consumption	• Purchase GCB • Assembles and transport GCB • Sells and transport GCB to processors • Also performs hulling when coffee bought from the farmer is in parchment form	• Purchase GCB • Sells GCB to other processors • Process GCB • Sell roasted and packed coffee to coffee shops and institutional buyers	• Purchase roasted and packed coffee from processors • Retail to coffee shops and household consumers • Sells coffee in cups	• Purchase roasted and coffee in cups

Figure 3. Product flow and activities of or services rendered by each supply chain member.

Information Flow

The flow of information among the supply chain players is a two-way process (Figure 4). Players exchange information on availability of supply, price relative to quality, selling price, by phone (usually by text messaging) or through face to face transactions.

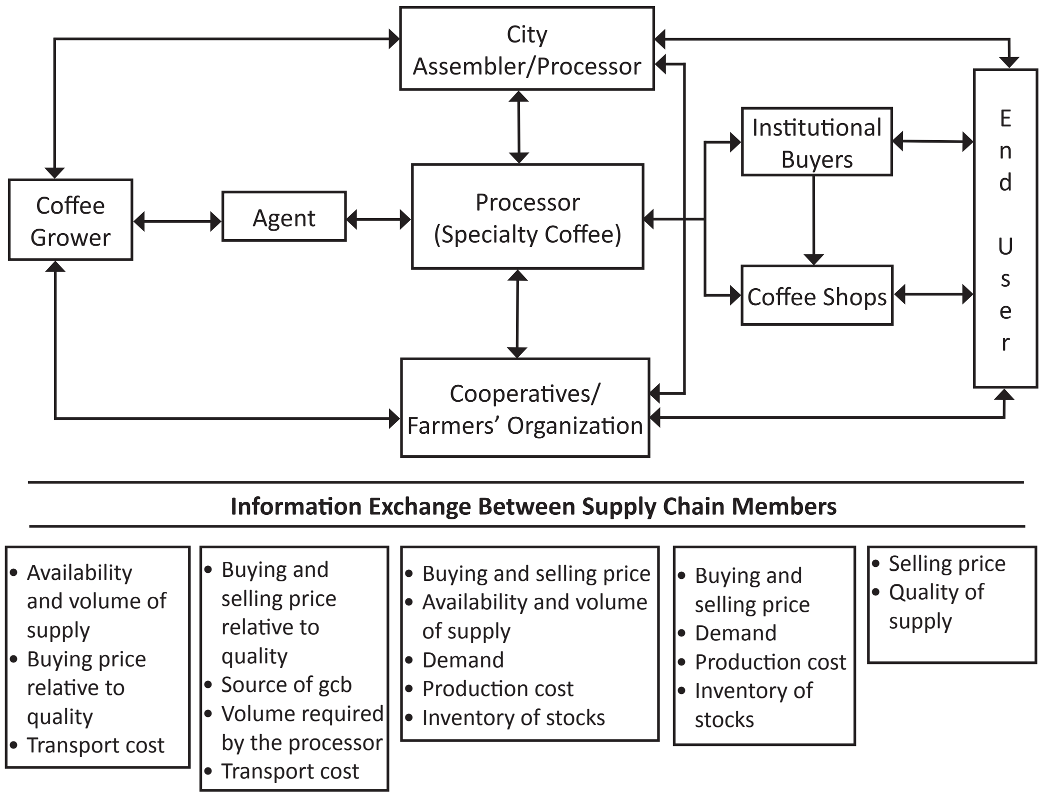
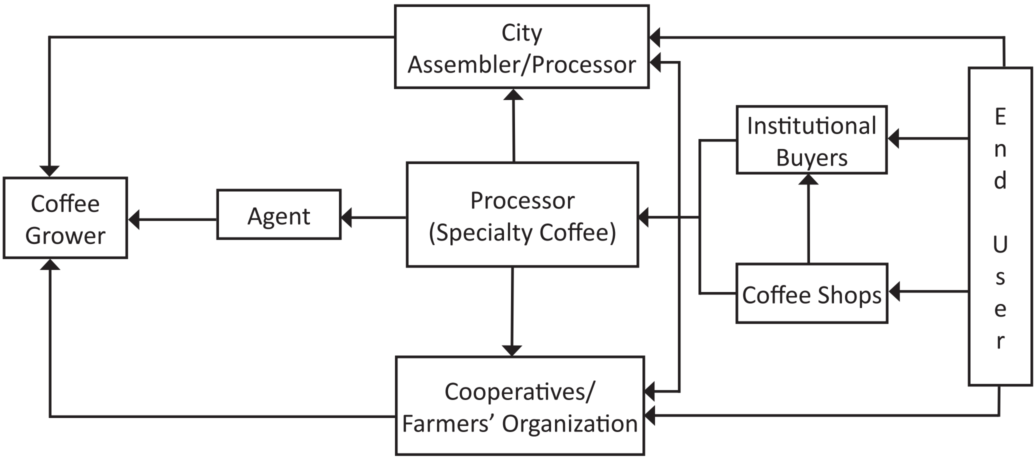


Figure 4. Information exchange between or among supply chain members.

Cash/Payment Flow

Figure 5 shows the flow of payments between supply chain players. In general, transactions are done on cash basis. However, for some players who are engaged in this activity for some time, for instance between the farmer-member and cooperative, payments to former are given after the latter had sold the product. Between agent and processors, some processors provide the buying capital to agents that source out coffee from individual farmers. In some cases, processors provide credit to farmers which can be paid back in terms of coffee. This scheme provides some leverage of obtaining the coffee produced by the farmer.



Model of Transaction and Transfer of Payment Among the Supply Chain Players

- In general, transaction between supply chain participants are on cash basis
- Credit terms between stakeholder are practiced ,likewise between agents and farmers
- Some processors (specialty coffee) provides buying capital to long-trusted agents
- Processor to institutional buyers practiced consignment market arrangement

Figure 5. Payment flow among the supply chain participants.

Cost and Return of Each Supply Chain Member

Table 1 presents the revenues realized, costs incurred, net income gained and return on expenses (ROE) by each supply chain participants. In performing their respective activities, each participant realized their income accordingly. Among the participants, the coffee shops have the highest share of revenue but also the highest share in cost because of investment in facilities, promotion, market space, and other operating cost. The market value of the processed coffee is highest at this point because coffee is sold in cup preparations.

On the other hand, the coffee farmers receive almost the smallest share in revenues and cost, next to agent and institutional buyers. Most of the cost incurred by farmers can be considered as non-cash cost because these comprise of labor from harvesting to processing which are normally performed by the farmers and family members. In addition, production cost is practically minimal because their coffee plants were not applied with synthetic inputs such as fertilizers and pesticides. Thus, the coffee that they produce is generally considered as organic.

Value Chain

The value chain of coffee from raw material (fresh berry) to roasted ground coffee is presented in Table 2. The information presented in the value chain would serve as guide in selecting investment and income opportunities and deciding what particular activities to perform along the chain. In addition, it would also help pinpoint what particular part of the chain to improve to cut down cost to further improve income.

Six kilograms of fresh coffee berries are required to produce a kilogram of roasted ground coffee. Normally, the operations required to produce the GCB is performed at the farm level. After this stage the succeeding activities are generally handled by the processors.

Farmers sell their coffee either in parchment or GCB form. By selling their coffee in parchment form they are actually losing the value adding opportunity of P6 per kg. This situation happens when farmers would like to do away with the tedious hulling operations by pounding method using the traditional mortar and pestle.

Processors incur the highest cost in roasting and packaging on top of their overhead cost. Packaging is expensive because their packaging material (usually bought from abroad) is bought per piece. Although it is also possible to buy it in volume to make the cost per unit less expensive, it is still impractical because these processors are only handling limited volume.

Given the following costs and margins at each stage of the processes, the average cost of packed roasted ground pure Arabica coffee is P350/kg.

Table 1. Revenues, costs, income and ROEs of supply chain members per kg of GCB, Benguet, 2010.

SUPPLY CHAIN PARTICIPANTS	AMOUNT (PHP/kg)	RELATIVE SHARE (%)
REVENUES		
Coffee Farmer	140.00	4.64
Agent	10.00	0.33
Processor (specialty coffee)	320.00	10.62
City assembler/processor	240.00	7.96
Farmers Organization/Cooperative	320.00	10.62
Institutional buyer	64.00	2.12
Coffee shops	1,920.00	63.70
COSTS		
Coffee Farmer	30.50	2.45
Agent	3.50	0.28
Processor (specialty coffee)	139.00	11.16
City assembler/processor	127.00	10.19
Farmers Organization/Cooperative	176.00	14.12
Institutional buyer	29.00	2.33
Coffee shops	741.00	59.47
INCOME		
Coffee Farmer	109.50	6.19
Agent	6.50	0.37
Processor (specialty coffee)	181.00	10.24
City assembler/processor	113.00	6.39
Farmers Organization/Cooperative	144.00	8.14
Institutional buyer	35.00	1.98
Coffee shops	1,179.00	66.68
ROEs		
Coffee Farmer	4.59	
Agent	2.86	
Processor (specialty coffee)	2.30	
City assembler/processor	1.89	
Farmers Organization/Cooperative	1.82	
Institutional buyer	2.21	
Coffee shops	2.59	

Table 2. Value chain per kilogram of roasted ground coffee, Benguet, 2010.

INPUT, COSTS OR MARGIN	PERCENT OF RETAIL PRICE	VALUE PER ITEM(PHP)	PRICE PER OPERATION/ PHASE (PHP)
Fresh harvested berries (6 kg)	27	96	96
Depulping cost	6	22	118
Fermenting and washing	2	6	124
Drying cost	2	6	130
Wet processor's margin	3	12	142
Hulling cost	2	6	148
Processor's Margin	2	6	154
Transport and handling cost	1	4	158
Warehousing cost	1	4	159
Trader's margin	1	5	164
Transport cost to roaster	1	2	166
Roasting cost	11	37	203
Grinding cost	1	3	206
Packaging cost	7	25	231
Promotion/marketing cost	4	15	246
Tax, office rental, etc.	10	35	281
Processor's margin	19	65	346
Retail price of roasted coffee	100	-	350

Perceived Problems of the Processors

The processors are the immediate users of the GCB produced by the farmers. Based on various coffee forums and KII, the perceived problems that hamper their particular activities and services along the chain were (a) limited supply of and costly procurement of GCB and (b) poor quality of raw materials.

<u>Limited supply of and costly procurement of GCB</u>

This particular limitation inhibits the processors from attaining their target level of production. This also prevents the industry from opening and sustaining the export markets. In a market situation where supply is limited relative to demand, the price of procuring the required raw material is high. Moreover, they have to compete with each other to secure part of their processing requirement. Hence, transaction cost is high because agents are employed to source out GCB from individual farmers.

<u>Poor quality of raw material</u>

This is very crucial among the processors of specialty coffee where they maintain certain quality standard to be competitive and stay in the business. Processors require a minimum grade of class 3 which corresponds to the classification of “exchange coffee grade” using the standard SCAA method. Rocky Mountain Café, one of the prominent specialty coffee processors, obtained coffee samples from different sources in Benguet. These samples were graded based on their defects to assess the quality of coffee currently produced in Benguet. Based on the analysis, among the four sources randomly selected, only one passed class 3 while the remaining fall under class 4 and class 5 which correspond to “below standard coffee grade” and “off grade coffee”, respectively (Table3). Interestingly, the major defect downgrading the coffee in the Cordillera is the high incidence of broken bean. Broken bean is a major defect that is usually obtained when the coffee bean is subjected to mechanical stress which is inherent to the particular method and tools used in processing.

Table 3. Quality grade assessment of green coffee beans from different sources in Benguet using the SCAA method, Benguet, 2009.

ITEM	DEFECT NAME	NO. OF PIECES WITH DEFECT				PERCENT OF TOTAL
		Source 1	Source 2	Source 3	Source 4	
1	Black	0	1	5	0	3.6
2	Stinkers	0	2	0	0	1.3
3	Stone and Stick	2	3	1	0	2.0
4	Floaters	0	0	2	11	1.4
5	Dried Cherries	0	0	0	0	0.2
6	Brokens	12	27	136	25	61.8
7	Shells	2	5	13	6	8.1
8	Insect Damage	4	8	24	15	15.4
9	Malformed	0	2	1	16	3.1
10	Half Black	2	0	6	0	3.1
11	Green	0	0	0	0	0
	Total defects	22	48	188	73	100

Source: Rocky Mountain Café, a multi-national specialty coffee processor operating in the Philippines.

SCAA Classification

Description	No. of Total Defects	Coffee Grade
Class 1	0 to 5 defects	Specialty Grade Green Coffee
Class 2	6 to 8 defects	Premium Coffee Grade
Class 3	9 to 23 defects	Exchange Coffee Grade
Class 4	24 to 86 defects	Below Standard Coffee Grade
Class 5	Above 86 defects	Off Grade Coffee

Performance of the Supply Chain

The performance of the current supply chain was assessed based on efficiency, flexibility and responsiveness.

Efficiency

The efficiency of the supply chain was measured in terms of: a) the cost incurred at the production and delivery of the product; b) the extent of quality/quantity losses and c) the income that accrued to the different supply chain participants. The cost incurred along the different levels in the processing of roasted coffee and its corresponding share on the total value of the final product was presented in the value chain (Table 2). At the farm level, the cost incurred in pulping and hulling which is currently at six and two percent, respectively, could still be reduced. At the processors level, the cost of roasting and packaging corresponding to 11 and seven percent, respectively, could still be cut down. In terms of quality, apparently the quality demanded by the market, which is at least class 3, was not produced due to inappropriate and inefficient tools used in processing. Current class of GCB produced at the farm level falls under class 4 and 5. Accordingly, the income that accrued to the supply chain participants (Table 1) could still be increased by cutting down production cost and improving the quality of the product.

Flexibility

This was measured in terms of the ability of the players to provide the quality and volume demanded by the customers. Apparently, the current production of Arabica in the Cordillera could not supply the demand of the market. Moreover, based on the quality analysis of the GCB produced in the region, the quality required by the market, which is a minimum of class 3 quality, cannot be produced using the current postharvest technologies available at the farm level.

Responsiveness

Responsiveness was measured in terms of the supply chain participant's satisfaction. The processors are the immediate users of the GCB produced by the farmer. It is evident that the current supply chain is less responsive, in terms of quality and supply of raw material, because the farmers were unable to produce the quality and supply of GCB required by the processors.

Improvement of the Identified Supply Chain in the Nodes Involving Postharvest Operations

This section discusses the production and postproduction practices of farmers growing Arabica in the Cordillera region and the resulting quantity and quality losses and costs brought about by these practices. It also discusses the different aspects considered in the design of the postharvest interventions and the results of the interventions when pilot-tested in two locations.

Production and Postproduction Practices of Arabica Coffee in the Cordillera

Coffee management and production

Arabica coffee produced in the Cordillera is categorized as organic because it is generally produced in the absence of commercial synthetic inputs like inorganic fertilizers and pesticides (Appendix Table 2). The trees are not pruned hence reaching heights that make harvesting more tedious and difficult. Weeding is the most common plant management applied. The weeds and naturally occurring waste materials are utilized as organic fertilizer.

The average GCB production per farmer per year is around 50 kg. About one-half of this production is sold in the market while the remaining are utilized for home consumption. However, because of the recent surge in the demand for organically grown Arabica coffee, more idle areas are being planted to coffee and are expected to augment supply three to five years from now.

Postharvest operations and practices

This section describes the various operations involved in producing and processing roasted ground coffee. The operations from harvesting until hulling is accomplished at the farm level while operations from roasting until packaging is performed at the processors level (Table 4). The descriptions of each operation are presented below:

Harvesting. This is done by manually selecting and picking ripe berries from the coffee trees. This method of harvesting which is called "priming" assures the best quality of coffee and is preferred by most processors. Harvesting is done twice a week with every harvest averaging 10 to 15 kg.

Depulping. Immediately after harvesting, berries are depulped manually. Majority of the farmers used mortar and pestle to depulp berries (Appendix Table 3). Others make use of improvised wooden pulpers. This traditional method often results to damage in fresh parchment and difficulty of separating pulp from the bean.

Fermenting and washing. After pulping, beans are soaked in water for at least 24 hours. This process removes the mucilage and increases acidity of GCB.

Drying. After washing fermented beans, it is dried by sundrying (Appendix Table 4). Although climatic condition in the uplands is cool and humid, the limited volume handled by each farmer still render the drying operation manageable. Drying is done by batch because of staggered harvest and each batch of drying lasts from one to two weeks.

Storing. Coffee is stored in parchment form (Appendix Table 5). Because coffee is harvested in staggered schedule for two to three months throughout the season, the volume of parchment coffee build up as it is stored. Parchment coffee is stored in polyethylene or plastic-layered sacks in room condition. Moisture content is crucial to effectively store the coffee without deterioration in quality. Farmers determine the moisture content of their coffee by feel or bite method.

Dehulling. Prior to roasting or marketing, parchment coffee is dehulled to produce the GCB. Dehulling is done using mortar and pestle, the same tool used for depulping (Appendix Table 6). This method of dehulling is tedious and often results to high percentage of broken beans.

Roasting. For farmers' consumption, roasting is done following the traditional method of open pan roasting using pan and ladle. On the other hand, processors use commercial scale roasters to ensure accurate, precise and even roasting. Roaster is a very expensive facility, hence small to medium scale processors avail of the roasting services provided by large-scale processors located in Manila and Cavite.

Grinding. This method is done using mortar and pestle for home consumption or with mechanical grinder for commercial production.

Packaging. This is done using multi-layered packaging materials to preserve the freshness, quality and natural aroma of the roasted ground coffee. Packaging comes in various sizes of pouch: 1 kg, 500 g, 250 g.

On-farm activities which include harvesting to hulling are accomplished by family members who are mostly female.

Table 4. Product form, process flow, methods and tools used and players performing each postharvest operations, Benguet, 2010.

PRODUCT FORM	PROCESS FLOW	METHODS AND TOOLS USED	PLAYERS
Fresh coffee berries	Harvesting	Staggered manual picking of ripe berries done in two to three months	Farmers
Fresh parchment coffee	Pulping	Manual depulping using pounding method; improvised wooden pulper, stone	Farmers
Fermented parchment coffee	Washing/Fermenting	Soak in water at least 24 hours	Farmers
Dried parchment coffee	Drying	Sundrying, estimate MC of parchment by feel or bite method	Farmers
Dried parchment coffee	Storage	Stored in polypropylene sacks or large plastic bags	Farmers/ traders operating in the village
Green coffee bean	Hulling	Manual pounding; mortar & pestle; rice mill	Farmers or trader/assembler
Roasted green coffee bean		Manual & mechanized roasting	Farmer-consumers/ Processors
Ground roasted coffee	Grinding	Manual or electrical Grinder	Farmer-consumers/ Processors
Ground roasted coffee in pack	Packaging	Packaging bags; sealed or resealable	Processors
Ground roasted coffee in pack	Marketing	Consignment or cash on delivery	Coffee shops, institutional buyers

Quality and Cost as Affected by the Postharvest Practices

The current postharvest operations were assessed to determine the causes of the problems identified by the processors and the implications to quality and cost of producing GCB.

High percentage of broken beans

This is attributable to the method and tools used for depulping and hulling. Based on the assessment and measurement of brokens occurring from dehulling and depulping operations traditional depulping and dehulling has an average broken beans of 6.17 and 8.06 percent, respectively. These two operations contribute to 14.23 percent broken beans which could already downgrade the quality of GCB to class 5 or “off grade coffee” classification. Apparently, the use of mortar and pestle for depulping and dehulling operations produce high percent broken beans because this practice subject the beans to excessive mechanical stress or damage.

In terms of capacity, the current dehulling and depulping practices are tedious to accomplish. Traditional depulping has a capacity of 4 to 7kg berries/hr while traditional dehulling has a capacity of 6 to 10 kg parchment coffee/hr. Accordingly, because these operations are tedious, slow and difficult to accomplish, their labor costs are also expensive at P3.60/kg input for depulping and P2.50/kg input for dehulling (Table 5).

Table 5. Performance of the current pulping and hulling practices in terms of broken, capacity and labor cost, Benguet, 2010.

OPERATIONS	PERCENT BROKEN	CAPACITY(kg input/hr)	LABOR COST (PHP/kg)
Pulping	6.17	5.5	3.60
Hulling	8.06	8.0	2.50

<u>High moisture content</u>

This problem is attributable to inaccuracy of measuring the MC of their product. Processors require that GCB must have an MC of 11 to 13 percent as this is the optimum level for safe storage and quality roasting. Farmers determine the moisture content of their product by feel or bite method. Although this method has been refined through long experience, it became apparent that it is not reliable because processors complained that some of the GCB procured have MC higher than recommended level. On the other hand, overdrying would be disadvantageous on the part of the farmer because it would render their product very light considering that it is quantified in terms of weight.

<u>High transaction cost in buying from Individual farmers</u>

Because of the inherent type of level of production existing in Cordillera, characterized by small-scale and backyard level of production, the average production of GCB per farmer per season is only 50 kg. The transaction cost on the part of the processor is high because they have to procure GCB from individual farmer to consolidate their requirement. Based on the analysis of the costs, ROEs and income of the supply chain participants, they are incurring P10 per kilogram employing agents. Their transaction cost would have been relatively lower if they would be transacting to organized coffee farmers with consolidated volume of GCB.

The Postharvest Systems Intervention

<u>Design and development of the postharvest intervention</u>

The design of the intervention considered the socio-cultural, physical, technological, organizational and financial aspects of the postharvest systems. The socio-cultural aspects included the characterization of the potential technology adopters in relation to their current cultural practices on coffee while the physical aspects considered the characteristics of the coffee commodity and the situations where coffee is generally grown. On the other hand, the technological aspects involved the matching of technologies that will be required to produce good quality GCB while the operational aspects considered the operation and management requirements of a farmers' group to produce improved GCB. The financial aspects included the costs of producing GCB if the proposed interventions were adopted in relation to the costs of their present practice.

<u>Prospective adopters of the postharvest systems</u>

To ensure the adoption of the intervention, the aspect of " who is currently doing what" was carefully considered in coming up with the appropriate matched of technologies. Majority of the coffee farmers have an average consolidated farm size of 150 m^2. Currently, majority of the farmers produce GCB and market individually while traders consolidate and sell GCB. Results of the benchmark study showed that while majority of the farmers dehull and depulp using antiquated tools, some of the farmers with relatively higher volume of produce prefer to sell parchment coffee or dehull using mechanical steel hullers intended for rice and corn milling. Majority of them practice storing parchment coffee until enough volume is accumulated for dehulling. Immediately after dehulling, GCB is sold to the market or traders operating within the area.

Moreover, almost 90 percent of the women are involved in harvesting and depulping operations once in a week working on 6 kg berries per week in a span of two months. The design considerations of the pulpers therefore considered that women will continue what they are doing at an easier way. The design of the postharvest system intervention considered that depulping operations would be done by the farmers in their farm immediately after harvesting and that dehulling could be done centrally within the village. The system will replace the old practice of depulping and dehulling using mortar and pestle. The system could be best operated by group of coffee farmers to get maximum benefit.

Physical conditions of the crop and the area where it is grown

Commodity characterization. In the selection and design of postharvest facilities, it is essential that, at the very least, the unique physical attributes of the commodity be examined and characterized. As such, basic characterization like material balance of the commodity was conducted. This facilitated estimation of the conversion from raw material (fresh berry) to final product (roasted coffee) which is essential in the capacity matching of equipment. This also served as guide in deciding what form of product to sell, whether fresh berries, parchment or GCB, to attain the highest financial return considering that these various forms have corresponding prices in the market. The material balance is shown in Figure 6.

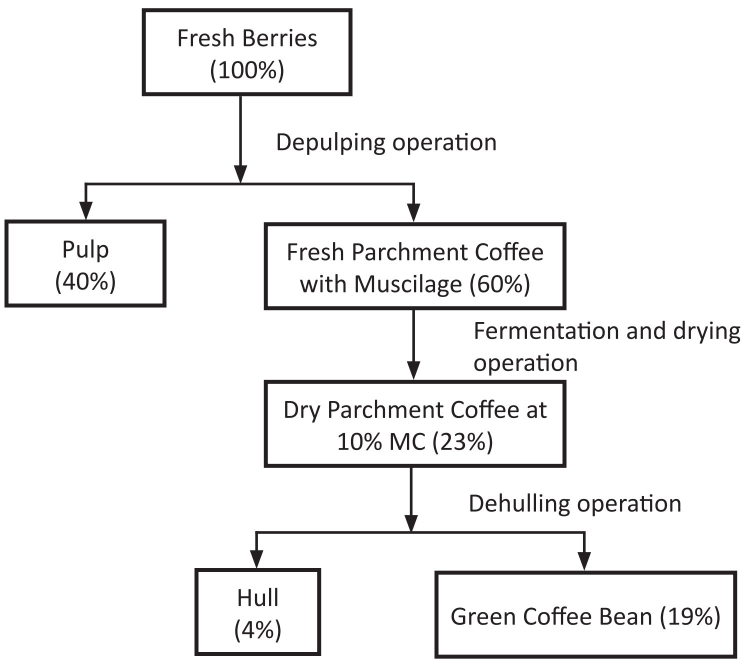


Figure 6. Material balance of fresh Arabica coffee berries to green coffee bean.

Physical condition of the coffee areas. Arabica coffee production in the Cordillera can be considered as backyard type because of the small area devoted for production per farmer. Coffee is generally considered as a secondary crop compared to other cash crops like potato, cabbage, carrots and other semi-temperate vegetables that are normally planted in prime areas. Because coffee trees are planted in areas where cash crop would not be practical to produce, coffee plantations are situated in hilly difficult areas. Coffee trees are generally planted in-between other forest trees (e.g., pine trees and “alnus”), in steep sloping sides of hills and mountains, sides of pathways and within the farmers' backyards. A typical coffee farm in Benguet would have an average of 50 bearing trees.

Technologies

Having identified the postharvest operations where inefficiencies occur, appropriate facilities were developed and/or assembled to reduce systems inefficiencies and operate a coffee processing systems that will produce higher grade GCB. The development of the system was preceded by an inventory and characterization of existing technologies used for coffee postharvest operations.

Inventory and characterization of existing technologies. An array of different coffee postharvest facilities/technologies is already available in the market. The most vital part was selecting the most appropriate technologies based on capacity, efficiency, operational requirement and cost. Capacity was based on the existing volume of coffee handled by individual farmer. Efficiency characterization was geared towards significant reduction in the extent of broken beans. Operational requirement was based on the source of fuel, availability of parts, labor requirement, etc. in relation to what was available in the area where it will be used. Cost consideration was based on the affordability and practicality of buying the facility considering the purchasing power of the intended user.

The results of the inventory pinned down the technologies that were included in the system to produce improved quality of GCB and meet the requirements of processors.   The pulpers, huller, moisture meter, sieves and sorting tables comprised the set of matched facilities.

Coffee pulper. Several coffee pulpers were tested and characterized. Test parameters were based on efficiency in terms of extent of broken, capacity, portability and cost. Since the existing pulpers in the market did not satisfy these considerations, modifications of existing designs were conducted in collaboration with the engineering unit of PHilMech. The outcome is a manual pulper that is light, portable, efficient and relatively cheaper than the existing pulpers. It was designed to be light and portable because depulping operation is sometimes accomplished on farm. One unique feature of this pulper is the use of rubber material in its pulping mechanism that prevents mechanical damage of the bean. It was found better than the existing technologies because it significantly reduced the extent of broken beans.   Also, it is relatively cheaper, P4500/unit (2010 price) against similar pulpers in the market with prices ranging from P5,000 to P7,000/unit.

A screen is used to separate the pulp from the wet parchment coffee.

Figure 7. PHilMech rubber-bib pulper with a capacity of 40 kg/h.

Coffee huller. Existing engine-driven hullers in the market, such as the Engelberg hullers, were characterized. Results revealed that extent of broken beans due to mechanical damage was eight percent. Although this type of huller has high capacity, it does not reduce the extent of broken; hence, a new design of huller was developed. Applying the same principle used in the design of pulper, the hulling mechanism of the new huller was replaced with rubber. The improvised rubber coffee huller (Figure 8) reduced the extent of broken by one-half. The capacity is 200 to 250 kg/hr and is driven by a 3 hp electric motor. Power consumption is also reduced as existing hullers in the market use prime mover with 9 hp rating.

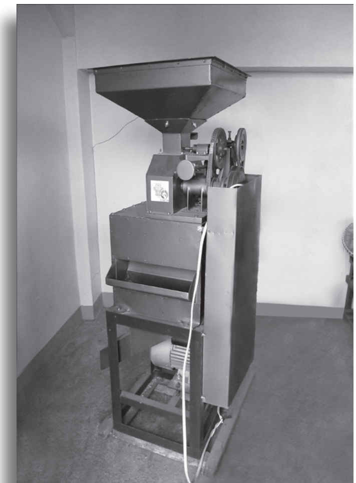


Figure 8. The rubber roll coffee huller.

Moisture meter. In collaboration with a private manufacturer developing and supplying similar testing instruments, a coffee moisture meter was developed (Figure 9). The design is light, digital read out and easy to use. The material used for its calibration was obtained from Cordillera to assure that the unique physiological attributes of the coffee from Cordillera are considered in the instruments program.

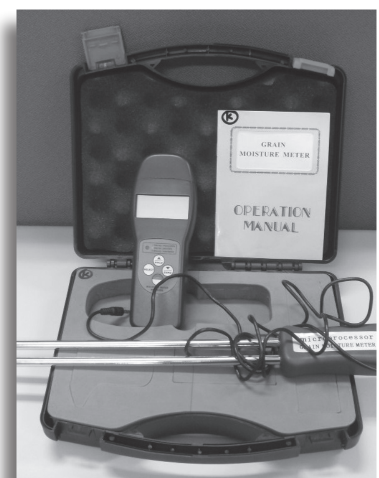


Figure 9. Moisture meter adapted for measuring moisture content of coffee

Sieves and sorting tables. Sieves separate large, medium and small GCB based on the size classification of the Philippine National Standard (PNS/BAFPS 01:2003). Figure 10 shows the set of sieves recommended to separate three size classifications of Arabica coffee. To separate large GCB (numbering 175 beans/25 g), sieves with 7.93 mm openings are used, and for medium (numbering 175 to 200 beans/25 g) and small GCB (numbering 201 to 250 beans/25 g), sieves with openings of 6.73 mm and 6.35 mm, respectively, are used. The sieve openings are appropriate for Arabica and Excelsa coffee only. The sieve openings for other types of coffee are different.

Sorting tables (Figure 11) facilitate manual sorting which is done to separate defective from good quality green beans.

Figure 10. Set of sieves recommended for Arabica coffee.

Figure 11. Sorting tables are used to facilitate the separation of defective GCB.

<u>Operational requirements</u>

The system was designed to be operated and managed by a farmer-based organization such as farmers association or cooperative (farmer-based coffee processing center). Since depulping operation is accomplished on farm, pulpers are to be distributed among the coffee farmers in cluster. Considering that each farmer harvests a small volume at a time, a unit of pulper can service the pulping requirements of about five adjacent group of farmers. The pulper was designed to be light to facilitate transfer from one farmer's area to another. The farmer's group could advanced the payment of the pulper which would be paid in kind in the form of parchment coffee by each farmer-member.

The huller, unlike the pulper, is permanently stationed in a processing building strategically located in the municipal center for accessibility. The location of the huller serves as the consolidation point of GCB. Farmers with accumulated volume of parchment coffee bring their parchment in the processing center for hulling. A certain fee, cheaper than the amount incurred using the traditional method, is collected. The collected fee is intended to sustain the operation of the processing center.

The cooperative or farmer's group buys the GCB of the farmer-members. The GCB are sorted, classified and temporarily stored at the processing center prior to marketing. With the aid of the moisture meter, the moisture content is accurately measured prior to storage or marketing. Under this scheme, the farmer's group consolidates the small volume produced by individual farmers. Quality standard as required by the market is also assured.

In terms of marketing, processors directly transact with the farmer's group, instead of individual farmers. Under this scheme, the farmer's group serves as the intermediary between the farmers and the processors. The processors save part of his transaction cost by directly transacting with the main source of GCB. On the other hand, farmers avail of a higher price due to improvement in quality.

The mode of transaction among the processors, farmer's group and the farmers is presented in Figure 12.

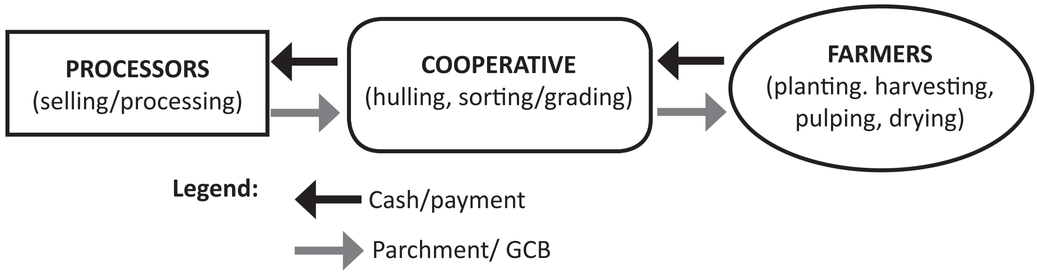


Figure 12. Flow of product and payment among the processors, cooperative and farmers under the farmer-based coffee processing center (CPC).

Pilot Testing of the Farmer-Based Coffee Processing Center

To provide quantitative proof that the system will succeed on a full-scale basis, pilot testing was done on two Arabica coffee growing areas within Benguet. The cooperators in the piloting of the farmer-based CPC were the Tuba Benguet Coffee Growers Association (Tubengcoga) and the Kibungan Arabica Growers Multi Purpose Cooperative (KAGMPC). These two farmers' groups are both engaged in the processing of GCB. Of the two cooperators, the KAGMPC is already advance in terms of final product because, on top of GCB, it is already engaged in the processing of roasted ground coffee. Kibungan has coffee as its "one-town one-product" (OTOP) while Tuba considers coffee as its second most important crop next to yam.

On top of the set of postharvest facilities provided for each association, they were provided with trainings on the operation, maintenance and management of the facilities. In collaboration with a multi-national coffee processor operating in the Philippines, the farmer's groups were also trained to sort and classify GCB adapting the SCAA method.

Effects of the Postharvest Intervention

<u>Improvement on the quality of GCB</u>

The quality of GCB was significantly improved with the use of the postharvest system. The extent of broken beans from depulping was significantly reduced to 4.79 percentage points or the percentage of broken beans was reduced by 78 percent (Table 6). Similarly, the extent of broken beans from dehulling was also significantly reduced by 6.71 percentage points or the percentage broken beans due to dehulling operation was reduced by 83 percent. In terms of grade, this translates to improvement from class 5 to class 2.

Table 6. Comparison of percent broken beans of "with and without intervention", Benguet, 2010.
** Significant at 1 percent level of significance

ITEM	PRACTICE		MEAN DIFF.	T -TEST VALUE	SIG. (2- tailed)
	With Intervention	Without Intervention			
Pulping	1.38	6.17	(4.79)**	(8.54)	0.00
Hulling	1.35	8.06	(6.71)**	(3.07)	0.00

<u>Reduction in depulping and dehulling costs</u>

Because of the improvement in the capacity and efficiency of the pulper and huller, the costs of depulping and dehulling operations were also reduced. Depulping cost was cut down by P2.30/kg or 64 percent of the usual cost while the cost from dehulling was reduced by P0.15/kg or 6 percent of the previous cost using the traditional practice (Table 7). The reduction in cost of the dehulling operation might seemingly be small but drudgery in dehulling which is brought about by using mortar and pestle has been completely eliminated with the use of the hulling machine.

Table 7. Comparison of capacity and cost in depulping and dehulling operations of "with and without intervention", Benguet, 2010.

ITEM	PRACTICE		MEAN DIFFERENCE
	With Intervention	Without Intervention	
Pulping			
Capacity (kg/hr)	25	5.5	19.5
Cost (PHP/kg)	1.30	3.60	(2.30)
Hulling			
Capacity (kg/hr)	200	8	192
Cost (PHP/kg)	2.35	2.50	(0.15)

Increase in farmer's income

To assess the relative advantage of adapting the intervention over the traditional method of processing from the viewpoint of the farmers, the study performed partial budget analysis (Table 8). Based on the results, farmers would have an incremental income of PHP 1,152/season or PHP23/kg. This incremental income is brought about by reduction in labor cost and appreciation in the value of their product due to improvement in quality. This estimate was based on the average production of 250 kg fresh berry per farmer per season which when process would yield 50 kg GCB.

Table 8. Partial budget analysis of applying the developed postharvest system versus the traditional postharvest operations, Benguet, 2010.

PROPOSED TECHNOLOGY			
TRADITIONAL POSTHARVEST METHODS	**VS.**	**DESIGNED POSTHARVEST SYSTEM**	
Added Costs (A)		**Added Returns (B)**	
=pulping cost (P1.30/kg x 250kg)	P 325	=increase in value of coffee (from class 5 to class 2) P10/kg x 50 kg	P500
=hulling & sorting cost (P2.35/kg x 75kg) + (P1.00/kg x 75kg)	P 251	=rebate (2% of P140/kg x 50kg)	P140
Reduced Returns		**Reduced Cost**	
		=labor cost from pulping (P3.60/kg x250kg)	P900
		=labor cost from hulling (P2.50/kg x 75kg)	P188
Subtotal A	P 576	Subtotal B	P 1,728
Estimated change in income (B less A)	= **P 1,152.00 /season**		

Reduction in transaction cost

With processors doing transactions with the farmers' groups or cooperatives instead of individual farmers, transaction cost is reduced by about P6.50/kg. Moreover, the quality of GCB is more assured because the consolidated volume of GCB underwent through quality standard done only by farmers' group. Hence, on top of better quality of raw material, marketing transaction between producers and users of GCB became faster and more efficient.

Financial Assessment of the Farmer-Based CPC

The investment cost of a complete set of postharvest facilities to operate a farmer-based CPC is P233,900 (Table 9). The source of revenue that will sustain its operation will be coming from the service fees paid by the farmers from hulling and sorting services, and the margin imposed on the price of GCB sold to the processors.

The financial performance of the CPC highly depends on the volume of processed and procured GCB. To determine the minimum volume of coffee that must be processed to sustain its operation, a sensitivity analysis was performed (Table 10). Based on the sensitivity analysis, the cooperative must process and procure a minimum of five tons of GCB per season to sustain its operation. Considering that the average production of farmer per season is 50 kg, it would require at least 100 farmers selling their GCB to the cooperative to make its operation sustainable or to aggressively increase the production per farmer by planting more trees or increasing yield by applying better cultural management practices.

Table 9. Investment cost of a complete set of coffee processing facilities for the production of GCB, Benguet, 2010.

ITEM	QUANTITY	UNIT PRICE (PHP)	TOTAL (PHP)
1. Pulper	20	4,500	90,000
2. Huller	1	75,000	75,000
3. Moisture meter	1	13,500	13,500
4. Processing tables	4	800	3,200
5. Weighing scale	1	2,200	2,200
6. Building improvement*	1	50,000	50,000
		Total	**233,900**

Table 10 . Financial performance of the farmer based CPC operating at different volumes of GCB per year, Benguet, 2010.

FINANCIAL INDICATOR	VOLUME PROCESSED PER YEAR (Metric Tons)		
	3	5	8
Investment = PhP233,900			
Revenue	656,500	1,024,000	1,610,500
Total Cost	714,123	740,729	777,979
Fixed Cost	436869	436,869	436,869
Variable Cost	277,254	303,860	341,110
Net income	(57623)	283,271	832,521
Financial Indicators			
PP (yr)	>10	2.47	1.38
IRR (%)	7.44	22.74	42.43
NPV	(43,559)	115,046	351,523
BCR	0.63	1.97	3.96

SUMMARY

The study mapped out and analyzed the supply chain of Arabica coffee in the Cordillera region. Assessment of the performance of the supply chain revealed that it is hampered by limited supply and poor quality of GCB produced at the farm level, among others.

The limitation in supply is inherent to the level of production existing in the Cordillera which is characterized by backyard type and low level of production. A typical coffee farmer in Cordillera has an average production of 50 kg of GCB per season. The existing production of coffee in the region is not sufficient to supply the volume required by the processors.

Problems on poor quality of GCB produced at the farm level is attributable to the poor postharvest practices and antiquated tools used in processing. In the absence of effective and affordable postharvest facilities, farmers use traditional tools like mortar and pestle in processing operations (i.e., depulping and dehulling). This conventional processing method produced GCB with high percentage of broken that consequently downgrade its quality.

The study developed a postharvest system designed to address the postharvest inefficiencies towards the downstream end of the supply chain using postharvest technologies that would produce the quality required by the market. The system was also designed to cut down labor cost because of high capacity and efficiency. The postharvest system is a set of matched postharvest facilities comprising of pulpers, huller, moisture meter, sorting table, weighing scale and a processing area. The system was operated and managed under a farmer-based organization engaged in the processing and marketing of coffee. With the use of the system, the extent of broken beans from depulping and dehulling was significantly reduced 78 and 83 percent, respectively. This reduction in broken beans corresponds to significant improvement in quality, from class 5 to class 2, passing the minimum requirement of the processors which is class 3 (lower numerical number implies better quality).

Farmers adapting the system over the traditional method of processing could get an incremental income of PhP1,152.00 per season or PhP23/kg because of reduction in labor cost and improvement in quality. On the part of the processors, direct transaction with organized farmers pooling the coffee produced by individual members reduced transaction cost by about P6.50/kg. Financial assessment of the system suggests that a minimum of 5 tons should be processed to make its operation financially viable.

CONCLUSION

The developed postharvest system would be an effective intervention to improve the supply chain of Arabica in the Cordillera region. Immediate beneficiaries of this intervention would be the coffee farmers and the processors. Farmers would be more productive because of improvement in quality and reduction in labor cost. On the other hand, the processors could cut down transaction cost and have access to quality raw material to come up and maintain quality processed product.

However, the problem on limited supply affecting the chain must be directly addressed through production-focused interventions i.e. increasing farm productivity and/or expansion of production areas. The postharvest intervention could only partly address the problem on limited supply through reduction in quantity and quality losses but in the short- to medium- term, this kind of intervention would definitely encourage farmer-growers to increase their production because post production operations are not only made easier but also offer value-adding opportunities to increase income.

POLICY RECOMMENDATIONS

The developed postharvest system would be an option for program planners that would design intervention to improve the Arabica coffee industry in the Cordillera region and other similar Arabica growing areas in the country. The result of the study could also be used not only for Arabica but for other coffee varieties as well (i.e. Robust and Liberica), with production level similar to Cordillera. The established specifications of the machines can be used in selecting the appropriate facilities if, for example, facility assistance would be the type of project intervention. The conditions identified to effectively operate and manage the system i.e. farmer-based organization with minimum volume of 5 tons, could be used as criteria to warrant sustainable operation of the farmer- based coffee processing center. These criteria could be used in screening and selecting potential project locations and recipients.

Recommendations for Further Research

Based on the findings of the study, roasting and selling roasted ground coffee provide sizeable amount of income and packaging costs present room for cutting down the production cost of ground roasted coffee. The performance of the supply chain could be further improved by looking into the:

- Technical and financial viability of putting up a centralized roasting facility in Benguet. This study will be aimed at cutting down the transport cost incurred by Benguet-based processors from using the roasting facilities that are only available in Manila and Cavite.
- Development of an equally effective but cheaper packaging material because the current packaging cost of the processors can still be further reduced.

ACKNOWLEDGEMENT

PHilMech is grateful to Ms. Mary Joy P. Paico, a research contractor, for the services rendered in coordinating meetings and gathering, processing and summarizing data that were needed in the project.

LITERATURE CITED

AGRICULTURAL MARKETING ASSISTANCE. 2006. First Coffee Investment Forum, Exhibition and Launching of the National Development Program, Baguio City.

BAYANIHAN. 2007. Benguet farmers to plant 1-M coffee trees. Retrieved on August 2, 2007 at http://www.bayanihan.org/htm/article.php/20070219164059858.

BUREAU OF AGRICULTURAL STATISTICS. BAS Online Statistics Database. Retrieved on August 15, 2011 at http://bas.gov.ph.

BUREAU OF AGRICULTURAL STATISTICS. 2007. Situationer on Coffee. Vol.2 No.5. Retrieved on October 10, 2007 at http://www.bas.gov.ph.

COFFEESCIENCE.ORG. Undated. Disease fighting. Retrieved on August 4, 2007 at http://coffee-science.org/fitness/diseasefight.

COFFEERESEARCH.ORG. Undated. Coffee drying. Retrieved on August 4, 2007 at http://www.coffeeresearch.org/agriculture/drying.htm.

DEPARTMENT OF AGRICULTURE. 2006. High Value Commercial Crops. Retrieved on October 3, 2007 at http://hvcc.da.org.ph.

FAWCETT, S.E., ELLRAM, L.M. and OGDEN, J.A. 2007. Supply Chain Management from Vision to Implementation. Pearson Education, Inc. New Jersey. pp. 530.

FOOD AND AGRICULTURE ORGANIZATION. FAOSTAT. Retrieved on August 15, 2011 at http://faostat.fao.org.

HUGOS, M. 2006. Essentials of Supply Chain Management. 2nd Edition. John Wiley & Sons, Inc., New Jersey. pp. 290.

JAMANDRE, W.E., R.C. SANSANO and E.S. GUILLERMO. 2007. Supply Chain Improvement for Goat in Selected Areas of the Philippines. Central Luzon State University. Science City of Munoz, Nueva Ecija.

KAMAU, I.N. 1980. Mechanical Drying of Arabica Coffee in Kenya. In: Kenya Coffee. 45:437. December 1980. p 343-355. Cited by coffeeresearch.org

MAGHIRANG, R. 2006. Coffee Development Program. Retrieved on October 3, 2007 at http://hvcc.da.gov.ph/coffee.html.

MITCHELL, H.W. 1988. Cultivation and Harvesting of the Arabica Coffee Tree. Coffee: Agronomy. Ed. R.J. Clarke. New York: Elsevier Applied Science. Cited by coffeeresearch.org. Retrieved on August 4, 2007 at http://www.coffeeresearch.org/agriculture/coffeestorage.htm.

STEIN, N. 2002. Crisis in a Coffee Cup. Retrieved on August 4, 2007 at http://money.cnn.com/magazines/fortune/fortune_archive/2002/12/09/333463.

SCOFIELD, A. Undated. Vietnam: Silent Global Coffee Power. Retrieved on August 4, 2007 at http://www.ineedcoffee.com/02/04/vietnam/

Van der Vossen. 1980. Kenya Coffee. 45:437. December 1980. p 343-355. Cited by coffeeresearch.org. Retrieved on August 4, 2007 at http://www.coffeeresearch.org/agriculture/coffeestorage.htm.

APPENDICES

Appendix Table 1. Characteristics of coffee farm in Mankayan, Atok, Tuba and Kibungan, Benguet, 2007-2008.

ITEMS	FREQUENCY (N=120)	PERCENTAGE REPORTING (%)
1. Size of coffee farm, m^2		
a. 50-250	52	53
b.251-500	28	23
c.500-1000	1	1
d. >1000	22	18
e. 10000	16	13
f. 20000	1	1
Mean = 2400		
2. Tenure		
a. owned	118	98
b. lease	2	2
3. Number of Arabica coffee bearing treess		
a. <50	68	57
b.51-100	11	9
c.101-200	10	8
d.200 above	29	27
Mean =280.63		
4. Number of non-bearing tree		
a. 0	37	31
b. <50	22	18
c. 51-100	18	15
d. 101-200	12	10
e. 201-300	7	6
f. 301-400	4	3
g. 401 above	20	18

Appendix Table 2. Coffee management and maintenance of farmers in Mankayan, Atok, Tuba and Kibungan, Benguet; 2008-2009.

ITEM	FREQUENCY (N=120)	PERCENTAGE REPORTING (%)
1. Fertilize coffee		
a. Yes	31	26
b. No	89	74
2.Reasons of not applying fertilizer		
a. Pure organic	92	77
b. No money to buy fertilizer	1	1
c. Not applicable	27	23
3.Type of fertilizer		
a. organic, compost	24	20
b. inorganic	2	1.7
c. chicken dung	6	5
d. did not apply	88	73
4.Cost of fertilizer/kg		
a. 90	1	1
b. 110	1	1
c. 130	1	1
d. 27	1	1
5. Number of sacks applied/season (Mean=2.9)		
a. .half sack	1	1
b. one sack	2	2
c. 1.5	2	2
d. 3	1	1
e. 5	1	1
f. 10	1	1
g. did not apply	112	93
6. Practice coffee pruning		
a. Yes	47	39
b. No	73	61
7. Cost of pruning		
a.300	1	1
b. 500	1	1
c. 600	2	1.7
d.1400	1	1
e. Not applicable	115	96
8.Spray fungicide		
a. yes		
b. no	1	1
9.Hired laborer	119	99
a. yes	20	17
b. no	100	83
10.Wage /day		
a.150	6	5
b.200	10	8

Appendix Table 3. Processing and depulping practices of farmers in Mankayan, Kibungan,Tuba and Atok, Benguet, 2007-2008.

ITEMS	FREQUENCY (N=120)	PERCENTAGE REPORTING (%)
1.Processing method		
a. dry method	9	8
b. wet method	111	92
2.When do you depulp		
a. after every harvest	107	89
b. after how many days after harvest	4	3
c. n/a	9	8
3.Source of pulpers		
a. home made	1	1
b. n/a	3	3
4. Method of depulping		
a. pounding /bayo	74	62
b. wooden depulper	27	23
c. adjusted corn mill	1	1
d. stone crushing	9	8
5.Acquisition cost		
a.500	1	1
b.800	1	1
c.1000	1	1
d.1500	1	1
e.2000	3	3
f.3500	1	1
g. n/a	112	93
6.Perceived problems in pounding/pulping		
a. broken parchment	26	22
b. tiring	7	6
c. slow performance/no separation	7	6
d. no separation	7	6
e. no separation ,needs repetition	3	3
f. broken parchment and you have to depulp it twice	1	1
g .n/a	69	58

Appendix Table 4. Drying practice of coffee farmers in the selected Municipalities in Benguet, 2007-2008.

ITEMS	FREQUENCY (N=120)	PERCENTAGE REPORTING (%)
1. Form of coffee being dried		
a. berry	10	8
b. parchment	110	92
2. Dry immediately		
a. yes	110	92
b. n/a	10	8
3. Mode of drying		
a. sun drying	120	100
4. Duration of drying		
a. 1-5	62	52
b.6-10	42	35
c. 11-15	12	10
d. 27	1	1
e.30	3	3
Mean =7		
5. Materials used		
a. bilao	22	18
b. sack	47	39
c. net	5	4
d. screen	4	3
e. sack and bilao	37	31
f. G.I sheet	4	3
g. bilao and G. I. sheet	1	1
6. Drying area		
a. surrounding area near the house	105	88
b. on the roof	7	6
c. multipurpose drying pavement	1	1
d.surrounding area near the house ,on the roof	6	5
e. on the roof, near the house	1	1
7.Location of drying pavement		
a. Pugo, La Union	1	1
8. Perceived problems of sun drying practices		
a. weather dependent	116	97
b. too expensive transportation	1	1
c. too long drying period	3	2

Appendix Table 5. Storage practices of coffee farmers in Mankayan, Atok, Tuba and Kibungan, Benguet, 2008-2009.

ITEMS	FREQUENCY (N=120)	PERCENTAGE REPORTING (%)
1. practice storage		
a. yes	101	84.5
b. no	19	15.2
2. reasons for storing		
a. price speculation	8	7
b. for consumption	77	64
c. accumulate all before disposing	9	8
d. price speculation, for consumption	5	4
e. reserved for emergency use	1	1
f. for roasting	1	1
g. good price at harvest time, immediate sale	2	2
h. n/a	17	14
3. reasons for disposing immediately		
a. no storage facilities	2	2
b. good price at harvest time	4	3
c. immediate sale/need of cash	31	36
d. inadequate storage facilities	1	1
e.good price at harvest time and immediate need of cash	1	1
f. n/a	81	67
4. form of coffee stored		
a. parchment	105	88
b. dried berry	3	2
5.duration of storage (months)		
a.1-6	32	27
b.7-12	59	49
c. no answer	29	24
6. problems of current storage practice		
a. molds	4	3
b. none	84	70
c. insect damage	3	3
d. n/a	29	24

Appendix Table 6. Hulling practices of coffee farmers in Mankayan, Atok, Tuba and Kibungan Benguet, 2008-2009.

ITEMS	FREQUENCY (N=120)	PERCENTAGE REPORTING (%)
1.Disposed green coffee		
a. yes	56	47
b. no	64	53
2.Mode of hulling		
a. pounding	119	99
b. mechanical /kiskisan	1	1
3.Acquisition cost		
a.200	1	1
b.500	1	1
c.1000	1	1
d.2000	1	1
4. Problems in pounding		
a. broken beans	34	28
b. tedious	4	3
c. time consuming	2	2
d. n/a	80	67

ABOUT PHILMECH

The Philippine Center for Postharvest Development and Mechanization, known then as the National Postharvest Institute for Research and Extension (NAPHIRE), was created on May 24,1978 through Presidential Decree 1380 to spearhead the development of the country's postharvest industry.

As a subsidiary of the National Grains Authority in 1980, the agency's powers and functions were expanded in line with the conversion of NGA to the National Food Authority.

In 1986, PHilMech moved to its new home at the Central Luzon State University compound in Muñoz, Nueva Ecija.

The agency was transformed from a government corporation into a regular agency through Executive Order 494 in 1992. It was renamed the Bureau of Postharvest Research andExtension (BPRE).

For years now, PHilMech is engaged in both postharvest research, development and extension activities. It has so far developed, extended and commercialized its research and development outputs to various stakeholders in the industry.

With Republic Act 8435 or Agriculture and Fishery Modernization Act (AFMA) of 1997, PHilMech takes the lead in providing more postharvest interventions to empower the agriculture, fishery and livestock sectors.

Pursuant to Executive Order 366 or the government's rationalization program in November 2009, BPRE became the Philippine Center for Postharvest Development and Mechanization (PHilMech) with twin mandates of postharvest development and mechanization.

For more information, please contact:

The Executive Director
Philippine Center for Postharvest Development and Mechanization
CLSU Cmpd., Science City of Muñoz, Nueva Ecija
Tel. Nos.: (044) 456-0213; 0290; 0282; 0287
Fax No.: (044) 456-0110
Website: www.philmech.gov.ph

PHilMech Liason Office
3rd Floor, ATI Building
Elliptical Road, Diliman, Quezon City
Tel. Nos.: (02) 927-4019; 4029
Fax No.: (02) 926-8159