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ABSTRACT

The project aimed to enhance the competitiveness of the Robusta and Liberica coffee by addressing the constraints in value adding operations particularly in the postharvest operations that need intervention.

Employing the Value Chain Analysis (VCA) framework, the potential value of coffee was not attained because of poor harvesting practice and lack of appropriate postharvest facilities for drying and hulling. Majority of the farmers harvest their coffee by stripping method, picking both ripe and unripe coffee berries at one time. Unripe berries when processed produce black beans. This is a major defect of green coffee beans (GCB). Harvest season coincides during the rainy months and the lack of pulpers and dryers prevent farmers from utilizing alternative drying methods when sundrying is not feasible. Longer drying periods result to overfermented beans that also induce mold growth. This leads to deterioration of the flavor of coffee and compromising its product safety. Sundrying using net underlays produce beans with earthy flavor because the beans touch the soil when there is no concrete pavement. This is rejected by processors after cup tasting. Some remote areas without huller still apply the primitive pounding method that produces GCB with high broken beans. These postharvest problems translate to low quality raw material for the processors and low income on the part of the coffee farmers.

Introduction of pulpers and dryers provided solution for drying. The use of coffee pulper allowed the use of "pulped natural method" of drying which immediately removed or split the thick skin (pulp) of the coffee berries, expediting the drying process. This is in contrast with the "dry method" practiced by majority of the farmers in the absence of a pulper. This dried the berries with the pulp still intact. Pulped natural method reduced drying time from seven days to three days thus preserving quality. In times of continuous rain, an "all weather (solar) dryer" allowed the farmers to dry their coffee without being soaked/rewetted by rain. This reduced handling cost while preserving quality. The use of moisture meter provided accurate measurement of moisture content which is essential for storing, hulling, roasting and prior marketing. The use of mechanical coffee hullers reduced the incidence of broken beans by half.

Farmers applying the pulper, dryer and huller increased income because of reduction in physical losses, reduction in labor cost and preservation of quality. The GCB passing the system provides processors with better quality raw materials essential for value adding operations.

Addressing the problems of poor harvesting practices such as stripping method requires a different strategy other than information campaign. Farmers' decision to apply stripping is inherent to the condition of the coffee production area and the productivity of the coffee farms.

INTRODUCTION

Coffee (*Coffea spp.)* is the most consumed beverage worldwide. It is also the most traded item next to oil. 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, the Philippines had an average annual self-sufficiency ratio (2011-2013) of only 49 percent (Philippine Statistics Authority, PSA, 2014) and had to import about PhP6.75 billion worth of coffee a year (average of 2010-2012) for its domestic consumption (FAOSTAT).

On the other hand, 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 significant health benefits were uncovered such as the coffee properties that prevent Type 2 diabetes, reduce the risk of colon cancer, and prevent Parkinson's Disease (coffeescience.org; undated). Consequently, there was a revival and rehabilitation of the coffee industry.

The Department of Agriculture under its High Value Crops Development Program (HVCDP) identified coffee as among the priority crops to be developed in the next five (medium term) to 10 years. Under the HVCDP is a Coffee Development Program which aims to make the Philippine coffee industry self-sufficient characterized by increased income among the different levels of supply chain players, and getting a significant share in the export markets , especially for specialty coffee products.

In 2012, DA allocated PhP163.32M for the coffee development program, giving clear-cut priority to postharvest infrastructures to be established nationwide in key coffee producing areas (DA- HVCDP, 2012). It is therefore vital that the information that will be needed to support the implementation of the program is provided on time. Immediate information that has to be generated would include: appropriate value-adding postharvest facilities, priority locations where to put up these interventions, the conditions that will make it viable, the necessary support mechanism to make the technology accessible and sustainable, the appropriate institutional organization that would handle and/or operate these interventions, the necessary social preparations and capacity enhancement and strategies that will make small players, especially the coffee farmers mainstreamed in the value chain are among the information that would be essential for the effective implementation of the National Coffee Development Program. Hence, the importance of this undertaking.

Objectives

General:

The project aimed to improve the value adding operations of Robusta and Liberica coffee through provision of appropriate postharvest and processing systems.

Specific:

Specifically, the project sought to:

1. Map out and describe the market chain and chain actors involved in the coffee value chain;
2. Describe and analyze the values added by various stakeholders in various market channels;
3. Identify the constraints of the value chain specifically in the areas of postharvest and formulate the corresponding intervention;
4. Pilot test the identified postharvest intervention and assess its technical, financial and socioeconomic viability, and;
5. Provide policy recommendation in identifying the appropriate postharvest support intervention that will enhance the competitiveness of the coffee industry.

Scope and Limitations of the Project

The project addressed the improvement of the value chain from depulping to the drying of GCB. The interventions were piloted in the provinces of Kalinga and Aurora. Kalinga province was selected upon recommendation of Nestle. Aurora province was selected in exchange of the project site in Surigao Del Sur due to the pressing concerns of peace and order situation especially in the coffee-producing municipalities of Surigao. The project cooperators were coffee cooperatives engaged in trading and processing GCB. Municipalities where the interventions were pilot tested recognized coffee as their "one-town- one- product" (OTOP) commodity.

The absence of farmers' organization engaged in Liberica processing, due to its scarcity in supply, compelled the project to pilot the intervention with cooperators producing Robusta with Liberica used only for blending. Liberica coffee, whose primary postharvest operations are the same with Robusta, may apply the interventions identified for Robusta.

REVIEW OF LITERATURE

Value Chain and Value Chain Management

Value chain is defined as an interlinked of value-adding activities that convert inputs into outputs which, in turn, add to the bottom line and help create competitive advantage. A value chain typically consists of (1) inbound distribution or logistics, (2) manufacturing operations, (3) outbound distribution or logistics, (4) marketing and selling, and (5) after-sales service. These activities are supported by (6) purchasing or procurement, (7) research and development, (8) human resource development, and (9) corporate infrastructure(www.businessdictionary.com).

Value chain management (VCM) is a strategic business analysis tool used for the seamless integration and collaboration of value chain components and resources. VCM focuses on minimizing resources and accessing value at each chain level, resulting in optimal process integration, decreased inventories, better products and enhanced customer satisfaction.

Coffee Production

World production

According to the Food and Agriculture Organization (FAOSTAT, 2015), the world's average yearly production of green coffee beans is 8.84 million MT (average of 2011-2013). Table 1 shows the world top producing countries. The production in Brazil (33%), Vietnam (16%), Indonesia (8%), Columbia (6%), and India (4%) constituted 67 percent of the total world production. The Philippines' rank was 14th and the total volume produced during the same period was only 1.2 percent. Brazil remains the largest coffee exporting nation but in recent years the green coffee market has been flooded by large quantities of Robusta beans from Vietnam (Scofield, undated).

Table 1. Top 10 world producers of coffee in metric tons, 2011-2013 (Source: FAOSTAT)

COUNTRY	Year			Average	Percent of total Production
	2011	2012	2013		
Brazil	2,700,540	3,037,534	2,964,538	2,900,871	33
Vietnam	1,276,506	1,565,400	1,461,000	1,434,302	16
Indonesia	638,600	691,163	698,900	676,221	8
Colombia	468,540	462,000	653,160	527,900	6
India	302,000	314,000	318,200	311,400	4
Ethiopia	376,823	275,530	270,000	307,451	3
Peru	331,547	314,471	256,241	300,753	3
Honduras	284,347	343,403	273,480	300,410	3
Guatemala	265,406	272,668	253,186	263,753	3
Mexico	237,056	246,121	231,596	238,258	3
Other countries	1,513,437	1,687,471	1,540,539	1,580,482	
World Total	8,394,802	9,209,761	8,920,840	8,841,801	

Philippine Production

The volume of production decreased from 105,850 MT in 2005 to 85,370 MT in 2013 (Fig. 1) or by about 2,270 MT/yr (PSA, 2015). Decline in the volume of production was reported to be due to the farmers' shift to other cash crops such as bananas, coconut and rubber, especially in the Mindanao area.

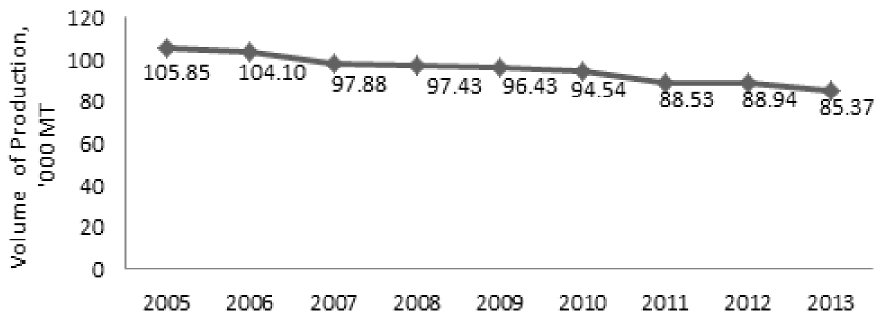


Fig.1. Production trends of green coffee beans in the Philippines (Source: PSA, 2015)

Coffee produced in Mindanao and Luzon constituted 75 and 18 percent, respectively, of the average annual coffee produce for the period, 2011 to 2013. Among the top 10 producing regions in the country, SOCCSKSARGEN tops the list followed by Davao Region and ARMM. Table 2 presents the top 10 producing regions as well as the leading province producing coffee within the region.

Table 2. Top 10 coffee producing regions considering all types of coffee, 2011-2013 (Source: PSA, 2015)

Rank	Region	Leading Producer within the Region
1	SOCCSKSARGEN	Sultan Kudarat
2	Davao Region	Compostela Valley
3	ARMM	Sulu
4	CALABARZON	Cavite
5	CAR	Kalinga
6	Western Visayas	Iloilo
7	Northern Mindanao	Bukidnon
8	CARAGA	Surigao del Sur
9	Central Luzon	Bulacan
10	Zamboanga Peninsula	Zamboanga del Norte

Based on the average of the annual production for the period 2011 to 2013, the 10 highest coffee-producing provinces include Sultan Kudarat, Compostela Valley, Sulu, Cavite, Kalinga, Iloilo, Bukidnon, Surigao del Sur, Bulacan and Zamboanga del Norte. These 10 provinces contributed 73 percent to the total annual volume of coffee harvested in the country.

Major varieties planted

The four major types of coffee grown in the Philippines are Robusta, Arabica, Excelsa, and Liberica (Fig. 2). In terms of the percentage annual volume of coffee produced in 2011-2013, Robusta had the highest volume (71%), followed by Arabica (22%), Excelsa (6%), and Liberica (1%).

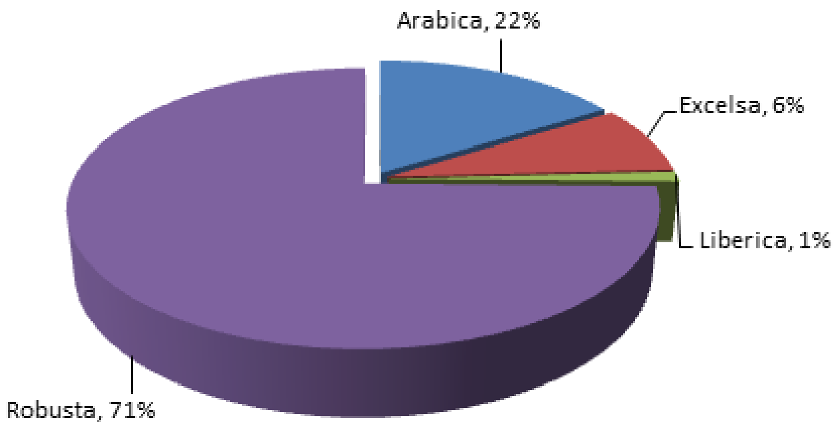


Fig. 2. Types of coffee produced in the Philippines, (PSA, 2015)

Coffee Trade

Robusta coffee is preferred by large industrial companies, like multinational roasters and instant coffee producers, because of its 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.

Coffee is traded in several forms, namely: green coffee, roasted, extracts and essences and coffee husks and skins. For the period 2010 to 2012, the Philippines exported a total of USD4.03 million worth of coffee. In terms of value, the coffee extracts contributed about 73 percent of the total value of exported coffee. For the same period, the Philippines imported USD482.2 million worth of coffee, with coffee extracts and GCB getting the highest percentage (65 and 34%, respectively) of the total value of coffee importation for the last three years. The figures indicate the huge potential of coffee in the local market to substitute for the importation.

The two major markets of Philippine coffee in 2011 and 2012 were Republic of Korea and mainland China with 55 and 32 percent, respectively, of the total export value of all forms of coffee (FAOSTAT, 2015).

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 coffees 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 coffees 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.

Harvesting

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

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 and overripe cherries.

Separation of good coffee berries

After harvesting, good ripe berries are separated from the overripe and undeveloped berries. Overripe and undeveloped coffee cherries 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.

Pulping coffee

After harvesting and separation of inferior quality berries, the flesh 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 coffees or these 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. In sun drying, coffee is shifted every 30 to 40 minutes. Sun drying coffee on pavements takes six to seven days for washed coffees, eight to nine days for pulped naturals (semi-washed), and 12 to 14 days for natural (dry-processed) coffees. 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 15 to 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 to 45^{0}C or a bean temperature of 35^{0}C so that coffee quality will not be seriously compromised. Stages 5 and 6 (15 to 11% moisture) require a drying time of six hours in a mechanical dryer using a drying temperature of 40^0 to 45^0C. 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 to 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. Fermentation is also 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 cherries 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 beans

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 dark 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 detailed information of the coffee bean classification.

CONCEPTUAL FRAMEWORK

The project employed the Value Chain Analysis (VCA) framework. Value chain is the sequential set of primary and support activities that an enterprise performs to turn inputs into value added outputs for its external consumers. As developed by Michael E. Porter, it is a connected series of organizations, resources and knowledge streams involved in the creation and delivery of value to end customers.

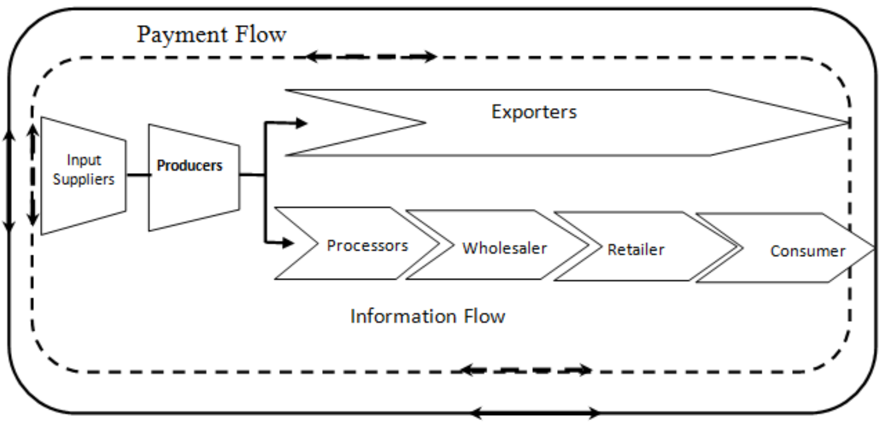
The essence of VCA is to improve strategic learning in enterprise development. It treats the enterprise not as a singular entity but as part of an integrated chain of economic functions and linkages across geographic boundaries (AsiaDHRRA, 2008).

Adapting the framework applied by AsiaDHRRA (2008), the VCA model integrates analysis of the commodity supply chain and that of the associated enabling environment. The model comprises of the following analytical entry points: (1) product and process flow, (2) information and money flow and, (3) the enabling environment (Fig. 3.). These entry points are categorized into: (1) Primary activities and, (2) Support activities.

Primary activities are those functions which are directly involved in the production, processing and distribution of the product. Support activities, on the other hand, are not directly involved in the actual manufacture of product but plays a vital role on the efficiency of production and distribution.

The primary activities may fall among the following: Inbound Logistics, Production and Processing and Outbound Logistics. The project concentrated on the production and processing component since the proposed intervention addresses the specific problematic operations of the value adding operations of GCB. Improvement of the value chain will come from improvement in quality and reduction in cost through provision of appropriate primary postharvest facilities.

Fig. 3. The Value Chain Analysis Model (Adapted from AsiaDHRRA, 2008)



Enabling Environment

Policies, Rules & Regulations	Infra. & Enterprise Devt. Facilities	Research & Technology & Institutional Services	Socioeconomic & Cultural Considerations

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

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 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,and in general, improve the coffee value chain.

The sequence of activities that would attain the objectives of the project is presented in Fig. 4. Project activities were divided into three phases. Phase 1 was designed to analyze the current supply and value chains of coffee. It identified bottlenecks or inefficiencies hampering the value adding operations in the production of GCB specifically in the field of postharvest.

Recognizing the sources of inefficiencies, corresponding improvements were formulated (Phase 2). It involved identification and matching of equipment appropriate for the particular chain actor, the current level of production and quality requirements demanded by the end users of GCB.

Phase 3 involved piloting of the intervention in selected major coffee producing areas. The performances of the postharvest intervention were evaluated based on loss reduction, quality improvement and reduction in cost. This phase of the project also included assessment of the benefits and costs created at the level of the technology adaptors. The major output is a viable system of postharvest facilities that can enhance the value adding operations of GCB.

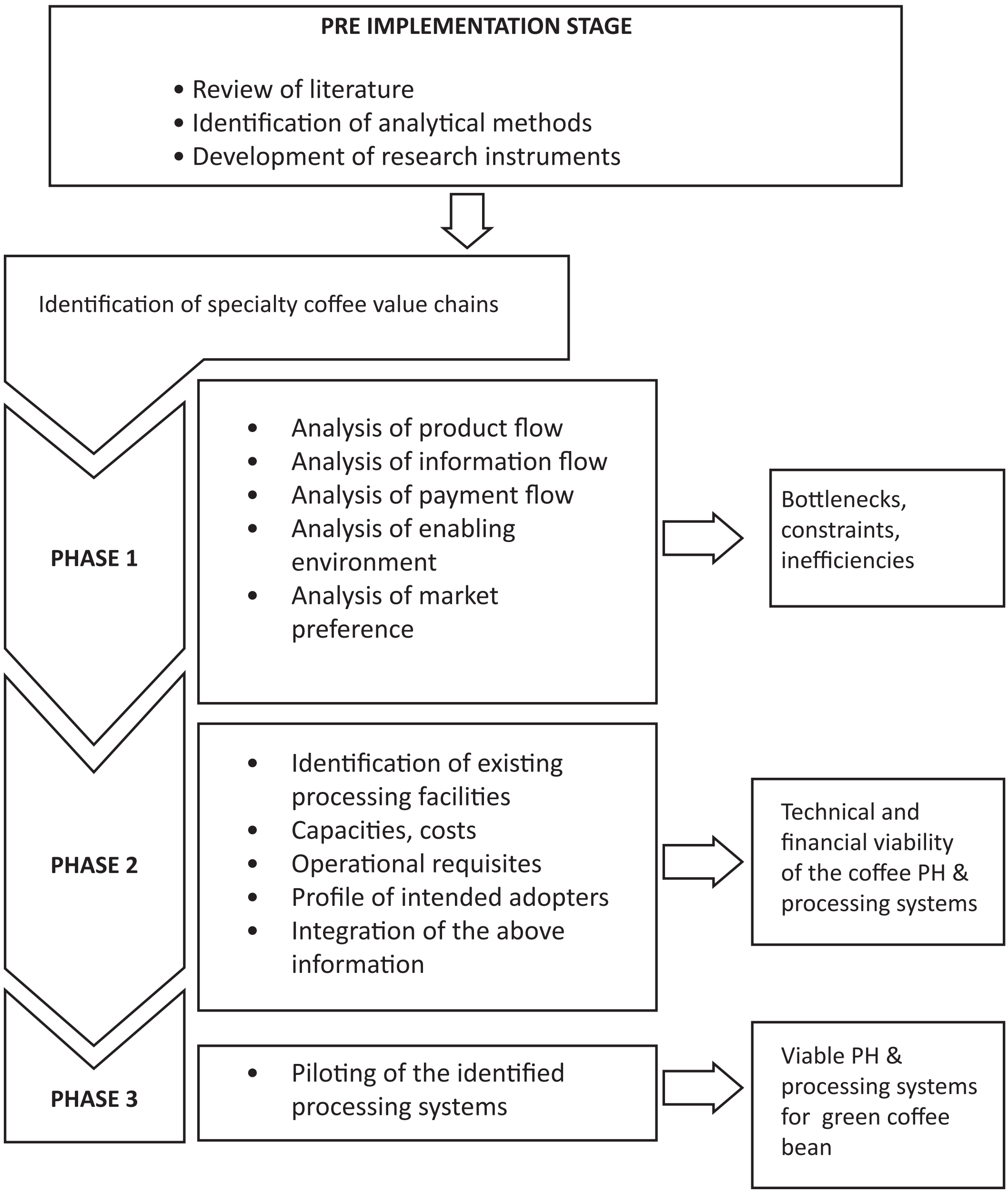


Fig. 4. Paradigm showing the major activities undertaken to attain the outputs envisioned by the project

METHODOLOGY

Data Gathering Procedure

Primary data were obtained using surveys, focus group discussions (FGD), and key informant interviews (KII) covering the year 2011 to 2012. Respondents were personally interviewed by the research team. Telephone interviews were also done for some of the respondents that did not make it to the scheduled meeting. The flow of the product from production areas to market and its movement from the producer to the consumers were traced. Chain actors were identified and their practices, roles, volume and form of products handled, cost and margins associated with the roles or practices, and quality requirements were determined, among others. For the Phase 3 of the project, data were gathered by actual observations and measurements.

Secondary data were also utilized to determine information on production, consumption, quality and grading of product, and major issues and constraints affecting the coffee industry based on the results/proceedings of various coffee fora and stakeholders meetings.

Sampling and Selection of Respondents

After determining the major postharvest systems practiced in the production of GCB and plain roasted ground coffee, respondents were purposively sampled to get the information needed. Respondents included coffee farmers, farmers organizations involved in coffee production and/or processing, baranggay- and municipality-based traders, roasted ground coffee processors, large industrial processors of coffee like Nestle, and coffee shops.

Chain-referral method was employed to get information on the stakeholders involved in the area for pre-identified coffee postproduction systems. Following some initial criteria like production and postharvest practices, variety grown, area devoted to coffee production, and type of product marketed, farmer-producers were located through referrals and consultations especially with the municipal agricultural officers and/or agricultural technicians assigned in the major coffee-producing areas. The producers identified their production input, technical and financial service providers, and market outlets while traders and wholesalers also identified their buyers, providers of logistics support and local processors. Specifically, the respondents were sampled from the referrals taken from the concerned chain actors.

1. Coffee farmers - respondents from this node or participants of the chain represent about 50 percent of the members of the farmers organization or cooperative
2. Coffee farmers cooperative - farmers association or cooperative engaged in processing and marketing coffee. These cooperatives are situated in a municipality that has coffee as either their OTOP or priority commercial crop
3. Barangay traders - barangay traders operating in the sample area
4. Municipal/city trader - traders where barangay traders sell their coffee
5. Local coffee processors - coffee processors in the locality whose product is

marketed within the province and reaches other major cities including Metro Manila
6. Industrial coffee processor - Nestle, being the major user of Robusta coffee for processing instant coffee under the brand name "Nescafe"
7. Coffee shop operators - coffee shops supplied by the identified processors

Data gathering for Phases 1 and 2 of the project were done in some of the major coffee-growing areas, such as: Kalinga, Bulacan, Bataan, Cavite, Quezon, Batangas, Nueva Vizcaya, Aurora, Iloilo, Surigao del Sur, Agusan del Sur, Sultan Kudarat, Davao, and Compostela Valley.

After identifying the weakest nodes along the value chain, appropriate technologies were assembled and pilot tested in two of the coffee-growing areas where there are farmers' groups that are involved in the production of GCB and in the processing of roasted ground coffee, namely: Diarabasin, Aurora and Pinukpuk, Kalinga. Project co-operators were identified following certain criteria foremost of which were: (a) farmers' group engaged in production and postproduction activities of Robusta and/or Liberica (b) interested to cooperate with the research team to get the necessary information required by the project. Direct observations of the production and postproduction activities were done by the research team to gather the time spent for each major activity, cost of production and processing coffee, problems encountered, quantity and quality of product recoveries and/or losses in each segment of the processing system, income derived from production and processing, and other related issues and concerns.

Methods of Analyses

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 is significant difference between observed efficiency indicators such as percent broken, duration of operation, etc.

Financial Analyses

Partial budget was used to determine and quantify the benefits and costs associated in adopting the new technology versus the traditional method.

RESULTS AND DISCUSSION

Mapping the Value Chain

Key Value Chains of Robusta Coffee

The value chain of Robusta coffee can be categorized into two major chains: (a) the local processors chain that produces roasted ground coffee (Fig. 5) and (b) the multinational processors chain, like Nestle that produces soluble instant coffee (Fig. 6).

The local processors chain is estimated to get 15 percent of the GCB produced locally. Players under this category would include Kalinga Blend, Mananig Coffee, Kalinga Brew, Aurora Blend, Bataan Blend, Bulacan Brew, Cafe de Lipa, Batangas Brew, and others.

The multinational coffee processor such as Nestle obtains about 80 percent of the entire national production of Robusta. This supply is just a small part of their total GCB requirement with their supply deficit source out through importation. Nestle has several buying stations located nationwide. All of the procured GCB are shipped to Cagayan de Oro where the large-scale processing plant of coffee is situated. Processed instant coffee is then shipped to Laguna where they are packed prior to distribution to major market outlets nationwide.

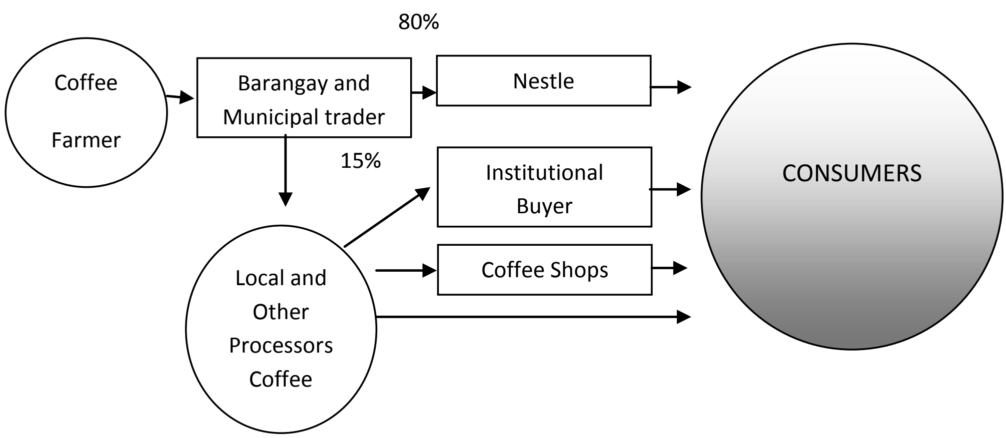


Fig. 5. The local processors supply chain

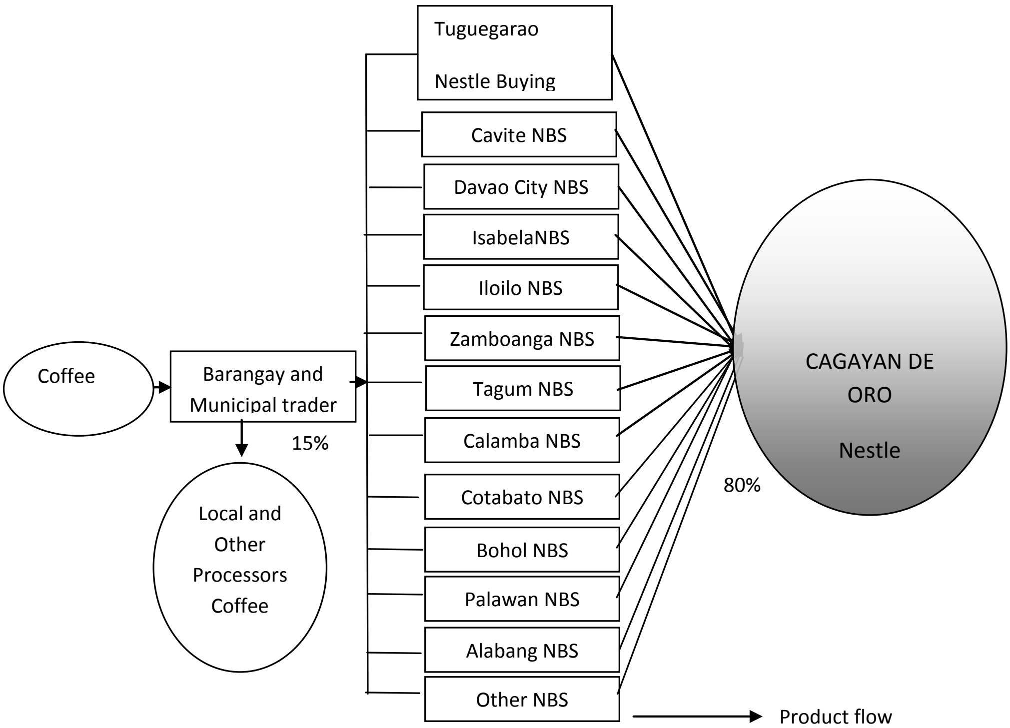


Fig. 6. The multinational (Nestle) processor chain

Value Chain Players

Input suppliers

Input suppliers include suppliers of seedlings, fertilizers, pesticides, farm tools and equipment. It also includes suppliers/importers of processing materials such as packaging, processing equipment and other utilities used for branding and preserving the quality of processed product.

Coffee farmers

Coffee farmers manage the farm, perform harvesting, depulping, drying, hulling to produce GCB required by the traders and processors. Some of them clean and sort their coffee before selling. Majority of them intercropped coffee trees with other crops such as banana, coconut and other forest and cash crops. They retain portion of their produce, estimated at five percent, for home consumption.

Barangay traders

This group of traders operates a buying station in the barangay, normally owns and operates a huller for custom hulling and directly buys the coffee of the farmers availing of the hulling service. In some cases, these traders also provide credit to coffee farmers which are repaid by the latter on a “charge to crop” basis. Some of them also do sorting activities to upgrade the quality of GCB and get better price.

Municipal/city traders/assemblers

Traders based in the municipality or city generally operate buying stations and buy coffee from walk-in farmers and barangay traders. They also perform sorting and re-drying of coffee to attain the quality standard imposed by Nestle buying stations. In some cases, they also have hullers and operate in a manner similar to barangay traders.

Local processors

Local processors are those engaged in processing of specialty or “gourmet” coffee. They invested in secondary processing equipment such as roasting facility, grinder and packaging equipment. Their raw materials are obtained from farmers and traders and they procure and stock a certain volume to sustain the raw material requirement for one year processing operation. Local processors sell roasted beans and/or roasted ground beans to coffee shops, restaurants, hotels and wet markets. They also perform trading by selling excess stock of green coffee beans to traders or nearest Nestle satellite buying station. Their share of GCB is estimated to be 10 to 15 percent of the total local production.

Satellite buying stations (Nestle)

Buying stations operated by Nestle are strategically located in major coffee producing areas. They buy coffee from farmers and traders and impose strict quality standards prior to procurement of GCB. A three-tiered quality control and grading system is adopted based on: (1) moisture content (MC), requires MC not greater than 11 percent but provides an incentive of PhP1/kg for each MC below 11 percent, (2) triage, which analyzes coffee beans from physical defects, and (3) cup tasting or cupping. The coffee beans have to pass these three quality indicators , otherwise the batch of GCB for sale will be rejected.

Multi-national processor (Nestle)

Nestle acquires about 80 percent of the total Robusta coffee produce in the country. It sources out its raw material deficit from other countries such as Vietnam, Malaysia and Indonesia. It operates a large scale processing plant in Cagayan de Oro where all Robusta GCB procured by satellite buying stations are shipped and processed as instant coffee. It also operates a nursery cum techno-demo farm in Tagum City, Davao del Norte as source of high yielding cloned planting material and technology hub for primary processing facilities such as pulper, dryer and huller. In the industry’s effort to promote and boost local production, Nestle is currently working on a collaborative project with DA, DAR and

DENR to put up more cloning nurseries nationwide to provide accessible and affordable quality seedlings to coffee farmers.

Other large-scale processors

Other large-scale coffee processors in the country are Café Puro, Blend 45, Kopiko, SanMig coffee, and other processors of instant coffee. These processors obtain a portion of their GCB requirements from local traders/assemblers and acquire additional GCB through importation from other countries such as Vietnam and Indonesia.

Coffee shops

Coffee shops are available everywhere. They retail coffee in cups in various preparations (black coffee, espresso, cappuccino, café latte, etc.). Generally, these local coffee shops acquire roasted ground coffee from local processors and invest on brewing equipment and similar facilities. They operate in hotels, restaurants, resorts, malls, recreational parks, public transport terminals, university canteens, and other similar places where energizing beverage is needed.

Institutional markets

This node retails/wholesales processed coffee from specialty coffee processors and instant coffee from Nestle and other processors. They charge a margin ranging from 20 to 50 percent of the wholesale price of the processor.

Consumers

The last actor of the value chain, buys roasted ground coffee and instant coffee in packs or ready to drink preparation from coffee shops, supermarkets and other retail markets.

Other chain stakeholders

Other stakeholders include the support service providers such as government agencies involved in research and development, facilitation of credit, technical assistance, mechanization and others like Philippine Center for Postharvest Development and Mechanization (PHilMech), Bureau of Soils and Water Management (BSWM), Agriculture and Marketing Assistance Service (AMAS), Philippine Statistical Authority (PSA) , Bureau of Agricultural Research (BAR), Bureau of Plant Industry (BPI), Bureau of Agriculture and Fishery Products Standards (BAFPS), Department of Agrarian Reform (DAR), Department of Environment and Natural Resources (DENR), Department of Trade and Industry (DTI) and Department of Science and Technology (DOST). State universities and colleges (SUC's) and nongovernment organizations (NGO's) are also actively involved in the conduct of R&D activities, information campaigns, training and the like.

Value Added Throughout the Chain

This section presents the value addition of coffee highlighting the costs and net income shares in the different levels of the coffee supply chain to determine the distribution of gain among the different stakeholders. Adapting the work of Lantican (2010), net income is the profit earned after deducting all the expenses of each participant from the total value of the final product at the consumer level. The computations of these costs and incomes were based on the material conversion of fresh coffee berry to one kilogram brewed roasted ground coffee.

The study considered the value chain of two market channels: (1) Kalinga–Tuguegarao-Manila market channel and (2) Aurora–Cavite market channel. Each market channel was further divided to represent two final products, which are: (1) GCB with Nestle as the final point of sale and (2) brewed roasted ground coffee with consumer as the final point of sale.

The Nestle value chain was not extended to the production of instant coffee as the company treats its production and processing data with confidentiality. Also, it is not necessary to further assess their efficiency since this multinational company is more capable of handling their efficiency concerns and has more advanced state-of-the-art processing technologies that they use in the production of their instant coffee. Policy intervention for this specific chain would be focused on improving the production of raw material required by these multinational players that utilize about 80 percent of the Robusta coffee production.

Table 3. Conversion values of coffee from one form to another, labor cost, and price in the production areas; 2012

Item		Value
5.55 kg fresh coffee berries	=	1 kg roasted coffee
Fresh berries	=	0.264 dry parchment coffee
	=	0.20 green coffee beans
Fresh coffee berries	=	0.18 roasted
Green coffee beans	=	0.80 roasted beans
1 kg ground coffee	=	133 cups of coffee
1 cup of coffee	=	PhP50/cup
Harvesting cost	=	PhP120/day @ 15 kg/day/person
Drying cost	=	PhP1/kg for 3 days
Bgy. Trader trucking cost	=	PhP13/kg
Hulling cost	=	PhP3/kg
Trader/miller sorting & transport	=	PhP3/kg; transport is PhP4/kg

On the other hand, the local specialty coffee processors' value chain that produce gourmet or roasted ground coffee was assessed. These players disclosed information on their respective production and processing costs to further enhance the performance of their value adding operations. The computation of costs and returns were based on the conversion rates of one form of coffee to another brought about by the progression of value-adding activities (Table 3).

Kalinga–Tuguegarao–Nestle and
Kalinga–Other Cities–Metro Manila Market Channels

For Kalinga–Tuguegarao–Nestle market channel, distribution of gross margin is concentrated at the coffee farmers at 79.79 percent followed by municipal/city trader and barangay trader at 14.89 and 5.31 percent, respectively (Table 4). In terms of cost, farmers also incur the highest share at 62.93 percent and consistently have the highest net income share at 16.86 percent.

However, the distribution of margin, cost and net income shares changes when the other players such as the processors and coffee shops were included in the value chain. In terms of gross margin share, coffee shops had the highest share at 90.38 percent followed by processors at 4.38 percent (Table 5). Coffee shops cost and net income shares also dwarfed the share of the other value chain actors. Interestingly, net income share of coffee processors is higher than the net income share of famers at 2.55 and 0.63 percent, respectively. It only reveals that there is income opportunity in performing value adding operations such as roasting and retailing.

Table 4. Cost and net income shares of the different chain actors in the Kalinga–Tuguegarao City (Nestle Buying Station) market channel with GCB as final product, 2012

Key Player	Farmer →	Barangay Trader →	Municipal Trader	Total
Cost (PhP/kg)	59.15	3.20	6.48	68.84
Net income (PhP/kg)	15.85	1.80	7.52	25.17
Cost share (%)	62.93	3.40	6.89	73.22
Net income share (%)	16.86	1.91	8.00	26.77
Total	79.79	5.31	14.89	100
Activities undertaken by specific stakeholders	Production, harvesting, drying, hulling, delivery	Transportation, others	Delivery and marketing, others	

Table 5. Cost and net income shares of the different chain actors in Kalinga –Tuguegarao City –Metro Manila market channel with brewed roasted ground coffee as final product, 2012

Key Player →	Farmer →	Barangay Trader →	Municipal Trader →	Processor →	Institutional buyer →	Coffee Shop	Total
Cost(PhP/kg)	59.15	3.20	6.48	46.00	33.30	651.00	799.13
Net income (PhP/kg)	15.85	1.80	3.52	64.00	6.7	1,609.00	1,700.87
Cost share (%)	2.37	0.13	0.26	1.84	1.33	26.04	31.97
Net income share (%)	0.63	0.07	0.14	2.56	0.27	64.35	68.02
Total	2.99	0.19	0.39	4.38	1.59	90.38	100
Activities undertaken by specific stakeholders	Production, harvesting, drying, hulling, delivery	Transportation, others	delivery and marketing, others	Roasting, packaging grinding, delivery and marketing, depreciation, etc.	Pick-up cost, others	Operating cost, depreciation, etc.	

Aurora–Cavite (Nestle Buying Station) and Aurora– Institutional Buyer Market Channels

For Aurora–Cavite (Nestle Buying Station) market channel, distribution of gross margin is concentrated on the coffee farmers at 53.19 percent followed by barangay trader at 39.72 percent (Table 6). Consistently, the farmers and the barangay trader had the highest cost shares at 42.55 percent and 32.98 percent, and income shares of 10.64 and 6.75 percent, respectively.

Table 6. Cost and net income shares of the different chain actors in Aurora–Cavite (Nestle Buying Station) market channel with GCB as final product, 2012

Key Player	Farmer →	Barangay Trader →	Trader/Miller	Total
Cost (PhP/kg)	40.00	31.00	5.00	76.00
Net income (Php/kg)	10.00	6.34	1.66	18.00
Cost share (%)	42.55	32.98	5.32	80.85
Net income share (%)	10.64	6.75	1.76	19.15
Total	53.19	39.73	7.08	100.00
Activities undertaken by specific stakeholder	Production, harvesting, others	Drying, hulling, trucking, labor, others	Sorting, trucking, others	

Similar to Kalinga–Tuguegarao-Manila market channel, the distribution of margin, cost and net income shares change when the processors and coffee shops enter the picture of the value chain. In terms of gross margin share, coffee shops had the highest share at 94.18 percent followed by processor at 4.90 percent and with farmers only getting about one percent (Table 7). This is because coffee farmers in Aurora sell their coffee as fresh berry, with the trader/processor doing the drying and hulling operation, hence obtaining higher income from performing the value adding operations.

Looking at the cost and net income shares, coffee shops consistently dwarfed the share of the other players getting the highest cost and income shares of 37.84 and 56.34 percent, respectively.

In light of the value chain presented for all the market channels, primary processing operations (harvesting, drying, hulling, sorting) contribute about 75 percent of the cost in producing GCB. While farmers get the highest cost share, they still get the highest net income share by performing harvesting, drying and hulling before selling the GCB to the next supply chain player.

Table 7. Cost and net income shares of the different chain actors in Aurora–Institutional Buyers market channel with brewed roasted ground coffee as final product, 2012

Key Player	Farmer →	Processors →	Coffee shop	Total
Cost (PhP/kg)	57	154.00	2,672.01	2,883.10
Net income (PhP/kg)	8	192.00	3,977.99	4,177.99
Cost share (%)	0.81	2.18	37.84	40.83
Net income share (%)	0.11	2.72	56.34	59.17
Total	0.92	4.90	94.18	100.00
Activities undertaken by specific stakeholder	Production, harvesting, others	Drying, hulling, roasting, marketing	Operating cost, depreciation, etc	

Coffee Farmers and Their Production and Postproduction Practices

The information presented under this topic were generated from interviews of coffee farmers from three major coffee-producing provinces, namely: Surigao del Sur, Kalinga, and Aurora. Although the information was originally intended to establish benchmark information on the areas where potential postproduction interventions would be pilot tested, the data could also be used to give indications of the characteristics of the coffee farms, postproduction practices adopted by farmers and other related concerns.

Coffee Farmers and their Coffee Farms

A typical coffee farmer in the provinces of Kalinga, Aurora and Surigao del Sur is about 49 years old and spent 7.52 years of schooling (Table 8). He or she has been engaged in coffee production for 23.10 years or about half of his or her entire life. A farmer owns 1.88 ha of Robusta farm which is situated about 1.67 to 384 kilometers away from their residences. Coffee farms of Surigao del Sur are situated relatively the farthest from the owners' residences. This situation in Surigao del Sur can pose a problem on sustainability since care and maintenance of the crop would be difficult on the part of the owner.

Table 8. Coffee farmers in Kalinga, Aurora and Surigao del Sur, 2011-2012

Item	Provinces			All (N=118)
	Kalinga (n=62)	Aurora (n=25)	Surigao del Sur (n=31)	
1. Age, years				
Mean	43.9	56.0	53.0	48.90
Range	21-75	27-76	38-73	21-76
2. Total years of schooling, years				
Mean	7.33	8.00	-	7.52
Range	0-15	3-14	-	0-15
3. Engaged in coffee farming, years				
Mean	20.7	30.7	21.8	23.10
Range	2-55	15-50	21-30	2-55
4. Land tenure, % reporting				
Owned by farmer-respondents	99	100	100	100
5. Size of coffee farm, ha				
Mean	1.78	1.96	2.01	1.88
6. Distance of coffee farm from residence, km				
Mean	1.67	2.60	384	102.31
Range	0.01-12.00	0.05-5.00	2.00-1,000.00	0.01-1,000.00
7. Number of fruit bearing Robusta trees				
Mean	943	499	1,384	965
Range	20-5,000	50-3,000	50-5,000	20-5,000
8. Number of non fruit-bearing Robusta trees				
Mean	172	0	101	117
Range	0-800	0	0-700	0-800
9. Number of Liberica coffee				
Mean	0	28	0	6
Range	0	0-700	0	0-700

Across the three provinces, a coffee farmer has 965 fruit bearing trees of Robusta variety. Some of them have non-fruit bearing Robusta trees of about 117 trees/farmer. It is important to note that the farmers of Aurora being the eldest (56 years) among the three provinces had no newly-planted trees. However, from among the farmer-respondents only Aurora farmers have planted Liberica coffee. This could be attributed to the program of the government to plant Liberica coffee. Coffee trees are generally planted in between other crops like coconut, banana, cacao, and other forest trees.

Production and Postharvest Practices in Producing GCB in Three Sample Coffee-Growing Provinces

This section describes some of the production practices and the sequential postharvest operations undertaken by farmers and other supply chain actors in the production of GCB. It mainly documents and examines each postharvest operation to accurately identify sources of inefficiencies that could identify the entry points of designing postharvest interventions.

Some production aspects

Some of the cultural practices followed by the coffee farmers from the three provinces sampled are shown in Table 9. Majority of the farmers (81%) practice pruning with the use of bolos. Very few apply fertilizer (3%) and pesticides (2%). For the few farmers of Aurora and Surigao del Sur who fertilize their coffee trees, most of them use organic fertilizers like animal manures. The benefit of weeding is recognized by the farmers (84%) especially during the time of harvesting.

More than half of the farmers (64%) have positive outlook towards coffee production and plan to plant more trees as source of additional income (54%), replacement of old/dead trees (7%) and trial of new varieties (4%) as recommended by government and private entities within the area. The reasons given by those who had no plan to plant more trees were the absence of area (25%) and other reasons like limited time available to take care of new trees and absence of seedlings (16%).

Harvesting

Harvesting of berries is done manually, both by priming (43%) and stripping (40%) methods (Table 10). Although priming method, practiced by picking only ripe coffee berries, is regarded as the best method of harvesting, almost equal percentage of farmers practice stripping method. Stripping method picks both ripe and unripe berries at one time resulting to combination of berries of different degree of ripeness (Fig.7). Farmers, despite their knowledge that unripe berries produce defective beans in the form of black bean, still perform stripping method because of its inherent advantages. Farmers with remote coffee farms complained of pilferage, hence waiting for the berries to reach full maturity becomes impractical under this condition. For coffee trees with low productivity (fewer berries), going back on the same tree is not cost effective due to high labor cost.

Table 9. Some production practices followed by coffee farmers from Kalinga, Aurora and Surigao del Sur, 2011-2012

Item	**Provinces (% Reporting)**			**All (N=118)**
	Kalinga (n=62)	Aurora (n=25)	Surigao del Sur (n=31)	
1. Practice pruning				
Yes	73	88	90	81
No	27	12	10	19
2. Apply fertilizer				
Yes	0	12	3	3
No	100	88	97	97
*Kind of fertilizer use**				
Organic	0	12	3	3
Inorganic	0	4	0	<1
3. Spray insecticide & fungicide				
Yes	3	0	3	2
No	97	100	97	98
4. Practice weeding				
Yes	82	80	90	84
No	18	20	10	16
5. Plan to plant more trees				
Yes	61	72	64	64
No	39	28	36	36
*If yes, why?**				
Additional source of income	46	72	55	54
Replace old/dead trees	14	-	-	7
Try new variety	2	-	10	4
*If no, why?**				
No more area to plant	25	12	20	21
Other reasons (no more time, maintain existing and other fruit trees, no seedlings)	16	16	16	16

*Multiple responses

Table 10. Harvesting practices of the coffee farmers from the coffee-growing areas of Kalinga, Aurora and Surigao del Sur, 2011-2012

Item	Provinces (% Reporting)			All (N=118)
	Kalinga (n=62)	Aurora (n=25)	Surigao del Sur (n=31)	
1. Method of harvesting				
Priming	49	32	40	43
Stripping	48	24	37	40
Both priming and stripping	3	44	23	17
2. Peak of harvesting season				
January	87	-	-	
February	13	-	-	
July-August	-	-	6	
September	-	-	68	
October	-	-	23	
November- December	-	100	3	
Start and end of harvesting	Dec.-Mar.	Oct.-Feb.	Jun.-Dec.	
3. Freq. of harvesting per month				
Once	18	0	0	9
Twice	16	88	90	51
Thrice	26	0	0	14
Four times	16	12	10	13
≥Five times	26	0	0	14
Mean (number of days)	4.14	2.24	2.21	3.24
Range (number of days)	1-15	2-4	2-4	
4. Tools used in harvesting				
Can and sacks	10	4	19	11
Ladder, can or basket or "pasiking" and sacks	90	96	-	68
"Kawit", can and sacks	-	-	81	21
5. Labor use in harvesting operations				
Family members	47	80	68	60
Hired labor	29	4	13	20
Both	24	16	19	21
6. Problems encountered in harvesting*				
Rain	-	-	10	3
Insect bites	50	59	23	45
Tedious (trees are already high)	58	41	7	41
Lack of manpower	14	-	13	11
Others (too far, bad roads)	2	-	-	1
No problem	3	-	55	16

*Multiple responses

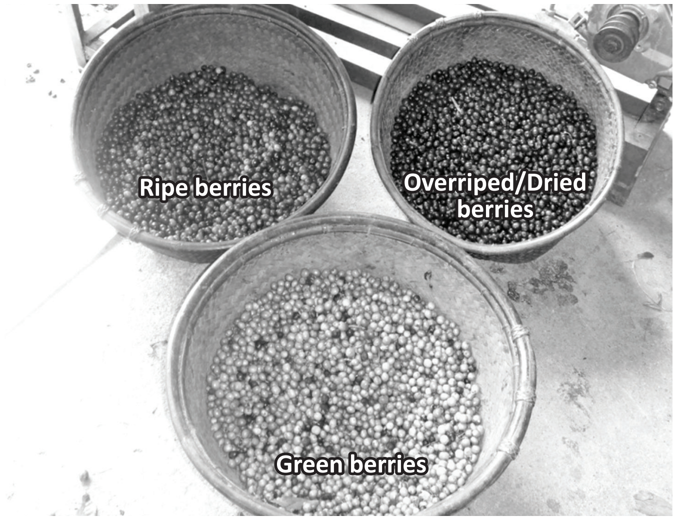


Fig. 7. Coffee berries harvested by stripping method showing the relative proportions of unripe, ripe and overripe/dried berries, 2012

In some cases, other farmers with well-managed coffee farms and do not experience pilferage prefer priming method. Some of these farmers are even engaged in processing and recognized the advantage of having good quality GCB as a result of priming method.

In addition, good agricultural practice (GAP) for coffee recommends not to leave unharvested berries at the end of the fruiting season as it will only harbour coffee borer which is a destructive coffee pest. Hence, the last batch of harvest should be stripped to avoid leaving unharvested berries on the plants.

Because of different climatic conditions, the three provinces covered by the study have different peaks of harvesting season. Aurora province was reported to have its peak of harvesting in November to December (100%) while Kalinga had peak harvesting periods in January (83%). On the other hand, Surigao del Sur had its peak harvesting in September-October (91%). For a given year, Surigao del Sur can give the earliest harvest of coffee in June. More than half (51%) of the respondents reported to harvest twice a month while the rest harvest more often from three to five times a month. The mean number of harvesting frequency is 3.24 times a month.

In farms where pruning is not practiced, coffee berries are generally found high up on the trees (Fig. 8). This situation renders manual harvesting tedious often requiring the harvesters to climb the trees to reach for the berries. Other harvesters require ladders and poles or “kawit” to facilitate harvesting. Among others, and other than the difficulty of harvesting (41%) especially of trees that have not been pruned, the painful bites of insects like ants (45%) have been the common problems during harvesting.

Fig. 8. Coffee trees that are not pruned makes harvesting tedious and difficult, Kalinga, 2012

Volume of harvest per farmer

Table 11 shows the quantity of harvest by farmers in terms of GCB. Across the provinces surveyed, the mean coffee produced by the farmers is 110 kg/yr of GCB.

Table 11. Coffee produced by farmers from the coffee-growing areas of Kalinga, Aurora and Surigao del Sur, 2011-2012

Item	Provinces			All (N=118)
	Kalinga (n=62)	Aurora (n=25)	Surigao del Sur (n=31)	
1. Green coffee beans produced, kg/yr				
≤50	22.7	72.7*	35.6	37
51-150	61.3	13.7	41.9	46
151-250	12.8	13.6	9.6	12
≥251	3.2	0	12.9	5
Mean	109.2	54.7	156.6	110.1
Range	12-390	8-180	20-900	
2. Weight set aside for home consumption, kg/yr*				
≤5	26.7			
5.1-10.0	43.3			
10.1-15.0	10.1			
15.1-20.0	16.6			
≥20.1	3.2			
Mean	9.3			
Range	1-30			

*Data on dried berries were transformed to green bean; farmers from Aurora practice selling dried berries; Farmers from Aurora and Surigao del Sur generally do not keep coffee for home consumption.

Farmers from Aurora generally sell dried berries. To make comparisons among the three provinces, the data on dried berries were converted to GCB. Farmers from Surigao del Sur had relatively the highest volume of harvest (156.6 kg/yr) while Aurora had the lowest (54.7 kg/yr). These data are in agreement with the number of fruit-bearing trees presented in Table 8 with the farmers of Surigao del Sur having the highest number of fruit-bearing coffee trees.

Farmers from Kalinga set aside and store dried coffee berries for home consumption. It is the practice to store dried berries for longer shelf life. Converted into GCB, the mean quantity of GCB retained by Kalinga farmers for home consumption is about 9.3 kg/yr. Drinking coffee among the farmers of Kalinga is a practice that has been deeply ingrained in their culture.

Drying

Majority (94%) of the coffee farmers apply the “dry method” which dries the whole coffee berry (Table 12). After harvesting, coffee berries are immediately dried normally by sun drying (78%). Some farmers from Surigao del Sur dry coffee berries that have been cracked or partly in parchment form. Sun drying is done for about six days using underlays such as tarpaulins, plastic nets, screens and sacks (Fig. 9-12). The major problem in drying activities was the unnecessary delay in drying due to rains (81%) which is generally present during the peak harvesting months. Since coffee harvest coincides during rainy months (August to December), sun drying becomes unreliable.

With continuous sunshine, it normally takes a week before the berries reach a moisture content (10 to 12%) safe for storage. But with intermittent rains it can take two weeks or even more causing the berry to over ferment and even induce growth of molds. Over fermentation increases acidity that results to off flavour when processed.

Some farmers in Kalinga (>16%) practice drying with heated air coming from direct wood-fired clay kiln (Fig. 13) which can expedite drying to one day. They call this “pugon” drying. However, coffee berries dried using this method is partially “roasted” and “smoky” in odour because of unregulated temperature and excessive smoke. Smoke coming in contact with the beans could bring down the quality of the beans during the coffee cup taste.

Table 12. Drying practices of the farmers from the coffee-growing areas of Kalinga, Aurora and Surigao del Sur, 2011-2012

Item	**Provinces (% Reporting)**			**All (N=118)**
	Kalinga (n=62)	Aurora (n=25)	Surigao del Sur (n=31)	
1. Forms of coffee dried				
Berries	100	100	77	94
Cracked berries	0	0	0	0
Parchment coffee	0	0	23	6
2. Berries are dried immediately				
Yes	74	76	97	80
No	12	24	3	12
Accumulate volume, then dry after 3 days	14	0	0	7
3. Method of drying				
Sun drying	58	100	100	78
Smoke drying	16	0	0	8
Sun drying and smoke drying	26	0	0	14
4. Duration of drying				
1-2 days	17	0	9	11
3-4 days	18	15	30	21
5-6 days	10	10	42	18
7-8 days	38	45	19	34
>8 days	17	30	0	15
Mean (number of days)	5.91	7.90	4.77	5.98
Range (number of days)	0.5-15	4-21	1-7	
5. Materials used in drying*				
Sacks	13	46	16	21
Bilao	3	0	0	2
Net	27	54	0	26
Screen	42	0	0	22
Tarpaulin	15	0	87	31
6. Drying area*				
Along the road	0	9	6	3
On the roof	2	0	0	1
Surrounding areas near the house	85	50	81	77
Multipurpose drying pavement	15	41	13	20
7. Problems in drying*				
Delayed drying due to rains/ weather dependent	76	100	77	81
Insufficient drying pavement	8	0	0	4
Foul smell due to smoke & over drying	21	0	0	11
Other problems	0	0	7	2
Did not encounter problem	0	0	16	4

Fig. 9. Sun drying coffee berries using tarpaulin as underlay, 2012

Fig. 10. Sun drying coffee berries using polypropylene sack and nets as underlay, 2012

Fig. 11. Sun drying coffee berries over concrete pavement and constant stirring facilitates drying, Aurora, 2012

Fig. 12. Sun drying during rainy months becomes unreliable and predisposes coffee to mould growth, Surigao del Sur, 2012

Fig. 13. A coffee farmer from Kalinga Province drying his newly harvested coffee in "pugon", 2012

Pulping

Some farmers (6%) apply the "pulped natural" method which splits or removes the coffee pulp prior to sun drying (Table 13). Coffee pulp is about 44 percent of the weight of the coffee berry, hence removing the pulp reduce drying time. This method is applied with the use of mortar and pestle and wooden pulper. Only a number of farmers have wooden pulper that is used for cracking/splitting coffee (Fig. 14). The presence of locally-fabricated wood pulpers validated the farmers' claims that drying is one of their major problems in coffee farming since they fabricated and used their own coffee pulping equipment to alleviate their problem in drying operations. The presence of self-fabricated pulpers are mostly found in areas that are generally rainy throughout the year like the province of Surigao del Sur.

While depulping facilitates drying, it could also produce broken beans because of the crude design that uses common wood nail in the depulping mechanism. Depulping efficiency of the locally-designed manually-operated wood pulpers is about 75 to 80 percent and capacity ranges from 40 to 50 kg/hr.

Fig. 14. Locally fabricated wooden pulper used for splitting /cracking newly-harvested coffee berries prior to sun drying, Surigao del Sur, 2012

Table 13. Depulping practices of the farmers from the coffee-growing areas of Kalinga, Aurora and Surigao del Sur, 2011-2012

Item	Provinces			All (N=118)
	Kalinga (n=62)	Aurora (n=25)	Surigao del Sur (n=31)	
1. Forms of coffee dried				
Berries	100	100	77	94
Cracked berries	0	0	0	0
Parchment coffee	0	0	23	6
2. Depulping operations				
Yes	0	0	23	6
No	100	100	77	94
Pulping facilities used				
Pounding (mortar and pestle)	0	0	16	4
Wooden pulper	0	0	7	2

Storing

More than half (60%) of the farmer-respondents store in the form of dried berries (Table 14). Coffee is stored in polypropylene sacks with or without double packaging of polyethylene bags and kept inside the farmer's house. They store for a period of 5.3 months for the following reasons: (a) for home consumption (34%), (b) price speculation (7%), and (c) both for consumption and price speculation (14%). For the majority of the farmers from Aurora and Surigao del Sur who do not store, 8 and 23%, respectively, they sell immediately after drying or harvesting because of immediate need for cash. For those storing, the presence of molds (3%) and insect damage (8%) were reported.

Table 14. Storage practices of the farmers from the coffee-growing areas of Kalinga, Aurora and Surigao del Sur, 2011-2012.

Item	**Provinces**			**All (N=118)**
	Kalinga (n=62)	Aurora (n=25)	Surigao del Sur (31)	
1. Practice storage, % reporting				
Yes	100	8	23	60
No	0	92	77	40
2. Form of coffee stored, % reporting				
Dried berries	100	8	23	60
Not storing	0	92	77	40
3. Duration of storage, months				
Mean	6.5	6.5	2.0	5.3
Range	2-12	1-12	1-3	
4. Reasons for storing, % reporting				
Price speculation	5	8	10	7
For consumption	65	-	-	34
Accumulate all before disposal	3	-	13	5
Both for price speculation & consumption	27	-	-	14
Not storing	0	92	77	40
5. Packaging during storage, % reporting				
Polypropylene sack	19	8	3	12
Sacks with or without plastic	81	0	20	48
Not storing	0	92	77	40
6. Problems encountered in storage, % reporting				
Presence of molds	5	-	0	3
Insect damage	15	-	0	8
None	80	100	100	89

Hulling

The form of coffee accepted and sold in the market dictates the postharvest operations undertaken by the farmer-sellers. Green coffee beans are produced when dried berries are dehulled using huller (Fig. 15). Almost three fourth (74%) of the farmer-respondents practice dehulling using mechanical hullers or locally termed as "kiskisan" (Table 15). Mechanical hullers are normally operated by barangay and municipal traders that procure and trade coffee with other supply chain players, generally with players engaged in coffee processing. These service providers maximize the use of mechanical hullers and also accept hulling/polishing rice and milling corn as part of custom servicing.

In some remote areas where huller is not available or practically inaccessible because of their location, farmers dehull their coffee by pounding method with the use of the traditional mortar and pestle (Fig. 16). Coffee dehulled using this method incurs relatively higher broken beans and when sold is a major form of defect when coffee is graded. This facility is still used in hulling small volume of coffee which are used for home consumption.

Table 15. Hulling practices of the farmers from the coffee-growing areas of Kalinga, Aurora and Surigao del Sur, 2011-2012

Item	Provinces (% Reporting)			All (N=118)
	Kalinga (n=62)	Aurora (n=25)	Surigao del Sur (n=31)	
1. Practice hulling				
Yes	90	4	100	74
No	10	96	0	26
2. Method of hulling*				
Mechanical/ kiskisan	90	4	100	74
Pounding using mortar and pestle	16	0	0	8
Not applicable	10	96	0	26
3. Problems in hulling operations*				
High percentage of broken beans	59	0	42	42
Tedious	7	0	0	4
Unclean coffee beans due to impurities (e.g., rice and corn hull)	43	0	3	23
None, machine properly adjusted	30	4	55	31
Not applicable	10	96	0	26

*Multiple responses

While almost one third (31%) of the farmers do not encounter problems in mechanical hulling, a significant percentage (41%) was concerned with high percentage of broken beans resulting from hulling. In addition, they reported that green beans dehulled by the mechanical hullers available in their areas were not clean with impurities such as rice and corn hull (23%). As mentioned earlier, aside from coffee, the village-based mechanical hullers are also used for corn and paddy milling as part of custom servicing.

Sorting

This is accomplished by manual segregation of defective beans from good beans (Fig. 17). This operation is normally performed by the traders. Traders are the last supply chain players before the processors. Hence, coffee bean must meet the quality standards set by processors such as Nestle and local processors to engage in trading transaction.

Fig. 15. Mechanical huller used for dehulling coffee, Kalinga, 2012

Fig. 16. Traditional pounding method for dehulling coffee using mortar and pestle, Kalinga, 2012

Fig. 17. Manual sorting of coffee most often performed by women, Bukidnon, 2012

Table 16. Marketing practices of the farmers from the coffee-growing areas of Kalinga, Aurora and Surigao del Sur, 2011-2012

Item	Provinces (% Reporting)			All (N=118)
	Kalinga (n=62)	Aurora (n=25)	Surigao del Sur (n=31)	
1. Form of coffee sold				
Green beans	87	4	100	73
Dried berries	3	79	-	18
Fresh berries	-	17	-	4
Green bean/ roasted/ roasted ground coffee	2	-	-	1
Not selling	8	-	-	4
2. Who decide on the price of coffee				
Buyer	96	100	100	98
Farmer-producer	2	-	-	1
Both	2	-	-	1
3. Characteristics considered by buyers in pricing coffee*				
Color	2	-	3	2
Breakage, color, impurities	76	8	90	65
Varieties	3	-	-	2
Moisture content	2	17	3	5
Ripe berries	-	12	-	3
No answer (do not know)	20	63	10	26
4. Problems in marketing coffee*				
Low/ fluctuating price	62	28	61	55
High transport cost	22	4	6	14
Combination of low & fluctuating price, high transport cost	38	80	35	46
Others (Lack of market information, buyers strict in quality)	-	8	13	5
5. Suggested solutions*				
Provision of appropriate postharvest facilities like pulpers, hullers & dryers	70	-	47	49
Provision of postharvest facilities & market linkaging	12	-	11	9
Seminars, training of farmers on p ostharvest technologies	3	13	-	4
Technologies to increase production	10	33	-	12
Price support/financial assistance	7	54	42	26

Disposal of coffee

Coffee is generally sold as green bean (Table 16). Green bean is the form of coffee without parchment and ready for roasting. While all the farmers from Surigao del Sur sell green coffee beans, some farmers from Aurora sell in the form of dried and fresh berries.

Other than green beans and dried berries, few farmers from Kalinga also sell in the form of roasted or roasted ground coffee. In fact, one can buy roasted ground coffee placed in plastic bags in the local market of Kalinga. The price of coffee is mainly dictated by the buyers. The buyers of coffee from Kalinga are the processors of roasted ground coffee within the province and Nestle which has a buying station in Tuguegarao and/or Nueva Vizcaya. Coffee from Aurora are processed as roasted ground coffee and sold to Nestle to their buying stations in Nueva Vizcaya and Cavite or to coffee processors in Batangas. Farmers and traders from Surigao del Sur sell to Nestle buying station nearest them.

The price of coffee is based on the percentage breakage, color and impurities (65%), which is basically the attributes determined by Nestle in buying coffee in addition to moisture content and cupping quality. About one fourth of the respondents were not aware of the attributes affecting the price of coffee. The major problems on marketing were: (1) low and/or fluctuating price (55%), (2) combination of low/ fluctuating price and high transport cost (46%). Although coffee areas are relatively near farmers' residence, coffee buying stations are far from the production areas and are generally located in the municipality requiring the producers to pay high transport cost to sell a small volume of harvest. Other issues raised by the producers were the lack of market information and the strict quality requirement enforced by the buyers. The perceived strictness of the buyers could have originated from the insufficient information of the producers on the quality requirements of the buyers, in particular, and the industry, in general.

Coffee farmers request for appropriate postharvest facilities (49%) to improve their coffee quality, price support and/or financial assistance (26%) and technologies to increase their production of coffee (12%). Other requests were the provision of trainings on postharvest technologies and market linkaging.

Perceived Constraints and/or Problems of Major Stakeholders

Supply chain actors identified the constraints hampering specific value adding operations (Table 17). The major constraints in improving the value chain of producing green coffee beans of Robusta and Liberica were gathered through surveys and KII. The identified constraints were validated by the results of testing the coffee beans produced using the present practice. The observations and recommendations for each constraints or problems were also presented to show the entry points of the project in improving the value chain, considering postharvest operations.

From the farmers' standpoints, the postharvest constraints to getting the best price for their GCB are: (1) prolonged sun drying which affect the quality of their coffee, (2) reduce quality of GCB due to high percentage broken beans and mixture of impurities like rice hull and corn grits, (3) absence of appropriate coffee postharvest facilities, and (4) low and/or fluctuating price. These observed constraints were validated by the traders who reported that the primary problem they encountered in procurement was the high moisture content (MC) of coffee offered for sale by the farmers. Nestle, which is the ultimate biggest buyer of GCB from the trader-consolidator set 11 percent as the acceptable MC for GCB and they are willing to give price incentive of PhP1/kg for every one percent lower than 11 percent. The poor quality in terms of the presence of high percentage of black beans which is attributable to the stripping method of harvesting was also reported by the traders. Most often, traders do the cleaning and sorting to pass the stringent quality requirements of the multinational coffee processors.

A big constraint to the processors of coffee is the limited supply of locally-produced coffee. In addition, the coffee beans offered for sale by the farmers are of poor quality with moldy beans, acidic and earthy taste and high broken beans.

Quality of the GCB Produced from the Present Postharvest Practices

Samples for quantity and quality analyses were taken from the field to determine which among the operations are contributory to the quality of the product produced by the farmers. Adapting the grading system of Nestle, the GCB produced following the present postharvest practices was evaluated to have downgraded quality due to the major physical defects in terms of black beans and broken beans (Table 18). Black beans and broken beans contributed 58.4 and 33.69 percent, respectively, to the total defects found on the sample GCB submitted for analyses. As discussed earlier, black beans is a result of unripe or immature beans resulting from stripping method. Broken beans, on the other hand, is attributable to the method of dehulling. Without further sorting to remove defects, only GCB from source 1 barely passes the quality standard of Nestle falling under grade 3. Nestle only buys coffee passing grade 3 triage.

Harvesting by stripping

The high percentage defect attributed to black beans (Table 19) is in turn attributable to the stripping method of harvesting as shown in the results of the physical analyses conducted in the harvest of the farmers practicing stripping method. The results show that more than half (52%) of the weight of the stripped coffee berries are unripe.

Pulping using traditional practice

Under the present postharvest practices, broken beans can occur during pulping and hulling operations using self-fabricated facilities. To determine the magnitude of broken beans, samples were taken for physical analyses the results of which are shown in Table 20. The use of wooden pulper to crack fresh berries could inflict 10.33 percent broken beans.

Table 17. Perceived problems or constratints identified by major coffee stakeholders in their value adding operations, 2012

Supply Chain Actor	Perceived Problems	Observations and Recommendations
Coffee Producers	Drying of coffee	• Sun drying is recognized as the most practical and cost effective method of drying. Problem arises when sun drying becomes unreliable due to monsoon rains coinciding with peak harvesting seasons. Appropriate method of drying coffee should be put in place. • The practice of depulping to facilitate drying should also be promoted with concomitant recommendation of an appropriate pulping technology.
	High broken beans during hulling operations with impurities	• Existing steel hullers inflict high mechanical damage resulting to high percentage broken beans; since these hullers are also used for milling paddy and corn, their utilization in coffee results to impurities like rice hull and corn grits
	Absence of appropriate postharvest facilities in the area such as pulpers and hullers	• Farmers recognized the need to depulp coffee berries to facilitate drying especially in production areas with abundant rains during harvesting; locally developed and fabricated hullers are inefficient
	Low and fluctuating price	• Relaxing the influence of supply and demand, low buying price is attributed to poor quality of GCB produced and sold by the farmers to the traders and processors that demand certain quality standards.
Traders (barangay, municipal or provincial-based traders)	High moisture content (MC)	• This quality limitation can be attributed to improper drying combined with the absence of an accurate means of measuring MC. While "bite" method is commonly practiced to determine if coffee is died enough, it became apparent that this method is not reliable.
	Poor quality of GCB with high broken and black beans	• Coffee harvested by stripping produces off grade GCB because of high percentage of black beans. • Pounding method of dehulling, as practiced by some farmers, results to high percentage of broken beans. Some existing mechanical hullers also produce high broken beans, but this can be attributed to the operators' skills and the condition of the huller. With skilled operators, properly maintained hullers produce relatively low percentage broken beans. • High percentages of black and broken beans are major defects of coffee resulting to poor quality beans.
Processors (multinational and local processors)	Poor quality of GCB (moldy beans, over fermented, earthy taste and high broken beans	• Moldy beans, over fermented and earthy taste are characteristics attributed to improper drying of coffee. Longer drying periods result to over fermentation that produces acidic flavor, while coffee dried in net underlay touching the soil produces earthy flavour. Moreover, ineffective drying results to moldy beans. • High broken beans are attributed to inefficient hulling.
	Limited supply	• Apart from low productivity and dwindling areas planted with coffee, quality and quantity losses also limit supply

Table 18. Physical analysis or triage of GCB produced from different sources adopting traditional methods of harvesting, drying and hulling using the Nestle triage system, 2011

Parameters	Defects of Coffee Produced from Different Sources (%)						Percent of Total
	1	2	3	4	5	Average	
1.Foreign body	0	0	0	1.50	0	0.30	0.94
2.Admixture	0	0	0	0	0	0	0
3.Black beans	10.00	6.00	31.00	23.33	23.00	18.67	58.40
4.Cherry/unhulled	0	5.30	0	0	0	1.06	3.31
5.Stinker beans	0	0	0	0	0	0	0
6.Husk fragment	0	1.70	0	0.22	0.33	0.45	1.41
7.Parchment fragment	0	0	0	0	0	0	0
8.Broken bean	6.00	5.30	17.33	11.33	13.89	10.77	33.69
9.Moldy bean	0	0	0	0	0	0	0
10.Immature bean	0	0	0	0	0	0	0
11.Insect damaged bean	0.33	2.80	0	0.23	0.23	0.72	2.25
Total	16.33	21.10	48.33	36.61	37.45	31.97	100

*Based on Nestle triage system
Grade 1 = coffee beans having or less than 8% triage
Grade 2 = coffee beans having more than 8% but not more than 12% triage
Grade 3 =coffee beans having more than 12% but not more than 16% triage

Table 19. Physical characterization of coffee berries harvested using stripping method, 2011

Description	Weight (grams)				Percent of Total Weight
	Source 1	Source 2	Source 3	Average	
Ripe	76	95	80	77	25
Physiologically mature	75	40	40	51.67	17
Unripe	140	153	170	154.33	51
Overripe	6	7	7	6.67	2
Dried berry	3	5	3	3.67	1.2
Total	300	300	300	300	

Drying using traditional practices

Sun drying coffee berries is the widely adopted method of drying coffee. Under extreme conditions some farmers use heated air to facilitate drying. One of the measures of the quality of GCB is an acceptable aroma based on cupping test. Coffee dried in pugon was submitted to Nestle for cupping, and without the benefit of undergoing cupping test, was immediately rejected by Nestle.

Table 20. Percentage broken beans of coffee berries depulped using wooden pulper, 2011

Parameters	Sample 1	Sample 2	Sample 3	Average
Initial weight (grams)	500	500	500	500
Wt. of broken (grams)	50	50	55	51.67
Percent broken	10	10	11	10.33

Dehulling using traditional hullers

Dehulling is the final removal of parchment. Farmers from the coffee areas apply the pounding method using mortar and pestle and by mechanical means using "kiskisan" or the Engelberg type of coffee huller. The pounding method could cause percentage broken beans of about 7 percent (Table 21) while a well-maintained and adjusted mechanical huller can produce 4.25 percent broken (Table 22). In some cases, the percentage broken beans could go as high as 18 percent (Table 18) if the machine is already old and/or poorly maintained and the operator is not properly trained.

Table 21. Extent of broken bean from coffee dehulled using the traditional pounding method, 2011

Parameters	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Average
Initial weight (grams)	500	500	500	500	500	500
Wt. of broken (grams)	40	35	30	32	35	34
Percent broken	8	7	6	6	7	7

Table 22. Extent of broken and unhulled beans using existing hullers operating in the project site, 2011

Defects	Huller 1	Huller 2	Huller3	Huller 4	Average
Broken beans (percent)	5.00	3.00	4.00	5.00	4.25
Unhulled (percent)	2.70	2.00	1.00	-	1.95

Note: Hullers tested were Engelberg coffee huller commonly found in coffee in traditional coffee areas

The results of the analyses showed that with the present postharvest practices followed by the coffee farmers in the three provinces studied, the quality of the resulting GCB is downgraded in terms of high percentage black beans and high percentage broken beans. In addition, cupping test yielded unsatisfactory results.

The Postharvest Interventions

This section describes the intervention designed to address the problematic postharvest operations resulting to relatively high quantity losses, comprising food safety, and limiting the value-adding operations of GCB. Interventions were focused on drying, depulping to facilitate drying, dehulling, and moisture content determination to monitor moisture content levels especially during storage.

Drying

Recognizing that sun drying is still the most practical and cost effective method for drying coffee, solar dryer is still recommended for drying. This recommendation also considers the volume of coffee dried by individual farmers for a given period of time. More than 80 percent of the farmers interviewed produced only up to 150 kg of GCB in a year (Table 18). To address the limitation of sun drying during intermittent rain, the dryer was designed with UV-stabilized cover, hence it was coined "all weather (solar) dryer" (AWSD). This design protects the coffee from rain and eliminates additional handling inherent to sun drying in pavement (Fig. 12). The plastic cover also intensifies the drying temperature, by 7-10^{0}C, thereby reducing drying time. The capacity of the dryer is modular by altering the length of the dryer because the width is determined by size of UV plastic available in the market. Considering the current average production of farmers which is about 110 kg GCB per season the appropriate size of AWSD per farmer is 2m x 7m with capacity of 160 to 180 kg per batch.

Figure 18. A farmer in Kalinga using an "AWSD" for drying depulped coffee berries, 2012

For drying operation that requires higher capacity and shorter drying period, the dryer can be coupled to a furnace that uses biomass materials (i.e., wood, coco husk, and the like) for fuel (Fig. 19). The AWSD attached with a furnace can dry coffee in 10 hrs per batch, thereby increasing drying capacity. This dryer is appropriate for farmers and traders or processors handling larger volume of coffee.

Fig. 19. An AWSD attached to a biomass furnace (1) a full-view of the facility and (2) a closer view of the furnace using available biomass materials in the area, Aurora, 2012

Coffee Depulping

Recognizing the need to immediately reduce the moisture content of coffee to avoid further fermentation, the AWSD was integrated to a coffee pulper. Depulping the coffee prior to drying further expedite drying process. As mentioned earlier, coffee pulp accounts for about 44 percent of the weight of the coffee berry. In effect, depulped coffee berry dries faster preventing over fermentation. The use of dryer in combination with pulper enables the farmer to apply a different drying method, the “pulped-natural method”. Brazil introduced and made this method famous and produces some of the best pulped natural coffees 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.

The pulper can be operated either manually (Fig. 14) for handling smaller volume or with the aid of a small gas engine for processing bigger volume (Fig. 15).

Fig. 20 . A coffee farmer in Kalinga manually operating a coffee pulper before drying his coffee in the AWSD, 2012

Fig. 21. A farmer in Aurora operating a coffee pulper attached to a small gasoline engine, 2012

Moisture content determination

Moisture meter provides accurate means of determining coffee MC which is essential prior to storing, hulling, roasting and marketing. GCB should be dried to 10 to 11 percent MC for safe storage. Several moisture meters intended for coffee are available in the market. The type of moisture meter will depend on the intended use of the MM and the available budget allotted for the equipment.

Improvement in the Value Chain

To determine the effects of the proposed interventions to some of the chain actors, postharvest facilities on drying, depulping and MC determination were assembled and pilot tested in two coffee-producing areas, namely: Pinukpuk, Kalinga and Diarabasin, Aurora with two cooperators. Information on the cooperators are shown in Appendix section.

With limited period of project implementation, the improvement in the chain was measured in terms of the quality of the GCB produced by the project co-operators.

Effects of drying intervention

The effects of the drying intervention were measured in terms of drying period and cupping test. There was a reduction in the time of drying when AWSD was used. The use of AWSD during sunny days reduced drying time of berries from seven days to five days or seven days to three days when berries were depulped with the aid of the pulper. In the presence of intermittent rains, the combination of AWSD and pulper reduced drying time from 14 days to six days.

Samples were submitted to Nestle buying station in Cavite to evaluate the cupping quality of GCB dried using the present drying methods. Coffee samples were obtained from the different sources on site which were dried using the traditional method and those dried using "all-weather solar dryer" (AWSD) for drying. One hundred grams of coffee beans obtained from each samples underwent physical analyses, e.g., moisture content determination, physical defect (black beans, broken beans and foreign materials) to determine the coffee grade. After grading, the coffee beans were roasted and cupped to evaluate the cup characteristics.

Cup tasting of coffee dried from AWSD passed the quality standard of Nestle (Table 23). This can be attributed to immediate drying of the coffee berries thereby eliminating possibility of over fermentation. Elevated drying bed also prevented the coffee from touching the soil thereby preventing flavour.

The drying method has an implication on the cupping quality of GCB because drying duration affects the fermentation process of coffee berry. As mentioned earlier, over fermented GCB results to high acidity that negatively affects the cupping quality of coffee. Results revealed that coffee berries dried by smoke drying ("pugon" method) are immediately rejected because of its smoky odour. Sundried berries for two weeks were also rejected due to over fermentation. Sundried berries for a week or less was accepted because it was immediately dried without undergoing excessive fermentation.

Table 23. Cup tasting results of coffee sampled from different drying methods, 2012

Samples	Cup Taste	Result
Sundrying, drying pavement, (2 weeks)	Low medium fermented Rating: 7.3	Rejected
Sundrying, drying pavement, (< week)	Low fermented Rating: 7.2	Accepted
"Pugon" drying	Rejected*	Rejected
All weather dryer with whole berry	Low grassy Rating: 7.2*	Accepted
All weather dryer with depulped berry	Low fermented Rating: 7.2	Accepted

Note: Evaluated by Nestle buying station in Cavite. Rating above 7.2 is not acceptable.
*Immediately rejected because of smoky odor

Effects of hulling intervention

Provision of hullers in remote areas that use pounding method significantly reduced extent of broken beans to three percent(Table 24). Also, the use of the improved pulper over the wooden pulper significantly reduced extent of broken by six percent.

Table 24. Comparison of quality indicators between with intervention and traditional practices for pulping and hulling, 2012

Item	Practice (%)		Mean Difference
	With Intervention	Traditional	
Percent broken (pulping)	0.70	6.80	(6.10)**
Percent broken (hulling)	4.25	7.25	(3.00)**

Note: Evaluated by Nestle buying station in Cavite. Rating above 7.2 is not acceptable.
*Immediately rejected because of smoky odor

Financial Analyses

Partial Budget Analysis

Assessment of the income advantages offered by adapting the "all weather (solar) dryer" (AWSD) over the traditional sundrying method revealed that farmers would have an incremental income of PhP2,400 per season during sunny days (Table 25) and an incremental income of P5,550 during intermittent rain (Table 26). Farmers adapting the AWSD in combination with pulper would have an incremental income of P1, 437 (Table27) and P4, 477 (Table 28) during sunny days and during intermittent rain, respectively.

This incremental income is brought about by reduction in labor cost, reduction in drying time, and appreciation in the value of GCB due to better quality. This estimate was based on the average production of farmers at 480 kg of fresh berry or about 100kg when processed to GCB. Labor cost using the AWSD is cheaper because handling is reduced. The use of pulper may not provide income advantage compared to the use of AWSD alone because of the small volume of coffee currently handled by the farmers. The advantage of the pulper will become evident when only when larger volume of fresh coffee is handled in the long run. The present cost of coffee pulper (P16,000) may not provide financial incentive due to its opportunity cost as against the limited volume handled by individual farmers.

Table 25. Partial budget analysis of applying the "all weather (solar) dryer" versus the traditional sundrying in pavement or net underlays, 2012

PROPOSED TECHNOLOGY			
ALL WEATHER SOLAR DRYER (AWSD)		**VS. TRADITIONAL SUNDRYING**	
Added Costs (A)		Added Returns (B)	
• Dryer (depreciation)	P500	Price premium, P5/kg x 100kg of GCB	P500
• Labor cost of AWSD for coffee drying	P450		
• Labor cost of AWSD for drying other crops	P450		
• Opportunity cost of dryer	P400		
• Reduced Returns			
		Reduced Costs	
		• Labor Cost of sundrying	P2,100
		• Labor cost of sundrying other crops	P1,000
		• Cost of net underlays for sundrying	P450
Subtotal A	**P1,650.00**	Subtotal B	**P4,050.00**
Estimated change in income per season (B less A) = **P2,400.00**			

Assumptions:

Investment Cost=P5,000

Life span= 5years

Depreciation=P5,000/5years

Opportunity cost=P5,000x8%

Capacity=160kg/batch

No. Of farmers using the dryer = 2

Average harvest per season = 480kg, at 3 batches

GCB conversion of 480kg berry= 100kg

Labor cost of dryer= P30/day x5days/batch x 3batches

Labor cost of sundrying=P100/day x7daysx3batches

Crops dried other than coffee= palay and corn

Weight of other crops= 300kg

Labor cost of dryer (other crops)=P30/dayx5days/batchx2batches

Labor cost of sundrying (other crops)= P100/dayx5days x2batches

Table 26. Partial budget analysis of applying the "all weather (solar) dryer" versus the traditional sundrying in pavement or net underlays with intermittent rains, 2012

PROPOSED TECHNOLOGY			
ALL WEATHER SOLAR DRYER (AWSD)		**VS. TRADITIONAL SUNDRYING**	
Added Costs (A)		Added Returns (B)	
• Dryer (depreciation)	P500	Price premium, P5/kg x 100kg of GCB	P500
• Labor cost of AWSD for coffee drying	P900		
• Labor cost of AWSD for drying other crops	P600		
• Opportunity cost of dryer	P400		
• Reduced Returns			
		Reduced Costs	
		• Labor Cost of sundrying	P4,200
		• Labor cost of sundrying other crops	P2,800
		• Cost of net underlays for sundrying	P450
Subtotal A	**P2,400.00**	Subtotal B	**P7,950.00**
Estimated change in income per season (B less A) = **P5,550.00**			

Assumptions:

Labor cost of AWSD for coffeer= P30/day x 10days x 3 batches

Labor cost of traditional sundrying coffee=P100/day x14daysx3batches

Labor cost of AWSD for other crops =P30/dayx10days/batchx2batches

Labor cost of traditional sundrying for other crops= P100/dayx14days x2batches

Table 27. Partial budget analysis of applying the AWSD in combination with pulper versus the traditional sundrying in pavement or net underlays, 2012

PROPOSED TECHNOLOGY			
ALL WEATHER SOLAR DRYER (AWSD)		VS. TRADITIONAL SUNDRYING	
Added Costs (A)		Added Returns (B)	
• Dryer (depreciation)	P500	Price premium, P5/kg x 100kg of GCB	P1,000
• Pulper (depreciation)	P213		
• Labor cost of depulping	P240		
• Labor cost of AWSD for coffee drying	P180		
• Labor cost of AWSD for drying other crops	P300		
• Opportunity cost (dryer+pulper)	P1,680	Reduced Costs	
• Reduced Returns			
		• Labor Cost of sundrying	P2, 100
		• Labor cost of sundrying other crops	P1, 000
		• Cost of net underlays for sundrying	P450
Subtotal A	**P2,400.00**	Subtotal B	**P4,550.00**
Estimated change in income per season (B less A) = **P1,437.00**			

Assumptions:

Investment cost of pulper=P16,000

Life span= 15years

Capacity=60kg/hr (manual operation)

No. of farmers using the pulper=5

Depreciation cost =P16,000/15years/5 farmers

Opportunity cost (cost of dyer + pulper)8% int. rate (5,000+16,000)x8%

Labor cost of depulping = P0.50/kg x 480kg

Labor cost of dryer= P30/day x3days/batch x 2batches

Labor cost of sundrying=P100/day x7daysx3batches

Table 28. Partial budget analysis of applying the AWSD in combination with pulper versus the traditional sundrying in pavement or net underlayswith intermittent rain; 2011.

Assumptions:

PROPOSED TECHNOLOGY			
ALL WEATHER SOLAR DRYER (AWSD)		**VS. TRADITIONAL SUNDRYING**	
Added Costs (A)		Added Returns (B)	
• Dryer (depreciation)	P500	Price premium, P5/kg x 100kg of GCB	P 500
• Pulper (depreciation)	P213		
• Labor cost of depulping	P240		
• Labor cost(coffee drying)			
• Labor cost of drying other crops	P480		
• Opportunity cost (dryer+pulper)	P360		
• Reduced Returns	P1,680	Reduced Costs	
		• Labor Cost of sundrying	P4, 200
		• Labor cost of sundrying other crops	P2, 800
		• Cost of net underlays for sundrying	P450
Subtotal A	**P3,473.00**	Subtotal B	**P7,950.00**
Estimated change in income per season (B less A) = **P4,477.00**			

Labor cost of AWSD for coffee= P30/day x 6days x 3 batches
Labor cost of traditional sundrying coffee=P100/day x14daysx3batches
Labor cost of AWSD for other crops =P30/dayx6days/batchx2batches
Labor cost of traditional sundrying for other crops= P100/dayx14days x2batches

SUMMARY AND CONCLUSION

The project was designed to improve the competitiveness of the coffee industry sectors by addressing the inefficiencies of its value adding operations in the production of GCB. Green coffee bean is the raw material required by multinational processors like Nestle in producing soluble instant coffee. The same material is also used by the local processors in producing brewed (specialty) coffee. These chain actors identified limited supply and poor quality of GCB as the major bottlenecks hampering their value adding operations.

Employing the VCA framework and tracing the different stages in the production of GCB, it was found out that the current harvesting, drying and hulling practices employed by farmers produce low quality GCB.

Harvesting by stripping method results to 52 percent unripe berries as this method harvest all berries in one time. Unripe berries when processed into GCB produce black beans. Black beans and broken beans are major physical defects of coffee. Hulling method by pounding results to seven percent broken beans.

Majority of the farmers dry their coffee by sundrying, the problem arises as coffee harvesting coincides during the rainy months. Newly harvested coffee berries should be dried immediately to preserve its quality. Prolonged drying period due to intermittent rains results to over fermentation that produces GCB with high acidity. Some farmers without access to concreted pavement dry their coffee using net underlays but touching the soil. This produces coffee with earthy flavor. Earthy flavor and high acidity are quality deteriorations that manifest when coffee is subjected to cup tasting.

Quality deterioration due to poor harvesting practice requires a different strategy other than information campaign. It has to be resolved through production-related interventions that would increase the productivity of coffee farms. The present condition of the farms in so far as accessibility, peace and order and productivity are concerned, provides the current harvesting method a number of disadvantages.

On the other hand, addressing other quality related problems would require postharvest facility interventions comprising of dryer, pulper, huller and moisture meter. The dryer is still solar dryer as solar drying remains to be the most practical and cost effective method of drying. The added feature of this dryer is the use of UV plastic for intensified drying temperature but not exceeding the 45^0C requirement. The plastic cover protects the coffee from rain hence the term “all weather (solar) dryer”. The design comes in variation, with furnace for operations requiring higher capacity, and without furnace for drying operation handling smaller (200 kg cracked berries or parchment) volume.

The pulper, in combination with dryer, is used to immediately remove the coffee pulp. Removing the coffee pulp effectively removes about 44 percent of the material to be dried, hence speeding the drying process. The pulper can be operated either manually or with the use of a small engine depending on the capacity requirement. The pulper has a capacity of 180kg/ hr (with engine) or 60kg/hr (without engine).

The huller, although existing in major coffee areas, can still be an effective intervention for remote coffee areas that still practice the pounding method of hulling and where existing hullers are already inefficient because of wear and tear. Pounding produces seven percent broken beans. The moisture meter provides accurate measurement of coffee MC essential for storing, hulling and prior marketing. These set of facilities were piloted in Kalinga and Aurora provinces with cooperatives engaged in coffee processing as the cooperators.

Results of the pilot study revealed that coffee dried using AWSD in combination with pulper reduced drying time by one half, from seven days to three days during sunny days and 14 to six days during intermittent rains. This prevented quality deterioration from over fermentation and also prevented coffee from touching the soil. Since coffee was immediately dried, mould growth was also prevented.

The use of pulper significantly reduced percent broken beans by 9.5 percent while extent of broken beans from hulling was significantly reduced by three percent. Total loss reduction due to pulper and huller was about 12.5 percent.

Evaluating its effect on the farmers income, farmers adapting the AWSD will have a maximum incremental income of P5,550 due to reduction in labor cost, drying period and improvement in quality of GCB .

GCB produced with the use of the facility intervention provides processors with better quality raw material. In effect, the value adding operations, from the producers to the processors, is enhanced. Improvement in the value adding operations may create incentives for the value chain players to expand production on the part of the farmers and increase investment on the part of the processors.

RECOMMENDATIONS

Provision of postharvest facilities such as dryers, pulpers, hullers and moisture meters can improve the competitiveness of the coffee industry sectors through loss reduction, improvement in quality and better income opportunities for the farmers. Dryers and pulpers can be distributed to farmers in cluster since they perform the drying operation that is crucial in the final quality of GCB. The huller together with the moisture meter should be handled by farmers' groups involved in trading and processing or individual assemblers and traders since they are the last supply chain players before the large scale processors such as Nestle. These assemblers may also operate larger capacity AWSD's to uniformly dry bigger volumes of GCB.The information generated can be disseminated in different forms of media for general awareness among program planners, implementers and potential technology adopters.

For program planners specifically, the research findings will be very useful in crafting the National Master Plan for Coffee. Postharvest facilities identified in the study can be included in the list of primary postharvest facilities that will be distributed in the major coffee producing areas of the country.

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NOTES

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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 and Extension (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.

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