Czech University of Life Sciences Prague

Institute of Tropics and Subtropics (ITS)

Department of Sustainable Technologies

Diploma Thesis

COFFEE PROCESSING TECHNOLOGY IN ETHIOPIA

Author: BSc. Habtamu G.Serbessa

Supervisor: doc. Ing. Jan Banout PhD.

Declaration

I declare that I have independently done my MSc. Thesis on the topic "***Coffee Processing Technology in Ethiopia***" and all other sources used are indicated in the "References".

In Prague, 16 April 2012 ----------

Habtamu G.Serbessa

Acknowledgement

I would like to thank many people and organizations who have helped me during my study and Thesis work. First I would like to forward my deepest gratitude to the government of the Czech Republic for their bilateral financial support throughout my Study.

My deepest gratitude and thanks goes to my advisor doc. Ing. Jan Banout PhD. His enthusiasm and encouragement has always inspired me to accelerate to the completion of the work. I am also very thankful to my instructors and all staffs members of the CULS Department of Sustainable Technologies in Tropics and Subtropics for their contribution in one way or another for the success of my study.

I would like to forward my special thanks to Mr.Tadesse Meskela general manager of Oromia Coffee Farmers Cooperative Union (OCFCU) and Addis Exporter sales and marketing manager Mr. Michael Mamo and all staffs members of the organization for their kind cooperation.

Finally, I am very grateful to my families, friends, and peers who, in one or the other way brought me up to a success in my academic endeavor. Above all, I praise the Almighty God for giving me the courage, strength and patient in my life to reach into this day!

Thank you!

Coffee Processing Technology in Ethiopia

Abbreviation

A.A.	Addis Ababa
CEPAL	Comisión Económica para América Latina y el Caribe
Co-op	Cooperatives
ECEA	Ethiopia Coffee Exporters Association
ECX	Ethiopia Coffee Exchange
GBE	Green Bean Equivalent
GDP	Gross Domestic product
ICO	International Coffee Organization
ITC	International Trade Center
Kenya AA	Type of Kenya coffee
KFCFCU	Kafa Forest Coffee Farmers Cooperative Union
OCFCU	Oromia Coffee Farmers Corporative Union
PB	Pea-berry
SCFCU	Sidama Coffee Farmers Cooperative Union
SNNPRS	Southern Nation, Nationalities and Peoples Regional State
UNESCO	UN Educational, Scientific and Cultural organization
USD	United State Dollars
UV	Ultraviolet
YCFCU	Yergacheffe Coffee Farmers Cooperative Union
1-Quintal	Equivalent to 100 kg (local term)
Woreda	Local name for district region

Abstract

Quality is the most important parameter in the world coffee trade. The quality of coffee is determined by 40% in the field, 40% at the post harvest primary processing, and 20% the secondary processing. This underscores the importance of primary processing in enhancing the quality and value of coffee. The purpose of this study was to examine coffee processing methods, evaluate constraints to processing, determining the type of processing methods used by small scale farmers and distinct coffee by regions. Twenty four farmers were interviewed from the coffee growing area, discussions were took place with general manager of Oromia Coffee farmers' Cooperative union and sales and marketing manager for the company called Addis Exporter: Addis Ababa, Ethiopia. The survey revealed that the methods of coffee processing in Ethiopia are Sun-drying of unpulped cherries and wet processing, of which Sun-drying is preferred by farmers. Washed coffee accounts for 30% while sun-dried account for 70% of all processed coffee. OCFCU helped constructing processing facilities in the Oromia. The key differences to coffee processing are lack of coffee processing facilities, high costs of materials for constructing the raised drying beds, limited technical know- how and long distance to the few processing facilities. Coffee processing can be improved through investment by provision of financial resources to purchase the requisite equipment and training so that the necessary technical, financial and commercial capability would be created for the sustainable management of the coffee processing facilities which are in progress in the Oromia Coffee farmers' Cooperative union (OCFCU) and TechnoServe Coffee Initiative Ethiopia with the support of the Bill and Melinda Gates Foundation.

Key words: Coffee, sun-dried, wet processing, coffee quality, OCFCU, processing technology, Ethiopia

Abstrakt

Kvalita je nejdůležitějším parametrem pro světový obchod s kávou. Kvalita kávy je určena ze 40% oblastí, 40% primárním posklizňovým zpracováním a 20% sekundárním zpracováním. To zdůrazňuje důležitost primárního zpracování při zvyšování kvality a hodnoty kávy. Cílem této studie bylo prozkoumat způsoby zpracování kávy, zhodnotit omezení při úpravách, určit typ zpracovatelských metod používaných drobnými farmáři a v neposlední řadě evaluovat odlišnost kávy podle regionů. Ve těchto tezích bylo dotazováno 24 zemědělců z oblastí, kde se káva pěstuje, bylo diskutováno s generálním ředitelem Družstevní farmářské unie pro pěstitele kávy Oromia (OCFCU), a s obchodním a marketingovým ředitelem společnosti zvané Adis Exporter: Addis Ababa, Etiopie. Průzkum ukázal, že metody používané při zpracování kávy v Etiopii jsou sušení nedrcený třešně na slunci a zpracování za vlhka, z nichž přirozené sušení je zemědělci upřednostňováno. Vypraná káva představuje 30%, zatímco sluncem sušená 70% veškeré zpracovávané kávy. OCFCU se podílí na budování zařízení pro zpracování kávy v Oromii. Klíčové rozdíly ve zpracování kávy spočívají v nedostatku zařízení na zpracování kávy, vysokých nákladech na materiál pro výstavbu vyvýšených sušících lůžek, omezených technických znalostí a velkých vzdáleností k malému množství zpracovatelských zařízení. Posklizňové zpracování kávy lze zlepšit prostřednictvím investic do nákupu potřebného vybavení a školení farmářů. Potřebnými technickými, finančními a obchodními schopnostmi by došlo k vytvoření udržitelného managementu pro zařízení na zpracování kávy, které je ve vývoji v Družstevní farmářské unii pro pěstitele kávy Oromia (OCFCU) a Iniciativě TechnoServ Cofee Etiopia, podpořené nadací Billa a Melindy Gatesových.

***Klíčová slova*:** káva, přirozené sušení, mokré zpracování, kvalita kávy, OCFCU, zprcovatelské technologie, Etiopie

Contents

List of Tables

List of Figures

List of Graphs

Appendices

Preface

Coffee is the second most traded commodity in the world market after petroleum. More than 80 developing countries produce and export in to the world market. For many of these countries, coffee is the most important source of hard currency one of which being Ethiopia (Berhe, 2010).

In fact, Ethiopia is endowed with environment suitable for producing different varieties and flavor coffee beans in general and Arabica coffee in particular. In the international market, there are some unique flavor coffee beans which are favored by many consumers. These include: floral, sweet, mocha, winy, and fruity. Ethiopia can produce all these and other types of beans. This is due, among other things, to its diverse ecological features such as suitable altitude, ample rainfall patterns, optimum temperature and fertile soils (Berhe, 2010).

In Ethiopia, coffee is grown predominantly on small-scale farms with limited and fragmented land holdings, little access to inputs and low prices. It is produced in various production systems, predominantly mixed plantings with other crops and shade trees**.** Thus, the majority of coffee production (90%) comes from the smallholders while the rest is produced by large-scale producers (state farms and investors). Ethiopian coffee is processed and exported in two processing techniques, namely, natural sun-dried (70%) and washed (30%) coffees (Kufa, 2004).

In Ethiopia, a large segment of the population is involved in the coffee industry due to the importance placed on the sector. The Coffee sector is privileged with the advantage of receiving government support for research, infrastructure improvement, financial and manpower contributions, quality control systems, and publicity. The creation of the Coffee and Tea Authority proves this fact and one of its objectives is to support the production and trade of coffee as well as research efforts (Aycheh, 2008).

In Ethiopia, technologies of coffee processing not been explored in a significant manner in the development of automation in agricultural and food industries. Particularly,

Ethiopian coffee quality inspection is based on traditional ways of classification and grading system (Aycheh, 2008).

Quality is the most important parameter in the World coffee trade. The quality of coffee is determined by 40% in the field, 40% at post-harvest primary processing, and 20% at secondary processing. This underscores the importance of primary processing in enhancing the quality and value of coffee (Musebe et al., 2007).

All in all, quality is a summative index of characteristics of coffee, such as its appearance in the raw, roasted, and liquid states and qualities comprising factors such as aroma, body, and acidity. Quality coffee depends on the variety, environmental factors (soil, altitude), insect or fungal attack, nutritional factors, and method of processing, drying hulling, and grading. Although it is possible to overcome the influence of these factors by adopting improved cultural practices, correct processing technique is necessary to provide deterioration in quality. Faulty processing can bring about deterioration of even the best quality coffee. Proper processing in the plantations can go a long way to preserve and enhance the inherent quality of good coffee (Chakraverty et al., 2003).

Therefore, the implementation of coffee processing technology in the sector will have a paramount importance to facilitate commercial activities by increasing efficiency, to sustain dependability of customer preferences and to promote the market.

Chapter 1. Introduction

1.1. Statement of the Problem

Needless to say, Ethiopia is one of the Least Developed Countries in the world. Its economy is based on agriculture. As such, the sector contributes about 45% to the GDP, 85% to employment, 85% to export, supplies raw materials to the manufacturing sector and food to the urban population (Ethiopian Foreign Trade manual, 2007).

During the period 2002-2007, the leading export product of the country was coffee. For example, during in the year 2007 the share of the biggest contributors to the export earning of the country was coffee 36%. In absolute terms this means that coffee accounted for USD 424 million in the same year (i.e. 2006/2007).It is therefore abundantly clear that export earnings from coffee still dominate.

Currently, the total area of the country covered by coffee is estimated to be more than 400,000 hectares and the total production at 350,000 tons per year. Annual exports approached 180,000 tons in 2006/07, a rapid rise compared to 58,000 tons in 1990/91(Ethiopian Foreign Trade manual, 2007).

Preliminary studies show that there is an ample room to increase coffee production through area expansion, productivity improvements and through further processing. Only less than 4% of the estimated 12.5 million hectares of highly suitable land is covered by coffee at the moment; and if the current 5-6 quintals/hectare yield could be improved to 10-12 quintals/hectare achieved by similar coffee variety producing countries like Kenya, it is possible to double the current level of total output from the existing cultivated land area and quality coffee processing by developing new technology and system. The study will give its own effort for successful conclusion for Ethiopia to harness huge benefits from its natural resource endowment**.**

1.2. Significance of the Study

Coffee processing is always related with the life of coffee producers in Ethiopia and the practices has-been primitive or traditional for so many centuries for known or unknown reasons,or related with the country's undevelopment conditions. This study therefore makes an attempt to contribute to the field and in the course of the research work identify areas that need the attentions of researchers so that the pros and cons will be understood and recommended to different coffee processing technology particularly helping the poor agricultural dependent farmers. In addition to the contributions to the understanding of the new development in coffee processing center.

1.3. Scope of the Study

Quality in terms of coffee is the most important parameter in the world coffee trade. In Ethiopia coffee quality suffers as a result of less care being taken for the trees and during harvesting and processing. About 40% of the quality of coffee is determined by primary processing, while the other 20% and 40% is attributed to secondary processing and field practices respectively (Musebe et al., 2011). The purpose of this study is to examine coffee processing methods, distinct coffee by regions, finding the cooperative support in terms of coffee processing technology. The study is basically concerned with analyzing the present coffee processing methods in the Ethiopia using by small scale coffee producers. In addition concern with analysis the country's new coffee processing technique related with new technology if available, which has a positive impact on coffee quality for domestic and international coffee trade. But the research intends to include some comparison with other countries processing methods and comparing the technology with coffee quality. Then if there are any differences which the study will show may fill the gap of new ideas in the processing field.

Chapter 2. General Principles of Coffee Processing

The two commercially well-known coffee species are Arabica, which originates from the Ethiopian Massif, and Canephora, more commonly known as Robusta (Mattsson et al., 2003). The first grows in uplands at over 600 m altitude with a temperate climate, but at 1000 m and higher gives better quality. The water content of the whole ripe fresh cherry is about 65%. Arabica, generally grown at higher altitudes, is weak-bodied, acidic and aromatic coffee. Its caffeine content is low (Wintgens 2004). Canephora, mainly represented by the Robusta variety, is a lower-altitude coffee. It is full-bodied, but bitterer, less aromatic.

Coffee processing target to lower the water content of fresh cherries to a level which allows the preservation of beans (about 11-12%), removing all the covering which surround the beans and arranging the beans according to market desires. In general when the coffee processing takes place, the two coffee beans are usually found in each fruit, and each bean is covered with a thin closely fitting skin called silver-skin. A second yellowish skin, the parchment, loosely covers the silver-skin, the whole being covered in a pulp which forms the flesh of the cherry (Ashworth, 2009).

After harvesting, different kinds of systems are used for processing: natural coffees are drying processed and washed coffees are wet-processed; more recently semi-dry (pulped natural) process has been introduced (Wintgens, 2004).

2.1. Harvest Period and Yield Estimation

The early assessment of coffee yields is important for production and commercialization. This can also be useful both to prognosis production and agricultural experimentation. From the beginning of plantation, these estimates are useful for the farmers to know, as early as possible, the benefit of their crop.

In an industrial plantation, of a cooperative or of coffee-growers associations, this helps them to determine more precisely the logistical supplies for transport and post-harvest treatment. On the national scale, early coffee harvest assessments allow the responsible to fix and negotiate the price of green coffee.

2.2. Harvesting (Primary Processing)

Coffee harvesting differ depend on its objectives on the method of processing (Wintgens, 2004). Each year coffee is harvested during the dry season when the coffee cherries are bright red, glossy, and firm. Ripe cherries are either harvested by hand, stripped from the tree with both unripe and overripe beans, or all the coffee beans are collected using a harvesting machine. These processes are called selective picking, stripping, and mechanical harvesting, respectively (Reddy, 2010).

The goal is to harvest all fresh, ripe cherries with the lowest damage to the tree, regardless of the processing system which is mentioned in the above. With the harvesting technology available today, 100% cherry harvesting may be only achieved by selective hand-picking, which mostly corresponds to the most expensive option available (Wintgens, 2004). In the situations where labor is threatened or expansive in relation to coffee prices, selection may have to be ignored so unripe and over-ripe cherries (unripe, ripe and over-ripe) have to be picked at once. However, the choice of harvesting practices on selective hand-picking is the only chose for the countries producing washed coffees.

2.2.1. Manual Harvesting

A coffee plant usually starts to produce flowers 3-4 years after it is planted, and it is from these flowers that the fruits of the plant (coffee cherries) appear, with the first useful harvest possible around 5 years after planting. The cherries ripen around eight months after the emergence of the flower, by changing color from green to red, and it is at this time that they should be harvested. The two most commonly used manual harvesting techniques are selective harvesting and stripping (Reddy, 2010).

2.2.2. Selective Harvesting

Selective harvesting contains of the hand picking of ripe cherries only. In the harvesting season every tree is visited numerous times, up to 10 times in some countries, (Wintgens, 2004) and only the ripe cherries should be selectively picked each time. The cherries are put into bags or baskets usually seized at waist level by the pickers. At the end of the harvesting season one final collection of all cherries, irrespective of their degree of fruitions, usually takes place.

One person can selectively collect from 50 to 120 kg of fresh cherry or 6-7 baskets collect per working day (Reddy, 2010). This variation is not only due to individual skills and training but also to the regularity of maturation, the yield per hectare, tree density and the gradient of the slop, however in the process a small percentage of unripe and over-ripe cherries is to be expected.

2.2.3. Stripping

Stripping involves of removing all the cherries present on a branch regardless of their degree of ripeness. This system normally has only one picking round. The cherries at all maturation stages are dropped either directly to the ground, which is prepared, or onto plastic sheets or cloth spread under the trees. At the time the weather is optimal then, coffee is collected soon after harvesting, also no side effect in terms of quality when the

cherries are dropped to the ground. A person can strip between 120 and 250 kg of cherries per working day (Wintgens, 2004).

2.2.4. Mechanical Harvesting

Two alternative technologies for mechanical coffee harvesting found nowadays, large mechanical harvesters on wheels and light hand-held harvesters (Wintgens, 2004).

2.2.4.1. Large Harvesters on Wheels

These large machines with their own engines, made originally in Brazil, then in the U.S. and more recently in Australia have been in the market for over two decades (Wintgens, 2004).

In the self-boosted machines the arrangement is two shaking heads, one on each side of the coffee row, dropping coffee onto a fish-plate collection system which unloads the cherries into a transference system that lifts them to an air-filled separator to discharge leaves and other light layers and to load the clean cherries into bags or boxes.

This kind of total harvesting system is measured by the percentage of cherries that should have been collected which are left on the tree. Full removal is nearly impossible unless a large percentage of unripe cherries are removed and the tree is damaged. In this case a second round is still required to avoid losing part of the crop. The system can damage the coffee tree with vibration speed and also skills of the driver's. Leaf removal is also unavoidable. However, the damage sustained by plantations which have been mechanically harvested for many years has not been reported to affect yields (Wintgens, 2004).

2.2.4.2. Light Hand-held Harvesters

This new system is commercially sold and functioning in Brazil since 1995 and its use is increasing, especially in areas where the slope and tree spacing do not allow the use of the larger machines on wheels. In spite of widespread trials in Colombia, Guatemala and India, the system is yet to be introduced on a commercial scale in countries other than Brazil (Wintgens, 2004).

Hand-held harvesters may be used in all conditions, coffee trees of all heights and any spacing between trees in addition, cause less damage to the trees than harvesters on wheels.

2.2.5. Picking Coffee from the Ground

Cherries are manually or mechanically dropped to the ground, then collected and conveyed to the next processing stage. In cases where mats are used to cover the ground, they are used to collect the cherries manually and unloaded into trucks, carts or bags depend on the available materials. If the cherries are dropped directly on the ground or left behind by the harvesters on wheels, they have to be either raked up or collected manually or by machines.

2.3. Dry Processing

Most often the dry process is used after non-selective harvesting, i.e. after stripping or mechanical harvesting (Wintgens, 2004). In this case, when the coffee reaches the processing line it is a mixture of unripe, ripe, over- ripe and partially dry cherries along with leaves and sticks and as well as stones when coffee is harvested directly on the ground.

The objective of dry processing is to clean the coffee cherries and to separate them, to the extent possible, according to their moisture content. Cherries at different moisture levels

are then dried separately to obtain a regularly dried product. However, many natural coffee producers simply ignore these steps and go directly from harvesting to drying without any cleaning or separation (Wintgens, 2004). The cleaning of coffee cherries is performed by winnowing, sifting and flotation.

2.3.1. Winnowing

The self-boosted harvesters have their own winnowers, to collect coffee from the ground, i.e. their own systems to clean the freshly harvested cherries by blowing off light skins. Other harvesting systems require separate winnowers, if the volumes harvested are large or the content of foreign matter is significant. Separation of light layers: dust, light sand, leaves; sticks are performed by either blowing or sucking out foreign materials with the help of an air current created by a fan.

The separation of other layers, larger or smaller than the cherries, is obtain by two vibrating screens, one with holes bigger than the cherries, which holds the larger impurities: stones, big sticks, and one with holes smaller than the cherries, which holds the cherries themselves and lets small layers: sand pass through. The two cleaning devices, fan and vibrating screens, are arranged in different sequences by various suppliers (Wintgens, 2004). The separation of heavy impurities the same size as the cherries cannot be made by winnowers with screens but rather by flotation in water**.**

2.3.2. Sifting

Heavy impurities smaller or bigger than the cherries like sand, stones, mud balls are separated from the coffee cherries by sifting, i.e. by using two vibrating screens with holes which are smaller or bigger than the cherries. The screens may be arranged one after the other or one above the other (Wintgens, 2004). In some machines sifting is combined with winnowing in one single structure that performs the two functions.

2.3.3. Flotation

Flotation is used to separate stones and cherries with different moisture contents. Moisture content of the mixture of strip-picked or mechanically harvested cherries varies widely, from 65% in unripe and ripe fruits to 25-30 % in partially dried ones (Wintgens, 2004).

Stones, which are denser than all cherries, also sink and can be separated from coffee by flotation. Even though stones that are bigger or smaller than the cherries are separated by sifting, stones of the same size as the cherries can only be separated by flotation.

2.4. Semi-dry Processing

The semi-dry process was initiated in the 1990s as an intermediate system between the traditional dry and wet methods (Wintgens, 2004). The semi-dry process was developed to address the problem of the mixture of unripe and ripe cherries found in the dry process after the use of flotation to separate the over-ripe and partially dry cherries. The semi-dry process is an answer to the need to separate immature cherries from mature ones when non-selective harvesting is used.

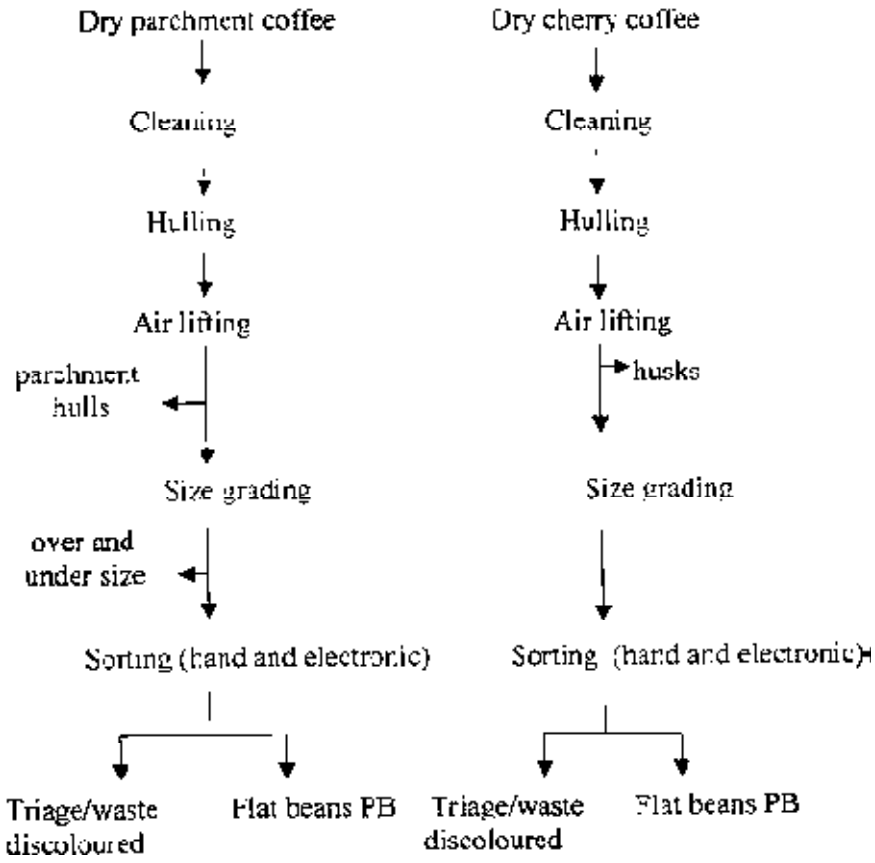


Figure 1- Processing steps in curing works (*Source*: Chakraverty, et al., 2003).

2.5. Wet Processing

Even though the disk pulper dates back to 1810 and the drum pulpers to 1850, wet processing remained practically the same until the early 1980s (Wintgens, 2004). It is only during the last 25 years, and more actively over the last 15 years, that wet processing has started to change**.**

The wet procedure gives the better quality and higher priced and Other Milds because it requires more precise centralized quality control (Mattsson, et al., 2003). In the Process, the fruit covering the seeds/beans is removed before they are dried. Coffee processed by the wet method is called wet processed or in most countries called washed coffee.

The wet method requires the use of specific equipment and substantial quantities of water (Reddy 2010). The goal of wet processing is to remove pulp and mucilage from ripe coffee cherries in an environmentally friendly way. In order to process only fresh ripe cherries, it is necessary to harvest only such cherries or to separate the unwelcome products before pulp and mucilage are removed (Chakraverty, et al., 2003). The description of the wet process will be divided into cleaning and separation, pulping and mucilage removal.

Most producers of washed Arabica coffees use selective harvesting (Wintgens, 2004). Wet processing after strip harvesting is only the case for Arabicas in Brazil, Hawaii, Ethiopia and Australia as well as for Robustas in a few countries. More than 35% of the global coffee harvest is processed by the wet method (Mattsson, et al., 2003).

2.5.1. Pulping

Pulping is to separate the pulp from the coffee bean. The pulp, which consists of the outer skin and a major part of the mesocarp, is torn off by squeezing the cherries in one of the following ways: Between a pulping bar and a rotating disk between a breast plate and a rotating drum. As they pass through the slots of a screen or between a rotary drum and a stationary screen case. Cherries should be pulped on the harvest day to prevent fermentation before pulping (Chakraverty, et al., 2003).

Today there are three types of pulpers in the market, disk, drum, and vertical pulpers are available. The disk type is not 100% efficient because of variation in size of berries and the fixed gap between the moving and stationary parts of the pulper (Chakraverty, et al., 2003). The important drum type pulper is capable of rejecting the unpulpable fruits and has facility for green cherry separation. The unpulped fruits are pulped by use of a repasser pulping system. The vertical-type pulper is capable of pulping any size of berries, yielding better turnout and using less energy and water.

2.5.2. Mucilage Removal

The idea is to remove the residual part of the mesocarp, called mucilage, which remains stuck to the endocarp (parchment envelope) after pulping. Mucilage is insoluble in water and sticks to parchment too strongly to be removed by simple washing (Chakraverty, et al., 2003).

Mucilage on the parchment skin can be removed by any one of the following methods: Natural fermentation, treatment with alkali, the enzymatic method, and attrition (frictional removal) in machine by fermentation followed by washing or by strong friction in machines called mucilage removers (Chakraverty, et al., 2003). Fermentation may be natural or accelerated by chemicals or enzymes (Wintgens, 2004). Mechanical mucilage removers operate by rubbing parchment beans against each other and against the mobile and static parts of the machines.

2.5.3. Natural Fermentation

The most common method for mucilage removal is natural fermentation. The hydrolysis of pectins is brought about by enzymes that are naturally present in fruits. Simple fermentation is carried out in concrete tanks which may vary significantly in size and shape. A system is running by using rectangular tanks with a sloped bottom, used both as a tank and a means of conveyance for coffee. Channel gates with screens allow the discharge of either water alone, as the tank fills, or water and coffee together at the end of fermentation.

Fermentation periods can differ substantially, from 6 to 72 h (Wintgens, 2004; Reddy, 2010), depending on the temperature, the amount of mucilage, and the concentration of digestive enzymes. Coffee is expected in fermentation tanks till the mucilage is completely digested and ready for washing, then checking the coffee by rubbing and washing a few beans by hand. Stopping fermentation at the right time is critical for coffee quality as this avoids over-fermentation and the formation of stinkers (Chakraverty, et al., 2003).

2.5.3.1. Washing of Fermented Coffee

Washing of fermented coffee is one of the main sources of water consumption and contamination in wet processing (Wintgens, 2004). Fermented coffee can be washed manually in the tank itself and in channels, by centrifugal pumps or by several types of specific machines which is depending on the processing locations.

Manual washing in the fermentation tanks is water and labor intensive, especially in large tanks. Water is added to parchment which is then stirred by hand with wooden paddles. The process is not always systematic and simple when tanks are large or particularly deep. Washing channels is water demanding washing system. However, the same water may be reused for grading. Recirculated water may be used no longer than one working day. If it is left overnight, the water is soon contaminated, and use of such water affects the quality of coffee adversely (Chakraverty, et al., 2003).

2.5.3.2. Post Fermentation Soaking

Wherever water supply is abundant and additional containers are available, the washed parchment may be soaked under water for about 12–24 h (overnight) and then given a final wash. This method seems to improve the quality of substandard coffees both in appearance and in the cup. The washed coffee can be graded in channels to separate heavy beans from ‘‘lights’’ (Chakraverty, et al., 2003).

2.6. Coffee Drying

Drying coffee is very different from drying grain. Grain is harvested with moisture content under 20 % and this only needs to be lowered by a few percentage points while coffee moisture content must be lowered from 55 to 12 %. Grain can withstand much higher temperatures than coffee without being damaged (Wintgens, 2004).

Coffee drying is to lower the moisture content of parchment or cherry coffee to about 12-13% so as to preserve the beans safely in storage (Reddy, 2010). Coffee moisture remains at 12% when air moisture at storage is between 60 and 65 %. In humid areas it is usual to dry coffee to 10 or 11% to increase storage time before coffee picks up moisture from the air. In other areas drying stops at 13 or 14% to account for moisture losses in hulling. Moisture levels below 10 or 11 % increase the breakage of beans at hulling, especially with Robustas that are stiffer. Moisture contents above 12 % increase the risks of quality and weight loss in storage (Wintgens, 2004).

Freshly pulped and washed coffee usually contains 52% to 54% moisture (Chakraverty, et al., 2003). After draining of excess water, beans are spread on the drying terrace. The thickness of the layer is usually 5–10 cm and coffee is raked at frequent intervals during daytime. Temperatures must be monitored during natural and artificial drying. Coffee temperatures should not exceed 40°C for parchment and 45°C for cherries (Wintgens, 2004). It is often thought that overheating can only occur in mechanical dryers. High temperature can exceeded in sun drying if the beans are not revolved frequently or, in the case of fine Arabica beans, protected by plastic sheets, a cover or a roof during the hottest hours of the day.

Controlling temperatures become difficult in the later stages of the drying process when moisture levels are low. In the beginning, there is a lot of water to be removed and relatively high air temperatures are not likely to persuade the beans to overheat. At this stage, air flow to remove the surface moisture is more important than the temperature itself. In sun drying, temperature is controlled by rotating the coffee frequently. Parchment should be covered before it becomes too hot. In machine drying, the temperature is controlled by fuel feeding, air flows.

Coffee moisture is high, 50-55 % or even more, at the beginning of the drying period so high air temperatures may be used without risk of overheating the coffee. In many dryers the coffee will not heat beyond 30°C while the moisture is high even though the air temperature may reach 90°C. It is widely accepted that the color and quality of Robusta coffees benefit from a high air temperature at the initial stages of drying (Wintgens, 2004).

Slow drying of coffee is a good solution to homogenize coffees received with irregular moisture contents. Culturally, coffee that is dried more slowly will have a more similar moisture content and a more uniform color because longer drying grants the beans more time to exchange moisture and to equalize their moisture content.

Well-organized drying system must ensure a good temperature control, homogeneous air distribution, and frequent turning of coffee. To revolve the beans to ensure good drying, and to shelter coffee to control moisture and temperature, manufacturers must equip the modern coffee dryer with features that enable better control and independence from adverse weather conditions.

2.6.1. Sun Drying

In general drying coffee using by patio takes 6-7 days for washed coffees, 8-9 days for pulped naturals (semi-washed), and 12-14 days for natural (dry-processed) coffees (Reddy, 2010). However the above coffee drying estimations are differ depend on location and researchers.

At this stage the outer shell is dark brown and brittle. The bean crashes inside the husk. Dried beans are bagged and stored for several weeks. Hulling of dried cherries is not usually practiced after drying. During this time the green beans inside the dried shell continue to lose some of their moisture content and spread out evenly by osmosis. The ratio of dry cherry to green beans is usually 2:1 (Chakraverty, et al., 2003). Drying coffee beans using direct sun energy can take place in many ways. Beans have direct sun contact but the difference between the drying systems is only where the coffee beans are placed.

2.6.1.1. Drying Grounds

Drying grounds are flat surfaces built with a small slope (0.5-1 %) to drain rainwater (Wintgens, 2004). Having holes screen for the matter of the coffee beans are placed at the low points to drain rainwater. Grounds are usually made of concrete, tiles or asphalt.

Compressed soil yards, still found in some areas. Drying grounds length should be laid out at an east-west orientation to maximize the reception of sunlight and to avoid shading by buildings and trees located alongside.

Parchment and cherries are handled essentially in the same way in this drying process. Wet coffee is spread in thin layers and revolved 8-10 times per day with a flat rake (Wintgens, 2004). During the initial stages of drying coffee should not be covered at night or when it rains.

Once coffee is partially dried, the thickness of the layer is increased and the coffee is piled and covered with plastic or canvas to shelter it from dew and rain. In some location sliding roofs or sliding trays are used to shelter coffee. Parchment requires more careful handling than cherry to avoid cracking and physical damage to the beans. Raking must be gentler. In tropical areas parchment is often covered during the hottest hours of the day to avoid cracking caused by overheating. Depending on climatic conditions, sun drying of coffee in yards takes from 7 to 15 days for parchment and from 12 to 21 days for cherries (Wintgens, 2004).

2.6.1.2. Drying Racks

This system take place with wire or plastic net trays assembled on table legs. They are mostly used to dry parchment coffee not cherries ones. Parchment is turned by hand and the drying procedures are similar to those used in drying grounds which was mentioned before.

Racks keep coffee cleaner and protect it from contamination from the ground also aeration from above and below keep accelerate the drying process. Racks also exposed to wind; and helps remove saturated air and give shorten drying times. When drying parchment coffee on racks it is advisable to cover it during the hottest hours of the day to protect from extra heat that may damage the beans (Wintgens, 2004).

2.6.1.3. Plastic Sheds

Plastic sheds are light wooden or metallic structures with a plastic roof and walls. The flat floor is made of concrete or tiles like a patio. Transparent plastic creates a greenhouse effect that may raise the temperature 10-15°C. Fans may be used to help remove the saturated air. Drying procedures are similar to those in a patio except that coffee is permanently sheltered from dew and rain. High costs limit plastic cabins to small areas and, sometimes, to dry premium coffees.

2.6.2. Mechanical Dryers

Machine drying contains of passing hot air through a bed of coffee. There are two methods. Through-flow and Cross-flow drying; through-flow drying is much more effective. It is a good practice to use drying air at a temperature of 60°C in the first stages of drying and slowly decrease the temperature (Chakraverty, et al., 2003).

2.6.2.1. Static Dryers

Static dryers are the most primitive type of dryers. Easy and cheap to build anywhere, they only require a tray made of a punctured metal plate, a fan and a source of heat. Vertical walls hold a round, rectangular or square horizontal tray and create a surrounded chamber underneath the tray and an open-top chamber above it. Coffee is loaded by hand onto the holed screen tray to fill the upper chamber.

A fan installed on the wall of the lower chamber blows hot air through the screen and the layer of coffee to be dried. Dry coffee is unloaded by hand. If the layer of coffee is not stirred, the beans closer to the screen will dry faster than the beans at the top of the layer. In this case, the coffee layer must be very thin. Tray dryers take from 25 to 30 h to dry wet parchment coffee and more to dry coffee cherries (Wintgens, 2004).

It has been many changes in terms of design and operation of dryers, such as automatic loading and unloading, rotating power-driven rakes, recirculation of hot air, and furnaces that accomplish smokeless combustion. Several commercial dryers (Wilken, Guardiola, Torres, Moreira, and American vertical grain) are marketed. Some of these are specially designed for washed coffee, some for cherry, and others for both types, namely, Coffee arabica and Coffee Robusta (Chakraverty, et al., 2003).

2.6.3. Sun Drying versus Artificial Drying

Ever since the first installation of coffee dryers, the debate between the facts of sun drying as opposed to artificial drying has been ongoing. Modern improvements in drying combined with the lack of skilled laborers and rising labor costs are currently leaning the balance in favor of mechanical drying. Today coffee is increasingly mechanically dried as exposed by the sales figures of drier manufacturers (Wintgens, 2004).

From an honestly practical point of view, assuming that sun dried coffee has somewhat better quality than mechanically dried coffee, (Wintgens, 2004) it should be noted that ideal sun-drying conditions can never be constant since they depend on climatic situations. If the weather is practically perfect, the quality of sun-dried coffee may well be superior, but this does not happen all the time, In contrast, the quality of mechanically dried coffee is constant irrespective of weather conditions. So, the average quality of coffee over the whole season will be better for mechanically dried coffee. The clear conclusion is that, over the full season, it is safer to have mechanical rather than sun drying in order to maximize quality.

Somehow mechanical drying needed where sun drying was difficult because of weather. Now it is becoming widespread as it offers a reliable means of producing quality coffee throughout the season and from year to year. If we take the specialty coffee market as a reference for coffee quality we will soon realize that several high-priced specialty coffees are mechanically dried. However, Coffee drying must be carefully performed whether under the sun or in machines.

2.7. Cleaning

The main purpose of cleaning coffee is to remove dust and light layers as well as other impurities those are larger or smaller than the coffee beans. The removal of defective coffee beans is the last processing step in order to guarantee a good-quality coffee and protecting the coffee processing equipment from damage (Ashworth, 2009). As pre-cleaners are used for dry cherries, dry parchment and green coffee, the screens should be inter-changeable. Some pre-cleaners have a third screen for the separation of undesirable coffee beans, i.e. cherry beans mixed with parchment or cherry and parchment mixed with green coffee.

2.7.1. Magnets

Coffee processing take place the magnetic part of the machine pick some ferrous materials like nails, screws and bolts in parchment, cherry and green coffee. Magnets range from simple plate models that require periodic hand cleaning to sophisticated self-cleaning rotary models that are machines in themselves with their own hoppers and motors.

2.7.2. Destoning

Destoning is the system which helps to separate by density and remove stones that are the same size as coffee and cannot be removed during the pre-cleaning process. Destoning is achieved by product flotation (density separation) and vibration (Wintgens, 2004). Destoners contain of an inclined vibrating metal screen with scales, bulbs or cleats. One or more fans installed below or above the screen create a strong upward air current that passes through the screen and the product to be separated. Coffee is fed through the top of the sloped screen and distributed to cover it completely.

As the beans move down the screen they meet with the upward air current that forces the lighter coffee to float, whereas the heavier stones remain in contact with the screen. The

vibration of the screen is transmitted to the stones by the scales, bulbs or cleats. This moves the stones upwards for discharge behind the machine. Floating coffee flows by gravity and is discharged at the front of the machine.

2.8. Secondary Coffee Processing

2.8.1. Milling

This Milling stage involve removing the last layers of dry skin and remaining fruit residue from the currently dry coffee, and cleaning and sorting it. These steps are often called dry milling to distinguish them from the steps that take place before drying, which collectively are called wet milling (Reddy, 2010).

Hulling is crunching off the parchment skin cover of the dry coffee beans or the cherry husks from dry cherry coffee (Reddy, 2010). Hulling simply preformed when rubbing the beans against each other and against the metal parts of the machines. In addition hulling can take place by tearing the husk as the coffee is pushed against a sharp edge of a blade of a screen hole or both.

2.9. Size Grading

Coffee graded is one part of coffee processing which takes place coffee by size to enable improved density and color separation, to allow more uniform roasting and most importantly to meet customer necessities (Chakraverty et al., 2003). Today size grading is required to improve the efficiency of density and color sorting as the market becomes less tolerant of defects. Both density and color sorting are faster and more accurate when the beans to be processed are of uniform size.

Most countries have their own description systems for their coffees and their grades, like Kenya's AA (widely known as a type of Kenya coffee), Colombia's Supremo, and Guatemala's SHB (Wintgens, 2004). A grade may be directly associated with a screen size and restricted to it regardless of any other feature (e.g. Kenya's AA), or it may imply

a size and other characteristics (e.g. Colombia's Supremo), or it may not indicate a size at all. However, most countries do consider sizes and shapes in their descriptions. Because of this, a grade will be associated with one or several screen sizes. Some countries export ungraded coffees, meaning, among other things that these coffees are not separated by size prior to sale. However, "ungraded" coffee is some times said to be above or below a given screen size, meaning that it is a mixture of sizes greater or smaller than that screen.

2.10. Color Sorting

Color sorting is the processing of coffee sorting that uses to remove defective coffee beans that have an unwelcome color (Chakraverty, et al., 2003). Coffee beans are color sorted by comparing the wavelengths associated with their color with wavelengths that correspond to acceptable colors. Off-color beans are rejected by a compressed-air ejection system. The well know coffee defects that removed by color sorters are black, dark, pale, white, unripe, waxy and fermented beans.

2.11. Coffee Grading

Grading is the process of categorizing coffee beans on the basis of numerous criteria such as size of the bean, where and at what altitude it was grown, how it was prepared and picked, and how good it tastes, or its cup quality (Reddy, 2010). Coffees also may be graded by the number of imperfections like defective and broken beans, pebbles and sticks per sample.

For the finest coffees, origin of the beans means the farm or estate, region or cooperative is especially important. Growers of premium estate or cooperative coffees may impose a level of quality control that goes well beyond conventionally defined grading criteria, because they want their coffee to command the higher price that goes with recognition and consistent quality.

2.12. Bagging and Storing Coffee Beans

In most case to weigh and bag coffee is to put the bag under the tube of a storage tower or elevator while on top of a platform scale, set to the chosen weight of coffee and bag. Coffee falls into the bag after the regulator in the spout is opened. The flow is interrupted by closing the valve once the estimated required weight is reached.

The final adjustment of weight is done manually by lifting coffee in or out of the bag. Bags with the exact weight are closed by sewing them up either manually or with a portable sewing machine. At the end of the line the green beans are selected and packed in jute bags (Mattsson, et al., 2003). Bags in which fertilizers, pesticides, and fungicides are stored should never be used for this purpose (Chakraverty, et al., 2003).

Automatic scales have a weighing bucket that receives coffee from an overhead silo (storage tower). The weighing bucket is connected by a device to the standard counter weight with the desired weight, each country has differ but in most case 60 or 69 kg is well known (Wintgens, 2004). The free flow of coffee into the bucket is restricted but not interrupted after coffee reaches a pre-set weight (usually a couple of hundred grams below the desired weight). If the weight of the bag is to be included, the counterweight has to be adjusted accordingly.

Coffee must be stored in dry and cool conditions. Exposure to the sun or moisture will rapidly deteriorate the coffee (Reddy, 2010). Storage in pergamino until right before the shipping time will help preserve the coffee. The main factors influencing color and appearance in green coffee is moisture content and time and temperature of storage (Chakraverty, et al., 2003). Burlap bags (made from jute) are often used for coffee bean storage because they allow air flow which is mentioned above. They also give age to coffee longer than plastic or paper bags. Burlap bags should be aired on the patios before storing coffee to prevent a baggy flavor. Coffee storage in humid and warm regions is a serious problem, because the coffee bean becomes white, or yellow to brown, depending on the degree of moisture in the air and the time of storage. This change in color is accompanied by a decrease in flavor quality (Ory et al., 1977).

Research in Kenya has shown that coffee seeds are suitable for over two years if stored at 15°C at 41 % moisture content in an airtight polythene bag (Reddy, 2010). Whole bean coffee preserves its freshness the longest. An inert gas for example nitrogen can be used to help preserve the whole beans to be protracted for longer however, some people claim that nitrogen could preserve coffee longer time, but after a few weeks the coffee no longer acts, tastes, nor smells like freshly roasted coffee and the process also expensive.

Chapter 3. Objectives of the Study

3.1. The Main Objective

The main objective of this study was to investigate the current coffee processing technology used by Ethiopian coffee farmers, processers and cooperatives, the available technology in terms of processing and the impact of quality.

3.2. Specific Objectives

- Examine coffee processing methods in the country.
- Evaluate Oromia Coffee farmers Cooperative Union (OCFCU) coffee processing technology as cooperate and availability of coffee processing systems and machineries for Wondo Genet area coffee farmers.
- Evaluate the support of private coffee processes in coffee processing development and examine if any assistance constructing new coffee processing machineries.
- Find the critical point in coffee processing technology and opening doors for researchers.

Chapter 4. Materials and Methods

In this chapter, description of the study area characteristics and the methodology used in the study will be explored. In order to find out the coffee processing technology in Ethiopia different research procedures and steps were followed. This includes the revisions of available relevant literatures, secondary data collection as well as primary data collection obtained from Oromia Coffee Farmers Corporative (OCFCU), Questionnaires for Wondo Genet coffee farmers, Ethiopia coffee Exchange authority (ECX), and Addis Exporter, using appropriate and convenient research methods. In primary data collection from the appropriate officials data will be gathered that structured by interviews, personal observations and formal and/or informal discussions.

There is a continuing debate about appropriate research methodology for conducting research. Although some researchers or field of study follow either qualitative or quantitative approach, most social scientists are recognizing the limitations that are inherent in a single approach which could be neutralized by combining both qualitative and quantitative methodologies.(Degefa, 2005).

In addition to the scholars argument in combing the two different approaches to strengthen the data validity, cross checking or triangulating data gathered from the community yields rigors results than when employing single approach. Therefore, in order to arrive at more reliable data, and improve its validity of the data gathered and used mixed method approach tools simultaneously.

4.1. Study Areas and Sampling Methods

4.1.1. Oromia Region

Oromia is one of the nine ethnic divisions of Ethiopia. Covering 353,632 square kilometers stretching from the western border in an arc to the southwestern corner of the country, the 2007 census reported its population is at over 27 million, making it the largest state in terms of both population and area.

It is the region where coffee first originated and it is by the Oromo people that the usage of coffee as a food started in the beginning of the 5th century. Oromia is approximately located between 3 degree and 15 degree North latitude and 33 degree and 40 degree longitude. The region is known for its unique native vegetation as well as for being the center of diversity for many different species of plant. The region is the birth place of coffee.

4.1.1.1. Discussion with Oromia Coffee Farmers Cooperative Union

Oromia Coffee Farmers Cooperative Union (OCFCU) is small farmers owned cooperative union which has members from all coffee growing regions in Oromia regional state. OCFCU was established in 1999 to facilitate the direct export of coffee produced by small farmers organized in cooperatives. OCFCU works exclusively in Oromia Regional State, which accounts for 65 percent of the country's total coffee growing land. In order to conduct data collection, questionnaires were prepared to guide the discussion.

4.1.2. Addis Exporter

Addis Exporter was founded in 1972 and today is one of the oldest privately held coffee export company in Addis Ababa, Ethiopia. The management team, which includes partners from the United States, has more than 100 years of combined experience in exporting high quality Ethiopian coffee to the world. In order to conduct data collection,

simple checklist was prepared to guide the discussion with Mr. Michael Mamo who is sales and marketing manager for the company.

4.1.3. Wondo Genet

Wondo Genet is small town surrounded by local coffee producers in the Southern Nation, Nationalities and Peoples Regional State (SNNPRS) of Sidama Zone, Southern Ethiopia. The town is located 255km far away from Addis Ababa, the capital of the country. It covers the area from some 15 km south of the town of Shashemene, near the Wondo Genet College of Forestry. The Questionnaires were took place in Wondo Genet area, and 24 farmers were selected systematically as to represent the population in the study.

4.1.4. Observation

Observation was one way of validating some of the data. In the method, fully involved in all the process of the data gathering, most of the situation was critically observed from the Surveyed sites. It was an opportunity to find out in practice what has been reported by the OCFCU, Addis Exporter and Wondo Genet farmers about the processing mechanism. During observation some pictures were taken to document physical evidence while verbal data was noted.

4.2. Data Analysis Techniques

Depending on the nature of data collected, Microsoft Office Excel 2007 employed to analyze and arrive at conclusions. In qualitative data analysis, discussions from key informants and focus group discussion are grouped and then checked for validity and reliability. This means if some ideas stand out from the average respondents, the issue will be analyzed and presented if necessary otherwise that data will be avoided altogether. Since the objective of using both qualitative and quantitative approach is to solidify the data collection processes where one cancels the weakness of the other, the analysis also will be done in reference to the other. That is qualitative analysis clarifies or cross check the quantitative data.

4.3. Limitation of the Study

The study covers general coffee processing technique focusing on available technology in the coffee processing stage in the country. In this study processing covers from coffee cherry harvesting until the final product of green coffee beans. Also, there are many Cooperatives and Exporters are found the country, but in this study it does not cover other than the one mentioned. Finally, the most literature part of the study depends on the book "*Coffee: growing, processing, sustainable production: A guide book for growers, processers, traders, and researchers*". Written by Jean Nicolas Wintgens in the year 2004, Wiley-VCH.Weinheim.

Chapter 5. Results and Discussion

5.1. Coffee in Ethiopia

Ethiopia is a large, landlocked country in the eastern Horn of Africa. It is about three times the size of California, or approximately the same size as France, Germany, and the United Kingdom combined. It is also the second most populous country in Africa, with an estimated population of 85 million people.

There are various legends about how coffee cultivation came about, but what we know for certain is that coffee drinking goes back at least 500 years, and most likely much longer. Coffee drinking is a deep part of Ethiopian culture, and a big part of the identity of the people.

From modern roasters and coffee houses in the capital of Addis Ababa, to the simplest pan-roasted coffee ceremony in a small rural hamlet, Ethiopians of all classes and ethnicities enjoy coffee. As a result, a very large portion of national production ends up on the local market. Unlike the situation in many commercially-productive countries, it is often possible to get a cup of top-quality coffee on the local market in Ethiopia. This gives the people who grow, buy, and sell coffee powerful insight into what makes for a delicious cup.

5.1.1. Ethiopian Commodities Exchange (ECX)

The Ethiopian Commodities Exchange incorporates a trading platform for coffee and as the name implies, it deals in several commodities, not just coffee. The basic function of the ECX is to provide a centralized, standardizing body where agricultural goods and futures can be traded. The ECX was originally designed with commodities like wheat, maize, and haricot beans in mind, with an eye towards helping to stabilize prices and

production, get better prices for farmers, and help the agriculture sector function more efficiently.

All coffee that enters the ECX is given a grade and a geographical designation. Grades are based on physical inspection of lots and on cupping. Grade 1 is the highest grade, and grade 9 is the lowest. Geographical designations are given at the "sub-regional" level, more specific than large regions like Harrar or Sidama, but less specific than the particular farm, village or woreda level. Once coffee is graded, it is stored at an ECX warehouse to prevent tampering, and coffee is bid on and sold to exporters.

Ethiopian laws governing the trade of coffee allow producers to directly export the coffee produced on their own farm without having to sell it to suppliers who then sell it to exporters. However, due to the small scale and weak capacity of most Ethiopian coffee producers and their geographic dispersion, there is a coordination failure in the market in that it is costly and risky for small farmers and international buyers to find each other and directly transact. The ECX Direct Specialty Trade addresses this problem. Producers may use the platform as a way to grade and store specialty coffees they intend to offer directly to the international market.

5.1.2. Brazilian and Ethiopian Coffee Harvesting Mechanization

What's been called "an industrial revolution" is occurring in Brazil's coffee sector, as farmers respond to several labor conditions pushing them into mechanical harvesting. The resulting changes may help Brazil increase production to meet future demands as they help farmers earn greater profits (ROASTeCoffeeBuzz).

Machine harvesting is looking more attractive to farmers as the labor pool shrinks. Even after increasing farm labor wages, the workers prefer to move to the more urban areas for jobs that are permanent rather than seasonal. Apparently there are many job opportunities in towns which are experiencing the kind of growth that calls for more labor. However, this also works out advantageously for the farmers, as mechanical harvesters work more economically, slashing harvesting costs by half. This is made possible by sharing the harvesting machines and tractors among co-op members.

Brazil has the advantage of more acreage where mechanization is feasible. It's estimated that 80% of Brazil's farms can be mechanically harvested; with only 20% being mechanized so far, there is lots of room for increase. Some farmers will have to widen rows between plants and incur some initial loss, but in the long run they will do better. Many others will be able to expand their crop acreage; they are no longer restricted by the amount of workers available, as mechanization makes it possible to farm many more acres without being dependent on the labor pool (ROASTeCoffeeBuzz).

Mechanization of Brazilian coffee farms is a good thing for coffee lovers, as the increase in production made possible will help fill the increase in worldwide demand. The Brazilian coffee industry is happy to produce more expensive, mild coffees to meet the demand, made possible by the time-saving machines. The faster harvesting will gather more of the fruit within the specific short timeframes during which the berries are at the right ripeness stage.

Table 1 - Global coffee production, 1997±2001/2 (averages) Grower Production (%) Productivity Share in Export price countries (kg/ha) national exports (US cents/lb) (*Sources*: Estimates based on CEPAL (2002: cuadro 2); ICO and World Bank databases).

Growers Countries	Production (%)	Productivity (kg/ha)	Share in national exports (%)	Export price (US cents/lb)
Brazil	31	752	3.80	87
Vietnam	9.4	2142	5.20	41
Colombia	10	756	11.00	116
Indonesia	6.5	482	0.80	62
Mexico	4.5	473	0.40	111
India	4.5	900	0.70	80
Guatemala	4	900	15.10	93
Ivory Coast	3.7	175	6.70	54
Ethiopia	3	909	28.90	117
Honduras	2.4	684	14.20	100
Rest	21	540		
Total	100	594		

With world demand for coffee increasing at the same time the Brazilian farm labor pool decreases, mechanization made affordable by the co-operatives is the best possible move for the farmers. In Ethiopia there is no any mechanized harvesting when comparing 20% of Brazilian mechanically harvested coffee farm. However, study show that mechanically

harvested coffee cheery affects coffee quality in many ways. The following table shows the global coffee production and takes comparisons with export price of Ethiopian and Brazilian coffee.

5.2. Sun-dried vs. Washed Coffees in Ethiopia

Ethiopia is home to large quantities of coffee in both of the world's two major production styles: Sun-dried natural, and fully washed. Certain production styles are more prevalent in certain regions, but in general it is possible to find both styles across the board in Ethiopia. Many countries have one national processing style, either washed (example: Colombia) or natural (example: Haiti). Ethiopia has both, and both on a large scale.

Processing refers primarily to the method of removing the skin, pulp, and parchment from the outer layers of the coffee cherry, to reveal the green coffee bean (actually the seed of the plant) underneath. The manner in which this is done has a huge impact on the flavor of the resulting coffee. Coffee pulp, or mucilage, is very sticky and dense in sugars. Special processes are needed to remove the mucilage from the beans. These general categories (washed vs. natural) are common throughout the coffee-producing world. However, the specifics of each process can vary considerably from country to country.

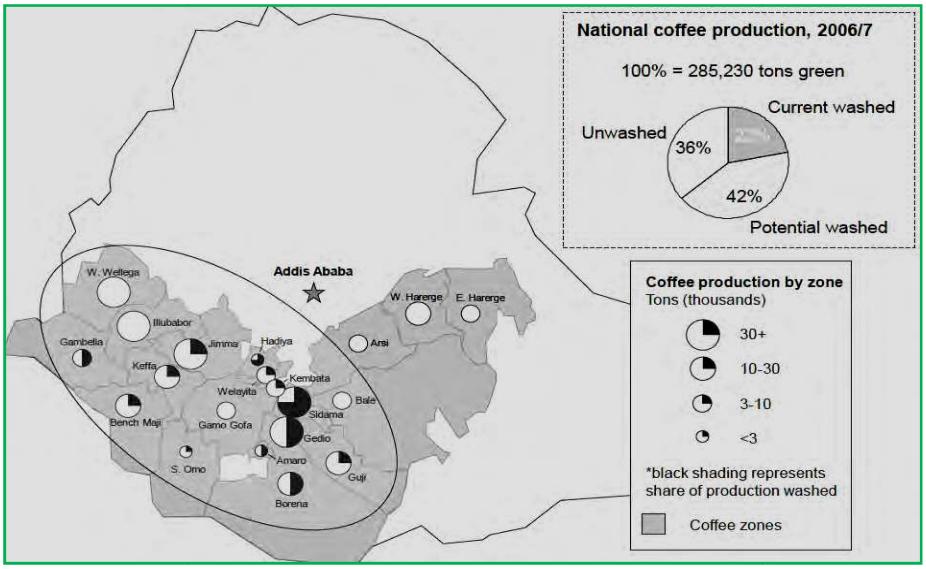


Figure 2-Coffee Growing Areas in Ethiopia and Approximate Production Volume (*Source*: Ethiopian Coffee Buying Manual 2011).

5.2.1. Sun-dried Natural Processing

In the dry or "natural" process, coffee cherries are dried whole. In Ethiopia, this is usually done using raised drying beds, though some coffees are also dried on the ground, especially coffees for the local market. Raised beds made out of wood posts, about waist-high, are covered in a material like burlap or nylon netting. Producers lay the coffee cherries, skin and all, out to dry on the beds.

Over time, the skin and sticky juices of the cherries dry out in the sun. This process can take several days to a few weeks, depending on the temperature and the intensity of the sun. At night, or in case of rain, the coffee is covered up. During the drying process, the cherries shrink in size and eventually become hard and completely dry. Once the process is completed, sacks of dried cherries are taken to a hulling station for the removal of the outer cherry.

Figure 3- Concrete drying coffee processing station south Ethiopia **(***Source:* Photographed by the author, 2010).

Care must be taken to ensure even drying of cherries, and to avoid any contact between the cherries and contaminating substances, like direct contact with soil. Insufficient attention to these details can lead to muddy, dirty, or fermented flavors in the cup. The great advantage of natural processing is that it does not require any water, nor any elaborate machinery or facilities. As a result, one finds more naturally processed coffees in drier areas, as well as poorer or more remote areas.

Figure 4-Drying beds (nylon net) coffee processing station south Ethiopia (Source: Photographed by the author, 2010).

Generally, as the result of prolonged and sun-fueled contact with the cherry's own natural sugars, sun-dried natural coffees have a sweet, fruity character with a creamy mouth feel. The best, most-carefully cared-for sun-dried natural coffees can have intense berry flavors, tropical fruit aromatics, and chocolaty undertones. Natural-process green coffee beans often have a yellowish or orange-like tinge to them. This comes from prolonged contact with the sugars as they "cook" into the bean in the sunlight (Ethiopian Coffee manual).

(Pick) Red Cherry

▼

Dry on paddy (bed) when beans become dry they will turn black

▼

Hulling /to remove skin (cleaning and grading)

▼

Hand pick

Figure 5- Simple Ethiopian Dry coffee Process Flow (*Sources*: Addis Exporter, Addis Ababa: Ethiopia)

5.2.2. Washed processing

In the washed or "fully washed" style of processing, the outer skin of the coffee cherry is removed immediately after harvesting, usually the same day the cherries were picked. This is done using machines which "pick" or scrape away just the very outer layer of the cherry, leaving behind the parchment coffee covered in sticky mucilage.

The "washed" designation refers to what happens to the coffee next. The mucilage-coated beans are then fermented with water in large tanks, usually cement. The process of fermentation breaks down the sugars in the mucilage and frees it from the parchment**.** Fermentation usually takes around 24 hours, though shorter or longer fermentation times are possible, depending on the local climate, altitude, and other factors.

Once fermentation is complete, the coffee is released from the fermentation tank and pushed manually, with the help of some flowing water, down long channels. This agitation frees up any remaining mucilage and separates it from the parchment coffee. At the end of the channels, the coffee enters another tank where it is rinsed with fresh water. The result is wet coffee in parchment, free of the sticky mucilage.

Figure 6- Wet coffee Processing station South Ethiopia (*Source*: Photographed by the author, 2010).

From the final washing tank, the wet parchment coffee is taken to dry in the sun, usually on raised beds. This process of drying happens quickly, because there is no skin or mucilage between the sun and the parchment. After one or two days in the sun, the coffee

is removed from the beds and stored in sacks in a warehouse. When it is to be exported, the coffee is usually taken to a larger central mill where the parchment is removed, and the coffee is sorted and bagged for export. The disadvantage of the washed process is that it requires large quantities of water and more infrastructures. In many locales, it is simply not feasible to do the washed process. Washed coffee tends to have a clarity of flavor and aroma that is often lacking in natural coffees. Many cuppers assert it is easier to taste the influence of soil and varietal in washed coffees. Acidity comes through more clearly, and the cup is generally cleaner. The cleanest, highest quality, high-altitude washed coffees can have an intensely refreshing character (Ethiopian Coffee manual).

(Pick) Red Cherry

▼

Pulping (remove the red cherry skin)

▼

Fermentation (24-72 hrs.) to remove mucilage

▼

Washing (in washing channels, rake/human labor)

▼

Soaking- 12hrs (to make coffee greenish and minimize acidity)

▼

(Pick) (Skin dry table/wire mesh (to let wet coffee dry) (3 hrs)

▼

(Pick) Dry table (7-12 days) (morning 8-10 and evening 4-5pm)

▼

(Pick) Defected beans

Figure 7- Simple Ethiopian Wet coffee Process Flow (*Sources:* Addis Exporter, Addis Ababa: Ethiopia).

5.3. Coffee Designations

5.3.1. The Distinct Coffee Regions of Ethiopia

In Ethiopia are now given to coffee a geographical designation and a grade of 1 through 9 by ECX. Commercial grade coffees are given a grade between 3 and 9, and are designated geographically by the letters A, B, C, and D. Remember, the letters do not represent grades, only geographical categories. Even cooperative coffees not passing through the ECX end up with a grade and a geographic code.

All coffees are also divided into four large groups: Commercial Washed, Commercial Unwashed, Specialty Washed and Specialty Unwashed. For example, a coffee might be designated "Jimma A, Grade 4" or "Sidama C, Grade 3". The first name in the designation (Jimma, Sidama) gives you the name of the larger region in which the coffee was produced. The letter that follows the name (A, C) shows you the sub- region that the coffee comes from.

5.3.1.1. Harrar Coffee and Distinction

Practically all coffee from Harrar is sun-dried natural. There are several heirloom varietals that grow specifically in this region, that interact well with the altitude, climate, and soil type to produce a very unique flavor profiles. Quality Harrar coffees are notable for a fruity characteristic and a creamy body. The finest Harrar coffees have a distinct note of blueberry, though many other fruity and fruit-like aromatic flavors can occur.

One kind of differentiated coffee that comes out of the Harrar area is the "amber bean" or "golden bean coffee." The reference here is to the appearance of the milled, unroasted coffee, which is yellowish/amber in color. One type of amber coffee is apparently the result of a certain varietal growing in a certain soil type in East Harrar. This is "naturally occurring" amber bean coffee, and often has an excellent, vibrant and rich blueberry flavor. Harrar coffee is exported all over the world, but there is a particular demand for it in Saudi Arabia. This constant demand tends to keep the price for commercial grade

Harrar coffee slightly higher than most other Ethiopian coffee regions. Harrar coffee all of which is unwashed is available in specialty grade and commercial grade.

5.3.1.2. Sidama Coffee and Distinction

The region of Sidama is in southern Ethiopia. It encompasses many individual origins, including, geographically, the area of Yirgacheffe. However, Yirgacheffe is classified as its own separate origin. In this section, discuss Sidama as a designated coffee origin. Yirgacheffe is covered in its own subheading.

Sidama features an extraordinarily wide variety of coffee flavors. Many different grades of both washed and unwashed coffees are produced, and there can be striking differences from town to town. Varying soil types, micro climates, and especially the countless heirloom coffee tree varietals make for a kaleidoscope of different flavors. It is difficult to make any single description of Sidama coffees, without immediately encountering another coffee that fits a completely different profile. The strength of Sidama lies in its variety.

One feature of excellent Sidama coffee is often a profound complexity. This derives from the many different heirloom varietals. Many different farmers and pickers, each with a very small patch of land, often with their own unique varietals, will pool their coffees at a cooperative. The resulting “blend” is a unique expression of the complexity of the horticulture in the surrounding area.

High grade unwashed Sidama coffees are known for their intense fruity characteristics, while being of somewhat lighter body than unwashed Harrar coffees, for example. Another striking characteristic of Sidama coffees is that even the washed coffees often retain a salient fruity characteristic, while having much more clarity and brightness than their unwashed counterparts. Excellent coffees of many different profiles can be found in all corners of Sidama. Sidama coffees are given three tags: a grade, a geographical letter designation, and designation as washed or unwashed.

5.3.1.3. Yirgacheffe Coffee and Distinction

Yirgacheffe is a small micro-region within the much larger region of Sidama. However, Yirgacheffe coffees are so distinct and so well-recognized internationally that they are grouped into their own special category. Though much, much smaller than the other regions, the quality of Yirgacheffe coffee has allowed it to become as well known or even better known that the large, famous coffee producing regions of Harrar and Sidama proper. Top grade Yirgacheffe coffees share many characteristics with the best Sidama coffees. Fruit flavors, a bright acidity, and a silky mouth- feel are some of its hallmarks. Yirgacheffe produces both washed and unwashed coffees. While it originally became famous mostly for its washed coffees, recent years have seen the export of some highly sought-after top-rate unwashed coffees as well.

Top grade washed coffees from Yirgacheffe are renowned for bright citrus acidity, often with a lemony character, with excellent sweetness. The other hallmarks of the coffee are a light, herbaceous quality that compliments the fruit flavors well, for a complex and flavorful coffee. The best unwashed coffees from Yirgacheffe often retain a high degree of acidity, with softer fruit flavors and sometimes berry characteristics.

5.3.1.4. Jimma Area and Forest Coffees Distinction

Jimma (Limu) coffee grows in the southwest of Ethiopia between 3,600 and 6,200 feet. Limu coffee (all washed) generally has a milder acidity than Sidama and Yirgacheffe; the flavor is generally characterized by a balanced and clean cup. Traditionally, Limu coffees marketed under that name have been processed washed; the unwashed Limu coffees have normally been offered under the Jimma category.

In the area of Bonga, a town in the Kaffa zone, more than one hundred Ethiopian investors have been developing estates and farms growing high quality Arabica coffee. It has suitable Agro-ecological conditions for specialty coffee production. Its altitude is between 1600 and 1900 meters the soil is red in color, and temperatures are conducive for coffee production. The area is known for distinct higher levels of precipitation and for that reason it is considered as one of the rainiest regions in Ethiopia.

As one of the first two Biosphere Reserves in Ethiopia, the Wild Coffee Forests in the former kingdom of Kaffa have been recognized as UNESCO Biosphere Reserve in the beginning of June 2010. Gesha is one of the districts of the Kaffa zone. Most farms, estates and cooperatives supply both washed and natural sun-dried coffees to international markets. With the support of the Gates Foundation, Technoserve established and constructed more than one hundred processing stations in the Southwest regions. Most of these stations have been built in the Kaffa and Limu regions.

5.3.1.5. Wellega Coffee and Distinction

Nekempti also known as Lekempti, is a region located within the state of Wellega, about 6 hours west by car from Addis. Originally, Lekempti is a sun-dried natural bean produced in western Ethiopia. The coffee is known for its large bean size, and the flavor can have a pronounced perfume-like aftertaste. Coffee processing styles in Wellega have traditionally been sun-dried natural.

In the near future it can be expected that the offerings of washed processing styles will be expanded through the washed coffee processing stations built with financial support by the Gates Foundation (executed through Technoserve).

5.4. Cooperative Unions in Coffee Sector

Most farmers in Ethiopia hold and work very small parcels of land. Over the years, farmers (with the help of the government) have formed local cooperatives and pool their coffee to create lots large enough for export. Usually these primary cooperatives have their own washing or drying station, though sometimes they use that of someone else.

The cooperative unions include the Oromia Coffee Farmers Cooperative Union (OCFCU), the Sidama Coffee Farmers Cooperative Union (SCFCU), the Yergacheffe Coffee Farmers Cooperative Union (YCFCU), and the Kafa Forest Coffee Farmers Cooperative Union (KFCFCU).

5.4.1. Oromia Coffee Farmers Cooperative Union (OCFCU)

Oromia Coffee Farmers Cooperative union (OCFCU) is the well-known coffee cooperative union in Ethiopia. There are four cooperatives in the country which are mentioned on the above; however Oromia region covers the most part of the country in terms of coffee production and processing.

5.4.1.1. Position of the Organization

Proclamation 147/1998 of the government of Ethiopia permitted the formation of higher level cooperatives (unions and eventually federations and a cooperative league). Using this opportunity for the first time, primary cooperatives societies were allowed to group together to increase their market power on both the input and product sales.

As a result, Oromia Coffee Farmers cooperative union (OCFCU) had been established in 1999 by 34 coffee producer primary cooperatives in Oromia Region. Following the government policy that allowed coffee producers to export directly by passing central auction markets, OCFCU seized the opportunity and managed to penetrate the international coffee market and become owner of Fairtrade and Organic certifications and ongoing certification of Utz kapen and Forest Alliance. Its member primary cooperative grew from the initial 34 to 197 to date total beneficiary as well increases.

The establishment of OCFCU was necessitated to support farmers produce in small-scale on small patches of land, with no access to agricultural equipment. These small scale farmers typically do not have access to transportation facilities to get their coffee processed or auctioned. The Union was, therefore, established as a means to provide protection, to serve as resources and expertise to the small cooperatives, so that they could overcome exportation problems and receive increased coffee revenue.

Coffee being the largest export crop of Ethiopia and means to link rural farmers to consumers of worldwide that smallholder farmers have traditionally been undeserved; even exploited and marginalized. The smallholder coffee farmers in Oromia region is no exception. To help coffee farmers get price information, capital and transportation as well

as necessary skills in production, processing and supply of coffee, there was no other alternative than establishing OCFCU said Mr. Meskela the manager of the union.

5.4.1.2. Achievements of OCFCU and Current Status

The virtual organizational structure of Oromia Coffee Farmers Cooperatives Union (OCFCU) coupled with its efficient management has resulted in improved coffee quality and overall operational efficiency. Dead on target, coffee growers have been benefiting more from their produce since the inception of the Union.

The Union buys, accumulates, processes and internationally sales coffee supplied by smallholders through their cooperatives. The managing, coffee processing, marketing and its commercialization has become modernized and standardized. Hence, the Union has been able to achieve in a short year since establishment incredible level of growth which further has inspired the cooperatives members to increase their capacity through helpful services they receive.

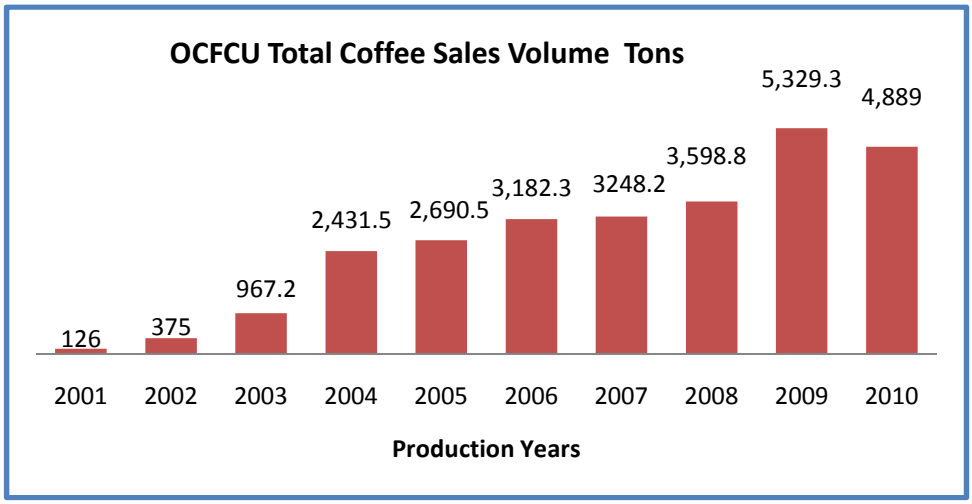
With cooperative experience in international markets, the Union focused on the importance of quality production traced to origin with substantial buyer monitoring and involvement with coffee growers. The Union has also understood the need for change in growing export coffee. Hence, it has succeeded in quality coffee exporting over the last decade. The growth in production size and profitability of members are together creating a momentum for further production, marketing and employment among member cooperatives.

With regard to building capacity of members' cooperatives, the establishment of OCFCU has been an overwhelmingly positive force. The Union has been improving year after year in building institutional capacity of member cooperatives. It has regularly been equipping members with necessary agricultural inputs, different coffee processing machineries, warehouses and material assets. Indeed, it has come a long way since it began this support initiative.

The Union has experienced astonishing growth, shooting from 34 farmer cooperatives representing 22,503 families in 1999, to the current membership of over 197 primary

farmer cooperatives representing more than 194 thousand members. Similarly, its sales volume has shown impressive growth year after year. For instance, the sales volume of the Union has shown steep growth since 2001.

The Union is now exporting: Organic certified coffee, Fair Trade certified coffee, Double certified (organic and fair trade) coffee and Conventional coffee. These products are of unique quality since due caution is given to the whole processes from tree to cup. In this regard, the Union controls overall activities associated with coffee producing, harvesting, processing, storing and direct exporting.



Graph 1- Sales Volume Sold by the Union (*Source:* Oromia Coffee Farmers Cooperatives Union 10th year Anniversary (2011)).

Well aware of the paramount importance of quality coffee to remain competitive in the world's stiff market, the Union has been devotedly working to ensure quality of coffee on sustainable bases. Towards this end, it offers training to members on quality production methods and post-harvest handling. The Union has also been making every effort to build capacities of its members through motivating them, creating market linkage and providing market information. All the relentless effort of the Union is to improve efficiency at all levels of production, harvest, processing and supplying of coffee to make the most out of export trade for the well-being of the farmers.

As a result, lives of the members have been meaningfully changing. Most of them

received dividends which they used to cover their thatched-roof house with corrugated iron sheets. Other Union members invested dividends back into their coffee ventures, started new businesses or paid for their children's education.

One of the outstanding achievements of the Union is the installment of a new coffee processing plant and construction of the Union's Head office with over 70 million Birr are good achievements of coffee cooperatives. It is believed that the processing plant would give much better capacity to the supply of marketable coffee ensuring efficiency in every step of quality control and vibrant service delivery. It would also speed up export delivery schedule by avoiding the wait for dry processing at the Ethiopian Central Warehouse and National Processing Plant. Besides, the installed processing plant, two warehouses with the holding capacity of 10,000 tons each and a line of sorting machinery with a capacity of processing 7 tons of coffee per hour have been installed. The Union and its member cooperatives now have 56 pulpers, 16 hullers and 71 warehouses.

Figure 8- Coffee processing in progress at OCFCU processing unit, A.A., Ethiopia (*Source*: Photographed by the author, 2011).

The current production capacity of the Union is close to 250,000 tons annually on nearly 420,000 hectares of land. Out of this, 45,824 and 25,360 tons are annual organic and Fair Trade certified coffee production respectively. The consistent follow up of producers, processors and suppliers in all the production chain from farm to market particularly supervision and inspection at various stages for quality coffee, has shown tremendous improvement.

The Union has also accomplished commendable work in securing the rights of names which would enable farmers capture more value from the trade, by controlling their use in the market and thereby enabling them to receive a greater share of the retail price. Hence, Ethiopia's coffee industry and farmers could earn commensurate return. Cognizant of the fact that better brand and supply management in the country and strategic promotion will clearly help create higher returns for everyone in the coffee chain, the Union has made remarkable achievements in this regard.

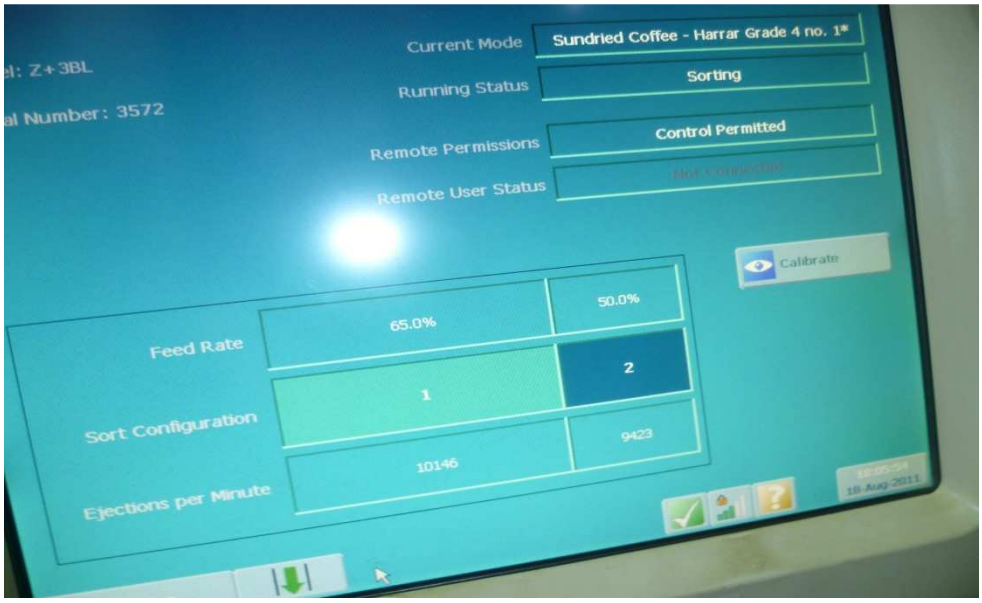


Figure 9- OCFCU computerized coffee sorting machine A.A., Ethiopia (*Source*: Photographed by the author, 2011).

Some co-operatives associated with the Union used the Fair Trade premiums to construct a system to treat ill and diseased plants, a warehouse for storage and to purchase 50 machines to wash their coffee beans. Several programs to improve quality have also been put in place. As well, the Union invests in the promotion of coffee production in order to extend its sales to new markets.

The benefits of the Fair Trade of course, helped for the construction of a number of primary schools and additional classrooms, clinics, and for the purchase of medical equipment and supply of clean water. Moreover, it assisted to offer care to farmers, their families and the community. The purchase of a grinding machine to reduce the costs associated with the grinding of coffee beans; the purchase of coffee washing stations, which have increased the quality of the products and many more, were also achieved as a

result of the revenue from Fair Trade coffee. As part of social service program, the Union has also constructed several elementary and high schools, clinics, potable water facilities, and bridges as well as installed coffee processing and drying machines to the farmers.

Generally, the livelihood of coffee grower member farmers is improving than ever before as a result of the Union's effort to improve coffee production and campaigning to get fair price at the international market as well as expansion of market information.

Table 2- OCFCU coffee processing machineries and production capacity (*Source:* Oromia Coffee Farmers Cooperatives Union 10th year Anniversary, 2011).

Type of Machineries	**Quantity**
Sorting machinery	1 (7tons/hr)
Pulpers	56
Hullers	16
Others	**Size**
Production capacity	250,000 tons/ annually
Covered Land	420,000 ha.
Warehouses	71 (all over the region)

5.5. Private Coffee Processers

There are many coffee processers found in Ethiopia. According to Ethiopian Coffee Buying Manual: Practical Guidelines for Purchasing and Importing Ethiopian Specialty Coffee Beans , 44 coffee growers, producers and exporters under one association, 98 members are working together in one coffee exporters association (ECEA) and 95 importers and traders in coffee beans.

5.5.1. "Addis Exporter" Coffee Processers

During the data collection in-terms of private coffee processing, issues have been personally discussed with Mr. Michael Mamo, who is sales and marketing manager for the company called Addis Exporter. Addis Exporter was founded in 1972 and today is one of the oldest privately held coffee export company in Ethiopia. The management

team, which includes partners from the United States, has more than 100 years of combined experience in exporting high quality Ethiopian coffee to the world.

They offer a full range of washed and sundried Arabica coffees grown in Ethiopia. The coffees are named after their production areas and are assigned a grading number established by the Ethiopian Coffee and Tea Authority to indicate type and quality. Grade 2 coffees are fine washed coffees while Grade 4 and 5 are unwashed sundried coffees.

There are many factors that contribute to the quality of coffee, mainly man and nature. Natural factors include altitude, duration and severity of rainfall, type of soil, genetic origin, and location of producing area. Ethiopian coffees have the genetic make-up and sturdiness to grow and spread with very little human interference**.** This means that there is not much need for pesticides and fertilizers, making them naturally organic.

Supervision of quality coffee begins with the coffee seedlings and ends when the coffee is shipped out to the international markets. Experts who are trained in the cultivation and handling of coffee are placed in each of the coffee producing regions to train and guide producers in the modern and scientific methods of planting, cultivating, processing and storing of coffee. These Coffees go through rigorous inspection checks by the Ethiopian Coffee and Tea Authority before they end up at the auction centers in the capital City Addis Ababa and Dire Dawa. The coffees are again inspected at the auction centers in order to discourage tampering route.

Coffee purchase at auction is brought to one of the three storage and processing facilities where its machine cleaned and further hand-picked by some 300 plus workers depending on quantity to ensure that only the perfect beans make it to the customers. Sample coffees are regularly liquored to ensure that the entire batch meets the high quality standard that customer's expect.

Coffee is then sent to the Quality Control Department of the Ethiopian Coffee and Tea Authority for a declaration certificate to its cleanliness, evidencing that each truckload of coffee scheduled for shipment conforms to the quality and grading standards stipulated in each of our sales contracts. The Department inspects and conducts cup tasting before it certifies the coffee fit for export. This integrated quality control system from the point of production to the point of delivery ensures that any one receive the finest Ethiopian

coffee. Table-3 Show 300g of sample of coffee used by the same coffee screening size to determent the amount of effect. Fewer grams of defect shows the best quality coffee beans “grade 1” and the highest defect takes “grade 5” which is less quality coffee beans.

Table 3- Defect counting system in Addis Exporter (300 grams of green Ethiopian coffee. *(Source*: Addis Exporter, Addis Ababa: Ethiopia).

Coffee grades	Total defect in g.	Size of screen (mm)
Grade 1	0 to 3	screen 14 to screen 17
Grade 2	4 to 12	screen 14 to screen 17
Grade 3	13 to 27	screen 14 to screen 17
Grade 4	28 to 45	screen 14 to screen 17
Grade 5	46 to 86	screen 14 to screen 17

5.5.1.1. Conversions of Green Coffee

Conversion means to give an idea the amount of green coffee in terms of different forms. For instance all quantity data in International Trade Center (ITS) coffee guide represent bags of 60 kg green coffee or the equivalent therefore, i.e. Green Bean Equivalent (GBE). Green coffee means all coffee in form of naked before roasting. The following is the calculation of modalities how to convert different types of the coffee into GBE:

Table 4- Conversions of green coffee (*Sources:* Addis Exporter, Addis Ababa: Ethiopia).

Form of coffee	Methods of converting into GBE
Dried cherry to green bean	Weight of dried cherry * 0.5
Parchment to green bean	Weight of the Parchment * 0.8
Roasted coffee to green bean	Weight of the roasted coffee * 1.19
Soluble coffee to green bean	Weight of Soluble coffee * 2.6
Liquid coffee to green coffee	Weight of the dried coffee solids contained in the Liquid coffee * 2.6

5.6. TechnoServe Coffee Initiative Ethiopia

TechnoServe helps entrepreneurial men and women in poor areas of the developing world to build businesses that create income, opportunity and economic growth for their families, their communities and their countries.

Money from coffee has helped Ethiopian's feed their family, send their daughter to school and invest in their coffee fields for the long term. With the money farmers will get, they will pay off debts and pay school fees." TechnoServe is helping to bring similar benefits to tens of thousands of other families. With the support of the Bill & Melinda Gates Foundation, the Coffee Initiative will empower 180,000 East African farmers over four years to improve the quality of their coffee and bring prosperity to their communities.

The work is impacting farming families in Ethiopia, Kenya, Rwanda and Tanzania. They impart best practices in areas such as plant nutrition and pest management to promote high yields. Technoserve works with farmers to build and operate wet mills processing stations that produce high-quality coffee beans. And they help farmers sell to the specialty buyers that supply the coffee shops and grocery stores in your neighborhood.

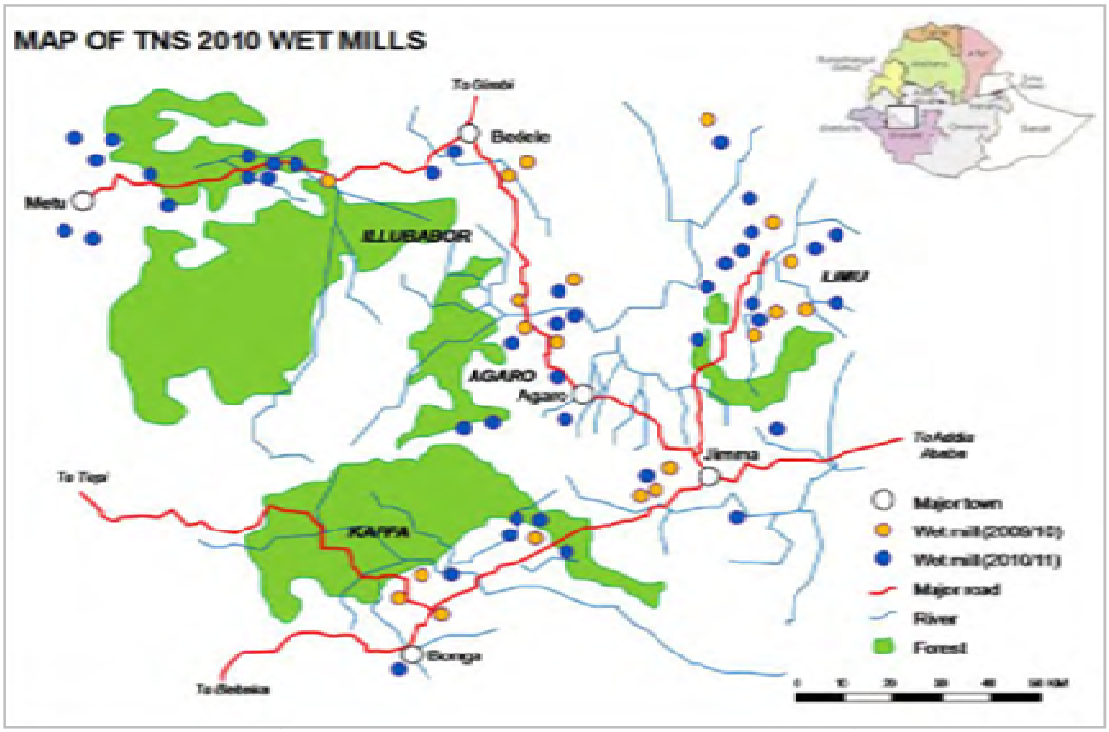


Figure 10- Coffee processing stations in western Ethiopia built by TechnoServe (*Sources:* TechnoServe Coffee Initiative Ethiopia).

As TechnoServe enter the fourth year of the program, TechnoServe is also providing innovations for the future. They are working with local banks to develop new financial mechanisms that give smallholder farmers access to loans. Across the program, they are introducing technologies that conserve scarce water resources and protect the environment for future generations. TechnoServe hopes to expand this work to double coffee incomes for one million farmers by 2019. With the right knowledge, a coffee bean can change lives on a grand scale.

5.7. Wondo Genet Coffee Farmers

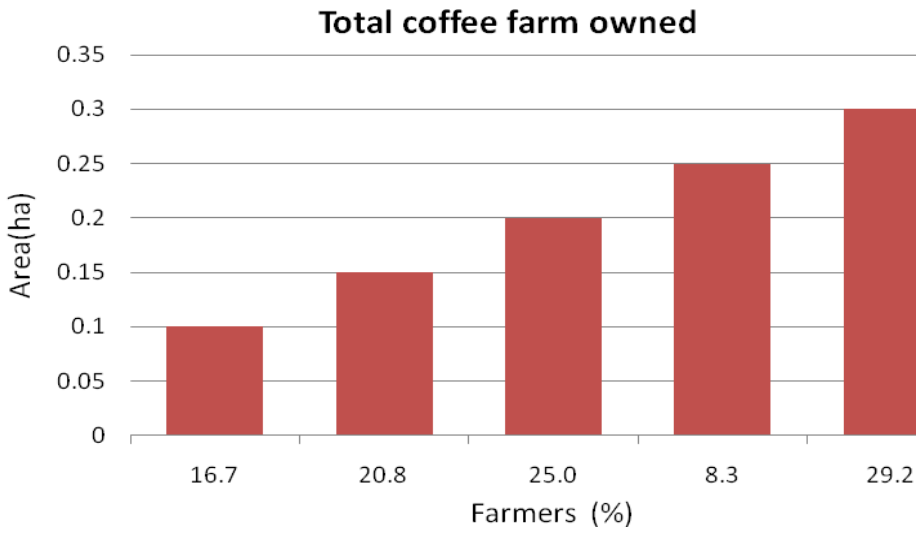
In Wondo Genet area farmers produce many cash crops, like: Sugarcane, chat, enset (false banana), potatoes, coffee, carrots, cabbages, red beets, tomatoes and other vegetables and fruits for a long time. Although coffee had been the primary cash crop before 1975, the coffee disease that spread rapidly in the area reduced its significance. In addition, the repeated displacement of farmers for various reasons reduced the production of coffee and other perennial crops (avocados, papayas, chat,) that take long time to grow.

Wondo Genet is well endowed with rich, but depleting, agricultural natural resources. The primary asset of the area is the existence of suitable fertile soil with enough water from precipitation and irrigation for the production of both annual and perennial crops. Even if the uncultivable lands (marshy, stony and hillsides) constitute a significant proportion of the total land size, the quality of the remaining arable land is very good, and makes Wondo Genet one of the most productive areas of the region.

5.7.1. Analyzing Farmers Respond

Wondo Genet area farmers have better experience in coffee production and understand the value of coffee as cash crops. However, they have difficulties in-terms of coffee processing and related issues. In general, the local farmers hold small land size for coffee production like other coffee producers in Ethiopia. The survey show that the local farmers owned coffee land from 0.1 – 0.3 ha/person, which is in line with many literature that stated 90% of Ethiopian coffee production comes from small land holders. In addition, all

farmers have alternative income sources than coffee due to seasonal fluctuation of coffee prices, little or no wet and dry processing stations and lack of technical support.



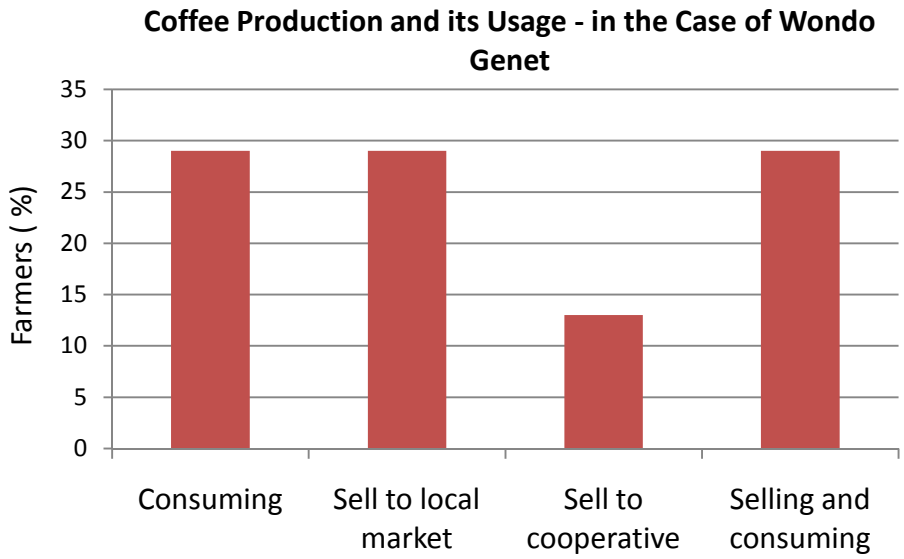
Graph 2-Total coffee farm owned by Wondo Genet farmers (n=24).

The survey also shows that the amount of annual coffee production that farmers can harvest. From 24 randomly selected farmers, 29 % of them produced around 50 kg of dry cherries, 25 % between 51-100 kg and the rest 46 % farmers harvested more than 101 kg per year. This shows that the current yield of coffee production in Ethiopia is from 500-600 kg/hectare as it has been mentioned in the literature review. However, this could be improved to 1000-1200 kg/hectare achieved by similar coffee variety producing countries like Kenya.

Table 5-Wondo Genet coffee producer's annual production

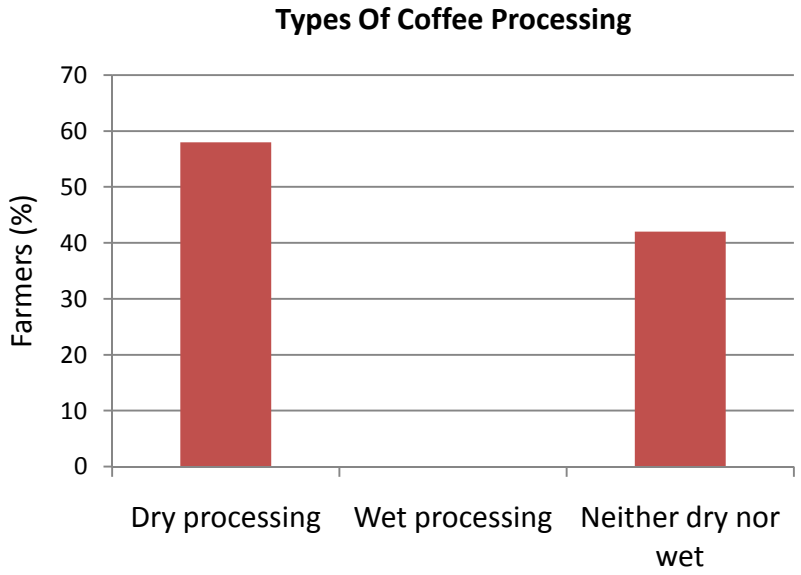
Farmers (%)	Annual production/kg
29	0-50
25	51-100
46	≥101

Like many farmers in the country, Wondo Genet coffee farmers use their coffee product for their household consumption and income purposes. The result shows 29 % of the farmers used the produced coffee for own consumption, which shows that Ethiopia is the country that uses most part of its produced coffee for local consumptions.



Graph 3-Coffee production and its usage –in the case of Wondo Genet (n=24).

The other 29 % said that they sell the whole their annual product into local market as dry and fresh harvested cherry. This is important for local farmers especially for women to have daily income to provide for the family basic needs like sugar, salt, and many other items. Again 13 % of the farmers responded that they sell the whole harvested cherry which they produced for coffee cooperative union. Just few farmers sell their cherry to cooperative because there is only one local union available in the area "Sidama Coffee Farmers Cooperative Union (SCFCU)" which is covering a lot of geographical area, and as the result of this, it is having difficulty to corporate with all coffee producers. Still the rest 29 % of the farmers said that they consume most part of their product and sell the rest into local market.



Graph 4-Types of coffee processing in Wondo Genet farmers (n=24).

The biggest challenge for most farmers was lack of access to coffee processing stations as it was shown in the survey. From the total farmers surveyed, 58 % uses dry coffee processing which is normally the most favored by many farmers because of its availability with necessary facilities for the process, and simplicity of the method. The rest 42 % use neither dry nor wet processing method, which means they sell the whole harvested cherries to local market or cooperate. Surprisingly there is no a single wet processing station around the area and even any other coffee processing machinery, which forced the local farmers to use only dry processing method.

Chapter 6. Conclusion and Recommendation

Conclusion

The Arabica coffee tree is originated in Ethiopia, where it grew wild. In fact, the name "coffee" derives from the Ethiopian region of Kaffa. In keeping with this strong coffee tradition, Ethiopia still produces some of the best coffee in the world. The majority of coffee production (90%) comes from the smallholders while the rest is produced by large-scale producers (state farms and investors). Ethiopian coffee is processed and exported in two processing techniques, namely, natural sun-dried (70%) and washed (30%) coffees.

The processing steps in coffee may be grouped into primary, secondary and tertiary steps. Primary coffee processing refers to the processing of coffee fruit to obtain coffee beans (also called green beans). The next stage refers to hulling, roasting and grinding. Tertiary processing involves making of instant coffee and/or other value addition operations.

Oromia Coffee Farmers cooperative union (OCFCU) and private coffee sectors are helping the Ethiopian coffee processing to take into second level. OCFCU is the well-known coffee cooperative union in Ethiopia and the union covers the most part of the country in terms of coffee production and processing. The union has built latest coffee processing unit, also wet and dry processing stations around the region which enable farmers and the country to compete the international market.

In Brazil the faster harvesting will gather more of the fruit within the specific short timeframes during which the berries are at the right ripeness stage. With world demand for coffee increasing at the same time the Brazilian farm labor pool decreases, mechanization made affordable by the co-operatives is the best possible move for the farmers. When comparing Ethiopian farmers, more Brazilians using mechanical harvesting machines however in most case mechanization system does affect coffee quality and study show that in most cases Ethiopia uses 100 % manpower harvesting method has helped for better coffee quality and price comparing Brazilian mechanization method. In Ethiopia shortage of farm labor is not the issue and handling harvesting in man power is important in terms of coffee quality.

TechnoServe Coffee Initiative Ethiopia also part of the process to develop coffee processing technology in Ethiopia. TechnoServe Coffee Initiative Ethiopia is helping the local farmers building processing stations which is very important for coffee processing development.

Key recommendations for the Ethiopian coffee industries are:

Farm extension/farm risk management: A well planned and implemented coffee extension programme is needed, engaging all agencies involved in research and extension, including a range of well-researched farm diversification strategies.

Water: Water resources are a key factor in the success of the coffee industry of Ethiopia. There is evidence that these resources are now on the edge of sustainability. As water has been considered a free resource, little care has been taken to use it in an economical way or account for its cost. Integrated management and monitoring of extraction rates is required to ensure the true value and cost of water is recognized. The Government needs to focus on the long-term environmental impacts (particularly water resources) of the coffee industry and to develop strategies to monitor and evaluate environmental impact and so ultimately help the industry to become more sustainable.

Farmer and processor/exporter organizations: As the Government moves toward greater market orientation of the coffee industry it should facilitate the building of a stronger private sector in the coffee industry, in particular by fostering representative

farmer and trade organizations and stakeholder organizations. While non-government groups may generate criticisms which the Government may not enjoy, in the long run this will help the industry be much more aware and adaptable to stakeholder needs. The Government needs to encourage representative farmer and trade organizations and stakeholder organizations by creating an 'enabling environment' for them to grow.

References

Aertsa, R., Hunderaa, K., Berechac, d. G., Gijbelsc, P., Baetenc, M., Mechelena, M.V., Hermya, M., Muysa, B., Honnayc, O. (2011). Semi-forest coffee cultivation and the conservation of Ethiopian Afromontane rainforest fragments. Forest Ecology and Management 261, 1034–1041.

Alessandrini,L., Romani,S.,Pinnavaia,G.,Rosa,M.D. (2008). Near infrared spectroscopy: An analytical tool to predict coffee roasting degree: analytica chimica acta 62 5 : 95–102.

Ashu,R., and Chandravanshi,B.S. (2011). Concentration Levels of Metals in Commercially Available Ethiopian Roasted Coffee Powders and Their Infusions. Bull. Chem. Soc. Ethiop. 25(1), 11-24.

Ashworth, G. S., Azevedo, P. (2009). Agricultural Wastes, New York: Nova Science Puplishers, Inc.

Aycheh, H.M. (2008). Image Analysis for Ethiopian coffee Classification. M.Sc Thesis Submitted to Graduate Studies of Addis Ababa University, A.A., Ethiopia.

Berhe, Y. (2010). The legal regime regulating coffee trade in Ethiopia. M.Sc Thesis Submitted to Graduate Studies of Addis Ababa University, A.A., Ethiopia.

Campbell, W.B., Ortiz, S.L. (2011). Integrating Agriculture, Conservation and Ecotourism: examples from the Field. London New York: Springer Dordrecht Heidelberg.

Chakraverty, A., Mujumdar, A.S., Vijaya-Raghavavan, G.S., & Ramaswamy, H.S. (2003). Handbook of Postharvest Technology: Cereals, Fruits, vegetables, Tea, and Spices. New York: Marcel Dekker, INC.

Chanakyal,H.N.,and Dealwis,A.A.P. (2004). Environmental Issues and management in Primary Coffee processing. Process Safety and Environmental Protection, 82(B4): 291–300.

Choi,M.Y., Choi,W., Park,J.H., Lim,J., Kwona,S.W. (2010). Determination of coffee origins by integrated metabolomic approach of combining multiple analytical data. Food Chemistry 121:1260–1268.

Cuadraa,M., Rydberg,T. (2006). Energy evaluation on the production, processingand export of coffee in Nicaragua. Ecological modeling 1 9 6 : 421–433.

Dersoa,E., Wallerb,J.M. (2002). Variation among Colletotrichum isolates from diseased coffee berries in Ethiopia. CABI Bioscience, UK ,Crop Protection 22:561–565.

Devi,R., Singh,V., Kumar,A. (2007). COD and BOD reduction from coffee processing wastewater using Avacado peel carbon. Bioresource Technology 99 : 1853–1860.

Duarte, G. S., Pereira, A. A., Farah,A. (2010). Chlorogenic acids and other relevant compounds in Brazilian coffees processed by semi-dry and wet post-harvesting methods. Food Chemistry 118: 851–855.

Especial Edition: Oromia Coffee Farmers Cooperatives Union (OCFCU) 10th year Founding Anniversary. (2011).A.A., Ethiopia.

Ethiopian Commodities Exchange (ECX): <http://www.ecx.com.et> (checked on 03/12/11).

Farah,A., Monteiro,M.C., Calado,V., Franca,A.S., Trugo,L.C.,(2006). Correlation between cup quality and chemical attributes of Brazilian coffee. Food Chemistry 98:373–380.

Feria-Morales, A. M. (2002). Examining the case of green coffee to illustrate the limitations of grading systems/expert tasters in sensory evaluation for quality control. Food Quality and Preference 13:355–367.

Freitasa, A.M. C., Moscab, A.I. (1999). Coffee geographic origin - an aid to coffee differentiation. Food Research International 32: 565-573.

Frisullo,P., Laverse,J., Barnabà,M., Navarini,L., Del Nobile,M.A.,(2011). Coffee beans microstructural changes induced by cultivation processing: An X-ray microtomographic investigation. Journal of Food Engineering 109 : 175–181.

Foreign Trade Promotion manual for Ethiopian Diplomatic Missions Economic and Business Affairs General Directorate Addis Ababa (2007). Based on Ethiopian Customs Authority data.

Gonzalez-Riosa, O., Suarez-Quiroza, M.L., Boulangerb, R., Barelb, M., Guyotb, B., Joseph-Pierre, G., Schorr-Galindoc, S. (2007). Impact of ‘‘ecological’’ post-harvest processing on coffee aroma: II. Roasted coffee, Journal of Food Composition and Analysis 20, 297–307.

Juliana C.F. Mendonça, Adriana S. Franca , Leandro S. Oliveira. (2008). Physical characterization of non-defective and defective Arabica and Robusta coffees before and after roasting: Journal of Food Engineering 92 : 474–479.

Kleinwächter, M., Selmar, D. (2010). Influence of drying on the content of sugars in wet processed green Arabica coffees. Food Chemistry 119:500–504.

Kufa, T., Environmental Sustainability and Coffee Diversity in Africa: Ethiopian Institute of Agricultural Research. Jimma Research Center: Jimma, Ethiopia.

Mancha Agresti, P. D.C. , Franca, A. S., Oliveira, L. S., Augusti, R. (2008). Analytical, Nutritional and Clinical Methods Discrimination between defective and non-defective Brazilian coffee beans by their volatile profile. Food Chemistry 106 : 787–796.

Masoud,W., Jespersen,L. (2006). Pectin degrading enzymes in yeasts involved in fermentation of Coffea arabica in East Africa. International Journal of Food Microbiology 110 : 291–296.

Mattsson, B.,Sonesson, U. (2003). Environmentally- friendly food processing. England: Woodhead publishing Limited.

Mirna,S.Q.,Oscar,G.R.,M. ,Barel,M., Guyot,B., Sabine,S.G. &,Guiraud, J.P. (2004). Study of ochratoxin A-producing strains in coffee processing. International Journal of Food Science and Technology: 39, 501–507.

Mohammed, A. (2007). Recreation use value of Wondo Genet wetland ecosystem – Ethiopia Masters' Thesis, submitted to the Swedish University of Agricultural Sciences.

Mudambi, S.R., Rao, S.M., Rajagopal, M.V. (2006).Food science .New Delhi: New Age International Ltd.

Muleta D., Assefa, F., Nemomissa, S., Granhall, U. (2007). Composition of coffee shade tree species and density of indigenous arbuscular mycorrhizal fungi (AMF) spores in Bonga natural coffee forest, southwestern Ethiopia: Forest Ecology and Management 241, 145–154.

Musebe, R., et al. (2007). Primary coffee processing in Ethiopia: Patterns, constraints and determinants. African crop science conference proceeding Vol.8.pp.1417-1421.

Musebe R., Agwanda C. A., Oduor G. I., Negussie E., Mitiku M.(2011).Costs and efficacy of operating coffee hand pulpers in Ethiopia: A cost- benefits analysis. *African Journal of Business Management* Vol. 5(11), pp.4415-4422, ISSN 1993-8233.

Noonim,P., Mahakarnchanakul,W., Nielsen, K.F., Frisvad, J. C.,. Samson, R. A., (2008). Isolation, identification and toxigenic potential of ochratoxin A-producing Aspergillus species from coffee beans grown in two regions of Thailand. *International Journal of Food Microbiology* 128:197–202.

Ory, R.L., Angelo, A.J.St. (1977). Enzymes in Food and Beverage Processing. Washington, DC: ACS Symposium Series; *American Chemical Society*.

Oscar, G.R., Mirna S.Q.,L., Boulangerb,R., Barelb,M., Guyotb,B., J.P.,Guiraudc, S. G.,Sabine. (2007). Impact of ‘‘ecological’’ post-harvest processing on coffee aroma: II. Roasted coffee. *Journal of Food Composition and Analysis* 20:297–307.

Otim,S.,and Ngateize. (1993). Uganda coffee supply response and export demand: An econometrics analysis. Kawanda research institute, Uganda.

Parker, J.N., Parker, P.M. (2003). Coffee: A medical dictionary, bibliography, and annotated research guide to internet references. San Diego: ICON group International, Inc.

Reddy,R.N. (2010) Agricultural process Engineering. New Delhi: Gene-Tech Books.

ROASTeCoffeeBuzz: Brazilian-Coffee-Co-op-Helps-Farmers-Mechanize. <http://www.roaste.com/CafeRoaste/ News/07/08/2011>.

Sacchetti,G., Mattia,C.D., Pittia,P.,Mastrocola, D. (2009). Effect of roasting degree, equivalent thermal effect and coffee type on the radical scavenging activity of coffee brews and their phenolic fraction. Teramo, Italy: *Journal of Food Engineering* 90 :74–80.

Selvamurugan,M., Doraisamy,P., Maheswari,M. (2010). An integrated treatment system for coffee processing wastewater using anaerobic and aerobic process. Ecological Engineering 36:1686–1690.

Senbeta, F., Denich, M. (2006). Effects of wild coffee management on species diversity in the Afromontane rainforests of Ethiopia. Forest Ecology and Management 232, 68–74.

Sharangi, A.B. (2009).Encyclopedia of horticulture and Allied Terms. Delhi: Daya Publishing house.

Siu,Y., G. Mejia .J. Mejia-Saavedra., J. Pohlan .M. Sokolov (2007). Heavy Metals in Wet Method Coffee Processing Wastewater in Soconusco, Chiapas, Mexico. Springer Science + Business Media, LLC: Bull Environ Contam Toxicol ,78:400–404.

Small-scale coffee processing: practical action, The Schumacher center for technology and development. Intermediate technology development group Ltd patron HRH. Bourton Hall,UK.

Solange, I. Mussatto & Ercília M. S., Machado & Silvia Martins & José A.

Teixeira. (2011). Production, Composition, and Application of Coffee and Its Industrial Residues. Food Bioprocess Technol 4:661–672.

Suarez-Quirozb,M., Gonzalez-Riosb,O.,Barela,M.,Guyota,B., Schorr-Galindob,S., G.,Joseph-Pierre.(2005). Effect of the post-harvest processing procedure on OTA occurrence in artificially contaminated coffee. *International Journal of Food Microbiology* 103 : 339– 345.

TechnoServe Coffee Initiative Ethiopia <http://www.technoserve.org/worimpact/success-stories/brewing-good>(online checked on 20/12/2011).

Tolosa, D. (2005). Combining Household Qualitative and Quantitative Data in Food Security Research. Working Papers on Population and land use in Central Ethiopia, no. 5 ACTA Geographica-Trondheim, Norway.

Velmourougane, K., Rajeev Bhat, b, T.N. Gopinandhan c, P. Panneerselvam. (2011). Management of Aspergillus ochraceus and Ochratoxin: A contamination in coffee during on-farm processing through commercial yeast inoculation, Biological Control 57, 215–221, Elsevier Inc.

Willem J. Boot (2011).Ethiopian Coffee Buying Manual: Practical Guidelines for Purchasing and Importing Ethiopian Specialty Coffee Beans. Fintrac Inc.: US Virgin Islands, USAID/Ethiopia's Agribusiness and Trade Expansion Program.

Wintgens, J.N. (2004). Coffee: growing, processing, sustainable production. A guide book for growers, processers, traders, and researchers. Wiley-VCH.Weinheim.

Appendices

Appendix 1 - Questionnaire Conducted to Oromia Coffee Farmers Cooperative Union Office (OCFCU)

For the Partial Fulfillment of MSc, I am kindly requesting you to provide accurate and genuine information so that, I can be able to make appropriate conclusion based on your information. Thanks in advance for your faithfulness.

1. What is OCFCU?
2. How many members are in the union?
3. What benefits are they getting being organized?
4. Total capacity of coffee production in the Union?
5. Types of coffee processing machineries which are available in the union and the region?
    - Manual harvesting
    - Harvesters on Wheels
    - Kinds of Winnows
    - Pulping machines
    - Mucilage Removal
    - Milling
    - Coffee drying machines
        - Natural drying
        - Mechanical Dryers
    - Green coffee Sorting machines
6. Total amount of green coffee provided to national market in kg?
        - washed
        - Unwashed
7. Comparing local consumption and national market supply, which one is higher?
        - Domestic consumption
        - Supplied to the national market

8. Are there any assigned professionals from your office to support farmers in their coffee production, especially in terms of processing?

    - Yes
    - No

9. Are there any capacity building and financial supports that you supply to the farmers for their coffee processing

    Yes ☐ No ☐

10. What do you think about the farmer's knowledge about coffee processing in terms of quality?
11. Do you think the farmers do care about their coffee quality?
12. In which stage is the biggest challenge take place for coffee processing in general?
    a. In the time of Seedling.
    b. In the time of Plantation.
    c. In the time of Harvesting.
    d. In the time of Coffee drying (processing).
    e. In the Storage time.
    f. Other…….
13. Is it possible to determent the coffee quality in the harvesting (cherry picking) time?
14. Are there any measures undertaken to promote organic coffee production?

    Yes ☐ No ☐

15. According to your knowledge, do you think there is any kind of research about Ethiopian coffee processing system?

Appendix 2 - Questionnaire Conducted to Wondo Genet Local Coffee Farmers

1. How much part of your total farm land is covered by coffee trees?
   - o ≤ hectares (1ha=10,000kare meter)
   - o ≥ hectare
2. Do you have any other income sources other than coffee?

   Yes ⌟ No ⌟
3. What is your annual dry coffee cherry production in kg?
   - o ≤50
   - o 51 to 100
   - o ≥ 101
4. What do you do with your coffee production?
   - Consuming all in the house
   - Selling all in the local market
   - Selling all for cooperatives
   - Some for house consumption and the rest selling into local market
   - Other……
5. What kind of coffee processing are you using?
   - o Dry processing for house consumption and for local market
   - o Wet processing
   - o None of them
6. What kind of coffee drying methods you are using?
   - o Sun drying
   - o Mechanical drying

7.Which kind of coffee processing machinery exist in your area, could be private, government or cooperatives?
   - o Coffee drier machineries
   - o Hulling station
   - o Wet processing unit
   - o Any other machineries if you know
8. Do you have any access from your district like coffee union or any other agencies in terms of coffee machineries usage? Yes No