

**ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY
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**DETERMINANTS OF COFFEE QUALITY IN WEST WALLAGA ZONE OF
OROMIA REGIONAL STATE**



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Technology University in Partial Fulfillment of the Requirements for the Degree of
Master of Science in Development Economics**

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Acronyms and Abbreviations

ARDO	Agricultural and Rural Development Office
CBD	Coffee Berry Disease
CDMIP	Coffee Development and Marketing Improvement Plan
CFC	Common Fund for Commodities
CLU	Coffee Liquoring Unit
CSA	Central Statistical Authority
CTDA	Coffee and Tea Development Authority
EAFCFA	East Africa Fine Coffee Association
ECEA	Ethiopian Coffee Export Authority
ECEE	Ethiopian Coffee Export Enterprise
EEA	Ethiopian Exchange Authority
FDRE	Federal Democratic Republic of Ethiopia
FAO	Food and Agricultural Organization of the United Nations
FTC	Farmers Training Centre
GARC	General Agricultural Research Center
GDP	Gross Domestic Product
ICO	International coffee Organization
ICM	International coffee market
ISO	International standard setting organization
ITC	International Trade Centre
MCTD	Ministry of Coffee and Tea Development
MOA	Ministry of Agriculture
NCBE	National Coffee Board of Ethiopia
NGOs	Non-governmental Organizations
OBPED	Oromia Bureau of Planning and Economic Development
OLS	Ordinary Least square

PAs	Peasant Association
RWH	Rain Water Harvesting
SNNP	Southern Nations and Nationalities and people
SNNRS	Southern Nations and Nationalities Regional States
UNDP	United Nations Development projects
VIF	Variance Inflation Factor
WFP	World Food Program
WWZPEDO	West Wallaga Zone Planning and Economic Development Office

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DETERMINANTS OF COFFEE QUALITY IN WEST WALLAGA ZONE OF OROMIA REGIONAL STATE

ABSTRACT

Coffee Arabica is an economically important crop, which is contributing the highest of all export revenues in Ethiopia. West wallaga is one of the major coffee producing zones of Oromia region. But there is lack of profound assessment works to identify the specific coffee quality problems in the zone and lack of adequate information on the effects of harvest and post harvest handling and processing techniques on coffee quality. Therefore, this study was conducted with an objective of identifying determinants of coffee quality of the study area. The sampling technique used to draw peasant associations (kebele) was systematic random sampling based on probability and 226 respondents of household farmers' were selected purposely. Cross-sectional types of data were used. These data were analyzed by employing the statistical procedures of Stata11. The logistic regression model was used to analyze the effect of explanatory variables on explained variable. From 14 explanatory variables analyzed in the study seven of them (method of weed control, prevalence of disease, compost application, harvesting stage, availability of storage, availability of train and sex of the household farmer) were statistically significant. On the other hand, experimental result of the study area revealed that out of 226 respondents, coffee quality of 74 (32.74 percent) household farmers was poor qualified and for 152(67.26 percent) of households' the quality was good.

The recommendation to the problem related to coffee quality were, active participation of ARDO and DAs to recall, encourage and enforce household farmers to control weed and developing best practice among farmers, cutting disease infected tree or changing species of coffee after a given period of time, more applying composts, harvesting in three stages to select only full red beans, expanding qualified storage by farmers, providing door-to-door training and giving special supports for female households in order to promote quality of this crop. The overall comment is that, the government must establish coffee quality measures and tasters at the rural household farmers' level and Price-quality relation must be established for coffee suppliers in the rural areas.

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Ethiopia is one of the least developed countries of the world with an average GDP per capita income of 315.99 US dollars in 2014 and with an average annual Gross Domestic Product (GDP) growth rate of 7.9 percent during 1991-2014 periods (World Bank, 2014). The country's economy is highly dependent on agriculture. The sector contributes about 40 percent to GDP, provides both direct and indirect employment to about 85 percent of the population and accounts for more than 90 percent of the country's export earnings. Therefore, it is widely accepted that the development of the agricultural sector has a crucial role in determining the course of industrialization (EEA, 2013). The Ethiopian Investment Authority (EIA, 2010) stated that, Agriculture is the mainstay of the Ethiopian economy and the most volatile sector mainly due to its dependence on rain and the seasonal shocks that are frequently observed.

The agricultural sector is crucially important to produce high quality export crops, which have significant demand in the world market. Although many crops are grown in the country, she is known in exporting only a few agricultural products. Some major export products of the country are coffee, chat, sugar products and cut flowers. Out of these a few agricultural export products, coffee is the single most important one that is contributing significantly to the country's economy. It plays major role in generating foreign exchange that is required to finance imports of essential goods.

In addition to being the most important export crop of the country, it significantly contributes to government revenue in the form of taxes and generates significant amount of employment opportunities (FAO, 2008). By and large, the same reference show that, the coffee sub-sector accounts for 81.2 percent of the total export trade tax revenue.

Coffee is the major source of foreign currency for Ethiopia and contributes more than 35% of the total export earnings (FAO/WFP, 2008). Thus, it is a cornerstone in the export economy of the country and it supports directly or indirectly the livelihood of over 15 million people (EEA,

2013). In Ethiopia, coffee is produced in four production systems, namely: forest, semi-forest, garden and plantation coffee in the Western, Southern, and Southwestern parts of the country (CFC, 2004). Coffee grows under diverse environmental conditions ranging from 550 m to 2600 m above sea level, with annual rainfall from 1000-2000 mm, temperature (minimum and maximum from 8-15°C⁰, and 24-31°C⁰, respectively), requires deep, well drained, loamy and slightly acidic soils (Paulos and Tesfaye, 2000). The estimated area of land covered by coffee is about 600,000 hectares, whereas the estimated annual national production of clean coffee is about 350,000 tons (Alemayehu *et al.*, 2008).

The objectives of the government with reference to the coffee sub-sector are to maximize foreign exchange earnings by exporting quality coffee and meet domestic demand for coffee. The government, thus, encourages the expansion of coffee production, processing systems and protecting of quality of coffee in the major parts of the Ethiopian rural economy (ECE, 2009).

Coffee is grown in many parts of the country. However, the major producing areas are Wallaga, Sidama, Kefa, Iluababor, and Hararghe which taken together account for more than 85 percent of national production (Gari, 2002). Each Woreda (district) of the country is classified as a major, medium and minor coffee grower based on the area covered by coffee trees (FDRE, 2003). Coffee production is concentrated mainly in the Oromiya and the Southern Nations Nationalities and People's Region (SNNPR).

Land covered by coffee in Ethiopia estimated to be 600,000 hectare and 63.3 per cent of it is found in Oromiya, 35.9 per cent in SNNP and 0.8 per cent in Gambela. Smallholder producers are responsible for about 95 per cent of production, while state-owned plantations account for 4.4 per cent and private investor plantations 0.6 per cent (FDRE, 2003).

West Wallaga zone is one of coffee growing zones in the Oromia Regional State, which has an estimated total area of land 23778.13 square kilometer (WWZPED, 2014). Currently, the total area of land covered by coffee in the zone is about 269,000 hectares, which includes small-scale farmers' holdings as well as state and private owned plantations. Coffee is the major cash crop of the Zone, which is produced in all woredas' of the zone.

Despite the favorable climatic conditions, variety of local coffee types for quality improvement and long duration of its production in west wallaga zone, coffee quality is declining from time to

time due to several improper pre-and post-harvest management practices. These quality problems are mainly associated with poor agronomic practices like uncontrolled shade level, lack of stumping, pruning and weeding; poor harvesting practices, such as stripping and collecting dropped fruits from the ground; improper post harvest processing and handling practices such as drying on bare ground, improper storage and transportation (Desse, 2008).

The expected potential for quality coffee production in the west Wallaga zone was very high considering its suitable environmental conditions such as altitude, rainfall, temperatures and fertile soil. To use efficiently these natural gifts and increase living standards of smallholder farmer and promotes economic development of the country in general and of the study area in particular; identifying determinants and solving the problem of coffee quality during harvest and post harvest management is very important.

1.2 Statement of the Problem

Coffee has significant contribution to the socio-economic development of the country. These are Source of income, employment contribution, foreign exchange contribution, output (GDP) contribution and the like. In order to properly exploit these benefits, substantial investment has been undertaken in this sub-sector.

The country has also taken various improvement measures in order to increase coffee output. These measures, besides improving the quality of the raw material and promoting marketing of processed coffee, include planting of disease resistant strains and fighting of coffee berry disease (CBD) and pests. However, there has been a serious doubt whether the quality of coffee production and processing and performance from this sub-sector has been satisfactory (World Bank, 2008).

In order to clear this doubts, identifying determinants of coffee quality and its related problems is important to overcome the problem and capitalize for good quality. Such information (study) could facilitate corrective measures to reverse misdirected or misplaced efforts, and guide future planning and decision-making in view of improving future performance of the growers and traders.

Some researchers identified determinants of quality of coffee in the country generally and in the Oromia region specifically. For instance, according to Tirufat (2011), quality of Coffee was

critical important to the coffee industry; but, the quality and productivity of Ethiopian coffee has been deteriorating from time to time, largely due to the quality awareness problem, stakeholders especially farmers and processors were not well trained about quality production, price paid for producers doesn't consider quality, problems of infrastructures and materials, predominant use of traditional production and processing methods.

Additionally, Desse (2008) and Anwar (2010) identified that coffee quality problems were mainly associated with demographic factors, poor agronomic and physiological like uncontrolled shade level, lack of stumping, pruning and weeding, poor harvesting practices, such as stripping and collecting dropped fruits from the ground and institutional factors. According to Ethiopian Commodity Exchange Authority (ECEA, 2008), the major quality problems that have observed on Ethiopia coffee include problems related to: Coffee harvesting, Processing and warehousing.

However, quality of coffee was influenced not only by those factors identified by the above researchers. Despite the favorable climatic conditions and variety of local coffee types for quality improvement, still there are gaps such as lack of profound assessment works to identify the specific coffee quality determinants and its problems in west wallaga zone and lack of adequate information on the effects of harvest and post-harvest processing and handling techniques on coffee quality.

The study was, therefore, designed to identify determinants of the coffee quality and its related problems in the West Wallaga Zone of Oromia Regional State thereby forward ways and means that would help growers and processors to produce better quality coffee in the zone.

1.3 Objectives of the study

The overall objective of this study is to evaluate coffee quality and its related problems in the west wallaga zone of Oromia regional state. The specific objective of the study is to identify determinants of coffee quality in the study area.

1.4 Significance of the Study

Over a million coffee farming households and about one fourth of the total population of the country are dependent on production, processing, distribution and export of coffee (Tirufat, 2011). Therefore, improving production, productivity and quality of coffee can assist the quest for poverty alleviation in the country.

The information generated by this study could be useful for the Agricultural and rural development office managers and experts, growers and traders of coffee, development planners, price setters and other government institutions.

The study would help to formulate and implement effective measures and adjustments that improve coffee quality related to harvest and post-harvest technologies and thereby contribute to the country's economic development in the future. Moreover, the study could also serve as a springboard for further comprehensive study.

1.5 Scope of the Study

Measuring quality of coffee and related problems in the whole Oromia region is very important for accuracy of the estimates and reliability of inferences. But due to insufficient financial resource as well as time limitations, the study was restricted to sampled farmers and traders in the western part of the Regional State, particularly western Wallaga Zone that started in September, 2014 and ended in August, 2015.

1.6 Limitation of the study

While the study was conducted so many constraints were observed by researcher. Some of them include; some farmers were not allowable to give response, because of fearing it as political issue. The researcher bases on the coffee farm size in order to select household respondent. But, many farmer households were afraid to tell their coffee farm size because of fear of additional tax. In order to assess quality in terms of cup quality; there are no tasters of cup quality of coffee (Odor and aroma taster) in the study area. Instruments used to assess quality of coffee (moister taster and slider) were not staid at a researcher home to use any time because; these properties are government office's ownership. Additionally, for more information and using as review literature there are no enough references and documentary sources regarding quality of coffee for the study area.

1.7 Organization of the Study

The study is organized in to five chapters. The first chapter includes background of the study, statement of the problem, objectives of the study, significance of the study, scope of the study, limitation of the study and organization of the study. The second chapter focuses on the theoretical review and empirical review literature related to the study. The third chapter deals with the description of the study area; sources and types of data used and research methodology followed and description of the model including dependent and independent variables.

The fourth chapter presents the results and discussion of the study that includes descriptive statistics and binary logistic regression analysis results and the final chapter presents summary, conclusions and some recommendations.

CHAPTER TWO

REVIEW OF LITERATURE

2.1 Theoretical Review

2.1.1 Origin, Growing Areas and Characteristics of Arabica Coffee

Arabica coffee is the only species found in Ethiopia which makes Africa the largest producer of Arabica beans (Trufat, 2011). Its centre of origin is geographically isolated from the centre of origin of other species of the genus *Coffea*. It is confined to the plateau of southwestern Ethiopia and on the Boma plateau of Sudan (Anthony *et al.*, 2001).

Arabica coffee is the earliest known and most widely distributed coffee species. It is grown throughout the tropical belt and in some areas even beyond the two tropics as in Brazil and Mozambique in the southern and in China in the northern hemisphere (Anthony *et al.*, 2001). Due to the dominance of traditional techniques, yields are low and although there is a good growing condition, Ethiopia is one of the world's lowest cost Arabica producers. National annual production is approximately 280,000 metric tons (FDRE, 2003).

In Ethiopia, coffee grows almost everywhere, under diverse environmental conditions ranging in altitude from 550-2600m above sea level and annual rainfall of 1000-2000mm (Wrigley, 1988). Although the major production areas are more concentrated in the south western and south eastern parts, coffee grows all over the country.

The size and shape of the beans differ depending upon the variety, environmental conditions and management practices. On average, beans are 10mm long, 6-7mm wide, and weight between 0.15 and 0.20g (CLU, 2008). Bean shape may be sub-globular, ovoid, oblong, linear-oblong, either rounded at both ends or pointed at one end and rounded at the other (FAO, 2005). The reach genetic wealth, the vast and highly suitable environmental conditions offer the greatest opportunity to produce superior quality coffee.

Ethiopian significant coffee producing regions have a particular taste and characteristic therefore, these coffee types are internationally well known. Even within a single region tastes are different. According to the International Trade Centre (ITC), 'Ethiopia produces some of the

world's finest "original" coffees such as Yirgacheffe, Limu and Harar. Other varieties of distinctively known coffee beans produced in Ethiopia, based on their contribution to the country's export are Jimma, Gimbi (west wallaga), Lekemti (East wallaga) and Sidama. These coffee types are internationally recognized and marketed either in blend or as 100percent Ethiopian products and they command high prices (Gari, 2002).

2.1.2 Coffee Production in Ethiopia

Yemen was the principal source of coffee Arabica germplasm before exploration began in Ethiopia a few decadesrd back (Anwar, 2010). Although early travelers and writers advocated many years ago that the Arabica coffee type originated in Ethiopia, after a more careful study of the biology of this rain forest plant, there was little to continue for careful observer that Desert Mountains of the Yemen be considered as the native habitat of an Ethiopian genetic center of coffee Arabica (Barel and Jacquet, 2010). The total area under coffee in Ethiopia was estimated to be 600,000 hectare from which about 351,000 tons of coffee was produced annually (CSA, 2008). About 97 percent of total coffee production and 95 percent of the total area cultivated with coffee in the country were under smallholder agriculture (FDRE, 2003).

Comparatively coffee holding sizes were small averaging from 0.6 hectare in Sidama zone to 1.2 hectare in Illuabbabor and 1.4 hectare in Wallaga zone (FDRE, 2003). Each Woreda (district) of the country was classified as a major, medium and minor coffee grower based on the area covered by coffee trees (FDRE, 2003). Coffee production was concentrated mainly in the Oromiya and the Southern Nations, Nationalities and People's Region (SNNPR).

Coffee was supplied to central market annually from different parts of the country. It was exported in two forms, namely unwashed and washed coffee. The unwashed coffee accounts for the largest proportion in foreign exchange earning of the nation. The proportion of unwashed coffee exported was greater in volume and value during 2007-2008 than that of the washed coffee, though washed coffee fetches the highest price on the world market (MCTD, 2008). The same source implies that about 84 percent of the total coffee export volume was supplied as unwashed type, while 16 percent was washed coffee. Similarly, unwashed coffee accounted for 79 percent of the value of coffee export.

There were about 18 zones of the country that regularly supply different quantities of coffee for central markets. In the year 2008, West Wallaga zone ranked first in supplying coffee that is stated by CSA (2009), as the largest supplier of coffee to the central market was West Wallaga zone with the total amount of 27,709 tons. It ranked first by covering 16.9 percent of the national supply and followed by Gedo, Jima and Sidama zones with their respective shares of 16.4, 15.5 and 12.3 percent, respectively. The four zones altogether accounted for 61 percent of the total supply of processed coffee of the nation.

There were three regions supplying coffee to the central market, namely Oromia, Southern Nations, Nationalities and Regional State (SNNRS) and Gambella Peoples Regional State. Oromia was the largest supplier of coffee (61 percent) followed by Southern Nations, Nationalities and Regional State (37.3 percent) and Gambella Regional State (1.6 percent) (CSA, 2009). The same source indicates value of coffee in the central market was ordered as of their volume supplied by these regions respectively.

2.1.3 The Concepts of quality in the Coffee Sector

The quality of coffee in the accepted sense of the term includes the physical, chemical, and organoleptic properties mainly sought after by the consumer (Lorey et al. 2006). These properties, which manifest themselves in appearance, shape and size, may be very different according to the type of coffee (Arabica, Robusta etc), the country of origin and the method adopted for processing, roasting and even the preparation of the brew (Barel and Jacquet, 2010).

For coffee, the definition of quality and the attributes considered have probably evolved through the centuries. But nowadays, this definition varies along the production to consumer chain which is at the farmer level, coffee quality is a combination of production level, price and easiness of culture; at the exporter or importer level, coffee quality is linked to bean size, lack of defects and regularity of provision, tonnage available, physical characteristics and price; at the roaster level, coffee quality depends on moisture content, stability of the characteristics, origin, price, biochemical compounds and organoleptic quality (Lorey et al. 2006).

Consumers have their preferences which vary from country to country and individual to individual, and these preferences dictate what is eventually purchased (Lorey et al. 2006).

More specifically, ISO (2004) define a standard for green coffee quality as; it requires several pieces of information, like the geographical and botanic origins of the coffee, the harvest year, the moisture content, the total defects, the proportion of insect-damaged beans and the bean size.

The quality of coffee is primarily determined by agro-ecology, genetic make-up, and management practices applied to coffee in the harvest and post-harvest processing and handling practices (Barel and Jacquet, 2010). The agro-ecology of the study area is excellent quality coffee production since it is within the ecological range of coffee where there is still wild population.

The genetic makeup of coffee in the study area, coffee Arabica, is most favorable to promote quality; its coffee beans are not so small. Hence, most problems of quality are attributed to the harvest and post harvest management practices. This includes problems related to harvesting, storage, processing, and transportation of the coffee bean. As of Ethiopian Commodity Exchange Authority the major quality problems that have observed on Ethiopia coffee include problems related to: Coffee harvesting, warehousing and Processing.

Coffee has value to give the consumer pleasure or satisfaction through flavour, aroma and desirable physiological and psychological effects (Yemane, 1998). Therefore coffee quality determines both the relative price and usefulness of a given quantity of coffee. Cup quality, often referred to as drinking quality or liquor quality, is an important attribute of coffee and acts as yardstick for price determination (Negussie *et al.* 2008). From the above reviews we understand that there is coffee quality problems related to harvest and post-harvest factors. However, most of these factors were not identified and explained specifically.

2.2 Empirical Review

2.2.1 Factors affecting Coffee quality

Coffee quality is a complex characteristic which depends on a series of factors such as the species or variety (genetic factors), environmental conditions (ecological factors), agronomical practices (cultivation factors), preparation of the beverage and taste of the consumer (Moreno *et al.*, 1995). Coffee quality is of critical importance to the coffee industry (Anwar, 2010). Quality coffee is a product that has desirable characteristics such as clean raw and roasted appearance, attractive aroma and good cup taste (Behailu *et al.*, 2008).

However, in Ethiopia the quality of coffee produced by farmers has been deteriorating from time to time (EEA, 2013). Moreover, factors that determine coffee quality are climatic conditions and soil characteristics of the area, agronomic practices, harvesting methods, storing, and processing, all contribute either exaltation or deterioration of coffee (Behailu *et al.*, 2008). Similarly, Damanu (2008) reported coffee quality, (at national level) as a combination of climatic conditions and the care taken during growing, harvesting, storage, exports preparation and transport. Furthermore, inadequate systems of harvesting, processing, storage and transportation are responsible for the wide spread failure to maintain the inherent quality of coffee produced in Ethiopia (Alemayehu *et al.*, 2008).

Climatic and Soil factors

The environment has also a strong influence on coffee quality (Decasy *et al.*, 2003). Altitude, temperature fluctuation, amount and distribution of rainfall and the physical and chemical characteristics of the soil are very important factors (Anwar, 2010). Climate, altitude, and shade play an important role through temperature, availability of light and water during the ripening period (Decasy *et al.*, 2003). Rainfall and sunshine distributions have a strong influence on flowering, bean expansion, and ripening (Harding *et al.*, 1987).

The slowed-down ripening process of coffee beans at higher elevations (lower air temperatures), or under shading, allows more time for complete bean filling (Vaast *et al.*, 2006).

The slower maturation process should therefore play a central role in determining coffee bean quality, and also its beverage quality (Silva *et al.*, 2005). Besides the beneficial effect of longer duration of the bean-filling period, a larger leaf area-to-fruit ratio (better bean-filling capacity) may also be linked to superior cup quality (Vaast *et al.*, 2006).

The role of soil types has been well studied and it is generally admitted that the most acidic coffee quality is grown on rich volcanic soils (Harding *et al.*, 1987). The perceived acidity of coffee brews has always been recognized as an important attribute of coffee quality. Acidity is typically a highly valued quality especially in Central American and some East African coffees (Yigzaw, 2005). Sourness, however, is an extreme of acidity and can be considered as defect. Acidity has been correlated with coffees grown at very high altitudes and in mineral rich volcanic soils.

On top of this Yigzaw (2005) reported that if other factors are kept constant, better quality coffee can be found at higher altitudes, while low land coffee were found to be somewhat bland, with considerable body. Moreover, coffee from high altitude areas was more acidic, with better aroma and flavor. Woelore (1995) reported that factors such as total rainfall, relative humidity, maximum-minimum temperatures with effect on water vapor content of the air and storage duration greatly affect quality of stored parchment coffee. Periods of prolonged drought may also result in lower quality beans (Wintgens, 2004). Most of the coffee tasters agree now that there is very little or no difference in flavor at all between the Arabica pure breeds cultivated under similar agro-climatic conditions (Wintgens, 2004).

Genetic factors

As harvesting method, the physiology of the plant itself and its genetic origin (species and genotype) also greatly influence coffee quality (Leroy *et al.*, 2006). Agwanda (1999) compared four traits (acidity, body, and flavor) and overall standard for their suitability as selection criteria for the genetic improvement of overall liquor quality. According to the author, based on correlation, repeatability and sensitivity analysis, flavor rating was recommended as the best selection criterion for genetic improvement of cup quality in Arabica coffee. But, this was not at suppliers level quality tasting.

The study of Yigzaw (2005) also revealed that coffee quality depends on genetic make-up and genes control the production of chemical compounds that behave as aroma agents either directly or as aroma precursors expressed during the roasting process. Hence while selecting a cultivar to be planted; coffee quality must be the first priority to be considered (Yigzaw (2005). Similarly, Agwanda *et al.* (2003) reported significant genotype- environment interaction effects on coffee bean quality. Selvakumar and Sreenivasan (1989) observed coffee quality variation ranging from good to excellent among 54 Arabica coffee accessions collected from Keffa, Ethiopia.

The genotype is a key factor, since it determines to a great extent important characteristics such as the size and shape of the beans as well as their color, chemical composition and flavor (Wintgens, 2004). The same source shows that the shape and structure of beans (elephant, pea bean and empty beans) are the result of both genotype and environmental factors.

Institutional factors

The National Coffee Board of Ethiopia (NCBE) was the first institution responsible for coffee which was established in 1957 with the aim of upgrading coffee quality, stimulating cooperative production, establishing marketing associations, conducting research and dissemination of information on coffee production, processing and marketing.

Then after, the plantations in the southwestern part of the county were organized under southwestern Agricultural Development organization. Eventually coffee plantations were organized under the Ministry of Coffee and Tea Development. From 1979 to 1989, coffee auction market had been operating under the control of the government that means the government set price ceiling, which was not competitive. After the 1990 market policy reform, the auction market was made free and the individual exporters and the Ethiopia Coffee Export Enterprise (ECEE) operate compositely by referring to the most recent world market price for Ethiopia coffee (Admasu, 1998).

In 1993, the Ethiopia Coffee Marketing Corporation (ECMC) was restructured in to two enterprises: the Ethiopia Coffee purchase and Sale Enterprise (ECPSE) and the Ethiopia coffee Export Enterprise (ECEE). Though research on coffee have been conducted nationally for more than four decades, the target of coffee research in Ethiopia was to develop CBD resistant, high yielding and wide adapting varieties to release for major coffee growing areas of the country (Getu, 2009). Coffee berry resistant crop has more opportunity to produce qualified coffee compared to others. However, there was no extensive coffee quality research conducted in the country except on fermentation, drying depth and time of storage (Solomon and Behailu, 2006).

Coffee Development and Marketing Improvement Plan in Ethiopia (CDMIP) was launched since 2003 to maximize the benefits driven from coffee by optimizing production and marketing systems of the industry (Alemayehu *et al.*, 2008). According to their report, the small holding coffee farmers in particular could not able to make use of appropriate inputs and implement tools such as pruning shears, bow saw and drying materials largely due to unavailability, poor purchasing capacity and absence of appropriate credit systems.

Effective Agricultural Extension services are of paramount importance for farmers to get timely advices and information on the availability, use and application of new, improved and modern agricultural inputs, technologies and practices. The Kiltukara and Manasibu Agricultural and

Rural development offices are responsible to offer agricultural extension services. Under these offices, different experts with different professions were organized at all levels and Development Agents (DAs) at Farmers Training Center (FTC). The Development Agents at the FTC are responsible to give extension services to the farming community and they are accountable to the Woreda Agricultural offices.

According to Jacquet *et al.* (2008), prior to market liberalization washed coffee was subjected to intensive supervision and close monitoring with the aim of keeping its quality in respect to training and technical advices about quality cherries collection, processing, drying and storing to concerned groups. But, currently, the intensity of supervision is reduced because of various factors including limitation of logistics, financial and human resources above all, there are no cherries formal market areas and legally identified coffee purchasers, delay of collected cherries a day before delivered to washing station and narrow price difference between different coffee grades (Jacquet *et al.*, 2008).

Socio-economic factors

Factors determining the adoption of technologies are more complex in case of perennial crops like coffee than in the case of annual crops. This is because of the difficulty in securing the benefits associated to the technologies due to the time gaps, and the nature of the commodity trade, which, is influenced by international markets (Admasu, 2008).

On the other hand, Mulugeta (1999) reported that access to credit, farm size, supplementary inputs, technical and institutional support like the extension service determine the adoption of technologies. Furthermore, Negussie *et al.* (2008) reported that family size, extension contact, attendance of training and experience in coffee farming did not significantly influence farmers' perception in survey made in any coffee productive woredas. According to their report adoption of improved varieties, literacy, visit and proximity to research center positively influenced farmers' perception.

2.2.2 Problems encountered in Coffee Supply

According to Ethiopian commodity Exchange Authority (ECEA, 2008) the following were problems encountered in coffee supply of Ethiopia.

Problems related with quality

There are many factors that contribute to the quality of coffee. They are mainly handlings by producers (man) and nature (Coffee variety, soil characteristics, moisture and manure supplied etc). Natural phenomenon includes altitude, duration and severity of rainfall, type of soil, genetic origin, and location of producing area, chemicals and pesticides. Harvesting methods and timing, packing and the likes were man related phenomenon. Supervision of quality coffee begins with the coffee seedlings and ends when the coffee was shipped out to the international market.

However, the supply of Ethiopia coffee (both wet-processed and sun-dried) to local and international market faces some basic quality problems. This quality problem makes the Ethiopian coffee unable to adequately compete in the international coffee market and earn reasonable price. The major quality problems that have observed on Ethiopia coffee include problems related to: Handling during harvesting, warehousing and Processing, that was usually done by coffee collectors or assemblers and whole sellers.

All these problems exert a negative influence on quality of coffee and made it not to be competitive and earn desirable prices in both local and international markets. The main sources of these problems among others include: Inadequate capacity and awareness of coffee producers and processors on quality, Lack of sufficient standard coffee processing machine in the major coffee producing areas or sometimes improper installation of coffee processing machine, Lack of proper place for coffee processing, Inadequate inspection, proper regulatory and controlling system and supervision of responsible bodies in the assembling, processing or preparation of coffee during harvesting due to negligence or lack of sufficient awareness (ECEA, 2008)

Inadequate Supply response due to insufficient prices

Farmers get very low prices compared to final boarder prices of the product in the local market. The greatest parts of the marketing margin go to the marketing middlemen. Similarly, in international market, coffee export is not getting the proper price it deserves. This has become disincentive to farmers in their coffee production. Several studies show that many farmers has shifted from coffee production to other high value cash crops such as chat in the years where there were very low prices such that in the early first have of 2000s (like 2001). For this reason, the overall coffee supply has not also grown as significantly as it is required to be. This is termed as low supply response from the side of coffee producers.

CHAPTER THREE

DATA AND METHODOLOGY

3.1. Description of the Study Area

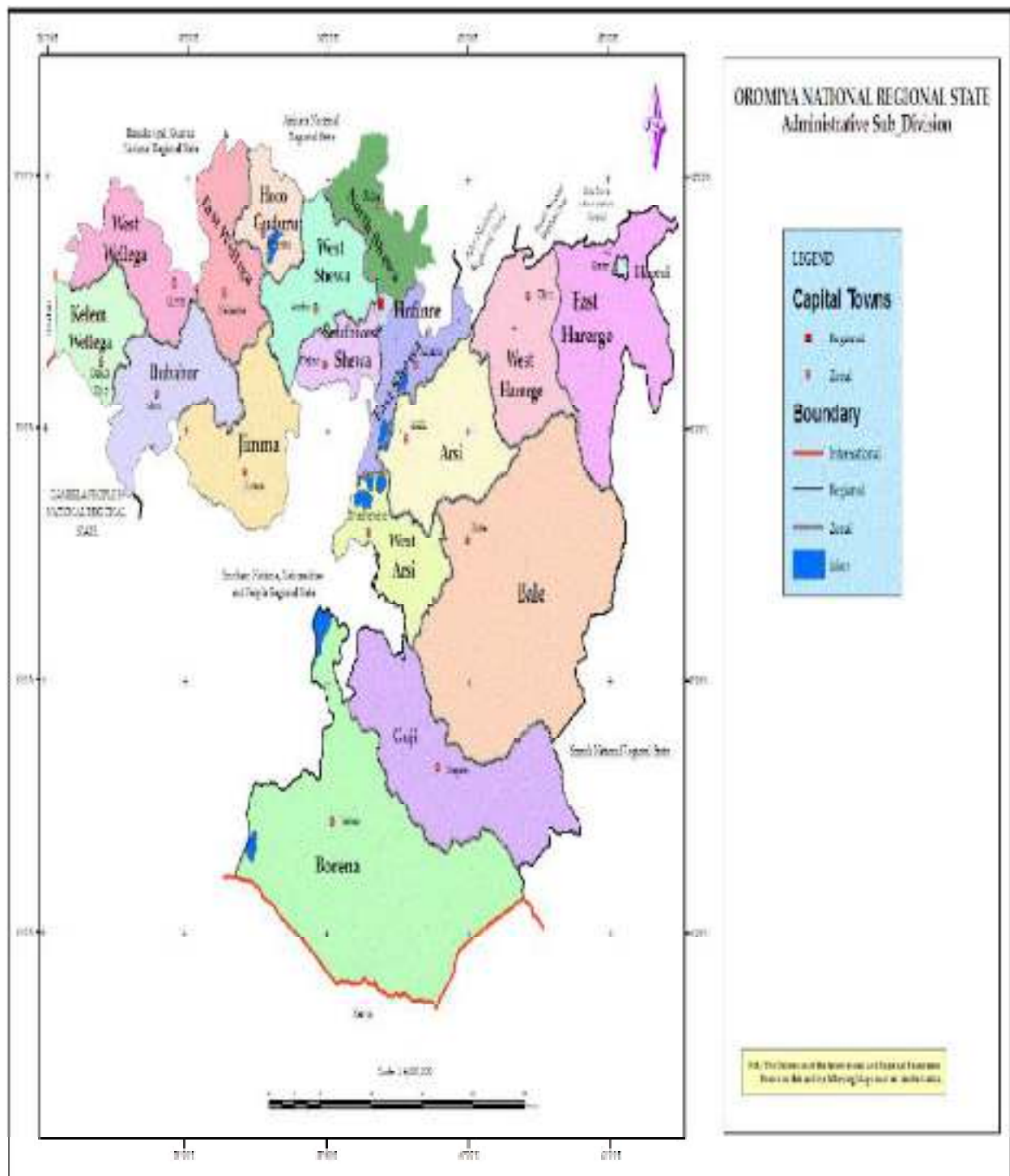
The study area, western Wallaga Zone, is one of Oromia National Regional State zones that faraway 441 kilometers from Addis Ababa, the capital of the country. The zone is situated at latitudinal and longitudinal ranges of $65^{\circ} 08' N$ to $89^{\circ} 15' N$ and $364^{\circ} 9' E$ to $340^{\circ} 10' E$ geographical grids, respectively (WWZPEDO, 2014).

The estimated total area of the zone is 23778.13 square kilometer that is about 6.8 percent of the total area of Oromia national regional state. West Wallaga zone is divided into 20 districts and further into 588 kebeles including Gihmbi , mendi and Nedjo towns. East Wallaga zone in the east, Illuababora zone in the south east, Beneshangul Gumuz Regional State in the west, north and north east, and kelem wallaga (Dambidolo) in the south border. (Figure1).

Topographically, it is characterized by diversified landforms, that is, mountains (such as Tulu Walal, Jorgo, Guma Gararba and Gori Mariam), dissected plateaus, hills, plains, valleys and gorges. The altitude range of the zone extends between 500 to 3340 meters above sea level and drained by several perennial rivers (like Birbirs, Dabus, Deddessa, Deggero, Sachi, Kujjur, Komis etc.) and tributaries. The climatic condition of the zone is classified into three basic groups: Dega, Winadega and Kola accounting for 62.5, 33.8 and 3.7 percent, respectively. The annual rainfall ranges from 1500 mm to 1840 mm and the mean annual temperature of the area is $24^{\circ} C$ (MCTD, 2000). High forest, woodland, reverine, shrubs and bush, savanna and man-made forests are available in the zone. The total population of the zone is estimated to be 1.9 million of which 0.94 million (49.4 percent) are males and 0.96 million (50.6 percent) are females. About 96 percent of the total populations of the zone dwell in rural areas and most of them (51.7 percent) are economically active (CSA, 2008).

A mixed farming system is practiced in the zone in which Crop production is dominant. The zone has an estimated arable land of 31.9 percent, of which about 27.8 percent is under cultivation while the rest is covered by grazing land, forest and others.

Figure1: Map of Oromia



Source: WWZPEDO, 2015

The major crops grown in the area include teff, maize, sorghum, barley, wheat, millet, haricot bean, field pea, chickpea, Niger seed and groundnuts. Moreover, coffee, chat, orange, banana, avocado, lemon, mango, and papaya are the major perennial crops grown in the zone. Coffee is the dominant cash crop grown almost in all districts of the zone. Likewise, West Wallaga zone had about 1.5 million livestock population of which 71.5, 14.4, 7.6 and 6.5 percent were cattle, sheep, goat and equines, respectively (WWZPEDO, 2014). Regarding the industry sector, there is no modern large-scale industry exists, but there are relatively a few small and medium scale industries available in the zone. These include grain mills, coffee hullers, coffee pulpers, wood works, metal works, oil mill and brick manufacturing.

The major transportation service is from road transportation. There are two main rural gravel roads crossing the zone to different directions. The main road passing from Addis Ababa to Asosa crosses the zonal capital Ghimbi town, Nedjo and Menesibu districts and passes to the west is asphalt. The other main road crosses the capital town of Ghimbi and passes to Qellem Wallaga zone which is North West of the west wallaga zone.

The other important services given in West Wallaga zone are communication services. There are 5 automatic telephone stations and 1 wireless at all kebeles of the woredas' rendering telecommunication services for the residences. More than 30 percent of the populations are mobile subscribers. There are postal services at all woredas' of the zone.

Majority of the population use traditional energy sources such as firewood, animal dung, charcoal, and crop residues. All urban centers are provided with hydro source electricity including some rural areas.

Fuel stations are very small in number in that there are only three districts having fuel stations with a total capacity of about 379800 liters per year. Regarding the educational facilities, there are 804 elementary schools, 61 senior secondary schools and 22 preparatory secondary schools are found in the zone. There are 5 hospitals (3 governmental and 2 NGOs), 63 health centers, 311 small clinics, 1 pharmacies and 33 drug stores and 39 rural drug venders rendering health services. The zone has different financial institutions such as commercial bank of Ethiopia, Construction and Business Bank, Awash Bank, Oromia International bank, credit and saving institution at all woredas and insurance companies providing insurance services.

3.2 Sources and types of Data

The entire data used in the study are primary. These data were collected by the physical observation, structured questionnaire, and interview questionnaire prepared to sampled farmers in the study area.

3.3 Method of Sampling

The sampling technique used to select sample size was multistage sampling technique in the study area. That means, Sample elements (household farmers) were selected at three stages by using both purposely and randomly. That is, selecting woredas in the first stage, Peasant associations (kebeles) and household farmer in the second and third stages respectively. Considering limiting factors such as time, money and other facilities; two woredas (Kiltukara and Menesibu woredas) that dominate the zone by production of coffee are selected purposely and their coffee quality problems were identified to infer the issue at all.

From 76 Peasant associations (PAS) of these two woredas, 9 (12%) of peasant associations were selected by systematic random sampling. That means, listing all Peasant Associations (kebeles) of these woredas in ascending order and 9 PAs are drawn by using sampling gap. The sampling gap used is 8 that came from total kebele divided to sample size. Then, 226 respondents of household farmers are selected purposely. These household farmers were selected based on size of coffee farm they own. Those have one hectare and above coffee farm were selected in the respondent farmers.

Sample sizes are determined following the procedures of probability proportional to size technique given by Cochran (1977) using the formula: $n = \frac{NZ^2PQ}{d^2(N-1) + Z^2PQ}$

Where, n is the sample size, N is total number of households, d is allowable error term (5% = 0.05), Z is the standard normal distribution that is equal to 1.96 at 95% confidence interval, P is the Probability of coffee producing farmers and Q is the probability of non- producer of coffee.

Total households (Population) of sampled kebeles = 2768

Total coffee producers from these kebeles = 2269

Total non-producers of coffee = 499

P= coffee producers/ total population = 2269/ 2768= 0.81

Q= non-producers/ total population = 499/ 2768= 0.19

$$n = \frac{NZ^2PQ/d^2 (N-1) + Z^2PQ}{(0.05)^2 * (2768) + (1.96)^2 * (0.81) * (0.19)}$$

$$n = \frac{2768 * (1.96)^2 * (0.81) * (0.19)}{(0.05)^2 * (2768) + (1.96)^2 * (0.81) * (0.19)} = 324$$

In order to find multiplier (k) professor Yalew Alem (2011) formula is used.

$$k = n/N = 324/2768 = 0.1$$

Number of respondent farmers = multiplier (k) x (coffee producers)

$$(0.1) * (2269) = \underline{\underline{226}}$$

3.4 Description of the Model

Collected data were predicted both by statistical description and logistic regression analysis. There are many situations in which the response of variable is dichotomous rather than continuous. Example of variable with only two possible values is quality status (the quality is either good that is acceptable or poor which is unacceptable). Logistic regression can be binary or multinomial. The binary or Binomial logistic regression is the type of regression which is used when the dependent variable is a dichotomous and the independent variables are of any type while Multinomial logistic regression is used when the dependent variable has more than two categories. When multiple classes of the dependent variable can be ranked, then ordinal logistic regression is preferred to multinomial logistic regression (Wooldridge, 2000). However, Continuous variables are not used as dependent variables in logistic regression.

Logistic regression can be used to predict a dependent variable on the basis of continuous and/or categorical independent variables and to determine the percent of variance in the dependent variable explained by the independent variable to rank the relative importance of independent variables; to assess interaction effects; and to understand the impact of covariate control variable.

The logistic regression applies maximum likelihood estimation after transforming the dependent into a logit variable (the natural log of the odds of dependent variable occurring or not). In this way, logistic regression estimates the probability of a certain event occurring. Note that logistic regression calculates changes in the log odds of the dependent variable, not changes in the dependent variable itself as OLS regression does.

Hosmer and Lemshew (1989) pointed out that a logistic regression has got advantage over others in the analysis of dichotomous outcome variables. Therefore, the following logistic model was used to measure relationship between explained and explanatory's variables: Quality of coffee (Q_c) = f(Harvest and post-harvest factors, Demographic factors, agronomic and physiological factors). Which gives the model of the form $Q_c = e^{\alpha + \beta'X_i + u_i}$

$$P_i = E(Q_c=1/\text{independent variables}(X_i)) = \frac{e^{Q_c}}{1 + e^{(Q_c)}} = \frac{e^{\alpha + \beta'X_i}}{1 + e^{\alpha + \beta'X_i}}$$

This equation is known as (the cumulative) logistic distribution function.

$P_i = E(Q_c=1/\text{independent variables}(X_i))$ can be interpreted as the conditional probability that the event(quality of coffee) will acceptable (good) given the above independent variables.

P_i ranges between 0 and 1 while Q_c ranges from $-\infty$ to $+\infty$,

If P_i is the probability that coffee has good (acceptable) quality, the probability of having poor (unacceptable) quality is $(1-P_i)$

$$(1-P_i) = \frac{1}{1 + e^{(Q_c)}} = \frac{1}{1 + e^{\alpha + \beta'X_i}}$$

$$\frac{e^{Q_c}}{1 + e^{Q_c}}$$

$$P_i/(1-P_i) = \frac{(1 + e^{Q_c})}{(1 + e^{-Q_c})} = e^{Q_c}$$

The ratio of these two probabilities is called odds ratio

$L_i = \ln P_i / (1 - P_i) = \ln e^{Q_c} = Q_c = (\alpha + \beta' X_i)$ That is, L , the log of the odds ratio, is not only linear in explanatory variables, but also (from the estimation viewpoint) linear in the parameters. L is called the logit, and hence the name logit model for the models.

Where: Q_c represent quality of coffee which is explained (dependent) variable. It is dichotomous variable that means, $Q_c = 1$ if it has good (acceptable) quality or $Q_c = 0$, otherwise.

U_i = represents error term (disturbance term).

α is minimum quality of coffee obtained even if there are no positive factors that affect quality of coffee (that means it is an intercept).

B' = B_1, B_2, B_3, \dots represents coefficients of explanatory variables (are parameters).

X_i = represents explanatory variables.

3.4.1 Description of Variables

Dependent variable

The dependent variable is quality of coffee (Q_c) for both wet and dry produced and processed by farmers that is dichotomous random variable (has good (acceptable) quality or has poor (unacceptable) quality status. It refers quality of coffee on the farm and that is going to be sold which is determined by the quality of coffee on the farm and it is also in turn influenced by the independent variables identified below.

The International Coffee Quality (ICQ) establishes criteria for acceptability (good) and unacceptability (poor) quality for coffee bean. Accordingly, coffee must fulfill the following criteria in order to say its quality is acceptable and become exported. Its defect per gram not more than 10, moisture content more than 8 percent and not exceed 12.5 percent, bean size not very small and not has black color. Quality of coffee is also acceptable if its product has desirable clean raw and roasted appearance, attractive aroma, and good cup taste (CFC, 2004). This was cup quality that depends on the quality of coffee on the farm. Thus, more attention must be given to the coffee on the farm starting from plantation up to the final consumption level.

Therefore, study tried to show that whether there was acceptable (good) or unacceptable (poor) quality of coffee at farmers' level by using both the experimental measures and data tools analyzing. Harvesting at full red mature stage, drying on the cemented floor, bricks floor and raised bed, using jut bag as packs material, no mixing of different type of coffee and having storage facility were precondition activities required from household farmers to produce acceptable qualified coffee.

Independent variables

There are a number of factors affecting quality of coffee in the study area and are explained hereunder.

Harvest and post-harvest factors: it includes activities and practices of farmers during and after collection of coffee beans. These factors are:

Harvesting stage (hstage): refers stage of maturity (full maturity, green mature or immature) at which farmers have harvested their coffee beans. If coffee is harvested before the beans are ripe or at immature stage, the end product shows color defect and will be cause of uneven roasts and leads to bean color and size classified as undesirable that provide unacceptable (poor) quality of coffee . It provides good quality when harvested at the full maturity stage. It was coded that harvesting at immature stage by 4, 3 for harvesting at green matured stage, code 2 for harvesting at mixture of red-green mature stage, and 1 for harvesting at all red matured stage to simplify complexity at regression. The variable expected to have positive correlation with quality of coffee from code 4 to 1.

Drying Materials of coffee (dmate): It indicates materials such as using cemented floor, and raised bed or ground on which collected coffee bean have dried. Cemented floor, and raised bed materials use for drying coffee are correlated positively with coffee quality, while drying on the ground correlated negatively with coffee quality.

Type of packing materials (tpmate): indicates type of packing materials (such as jute bags (sacks), non-Plastic bags, and clay pot) that farmers use for marketing and storage of coffee bean or coffee cherry. Value 1 represents jute bags (sacks), 2 plastic bags, and 3 clay pot in regression. The study indicates that packaging materials coded 3 to 1 have positive correlation with coffee quality.

Availability of Storage (avstore): Indicates availability of qualified storage house. Most farmers have no storage house that leads quality of coffee changes and become poor (unacceptable). For its measurement and analysis, availability of storage facility is coded as 1 and 0 for those have no storage facility. The study show that availability of storage positively correlated with the quality of coffee.

Institutional factor (htrain): refers factors such as supports from woredas' agricultural and rural development office and DAs in the form of providing training on the harvesting and production of coffee and providing new techniques of production and high yield variety that influences quality of coffee. The availability of this institutional service improves quality of coffee and decrease if not. Thus, this variable was positively correlated with quality of coffee. It was coded that 1 for trained household farmers and 0 for those not trained.

Demographic factors: it includes the following human related factors.

Sex of household head (hsex): This is a dummy independent variable, indicating the sex of the household head. Male head household and female head households were not equally access to improved technologies, credit and extension services. Therefore, male status of household head has positive relation with adoption of coffee quality in the pre and post harvest management practices. Male household head Valued 1 and 0 for female.

Age of household head (hage): implies number of years he/she can undertake on farm operations. In fact, Elder farmers with longer farming experience have better competence in assessing the characteristics and potential benefits of new technologies than younger farmers with shorter farming experience. Therefore, the numbers of farming years have positive relationship with the coffee quality in the pre-harvest, harvesting and post-harvest management practices. The more his/her age, the greater his/her farm experience and the better quality he/ she become produce and offer.

Educational status of household head (estatus): It refers to formal education (knowledge to accept and apply the improved technology) of the household head and he/she was either literate or illiterate. Farmers with higher formal education; at least grade 5 (literate farmers) have more potential to participate in quality maintenance practices than illiterate farmers. Thus, educational

status has positive relationship with coffee quality. In this study, Code 1 and 0 was represented for Literate and illiterate household farmers respectively.

Agronomic and physiological factors: These are factors associated with the coffee (its physical feature) plant cultivation which may affect the quality of coffee beans.

Age of coffee trees (ageco): It is independent variable, indicating the age of the coffee tree which may be in the young coffee tree, or old aged coffee tree. Coffee tree gives service for more than 20 years. In order to simplify complexity and to measure the variable, coffee age with less than 20 valued as 1 and 0 for those greater than 20years. Coffee quality decreases with an increment of age because its bean output becomes smaller and smaller which decreases price per kilogram and increase defects per gram. Thus, the hypothesis shows that age of coffee tree has negative relationship with the dependent variable.

Prevalence of coffee weeds (weed): This represents weeds that occur in the coffee farm and change age of coffee tree, size and color of coffee bean, number of defects per gram, price per kilogram and reduce quality of coffee. Thus, this variable has negative relationship with dependent variable (quality of coffee). In order to simplify complexity, existence of weed was coded by 0 and 1 for no weed prevalence.

Disease observation in coffee farm (ediseas): This represents the incidence of any type of diseases in the coffee field. It includes coffee tree disease and its berry disease those reduce quality of coffee. The study indicates that coffee quality have inverse relation with disease incidence and severity. Code 1 represented for no disease observation in the coffee farm and 0 for existence of disease.

Coffee tree pruning and or stumping (sprun): was cutting branches of coffee those affected by disease or old aged coffee tree. It produces sustainable and good quality of coffee and has positive relation with it. Since it was dummy variable, 1 represents stumped and or pruned coffee tree and 0 for non-pruned and or stumped.

Mechanism of weed control (mweedco): It indicates mechanisms such as collecting weed by slashing, by hand, digging, inter-cropping and non-controlling weeds in coffee field. Collecting by hand does not improve as of the other methods because perennial weeds cannot remove by

hand. Thus; it has negative relation with quality of coffee. To measure the relationship between quality of coffee and these mechanisms, assigning code to each mechanism simplify complexity during regression of the variable in the selected model. Therefore, controlling of weed by slashing tools was represented by code 1, 2 for hand using, 3 for digging, code 4 for intercropping mechanism and 5 for not weed controller. From code 1 to 5 the quality negatively related and positively from code 5 to 1.

Compost application (composta): is application of plant and other residues that improves activity of micro- and macro-nutrients availability in the coffee farm and in turn improve quality of coffee. Therefore, the variable has positive correlation with quality of coffee. Code 1 and 0 was used for compost users and non-users respectively.

The model explained above was applicable as alternatives to the linear probability Model and Probit model. Linear probability Model indicates that there is linear relationship between dependent and independent variables. But, the relationship between quality of coffee and its determinants may not always linearly relate to each other. The other reason which makes not to use this method was that the probability of dependent variable is limited to either 1 or 0. But, under the above logistic regression model it ranges between negative infinity and positive infinity. Data was explained by using statistical description and chi-square analyses. The significance of association between two and above attributes was tested by using Pearson χ^2 -test. Thus, the χ^2 -test, Fisher's test exact if necessary, was considered as an appropriate test for judging the significance of association between explained and explanatory variables depending on their p-values. VIF test was used to test existence of multi colleniariry between independent variables.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Descriptive Statistics

4.1.1 Agronomic and Physiological factors

There are many agronomic and physiological factors affecting the quality of coffee. As indicated in tables below, among agronomic and physiological factors affecting coffee yield quality, age of coffee trees, pruning and stumping, existence of weed, methods of weed control, disease prevalence, and application of compost were assessed in this study.

Accordingly, the result of the field survey showed that among 226 coffee farmers interviewed 81.42% (184) owned old coffee trees (>20 years), while 18.58 % (42) of them owned coffee trees less than twenty years old. The productivity and quality of old aged coffee decline and smaller than that of younger coffee trees (Clifford, 1985). From 184 old aged coffee 23.4% of them brought poor qualified coffee and 58.02% brought good qualified coffee. Even coffee beans from young aged coffee 9.29% was poor quality, due to other factors including poor management practices of household farmers. But, Yigzaw (2005) reported that beans from young trees are likely to be mild and have good quality with small or no defective and fine in flavor. Beans from old trees produced were full of black colors and many defectives which were inversely related with coffee quality. The chi-square analysis indicated that ($X^2= 6.976$) there was strong association between this agronomic factor and quality coffee production at less than 5 percent probability level. Table 4.2: Frequency, proportional distribution and chi-square of coffee quality with the age of coffee tree

Quality of coffee	Age of coffee tree						X^2	p-value
	>20 year		< 20 year		Total			
	Freq.	Percent	Freq.	Percent	Freq.	%		
Poor quality	53	23.40	21	9.29	74	32.74	6.976	0.008
Good quality	131	58.02	21	9.29	152	67.26		
Total	184	81.42	42	18.58	226	100		

Source: computed from own collected data, 2015

Similarly, in this survey it was observed that even though the majority of coffee plantations in the farmers hand were greater than 20 years old, only 5.31% (12) of coffee farmers undertake pruning and/or stumping activities.

Coffee tree pruning/stumping is an extremely important activity for reducing incidences of diseases, modifying air movement within the plantation, which in turn reduces leaf drying time. From 5.31% coffee tree pruned and or stumped, larger percentage (3.98%) gave quality coffee.

From 226 sampled farmers 95% of them did no stump or prune their coffee tree and the highest percent of poor quality (31.4%) was from non-pruned coffee. Coffee bean from old aged type was small in size and the numbers of defective per gram for the small sized coffee bean were many. Thus, this variable was negatively associated with the quality of coffee. But, the chi-square analysis indicated that, association between coffee quality and coffee tree pruning and /stumping($X^2 = 0.345$) is not statistically significant (table 4.3).

Table 4.3 Frequency, proportional distribution and association (chi-square) of coffee quality with stumping and or pruning of coffee tree

quality of coffee	Pruning and/stumping of coffee tree						X^2	p-value
	No		Yes		Total			
	Frequency	%	Freq.	%	Freq.	%		
Poor quality	71	31.40	3	1.33	74	32.74	0.345	0.557
Good quality	143	63.29	9	3.98	152	67.26		
Total	214	94.69	12	5.31	226	100		

Source: computed from own survey data, 2015

On top of absence of stumping and pruning it was identified that majority of household farmers (66.36%) responded that the prevalence of disease on their coffee farm (Table 4.4).

Additionally, 93.81%of the household farmers did not apply or use compost in their coffee field. Poor quality producers due to no use of compost application were 31.41% of the respondent (Appendix 2, table 4.7). 31.85% of the respondents' coffee products of the study area were poor qualified due to disease infection.

The disease observed on the bean was Coffee berry disease (CBD) that change color of coffee beans and fall from their trees before they mature. The coffee beans infected by Coffee Berry Disease have many defectives per gram and black in color. Additionally, coffee disease observed was on the tree of coffee which dries and decline production, productivity and quality of coffee. As the consequence of this the quality and quantity of coffee might have decreased considerably.

Chi-square analysis revealed that, coffee quality and prevalence of disease on the coffee farm ($X^2 = 47.146$) have strong statistical association at less than 1% probability level. In contrast, compost application ($X^2 = 0.8676$) was not strongly associated with quality of coffee (Appendix 2, table 4.7).

Table 4.4 Frequency, proportional distribution and association (chi-square) of coffee quality with the existence of disease on the coffee farm

quality of coffee	Prevalence of disease on the coffee tree and beans						X^2	p-value
	No		Yes		Total			
	Frequency	Percent	Freq.	Percent	Freq.	%		
Poor quality	2	0.89	72	31.85	74	32.74	47.146	0.000
Good quality	74	32.74	78	34.51	152	67.26		
Total	76	33.63	150	66.36	226	100		

Source: computed from own collected data, 2015

Additionally, weed prevalence on the coffee farm was another issue assessed by the study. Of all household respondents, 88.93% of them reported that their coffee farms have weed. Only 11.06% of coffee farms' of the sampled farmers did not have weeds (table 4.5). From coffee tree in which weeds exists, 28.76% and 60.18% of them provide poor and good quality coffee for it owners respectively. 7.08% of the coffee farms are free from weed and produced good qualified coffee. Coffee farm that was free from weed (3.98%) also produced poor qualified coffee.

However, chi-square analysis to test association of prevalence of weed with quality of coffee ($X^2 = 0.1354$) shown that, there was no strong association between these variables.

Table 4.5 Frequency, proportional distribution and association (chi-square) of coffee quality with prevalence of weed in the coffee farm

quality of coffee	prevalence of weed in the coffee farm						X ²	p-value
	Weed exist		No weed exist		Total			
	Frequency	Percent	Freq.	%	Freq.	%		
Poor quality	65	28.76	9	3.98	74	32.74	0.1354	0.713
Good quality	136	60.18	16	7.08	152	67.26		
Total	201	88.94	25	11.06	226	100		

Source: computed from own collected data, 2015

Uncontrolled weed affect production, productivity and quality of coffee. Thus, Controlling of weed is an important activity to improve production and productivity of any crop. However, 17.26% of household respondents were not engaged in weed control generally and 10.07% of them produce poor quality coffee.

In another way, selecting mechanism of weed control was another important issue to be considered. For instance, mechanism of weed control such as digging influences quantity and quality of coffee. Most of household respondents (35.84%) used this method and 24.34% of them produce poor quality coffee (table 4.6). Digging of coffee may impact (cuts) root of that coffee and make it not to give enough and even make its tree dry. As an alternative slashing tools use to control weed was better for coffee. Out of 46.90% farmers used this mechanism, 32.75% of them produce good quality coffee. From sampled household farmers, none of them has used hand and inter-cropping mechanism to control weed from their coffee farm.

The chi-square analysis of studying association of mechanism of weed control with coffee quality shown that($X^2 = 1.8166$), there was no significant association between them.

Table 4.6 Frequency, proportional distribution and association (chi-square) of coffee quality with mechanism of weed control by household farmers

quality of coffee	Mechanism of weed controls								X ²	p-value
	Slashing tools		Digging		No weed control		Total			
	Freq.	%	Freq.	%	Freq.	%	Freq.	%		
poor quality	32	14.15	26	24.34	16	7.09	74	32.74	1.8166	0.403
good quality	74	32.75	55	11.50	23	10.17	152	67.26		
Total	106	46.90	81	35.84	39	17.26	226	100		

Source: computed from own collected data, 2015

4.1.2 Harvest and Post-harvest factors

As indicated by chi-square analysis above, most of agronomic and physiological factors were not associated with quality of coffee, except with prevalence of disease on the coffee farm. Thus, quality deterioration problems of the study area were associated with other factors. One of the most determinants of coffee quality was harvest and post-harvest factors such as harvesting stage of coffee beans, type of drying materials used, type of packing materials used, availability of storage, mixing up of different type and differently harvested coffee, availability of training services from Agricultural and Rural Development Office (ARDO) and Development agents.

As shown in the following table 4.8, majority of the surveyed farmers were exercising more in harvest and post-harvest management practices in terms of harvesting at full red maturity stage (61.50%). Farmers also harvest their coffee beans before full red stage (38.50%). That means at a mix of red-green mature stage (33.16%) and at green mature stage (5.34%). No household farmer harvests his/her coffee beans at immature stage. Poor quality produced by farmers in relation to harvesting stage of coffee beans was 3.98%, 23.89% and 4.90% for farmers those harvested at full red mature, mixtures of red-green, and green mature stages respectively. Thus, harvesting before all beans was full red lead poor quality production.

The chi-square analyses of these variables is 114.9572; that shows there was strong association between coffee quality and harvesting stages of coffee beans in the study area. The proportion of harvesting at full red stage in production of good qualified coffee was greater than the proportion of harvesting at mixtures of red-green mature stage. Thus, harvesting at full red stage has more

likely to produce acceptable quality of coffee compared to harvesting at mixtures of red-green matured stage.

Additionally, harvesting at green mature stage has smaller proportion in the offering of acceptable quality of coffee compared to harvesting at full red and mixture of red-green stages.

Table 4.8 Frequency, proportional distribution and association (chi-square) of coffee quality with harvesting stage of coffee beans for sampled household farmers

quality of coffee	Harvesting stage of coffee beans								X ²	p-value
	Full red		Mixture of red-green		Green mature		Total			
	Freq.	%	Freq.	%	Freq.	%	Freq.	%		
Poor quality	9	3.98	54	23.89	11	4.90	74	32.74	114.957	0.000
Good quality	130	57.52	21	9.27	1	0.44	152	67.26		
Total	139	61.50	75	33.16	12	5.34	226	100		

Source: computed from own collected data, 2015

Green mature stage harvesting has small or no contribution to coffee quality production and process. But, in the area with too cold coffee do not become red easily and it takes time. So farmers decide to harvest (collect) it after its beans are matured. In other way, very poor farmers harvest coffee before it become red mature and hulled it to sell and get income which deteriorates quality. From 12(5.34%) of household harvest at green mature stage, only 1 (0.44%) has produced qualified coffee.

Coffee harvested from the tree need appropriate drying material to keep quality of the product. Most of sampled household farmers (65.49%) of them dry on wooden bed such as bamboo made raised beds while 2.65% (6) of them dry on the cemented floor which was favorable to keep coffee quality (table 4.9). On another way, 31.87% (72) of the sampled household farmers dries their coffee on the ground which deteriorates quality of the product.

Farmers those used cement floor, raised bed and ground to dry coffee and produced good quality coffee were 2.65%, 63.72% and 0.90% respectively. While, 0%, 1.77% and 30.97% were for producers of poor qualified coffee respectively.

However, the Chi-square test for the materials used for drying coffee ($X^2 = 199.498$) revealed that there was strong statistical association with quality of coffee. Drying coffee on the cemented floor has more likely to offer good quality of coffee compared to drying on the raised bed. In turn, drying on the raised bed has more likely to offer acceptable quality of coffee compared to drying on the ground.

Table 4.9: Frequency, proportional distribution and association (chi-square) of coffee quality with types of drying materials used by farmers

quality of coffee	Types of drying materials used by farmers								X^2	p-value
	Cement		Wooden bed		Ground		Total			
	Freq.	%	Freq.	%	Freq.	%	Freq.	%		
Poor quality	0	0	4	1.77	70	30.97	74	32.74	199.498	0.000
Good quality	6	2.65	144	63.72	2	0.90	152	67.26		
Total	6	2.65	148	65.49	72	31.87	226	100		

Source: computed from own collected data, 2015

On the other hand, types of packing materials used by farmer determine quality of coffee. As shown by table 4.10, farmers in the study area have packed their coffee in to three different types of materials (Jute bag (6.19%), Non-plastic bag (86.28%), and Clay pot/ 'kukula' (7.52%) those determine coffee quality differently. 25.22% and 7.08% of the household respondents produced poor qualified coffee because of their using non-plastic and clay pot and or kukula respectively. Packing coffee in the jute bag was more preferential to coffee quality, because in this material coffee get air and its moisture content do not reduced highly even if it was stored for long period of time. Therefore, using jute bag (sack) to pack coffee protects the moisture contents of that coffee normally.

The chi-square analysis for type of packing materials used ($X^2 = 34.337$) shows that there is strong association with quality of coffee. Packing coffee beans in to Jute bags is more likely to offer good quality of coffee compared to packing coffee beans in to non-plastic bags. In turn, coffee packed in the non-plastic bags are more likely to be acceptable quality compared to coffee those packed in to clay pot and or *kukula*.¹

Table 4.10 Frequency, proportional distribution and association (chi-square) of coffee quality with types of packing materials used

quality of coffee	Types of packing materials used by farmers								X^2	p-value
	Jute bag		Non-plastic bag		Clay pot or <i>kukula</i>		Total			
	Freq.	%	Freq.	%	Freq.	%	Freq.	%		
Poor quality	1	0.44	57	25.22	16	7.08	74	32.74	34.337	0.000
Good quality	13	5.75	138	61.06	1	0.44	152	67.26		
Total	14	6.19	194	86.28	17	7.52	226	100		

Source: computed from own collected data, 2015

As shown in the table 4.12 below and Appendix 2(table 4.11), from all sampled household farmers, 11.06% and 91.15% of them were lacked training and storage facilities respectively. From those have no storage facilities 30.53% of them produce poor qualified coffee and 60.62% of them produce good qualified coffee (Appendix 2, table4.11). Additionally, from 8.85% of household farmers those have storage 6.64% majority of them produce good qualified coffee.

Compared to non-owners, the quality of coffee for those owns storage facility was better. Even some of farmers those have storage facility, offer poor quality of coffee because it was not cemented or bricked floor rather it was a class of house where they put their crops to keep favorable price for it. Additionally, few farmers reported that, they store their coffee for more than four months. But, Anwar (2008) explained that “storing coffee for more than four months

¹ '*kukula*' is a local name which referred as a type of pot made from baboon and other woods that farmers use to store different products in it.

decrease its moisture content and make it poor qualified coffee.” Obiero (2008) reported that” storing dried parchment coffee for more than four months resulted in woody flavor, which lowers quality.” Therefore, having storage alone is not enough to produce and offer quality coffee.

Additionally the empirical result shows that, 88.94% of respondent farmers were trained by Agricultural and Rural Development Office (ARDO) and Development Agents (DAs) .while 10.18% of them were not trained. It was surprising that even trained farmers did not kept quality of coffee as trained by ARDO specially to stop drying coffee on the ground. Therefore, 22.13% trained farmers produce coffee with poor quality.

Chi-square test for availability of institutional training and availability of storage for farmers ($X^2= 44.819$, $X^2 = 3.6513$) revealed that, training service has significant association with coffee quality while availability of storage has no strong association (Appendix 2, table 4.11). Based on their proportion, trained farmers are more likely to produce good qualified coffee compared to those non-trained. This result could be attributed to the fact that majority of the farmers trained both by DAs as of plan and strategy of the government. Therefore, Coffee quality problem was not arising due to lack of training, but absence of deep rooting train offered by household farmers. Generally, the overall result of chi-square analysis for harvest and post harvest factors show that they have strong association with coffee quality.

Table 4.12 Frequency, proportional distribution and association (chi-square) of coffee quality with training service for household farmers

Quality of coffee	Training of household						X^2	p-value
	Trained		Non-trained		Total			
	Freq.	%	Freq.	%	Freq.	%		
Poor quality	51	22.13	23	10.18	74	32.74	44.819	0.000
Good quality	151	66.81	2	0.88	153	67.26		
Total	201	88.94	25	11.06	226	100		

Source: computed from own collected data, 2015

4.1.3 Demographic factors

In this study, some demographic factors such as sex of household head, age of household head, and educational status of household head were assessed to know their pattern of distribution in the study areas.

As indicated in table 4.13, from a total of 226 household respondents 96.45% (218) of the household coffee farmers were males, whereas, the remaining (3.53%) were females. The result of study indicated that from 218 sample male household heads 66.81%(151)of them produced good quality of coffee while 29.64% of them produce poor qualified coffee and from eight sampled female household heads 3.09% (7) of them produce poor qualified coffee.

Male households were producers of qualified coffee than female households that is similar to statements of different authors. “Female households have less access to improved technologies, credit and extension service” Said, Ellis and Mudhara, (1995). On the other hand, male-headed households have better access for information than female households that helps for adoption of improved agricultural technologies (Anwar, 2010). Therefore, male status of household head was positively correlated with adoption of coffee quality during harvest and post-harvest management practices.

The result of study for association of sex of household farmer with coffee quality ($X^2 = 11.292$) shown that there was strong association between them. The proportion of male household in the production of good quality of coffee is greater than proportion of females. Thus, male household farmers are more likely to produce good qualified coffee compared to female household farmers.

Table 4.13 Frequency, proportional distribution and association (chi-square) of coffee quality with sex of household farmers

Quality of coffee	Sex of household						X ²	p-value
	Male		Female		Total			
	Freq.	%	Freq.	%	Freq.	%		
Poor quality	67	29.64	7	3.09	73	32.74	11.292	0.001
Good quality	151	66.81	1	0.44	153	67.26		
Total	218	96.45	8	3.53	226	100		

Source: computed from own collected data, 2015

In terms of age about 10.63% of the respondents were found in the age category of greater than 18 and less than 35 years, 89.37% in the age category of greater than 35 years (Table 4.15). The average year used to say farmer has experience on farming was 35 years (Gari, 2002). The empirical result revealed that quality of coffee was deteriorated by both young and old aged household farmers (9.73% and 23.00%) respectively. The study of Senkondo *et al.* (2004), in Tanzania revealed that experiences in farming were positive and significant in explaining adoption of Rain Water Harvesting (RWH) technology. Additionally, the results of Chi-square analysis show that there was strong association ($X^2 = 42.334$) between age of household farmer and quality of coffee in the study area at less than one percent probability level. Experienced farmers (farmers with age greater than 35) are more likely to produce good qualified coffee compared to young farmers (farmers with age less than 35).

Table 4.15: Frequency, proportional distribution and association (chi-square) of coffee quality with age of household farmers

Quality of coffee	Age of household head						X ²	p-value
	>35 year		<35 year		Total			
	Frequency	%	Freq.	%	Freq.	%		
Poor quality	52	23.00	22	9.73	74	32.74	42.334	0.000
Good quality	150	66.37	2	0.9	153	67.26		
Total	202	89.37	25	10.63	226	100		

Source: computed from own collected data, 2015

From the total sample households, 42.04% of coffee farmers were literate and the remaining (57.96%) were illiterate farmers (Table 4.16). The finding of several studies (Dasgupta, 1989; Zemedu, 2004) revealed that level of education has strong association and is significant determinant with farmers' adoption of improved agricultural technologies. Karki *et al.*(2004) undertook a study in a mid-hill district of Nepal to assess the impact of foreign-aided project in technology adoption and food security and to identify factors determining adoption of improved technology in case of small holder peasants and they have stated that coefficient of years of schooling positively influenced farmers' adoption decisions on improved agricultural technologies.

Education is very important for the farmers to understand and interpret the information coming from any direction to them. Farmers' education is also pivotal for the effective work of extension services, because if the farmer has better educational status they can have a capability to understand, interpret and implement easily the information transferred from Development Agent (DA) to them. The coffee quality of 40 (17.70%) illiterate sampled households' was poor qualified and 40.26% of their coffee was good in quality. From 95 sampled literate household farmers, 34 (15.04%) of them produced poor qualified coffee and 61(27.0%) of them produce good qualified coffee (table4.16).However, the Chi-square analysis of educational status of farmers($X^2 = 0.6905$) revealed that educational status of household farmer has no strong association with quality of coffee.

Table 4.16 Frequency, proportional distribution and association (chi-square) of coffee quality with educational status of household farmers

Quality of coffee	Educational status of farmers						X^2	p-value
	Illiterate		Literate		Total			
	Freq.	%	Freq.	%	Freq.	%		
Poor quality	40	17.70	34	15.04	74	32.74	0.6905	0.406
Good quality	91	40.26	61	27.0	152	67.26		
Total	131	57.96	95	42.04	226	100		

Source: computed from own collected data, 2015

In general, the statistical results of the explanatory variables indicated that quality of coffee was highly associated with activities of farmers during harvest and post-harvest technologies in additions to some physiological and agronomic factors such as disease prevalence in the coffee farm. Therefore, Coffee quality problems of the study area are due to poor management practices of household farmers specifically their activities during harvest and post-harvest technologies.

4.2 Binary logistic Regression Analysis

The logit model was employed in this study to estimate the effects of the hypothesized independent variables on dependent variable. In order to show significant association between all independent variables and coffee quality, a careful analysis of each variable was undertaken. The Pearson chi-square test was used to test existence of significant relationships between dependent

and independent variables. The level of significances of the model was 95 percent. Thus, the maximum error term (the level of significance) of the model was 5 percent.

In order to say coffee product of household farmer has good or poor quality, experimental assessments was performed on all coffee products of sampled households by using experimental instruments. The names of tools are moisture taster and slender. As its name indicates moisture taster measures level of moisture content for a sampled commodity. To say coffee has good quality, its moisture content must be between 8.5 percent and 12.5 percent which was set by International Coffee Quality (ICQ). The average moisture content of the sampled farmers in the study area was 10.53percent.

The second tool was slender that was used to take sample of coffee to count numbers of defects. As set by the ICQ, defective per gram never be greater than ten (10) to be good qualified coffee. But, at woreda level Agricultural and rural development office of both woreda stated that defect per gram be at most 15 to be accepted as good qualified coffee. The average defective coffee bean per gram for the sampled farmers was 7.474. The assessment result indicated that, coffee quality of 152 (67.26%) and 74 (32.74%) sampled household farmers were good and poor qualified respectively (Appendix 2 table 4.1).

After assessments are made, interview questionnaires were made for illiterate farmers and distributed questionnaires were for literate farmers. Then, binary logistic regression was conducted up on selected variables to identify significant variables related to quality of coffee.

Fifteen independent variables that were included in the model were ages of coffee tree, coffee tree pruning, type of coffee weed, methods of weed control, compost application to coffee, diseases observation in coffee farm, harvesting stage of coffee beans, drying materials of coffee, type of coffee packing materials used, storage availability, support from Agricultural and Rural Development Office via training, age of household head, sex of household head , family size and educational status of household heads.

The results of this study confirmed a prior expectation of researcher that the quality of coffee was influenced by the physiological and agronomic, harvest and post-harvest and demographic factors. The value of logistic regression Chi-square test shows the overall goodness of fit of the

model was at less than one percent significant level. Since the VIF test of the model gives value less than 5 there is no multicollinearity between independent variables (Appendix 2).

Out of 14 explanatory variables hypothesized to affect coffee quality in the model, seven were found to be statistically significant. These factors include disease prevalence in the coffee farm, non-controlling of weed under methods of weed control, compost application to the coffee farm, harvesting stage that includes green stage harvesting and mixture of red-green stage harvesting, availability of storage for farmers, training service, and sex of the household head. The result of the analysis is presented as follows. Table 4.17: Analysis of Factors affecting Coffee Quality

Quality of coffee	Coefficients	Std. Error	z-value	P>/z/	Odds Ratio	Marginal effect(dy/dx)
Age of coffee	-0.8956028	0.3941314	-0.93	0.353	0.4083613	-0.2553402
Disease observation	-1.337766	4.7323	-3.83	0.000***	167.9907	-0.2693222
Weed prevalence	-0.2783044	0.8994376	-0.683	0.41	1.320888	-0.0454948
Digging	-0.8012997	0.6190671	-0.32	0.747	0.7725787	-0.0231272
No weed control	-0.9138608	0.1475444	-2.00	0.046*	0.1614517	
Pruning and or stumping	2.893219	1.25564	0.82	0.411	10.80307	0.0508417
Compost using	1.533426	0.0413104	2.36	0.018**	0.0269399	0.7918091
Mixture of red-green stage	-0.757035	0.0094134	-5.80	0.000***	0.0124345	-0.182439
Green stage	-2.548545	0.006532	-2.34	0.019**	0.002563	
Raised bed	13.88247	0.0017166	0.04	0.492	9.35	-0.2069543
Ground	-18.10847	0.0000251	-0.01	0.794	1.37	
Non-plastic bag pack	-1.146457	2.56014	-0.14	0.887	0.3177605	-0.2255167
Clay pot and kukula	-6.490709	0.0125746	-0.78	0.433	0.0015175	
Availability of storage	1.332317	0.0796671	2.11	0.034*	0.0597959	0.154906
Training service	1.416605	23.95853	2.00	0.008***	16.91264	0.2734823
Sex of farmer	1.605153	119.5865	2.k,i69	0.007***	74.5016	0.7451348
Age of farmer	2.576658	0.1136967	1.21	0.226	0.0441256	0.0792885
Educational status	-0.1813121	0.8501686	-0.18	0.859	0.83475	-0.0019188

Number of observations = 226, LR chi2 (14) = 21, Prob > chi2 = 0.0000, Pseudo R2 = 0.7520, Log likelihood = -35.438113

Note: *** shows significances at less than 1 percent probability level, ** indicates significant variables at 2percent probability level and * for significances at greater than 3percent probability level.

Source: computed from own survey data, 2015

4.2.1 Agronomic and Physiological factors

From the significant variables, existence of disease, harvesting stage at mixtures of red- green mature stage, mixing up of different and or differently harvested coffee type, training of farmers and sex of household head were found to be statistically highly significant at less than one percent probability level. Three of these significant variables; disease prevalence in the coffee field, methods of weed control and compost application to the coffee farm were from physiological and agronomic factors. The effects of the model estimates were interpreted in relation to the significant explanatory variables as follows:

Disease observation in the coffee farm (ediseas): the variable represents incident of disease on coffee tree and beans and it was highly associated and significant at less than one percent probability level. The odds ratio shows that, other variables remain unchanged; coffee those infected by disease were about 168 factors less likely in the production of good quality as compared to that are disease free (Table 4.17).

The marginal effect of disease observation on the quality of coffee also shows that, there is negative relationship between them. Other variables remain constant, observation of disease on the coffee tree and or beans decreases production of good quality coffee by 26.932 percent. The result was similar to the statement of Wintgens (2004); “the disease occurrence can lead to poor quality coffee that gives off and disagreeable odor.”

That means, it affect the cherries directly or cause them to deteriorate by debilitating the plants, which will then produce immature or damaged fruits that affect its quality. For instance, when coffee berry disease (CBD) attacks the fruit in its more advanced stage of growth, it causes severe damage to the crop and coffee quality (Eshetu and Girma, 2008). Healthy bush always give a better quality product (Tirufat, 2011).

Methods of weed control (mweedco): Most of the interviewed farmers report that they control weeds by using slashing tools and digging while others have said we can't control weed in each and every year. There were no households control weeds by inter-cropping. From these, non-controlling of weeds was statistically significant. Many interviewed farmers reported that, weeds are observed in their coffee farms and some of them did not control it from time to time. Its

marginal effect revealed that, there was inverse relationship between methods of weeds control used by farmers and production of quality coffee. Other variables remain unchanged, methods of weed control (digging use to control weed and non-controlling of weeds) decrease production of good quality of coffee by 2.313percent.

The empirical result of odds ratio also shown that, other factors remain constant, household farmers those not control weeds from their coffee farm were less likely to produce good qualified coffee by 0.161 factor as compared to those control weeds. In other words other variables remain constant, households those control weed from their coffee farms have 0.839 factor more likely to produce good qualified coffee compared to those not control weeds that shows weed controlling has better value in producing good qualified coffee. This is similar to the statement; ‘competition among weeds and crops for light and nutrients affect both types of plant; nevertheless, weeds almost always have a deleterious effect on crops’ (Petit, 2007).

Compost Application (composta): In line with the prior expectation of researcher, the variable compost application was related positively with maintaining coffee quality and it was statistically significant at 2percent probability level. There are two types of composts. These are organic composts such as animal dung or process residue and plant residues and non-organic (mineral) fertilizers. From these two, compost users of household farmers of the study area apply only organic composts in the coffee farms.

The odds ratio for this variable indicated that keeping the influences of other factors constant, households those apply compost in their coffee farm most likely to produce good qualified coffee by 0.0269399 factors as compared to non-users. In other words, household farmers those do not apply compost on their coffee farm were less likely to produce good qualified coffee as compared to compost applicators. The proportional difference between compost users and non-users also revealed that compost users have more likely to produce good qualified coffee compared to non-users.

Additionally, other variables being constant, its marginal effect indicates that quality coffee production of compost users per a year increased by 79.18percent. This result was supported by Wintgens (2004) statement of “compost acts as a good soil conditioner and improves the physical, chemical and biological properties of the soil and brings good growth conditions which

have a positive effect on bean size and flavor.” A significant improvement in growth and yield of mature coffees was reported in response to coffee pulp and husk compost application (Chane, 1999).

4.2.2 Harvest and Post-harvest Factors

Another major determinant of coffee quality was harvest and Post-harvest factors. The effects and association of post-harvest technology on the quality maintenance were higher than other factors.

Harvesting stage (hstage): Harvesting stage has high significant association with quality of coffee. From three harvesting stages two were statistically significant.

Harvesting at a mixture of red-green stage (2): The odds ratio of this variable indicates that, other variables remain constant, household farmers those harvest their coffee at a red- green mature stage were less likely to produce good qualified coffee by 0.01244 factors as compared to those harvests at full red mature stage. In other words, other factors remain unchanged, farmers those harvest at full red mature stage have more likely to produce qualified coffee compared to those harvest at mixture of red-green stage.

Off all variables harvesting stage is the major factor that needs appropriate management in order to keep quality of coffee. The marginal effect of this variable indicated that, farmers of the study area decreased production of quality coffee by 18.244percent when they harvest at mixture of red-green and green mature stage. Anwar (2010) states that, “red ripe cherry should be selectively picked from the tree to maintain the quality of the green beans.”

The association test by the Pearson chi-square analysis shown that, the proportion of red-green harvesting was less than the proportion of harvesting at full red stage in good quality of coffee offer that proves harvesting at full red mature stage has more likely to produce good qualified coffee compared to harvesting at red-green mature stage.

Harvesting at green mature stage (3): Additionally all other variables remain unchanged, farmers those harvest coffee at green mature stage were less likely to produce good qualified coffee by 0.00256 factors as compared to those harvest at full red mature stage. In another statement, all other variables remain unchanged, household farmers those harvest at green mature

stage were more likely to produce poor qualified coffee by amount equal to odds ratio of 0.898 factors as compared to those harvest at full red mature stage. Including Fisher's exact test, test of association shown that, harvesting at green matured stage has less likely to produce good qualified coffee compared to harvesting at full red and red-green matured stages. Thus, harvesting before full red mature stage has reduced quality of the product. The result is similar to the statement of Tirufat (2011); "the most common defect in coffee becomes from harvesting green coffee."

Availability of coffee storage facility (avsore): In line with prior expectation, availability of storage was positively correlated with quality of coffee product offered by household farmers. Thus, the odds ratio result of logistic regression shown that, household farmers those have storage facility were more likely to offer good qualified coffee by 0.0598 factors as compared to those have no available storage.

The proportional contributions of household farmers those have no storage to offer quality coffee was smaller compared to those have storage facility in the study area. Additionally, the marginal effect of having storage facility on the quality coffee production showed that, other variables remain constant, farmers those have warehousing increase offering of good quality coffee by 15.491 percent per a year. FAO (2008) stated "that an important recommendation for safe storage is to ensure that products accepted into storage are sufficiently dry (for coffee beans this is around 11-12.5percent moisture content on a dry weight basis)."

Training service (htrain): It refers institutional service provided to household farmers regarding harvest and post-harvest technologies through training and practical showing. It was statically significant less than one percent probability level. It is in line with prior expectation of researcher that the variable has positively related to quality of coffee production.

Other factors remain changed, provision of train service to household farmers increase production of qualified coffee by 27.35percent (which is represented by marginal effect). The empirical result of odds ratio also showed that, other things being the same, trained household farmers were 16.913 factors most likely to produce good qualified coffee as compared to non-trained households. Mulugeta (1999) reported that, technical and institutional support like the extension service determines the adoption of technologies in the rural areas.

4.2.3 Demographic factors

From five demographic factors assessed in the study only one of them (sex of household head) was statistically significant.

Sex of household head (hsex): Sex of household head was statistically significant at less than 1 percent probability level. In lined with prior expectation of the researcher, male farmers were more likely to produce good quality of coffee than female headed farmers. Marginal effect of gender on the production of quality coffee revealed that, other things being the same, production of quality coffee increased by 74.51percent if the head of the household is male.

The odds ratio also showed that, male head household farmers were more likely to produce good quality of coffee by 73.5016 factors as compared to female headed household farmers. The result is similar to statements of Ellis and Mudhara (1995); “female households have less access to improved technologies, credit and extension service.” On the other hand, Anwar (2010) explained that “male-headed households have better access for information than female household heads that helps for adoption of improved agricultural technologies.”

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

Agriculture is the dominant economic sector in Ethiopia. In spite of its importance, poor quality production is the major characteristics of the sector. From cash crops of the country that are offered to domestic and international markets, coffee is the dominant one in terms of foreign exchange earnings. Additionally, coffee is the means of livelihood directly and indirectly for major percentage of the country's population including urban dwellers. The importance from this crop and its performance improve if its quality is improved. However, quality coffee production of the country is deteriorating from time to time and there is a problem of profound assessment works to identify the specific coffee quality determinants in Oromia as a general and in west wallaga zone in particular. Therefore, the study was designated to identify the determinants of coffee quality in the West Wallaga zone of Oromia regional state. In order to meet the objective of the study primary data were used. Cross-sectional types of data were collected from 226 household farmers. Quality of coffee was analyzed by both experimental and survey data by using logistic regression analysis.

5.2 Conclusions

Coffea Arabica is an economically important crop, which is contributing the highest of all export revenues in Ethiopia (Anwar, 2008). Coffee being the major cash crop of the west wallaga Zone, it is produced in all (17) woredas' and serves as a major means of income for the livelihood of coffee farming families.

Despite the favorable climatic conditions and variety of coffee types in this Zone, quality of coffee is poor due to traditional poor harvest and post-harvest practices which are still used by majority of the farmers, where the bulk of the production comes from. Coffee quality is a complex characteristic which depends on so many factors such as environmental conditions (shade, rain, range of temperature), physiological factors, agronomic practices (farm management), and processing systems (post-harvest factors) of the farmers.

But, there is gap on identification of coffee quality problem of west wallaga zone arises from harvest and post harvest managements of farmers. This study was, therefore conducted in the year 2014/15 both by experimental assessment using moisture taster and slender equipments and data tools gathered from the two woredas' of the zone (kiltukara and menesibu) with an objectives of assessing the impact of harvest and post-harvest processing practices on the quality of coffee, identifying the problems associated with coffee processing practices in the study areas, investigating socio-economic factors related to coffee quality and drawing recommendations to alleviate the problems of the zone.

In order to meet the objectives of the study, purely primary data were used. The sampling technique used to select sample size was multistage sampling method in the study area. That means, after selection of two weredas purposely in the first stage, nine peasant associations were selected based on systematic random sampling on the second stage and total of 226 respondents (household farmers) were selected purposely (based on their coffee farm size) at final stage.

On the other hand, for the experimental analysis a total of 9 kebeles' FTC was taken a place where experiment could undertake for a sampled coffee. A binary logit model was employed to determine factors affecting coffee quality. Out of 15 explanatory variables analyzed by the model, seven of them were observed to be significant to affect quality of coffee.

The result of experimental analysis revealed that the average moisture content of sampled kebele was 10.53percent which lies within the range of moisture content required for acceptability of quality and similar to the average moisture content identified by the ARDO. From the assessment result, the moisture content of coffee for the sampled kebeles was similar (has no great difference between kebeles).

In binary logit regression analysis on the raw data obtained from coffee farmers shown that, factors those significantly affect coffee quality were found to be disease prevalence in coffee farms, non-controlling of weed in the coffee farm, compost application on the coffee farm, harvesting stage (harvesting at mixture of red-green stage and at green stage), availability of storage, training service for farmers from ARDO and DAs and sex of household head.

From agronomic and physiological factors prevalence of disease on the coffee farm, method of weed control (non-controlling of weed) and compost applications on the coffee farm were

statistically significant variables. The other variables were harvest and post-harvest factors such as harvesting at mixture of red-green stage, harvesting at green stage, availability of storage facility, training service from institutions, while sex of household head was the only significant variable from demographic factors.

The value of logistic regression Chi-square test shows that overall goodness of fit of the model was at less than one percent probability level. The empirical result showed that, those households' not controlling weeds from their coffee farm were less likely to produce good qualified coffee compared to those who control weed. Other variables remain unchanged, methods of weed control (digging use to control weed and non-controlling of weeds) decrease production of good quality of coffee by 2.313percent.

Additionally, coffee those not infected by disease were more likely to produce quality coffee as compared to disease infected coffee which is similar to the statement of Wintgens (2004); "the disease occurrence can lead to poor quality coffee that gives off and disagreeable odor." It was identified that the most quality and quantity problem related to coffee product in the study area was existence of disease. This observable disease was both on coffee tree and on its beans. The disease on coffee tree makes that tree dried while the coffee bean disease changes its color and falls beans before mature stage. Additionally, the marginal effect of disease observation on the quality of coffee also showed that, other variables remain constant, observation of disease on the coffee tree and or beans decreases farmers' production of good quality coffee by 26.932 percent.

The log likelihood result also shown that compost application by household farmers on their coffee farm has significant effect on the quality of coffee. There are two types of composts. These are organic and non-organic composts. From these two, farmers of the study area use only the organic one in his/her coffee farm. Keeping the influences of other factors constant, household farmers those apply compost on their coffee farm were 0.0269399 factors more likely to produce good qualified coffee compared to non-users of compost. In other way, other variables being constant, its marginal effect indicates that quality coffee production of compost users per a year increased by 79.18 percent than non-users.

One of significant variable from harvest and post-harvest factors was harvesting stage. It is a stage at which coffee beans were harvested. The household farmers of the study area harvest

their coffee at three harvesting (full red stage, mixtures of red-green and at green mature) stages. Two of these (mixtures of red-green and harvesting at green mature) stages were statistically significant. The marginal effect of this variable indicated that, farmers of the study area those harvest at mixture of red-green and green mature stage decrease production of quality coffee by 18.244 percent compared to those harvest at full red mature stage.

The odds ratio of this variable indicates that, other variables remain constant, household farmers those harvest their coffee at a mixture of red-green stage were less likely to produce good qualified coffee by 0.01244 factors as compared to those harvests at full red mature stage. Additionally, all other variables remain unchanged, harvesting at green mature stage by farmers has less likely to produce good qualified coffee by 0.00256 factors as compared to harvesting at full red mature stage. The most common defect in coffee comes from harvesting green coffee (Tirufat, 2011). From the assessment result, qualities of coffee for those are harvested at all red mature stage were better than other harvesting stages.

Additionally, having storage facility is important precondition to offer qualified coffee. The odds ratio result of logistic regression showed that, household farmers those have storage facility were 0.0597959 factors more likely to offer qualified coffee as compared to those have no available storage. In other way, the marginal effect of having storage facility on the quality coffee production showed that, other variables remain constant, farmers those have warehousing increase offering of good quality coffee by 15.491 percent per a year than those have no storage facility.

The last harvest and post-harvest variable statically significant was institutional service provided to household farmers through training and practical showing. The influence of trained and non-trained farmers on coffee quality and production yield were not equal. This was checked from empirical result of assessment. The study identified that, trained household farmers produce good qualified coffee as compared to non-trained households. Other factors remain changed, provision of train service to household farmers increase production of qualified coffee by 27.35percent. The empirical result also showed that, trained household farmers were 15.913 factors more likely to produce good qualified coffee as compared to non-trained households.

Sex of the household head farmer is the only demographic factor statistically significant in the model. The effect of male headed household and female headed household on the quality coffee production was different. For instance, marginal effect of gender on the production of quality coffee revealed that, other things being the same, production of quality coffee increased by 74.51percent if the head of the household is male. This was due to unequal practice and acceptance of new techniques (extension techniques). Even though they have ability they were not active as male on application of new technologies such as pruning and stumping, weed controlling, harvesting before beans fall to the ground and the l

5.3 Recommendations

Based on the data and results of this study the following points are recommended.

1. In the study area, there is a problem related to weed control activity by the household farmers. Even those who control weed uses digging which was not recommended method while others are not engaged in controlling. This may be because of lack of awareness and absence of following the situation of coffee tree from time to time. Most of household farmers also go to coffee forest only to harvest coffee beans. Thus, more active participation and supports of Development Agents (DAs) and Agricultural and Rural development offices (ARDO) of the woreda were required to recall, encourage and enforce household farmers to control weed.
2. Prevalence of coffee disease is the problem of the study area. In the study area, coffee infected by disease has less likely to give acceptable (good) qualified coffee compared to non-infected coffees. Thus, cutting infected coffee before disease is transferred to others and using chemical as well as other medicines once or twice in a year to protect coffee beans is required. They have to change species of coffee after a given (at most 20 year) period of time. Additionally, governments have to find alternative chemicals and medical solutions to alleviate this huge economic problem. Another policy is, disease resistant coffee types must be identified and distributed at low cost to the coffee suppliers.
3. Household farmers of the study area have awareness problem to apply (use) compost in their coffee farm. This is because of lack of habits to use compost for coffee rather it was only for other gardens near houses. But, the result of this study revealed that, quality coffee produced by

household farmers those do not apply compost on their coffee farm was smaller as compared to compost applicators.

Therefore, more application of organic composts such as plant residues, husks, garbage's from houses and industries (near town) were required. Habit of using inorganic composts such as fertilizers in the coffee farm should be developed. Strong institutional training is required. Experimental and practical land reserved for coffee farm must be established and expanded in all rural areas. Additionally, inter-cropping is important to coffee since coffee gets inorganic minerals which was another alternative to increase production yield, quality and also serve as weed controlling method.

4. Coffee quality deterioration of the study area was related to harvesting stage of coffee beans. Huge numbers of household farmers harvest their coffee at a mixture of red-green mature stage. However, harvesting before full mature stage (at a red-green mixture and green stage) decrease quality of coffee by increasing defect per gram and giving black color of its bean. Due to this, farmers should have to harvest their coffee three times (rounds). First, only full red beans must be selectively collected by leaving green mature and immature beans. Secondly, after a while the green mature became full red those must be harvested and the previous immature is now on green mature stage. At last, the remained coffee beans should be collected after they become full red mature stage. Additionally, there must be rule and regulation transferred to farmers at a time of training for those harvest before full red mature stage.

5. Most of the household farmers have no available storage to keep quality of coffee. They simply put within their house even around washing hand and others put a sun place that declined quality of coffee. Therefore, each and every farmer must have specified and qualified storage service.

6. Even though most of household farmers were trained some of them were left untrained. The trainers must convince them systematically by creating difference between trained farmers and non-trained farmers. Trained farmers should have to get subsidy in order to attract others. Another policy is, Door-to-door training should be available. Coordinating according to their relationship is also another way of solution.

7. Quality of coffee for male households and female households in the study area were different. Male head has more likely to produce good quality of coffee compared to female head households. This is may be due to inequality in activities of labor force such as constructing raised bed, controlling weeds, harvesting at full red only, applying compost in coffee farms and the likes which also differentiates their marginal productivity.

Great impact of sex difference on quality of coffee production must be solved or declined by the following measures: Women households must be included in the controlling and following coffee quality of their relatives and surrounds. Special subsidy provision should be given by the government to female households those produce qualified coffee to attract others. ‘Special labor-support program’ must be created for female household head during harvest season by surrounding male household farmers through training supports of Development Agents (DAs).

Generally, the coffee quality problem of the study area is at the farmers’ level. But, the government gives more attention to measure and test at the woreda (traders or processors) level. Therefore the overall recommendations that affect all variables are: The governments have to establish coffee quality measures and tasters at the rural farmers’ level either by hiring permanent worker or creating an organization. Price-quality relation must be established for coffee suppliers. That means, household farmers those who produce good qualified coffee must get higher price.

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APPENDICES

Appendix 1

Questionnaires used to collect data instruments from respondents

I. Demographic information

- 1.1. Name of farmer _____
- 1.2. Woreda _____ Kebele/PA _____
- 1.3. Sex of Household head A. Female headed household B. Male headed household
- 1.4. Age of Household head A. ≥ 35 year, B. < 35 year
- 1.5. Family size A. ≥ 4 family member B. < 4 family member
- 1.6. Educational status of Household head A. literate B. Illiterate

II. Farm practices (physiological and agronomic)

- 2.1. In which range of age most of your coffee trees find?
A. < 20 B. ≥ 20
- 2.2. Do you stump/ prune your coffee tree?
A. No B. Yes
- 2.3. Is weeds are prevalent in your coffee farms?
A. No B. yes
- 2.4. What types of weeds are observed in your coffee farm?
A. Soft weeds B. Coach grass C. pennarial weeds D. others _____
- 2.5. What kind of mechanism do you use to control weeds?
A. Slashing tools B. Hand weeding C. digging D. inter- cropping E. I don't control
- 2.6. Do you apply compost to your coffee farm? A. No B. Yes
- 2.7. Is your coffee farm far away from your house? A. No B. yes
- 2.8. Do you observe any disease on your coffee tree and beans?
A. No B. Yes

III. Post-harvest practices

3.1. At which fruit maturity stage do you harvest your coffee for sale?

A. Full red mature stage B. mixtures of red-green mature stage C. Green mature stage D. Immature stage.

3.2. Who often harvest your coffee? A. Own family B. Daily laborer C. both

3.3. Where do you dry your coffee? A. On cemented floor B. On wooden bricks, mesh wire and bamboo made bed C. ground.

3.4. What type of bag do you use for coffee packaging? A. Jute bag B. non-Plastic bag C. Clay pot/kukula.

3.5. Do you have storage house for your coffee to store? A. Yes B. No

3.6. If you have storage in which of the following it is included?

A. cemented B. raised beds C. ground

3.7. How long do you keep your coffee in store before offering to market?

A. < 4 months B. > 4 months

3.8. Is there training and other supports from ARDO or agricultural Extension agents? A. Yes B. No.

3.9. Do you mix differently harvested coffee while selling? A. No B. Yes

3.10. Do you have time constraint during peak coffee harvesting period?

A. No B. Yes

3.11. What type of coffee harvesting practices do you use during coffee harvesting? A. Selective picking B. Strip method C. From the ground

D. others _____

3.12. Do you sell coffee before price announcement? A. yes B. No

3.13 Where can you sell your coffee? A. At my house to small collectors B. In the legal local market

3.14. How price of coffee changes in your local market?

A. increasing B. decreasing C. conditional (unstable)

Appendix 2

Table 4.1 Frequency and proportional distribution of coffee quality assessed for household farmers of the study area

quality of coffee	Frequency	Percent	Cumulative percent
Poor/unacceptable quality	74	32.74	32.74
Good/acceptable quality	152	67.26	100.00
Total	226	100.00	

Source: computed from own collected data, 2015

Table 4.7 Frequency, proportional distribution and association (chi-square) of coffee quality with compost application on the coffee farm by household farmer

Quality of coffee	Compost application of farmers on coffee farm						X ²	p-value
	Non-users		Users		Total			
	Frequency	Percent	Freq.	Perc.	Freq.	%		
Poor quality	71	31.41	3	1.33	74	32.74	0.8676	0.3520
Good quality	141	62.39	11	4.86	152	67.26		
Total	212	93.80	14	6.19	226	100		

Source: computed from own collected data, 2015

Table 4.11 Frequency, proportional distribution and association (chi-square) of coffee quality with availability of storage for household farmers

Quality of coffee	Availability of storage for household farmers						X ²	p-value
	No store		Store exist		Total			
	Frequency	Percent	Frequency	%	Freq.	%		
Poor quality	69	30.53	5	2.21	74	32.74	0.5974	0.440
Good quality	137	60.62	15	6.64	152	67.26		
Total	206	91.15	20	8.85	226	100		

Source: computed from own collected data, 2015

Variance Inflation Factor (VIF) test of multi-collinearity

Variable	VIF	1/VIF
Age of coffee tree	1.46	0.686872
Observation of disease	1.42	0.706504
Weed prevalence	1.28	0.779677
Methods of weeds control	1.13	0.884957
Pruning and stumping	1.08	0.925092
Compost application	1.15	0.869105
Harvesting stage	1.60	0.626138
Types of drying materials used	1.53	0.652507
Types of packing materials used	1.47	0.679002
Storage facility	1.25	0.797453
Training service	1.55	0.644967
Sex of household head	1.12	0.889422
Age of household head	1.66	0.600973
Family size	1.09	0.915860
Educational status	1.20	0.835566
Mean of VIF	1.33	

Source: computed from own collected data, 2015